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STUDY GUIDE

RIGGING

Basic to Advanced

This booklet is the property of:	

Review Log

Version Number	Date Updated	Details of Updates	Reviewed by	Authorised By
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Preface

This study guide has been developed to serve as 'Refresher' tool for Candidates who already hold the High-Risk Work Licence for the units and are required to undertake a Verification of Competence (VOC) for the HRW classification. The information contained may assist with completing the Theory component of the VOC.

Introduction

Rigging is work involving the use of mechanical load shifting equipment and associated gear to move, place or secure a load including plant, equipment or members of a building or structure and to ensure the stability of those members and the setting-up and dismantling of cranes and hoists.

There are four certificate levels involved in rigging:

- Dogging
- Basic rigging
- Intermediate rigging
- Advanced rigging.

This guide outlines the competency-based skills needed to carry out basic, intermediate and advanced rigging safely. Basic rigging incorporates the skills needed for dogging.

Basic rigging

Those qualified in basic rigging must know how to carry out work associated with:

- Movement of plant and equipment
- Steel erection
- Particular hoists
- Placement of pre-cast concrete
- Safety nets and static lines
- Mast climbers
- Perimeter safety screens and shutters
- Cantilevered crane loading platforms

Intermediate rigging

Those qualified in intermediate rigging must know how to carry out work associated with all basic rigging competencies and:

- The rigging of cranes, conveyors, dredges and excavators
- All hoists
- Tilt slabs
- Demolition
- Dual lifts

Advanced rigging

Those qualified in advanced rigging must know how to carry out work associated with all basic and intermediate rigging competencies and:

- The rigging of gin poles and shear legs
- Flying foxes and cableways
- Guyed derricks and structures
- Suspended scaffolds and fabricated hung scaffolds

Legal Obligations

Cape Australia Onshore Pty Ltd will at all times abide by the principles of access and equity to persons regardless of cultural background, gender, sexuality, disability or age. Cape Australia Onshore Pty Ltd shall endeavour to solve all matters of appeal, grievance or complaint nature to a satisfactory conclusion and have an established process for complaints and appeals.

If required, Cape Australia Onshore Pty Ltd shall provide a service to support the language, literacy and numeracy skills of a participant and shall provide a flexible learning strategy to suit the participant's specific needs.

Cape Australia Onshore Pty Ltd will at all time when engaged in assessment practices, conduct assessments to the Australian Skills Quality Authority (ASQA) standards. Additionally, these assessments shall be of a high quality to satisfy the requirements of the relevant training packages and the level of competence expected within the relevant industry domain.

Cape Australia Onshore Pty Ltd, applies the principles of assessment based on the 'rules of evidence' - validity, reliability, fairness and flexibility.

All forms and policies shall be made available through the course Facilitator or Cape Australia Onshore Pty Ltd, Management upon request for the perusal of the course participant.
Comments or suggestions for the improvement of this Training Manual are welcomed and made in writing.

Disclaimer

This study guide provides information to those who have previously achieved competence in the High Risk Work Licence Unit, however are required to undertake a Verification of Competence (VOC) and may need revision in areas of learning.

The guide was developed by Cape Australia Onshore Pty Ltd, and while every effort has been made to ensure that these materials are accurate, Cape Australia Onshore Pty Ltd accepts no responsibility for loss or damage resulting from any omissions or inaccuracies.

SECTION 1 - General Rigging Principles

1.1 Flexible Steel Wire Rope

Flexible steel wire rope (FSWR) is the link between the crane and the load.

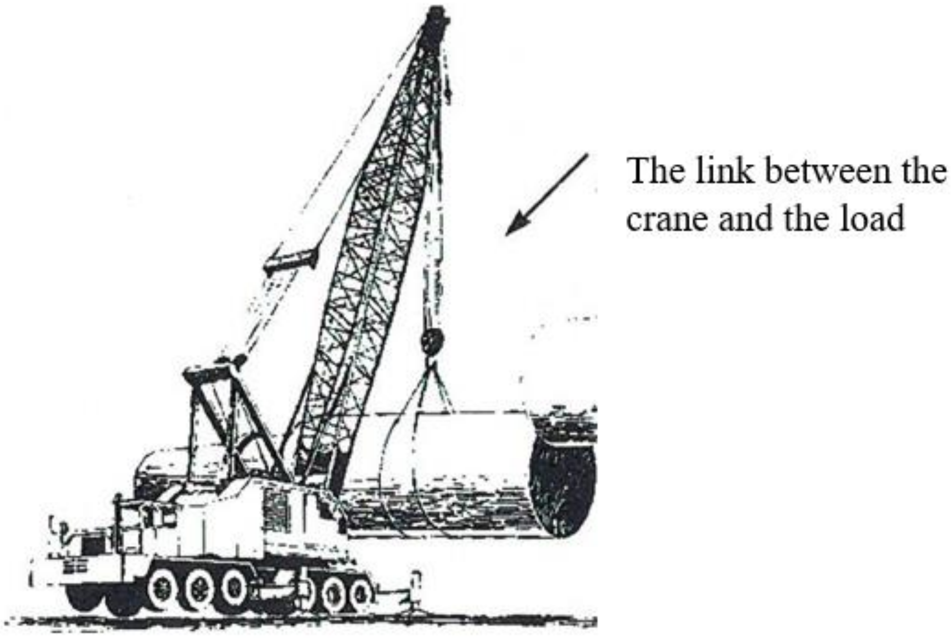
The hoist drum of the crane is the pulling mechanism which rotates, hauls in and stores surplus wire. The braking mechanism is connected to either the drum or the gearing which is joined to the drive mechanism.

The wire passes over the head sheave of the crane and then down to the load.

There are many different types of lays and construction of FSWR to combat fatigue and abrasion, the two destructive forces which occur whenever FSWR is bent over a system of sheaves.

Wire flexes as it bends over sheaves and drums. As the wire bends over the sheave fatigue takes place.

The outer wires are stretched, and the inner wires are crushed against the sheave groove or drum.



Wire never lays straight into the groove of a sheave because the load swings slightly or the rope vibrates. This causes friction or abrasion between the side of the sheave and the wire, wearing the outer wires of the strands.

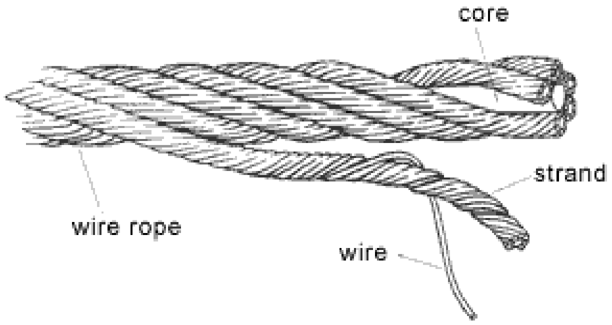
Flexible Steel Wire Rope — Lays and Construction

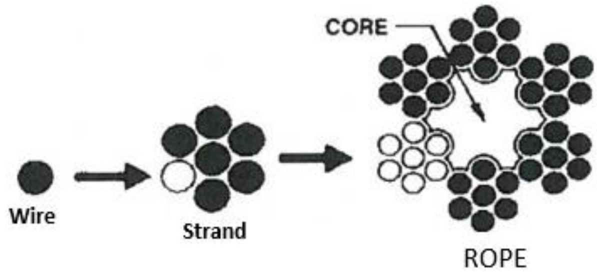
FSWR is constructed of wires and strands laid around a central core. In the illustration below there are 19 wires to the strand and 6 strands around the core making up the rope.

It is important not to confuse wires and strands. If a strand is broken, the rope is unusable. A single broken wire in a sling is not as important unless broken immediately below a metal fitting or anchorage.

6x19 Construction FSWR

Composition of Wire Rope





The core can be:

- Fibre Core (FC)
- Independent Wire Rope Core (IWRC)
- Plastic Core (PC)

The tensile strength of wire ranges from 1220 megapascals (MPa) to 2250 MPa. The most commonly used tensile strengths are 1770 MPa and 1570 MPa.

A 6/19 (six strands of 19 wires each) is the minimum FSWR construction that can be used for slings.

The size of a rope is determined by its diameter. The smallest diameter FSWR that can be used for lifting is 8mm.

Lay is the direction the wires are formed into strands and the strands are formed into the finished rope.

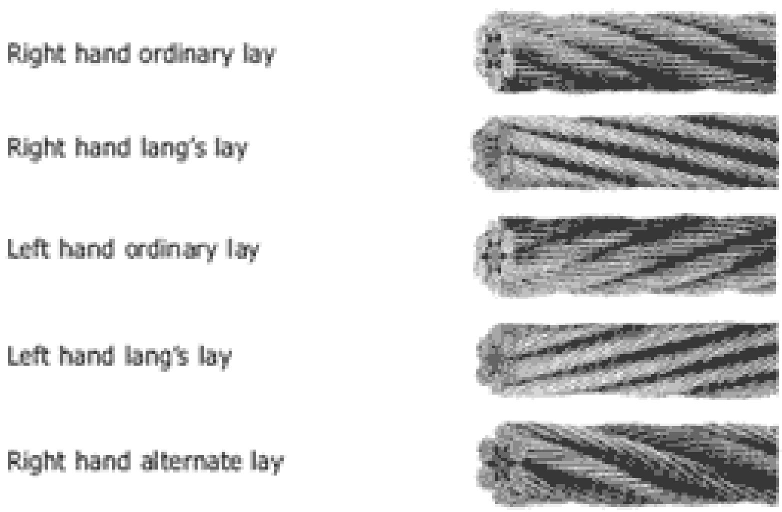
The strands can be laid either left or right around the core. In left hand lay the strands are laid anti-clockwise and in right hand lay they are laid clockwise.

Ordinary lay is where the wires are laid in the opposite direction to the strands.

Lang's lay is where the wires are laid in the same direction as the strands.

There is therefore:

- Right hand ordinary lay - RHOL
- Left hand ordinary lay - LHOL
- Right hand Lang's lay - RHLL
- Left hand Lang's lay - LHLL



Lay does not affect the working load limit of the rope but it does determine characteristics such as the spin of the rope.

Lang's lay is used where both ends are fixed to prevent rotation such as for luffing. It must not be used for lifting. (Inspection for bird caging at the anchorage point must be done regularly.)

Most general-purpose ropes are right hand ordinary lay.

Pre and Post Forming

Flexible steel wire ropes that are used as crane rope and for slinging are either pre- or post-formed.

Pre-formed ropes have the spiral (helix) put in the individual wires before the wire is laid into the strand.

Post-formed ropes are put through a series of off-set sheaves to bend the spiral into the individual wires after the rope is laid into the strand.

Both pre-formed and post-formed ordinary lay ropes are more resistant than unformed, or Lang's lay to unlaying when cut.

Lang's Lay FSWR

Lang's lay is more flexible and harder wearing than ordinary lay ropes. It is used as excavator, dragline, and pile driving ropes where severe abrasion occurs. It is harder wearing because more of the individual wires are exposed to the sheaves.

Lang's lay has a tendency to unlay if it is used as a single fall crane rope because both wires and strands are laid up in the same direction into the rope. Pre- and post-forming make the rope easier to handle but it will still unlay under load.

Ordinary Lay FSWR

Ordinary lay ropes are used extensively for slinging.

They are more resistant to unlaying and have less wire exposed to sheaves because of the opposite spiral. They are also more resistant to crushing and kinking because of the very short length of exposed wires.

Ordinary lay ropes are less resistant to abrasion than Lang's lay.

Left Hand Lay FSWR

A manufacturer may make up a FSWR with left hand lay strands on request. Left hand lay ropes are usually made for a special purpose. They will kink and twist when laying up into a purchase or system of sheaves if they are not laid up in the opposite direction to right handed lay.

Non-Rotating Ropes

Under load all FSWR’s have a tendency to unlay including pre- or post-formed and ordinary or Lang's lay.

To prevent unlaying a left hand lay rope is layed inside a right hand lay rope. This is called a non-rotating ordinary lay rope and is usually used as crane rope. Under strain the opposite spiral in both the inner and outer layers are counter balanced and the rope does not twist.

Core Slippage

Non-rotating ropes require careful handling. If the outer strands slip or unlay slightly the core will protrude from the end of the rope. This is called core slippage.

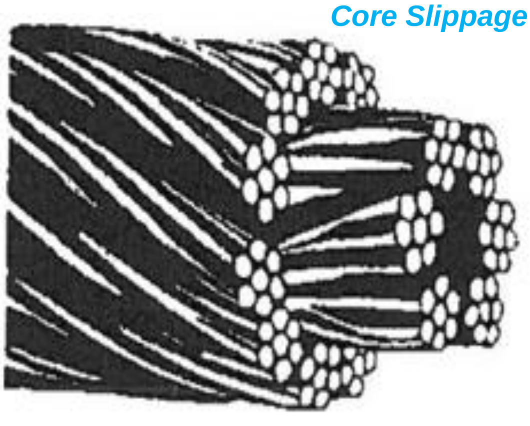
Core slippage can occur if the ends of the rope are not properly whipped before making a cut. Whippings of annealed wire must be put on either side of where the cut is to be made.

The whippings should be put on with a serving mallet very tightly for a distance of at least 1 to 2 times the rope diameter each side of the cut for ropes to 24mm diameter and 4 times for ropes over 24mm diameter.

Core slippage can occur as a wire is rope around a thimble for splicing. The outer wires may 'birdcage' or open up as the rope is bent around the small diameter thimble. It is preferable to use large diameter thimbles.

The rope should be tightly served (bound) with marlin or spun yarn for the distance of the length around the thimble, plus twice the length of the annealed wire flat throat seizing.

Core Slippage



The seizing should be put on both parts of the rope immediately after securing the thimble into the served eye of the rope. The length of the throat seizing should be equal to at least 3 times the rope diameter.

Severe core slippage can occur when bending non-rotating ropes into wedge socket anchorages due to the small radius of the wedge.

If a wedge socket is used on a non-rotating hoist fall the rope should be frequently inspected.

Handling

Non-rotating ropes are counter balanced to stop the tendency to twist or spin either way. However, they are very pliable and bad handling can put turns into the rope.

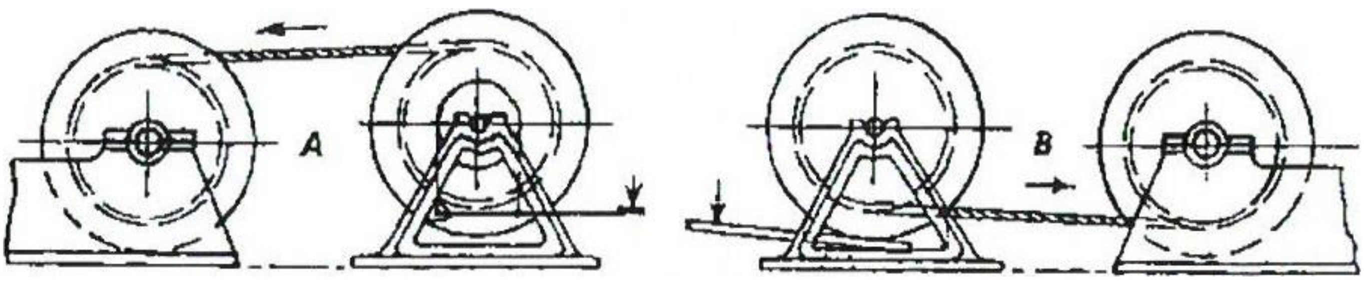
As turns are put into a rope the outer strands become shorter and the inner core slips along and protrudes from the end and the outer strands bulge into bird caging. The inner core therefore takes all of the load and may break.

Non-rotating ropes can be used successfully as single and multi-fall crane hoist ropes. However, bird caging at the anchorage is a common fault when they are reeved up as luffing ropes.

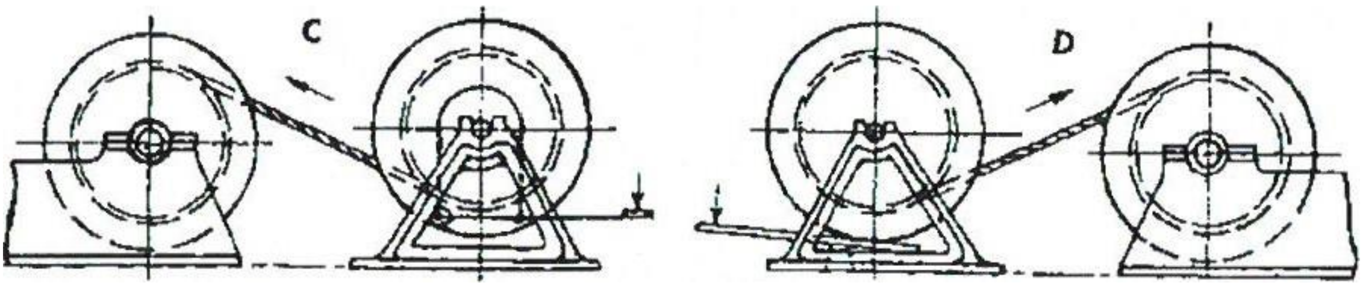
Installation

There is a danger of kinking or putting turns into the uncoiled rope when uncoiling it from the manufacturer's spool or reel.

Correct Re-reeling of Ropes



Incorrect Re-reeling of Ropes



If a loop forms in the slack rope a kink will form as the rope is drawn tight, or wound on to a drum. Therefore, this section of the rope should be discarded.

Mount reels or spools onto a shaft so that the reel will revolve when the rope is pulled off. Care should be taken to brake the spool to keep tension on the rope as it is removed.

Non-rotating Constructions

Three common multiple strand, non-rotating ropes are:

- 17 x 7 N.R — 11 (strands) of (6/1) over 6 (strands) of (6/1) over hemp core.
- 18 x 7 N.R — 12 (strands) of (6/1) over 6 (strands) of (6/1) over hemp core.
- 34 x 7 N.R — 17 (strands) of (6/1) over 11 over 6 of (6/1) over hemp core.

Non-rotating ropes prevent spin in nearly all circumstances.

Construction Types

Traditionally, round strand Lang's and ordinary lay FSWR have been constructed of:

- 6 strands of 19 wires (6 X 19)
- 6 strands of 24 wires (6 X 24)
- 6 strands of 37 wires (6 X 37)

Four strand ropes are also being used in newer cranes and hoists which have the same number of wires as six and eight strand ropes.

Most FSWR are parallel or equal laid with the inner wires in the strand laid in a longer spiral so that the top wires do not cross the inner wires.

To prevent a different spiral in the inner and outer wires of strands and to obtain parallel lay, different size wires are laid into the same strand. The standard constructions which use this method are:

1. Seale
   Large diameter wires are laid up on the outside and smaller wires are laid up on the inside over a central core wire. The large wires resist abrasion and the small wires give flexibility.

2. Warrington
   Alternative large and small wires are laid up on the outside of the strand combining flexibility and resistance to abrasion.

3. Filler
   A number of wires are laid over a central wire and an equal number of very small wires are laid in the valleys of these wires. Larger wires are then laid in the valleys between the large and small wires. Seale and Warrington, and Filler and Seale have been combined to make 'Warriflex' and 'Seale-Filler' which both have greater flexibility combined with resistance to abrasion.

Rope inspection

When inspecting ropes inspect the whole system not just the FSWR. Ropes can be affected by:

- Physical and mechanical factors such as abrasions, fatigue, reverse bends and so on
- Environmental conditions such as the weather, salt air, freezing conditions, extreme heat, steam, acid vapours, dust and so on

1. Mechanical damage due to rope movement over sharp edge projection whilst under load.

2. Localised wear due to abrasion on supporting structure. Vibration of rope between drum and jib head sheave.

3. Narrow path of wear resulting in fatigue fractures, caused by working in a grossly oversize groove, or over small support rollers.

4. Severe wear in Lang's lay, caused by abrasion at cross-over points on multi-layer coiling application.

5. Severe corrosion caused by immersion of rope in chemically treated water.

6. Typical wire fractures as a result of bend fatigue.

7. Wire fractures at the strand, or core interface, as distinct from 'crown' fractures, caused by failure of core support.

8. Typical example of localised wear and deformation created at a previously kinked portion of rope.

9. Multi-strand rope 'bird caged' due to tortional unbalance. Typical of build-up seen at anchorage end of multi-fall crane application.

10. Protrusion of IWRC resulting from shock loading.

Broken Wires

As the rope lays into a sheave friction occurs and the outside of the wires wear and become flat. Lang's lay ropes are much less prone to outer wire wear than ordinary lay.

As outer wires wear, and the wire rope is bent over sheaves the fatigue will start to break them.

The maximum number of broken wires allowed in a FSWR is 10 per cent of the total number of wires over a length 8 times the diameter of the rope.

For example: 25mm diameter / 6 x 19 Seale.

Diameter = 25mm

25 x 8 = 200mm length

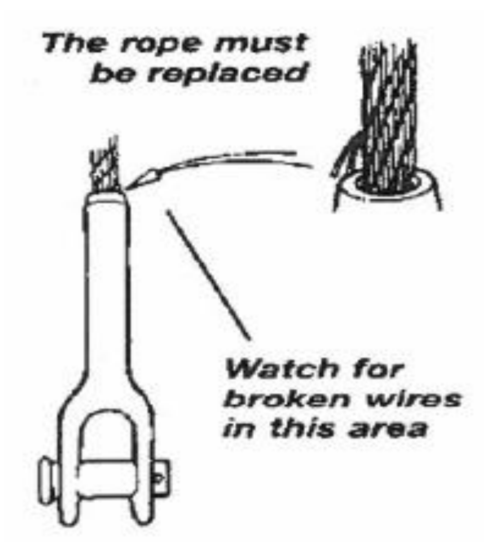
Total wires in 6 x 19 = 114 wires

10 per cent of 114 = 11.4 wires

Maximum number of broken wires allowed in a length of 200mm
= 11

Condemn any FSWR showing broken wires in the valleys between the strands (an indication of extreme fatigue).

Condemn a FSWR where there is one broken wire at the start of any anchorage. This is a sign of localised fatigue.



Crane or luffing pendant ropes should be checked for broken wires. Although they do not pass over sheaves they are subject to fatigue due to vibration.

If there are three or more broken wires in eight rope diameters the pendant should be inspected by a rope expert.

External wear on the individual wires is caused by friction on drums and sheaves.

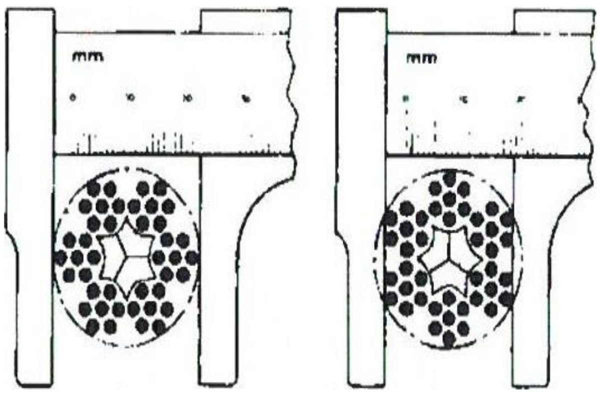
Where the rope diameter has reduced to 85 per cent or less of the original diameter, the rope should be discarded even if there are no broken wires.

Fibre rope cores can be crushed and broken if the rope is bent over sheaves while the core is frozen. Under these conditions the FSWR can eventually lose its shape with serious internal corrosion.

When first reeved up and put to work a wire will show considerable wear because it is 'bedding in' to the sheave and drum grooves. After bedding in the outer wires will slowly continue to wear and the wearing surface will increase, although on crane ropes the rate of wear will slow down. Consider condemning FSWR when wear on the individual wires starts to exceed one third of their original diameter.

Before re-roping a thorough inspection should be made of the whole sheave system with special attention given to the sheave and drum grooves. A sheave which has been damaged by a previous rope will seriously damage a new rope.

Reduction in Diameter



CORRECT METHOD ***INCORRECT METHOD***

The anchorage should be inspected. One broken wire at an anchorage condemns the rope at that point.

Also check for:

- Cracks
- Chafing of wires
- Worn pins
- Worn clevises
- Worn thimbles
- Corrosion/rust
- Crushed or jammed strands especially where the rope may have jumped off the sheave and jammed between the sheave and cheek plate
- Wear on the outside wires when the individual outside wires are worn to more than one third of the original diameter
- Bird caging in Lang's lay or non-rotating ropes especially at the anchorage
- Overloading which can usually be seen by the elongation of the lay (a normal lay takes approximately 8 diameters for a complete spiral)

Handling New Rope

When a new rope is ordered it is essential that the manufacturer's recommendations regarding length, lay, construction and diameter are followed. If this is not done the life of the rope can be severely reduced.

Laying onto a Drum

The new rope should be delivered on a spool. Set up a spool so that the rope runs from the top of the spool to the top of the drum, or from the bottom of the spool to the bottom of the drum.

If a new rope is delivered in a coil, a turntable should be rigged up to run the rope onto the drum. A coil of rope must not be laid on the ground and wound straight onto the drum otherwise there will be severe twisting and kinking of the rope.

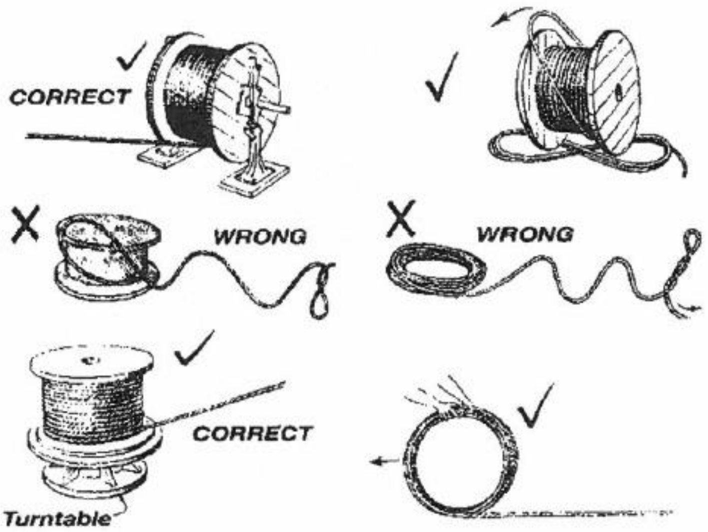
Do not take rope off one side of a reel laid flat on the ground as a loop because a kink may be produced from each wrap of the rope taken.

The whole cross section of the rope must be held solid when bolting or securing hoist or luff ropes to winch drum anchorages. If a rope is not completely secured the inner strands can pull out leaving only the outer strands secured at the anchorage.

It is preferable to make some form of gripping mechanism to keep the rope tight as it is wound onto the drum. Two pieces of 100mm x 50mm timber bolted either side of the rope and secured to the head of the boom can be used. The bottom layers of the rope must be tightly and neatly laid onto the drum.

The bottom layers on multiple layered drums must be laid on correctly. If they are not, the lead rope will jam in between lower layers under a heavy load causing condemnable defects in a new rope.

When laying the rope onto an ungrooved drum, use a mallet or a piece of timber (to prevent damage to FSWR) to tap the turns together as they wind onto the drum to ensure that there are no gaps between the lays.



Wire Rope: Method of uncoiling

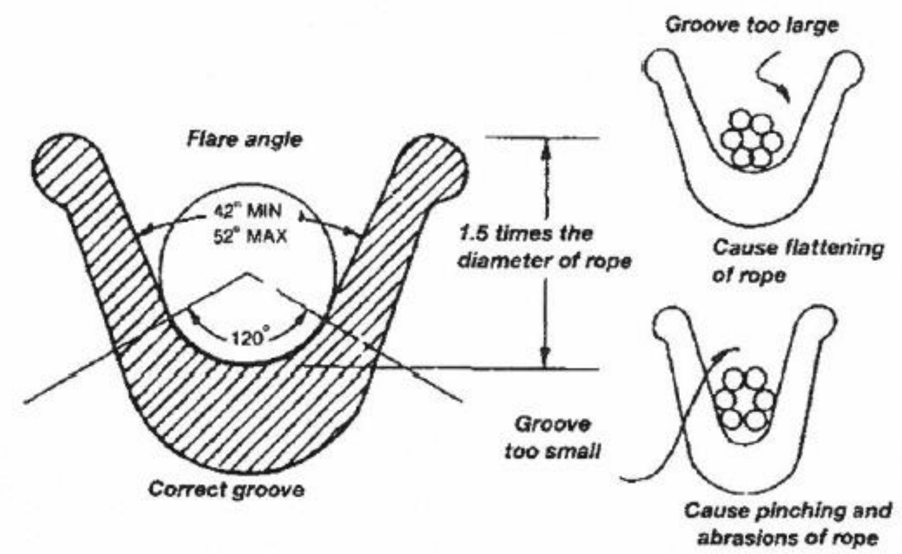
1.2 Winches, Sheaves and Purchases for Flexible Steel Wire Rope

Sheaves

Sheaves lead the rope over the head of cranes and hoists and are used in pulley systems to gain a mechanical advantage.

Flare angle and groove depth

The groove depth of a sheave when using FSWR should not be less than 1.5 times the rope diameter. However, if the rope is positively prevented from leaving the groove the minimum depth of the groove can be equal to the rope diameter.



The sheave groove sides should have a flare angle of a minimum of 42 ^{0} and a maximum of 52 ^{0}.

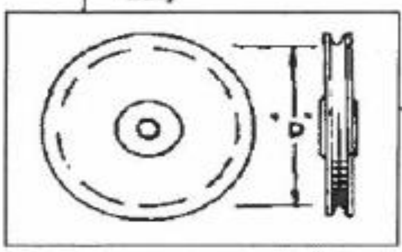
The grooves should be slightly larger than the nominal diameter of the rope. Grooves which are too large will flatten the rope. Grooves too small will pinch the rope and the extra friction can cut it to pieces.

Sheaves should have a smooth finish with flared edges which are rounded off.

Sheave Diameters

The table below gives sheave diameters and safety factors for types of work:

Duty	Classification	Type of work	Ratio to rope diameter			Safety factor	
			Drum	Sheave	Equaliser Sheave	Reeved	Other
Light duty	M1	Manual lifting with a chain block or 'one off' installations	11.2	12.5	11.2	3.15	2.5
Medium duty	M5	Normal use such as operation of a mobile crane	18.0	20.0	14.0	4.5	4.0
Heavy duty	M8	Continuous operation such as EOHT crane in steel prod. or a tower crane on building site.	25.0	28.0	18.0	9.0	5.0



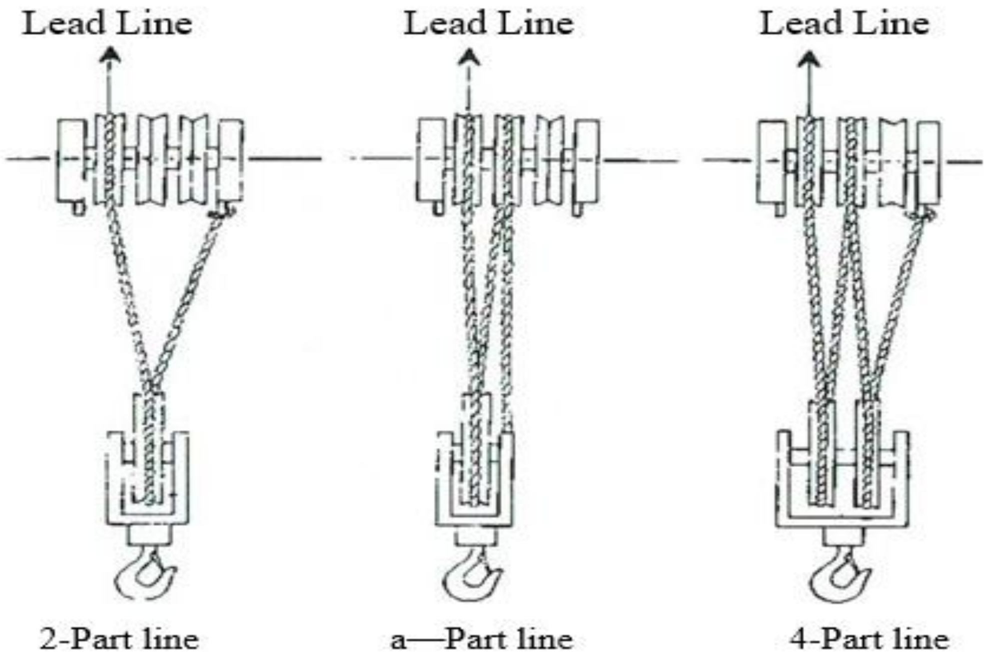
Caution: Modern cranes and hoists are complex engineering equipment, and many have special construction luff and hoist ropes. It is essential that the sheaves which were designed for a particular crane or hoist are used for that purpose.

It is also essential that when a rope is replaced, the replacement is the same diameter and construction and that the sheave system is thoroughly checked to ensure that any damaged or worn grooves likely to ruin the new rope are repaired or replaced.

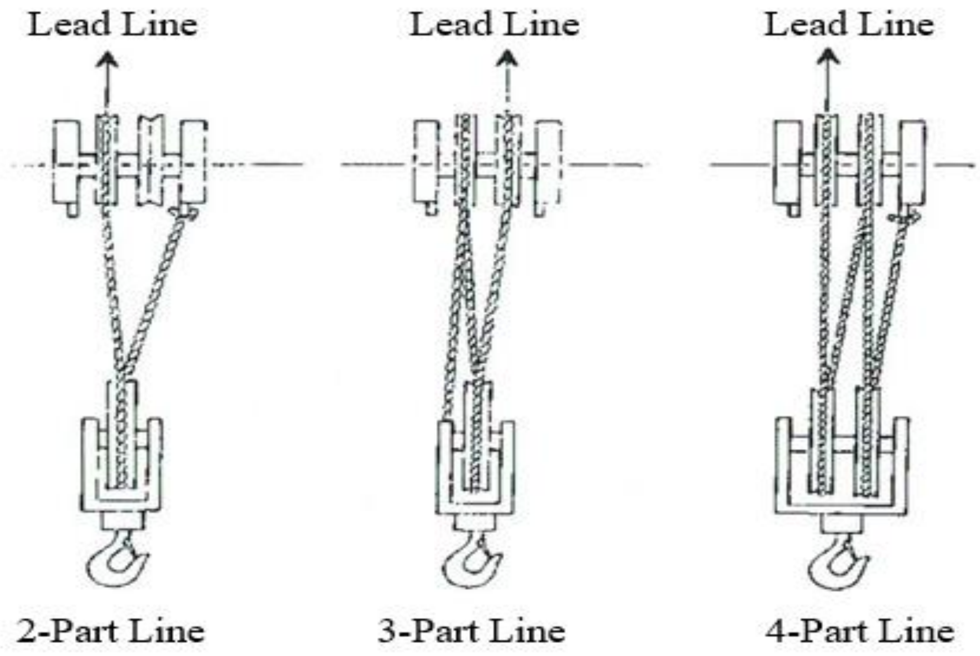
Reeving

Large capacity cranes have several parts to the main hoist fall, making the main hook very slow.

When reducing the number of parts to give a faster hook ensure that the falls are not reduced from one side of the boom head sheaves and the main hoist block.



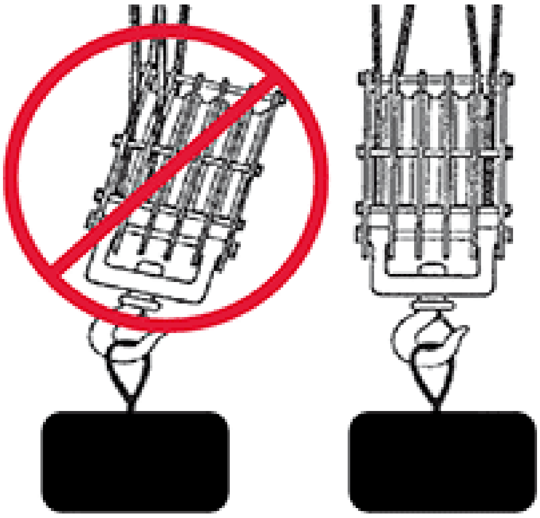
3 Sheave boom point



2 Sheave boom point

Otherwise rotational torque can develop on the boom head exerting side pull on the main hoist block. When reducing parts, the rope must be reeved again to ensure that there are an equal number of parts either side of the boom head and the main hoist block.

The number of parts must be capable of supporting the load to be lifted. A fast hook must still be a safe hook.



Unsymmetrically reeved blocks will tilt under heavy load

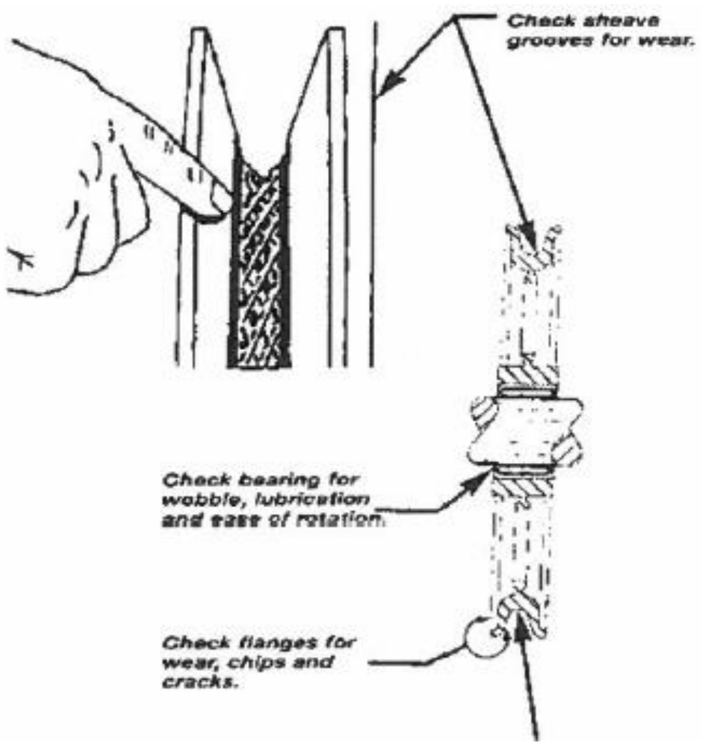
Inspection

Sheaves should be inspected regularly. Pay particular attention to the sheave groove and flange.

Any cracks or chips on the flange can cut the rope as it lays into the groove.

The groove should be checked for wear that will result in the reduction of the groove diameter and give an uneven bearing surface for the rope.

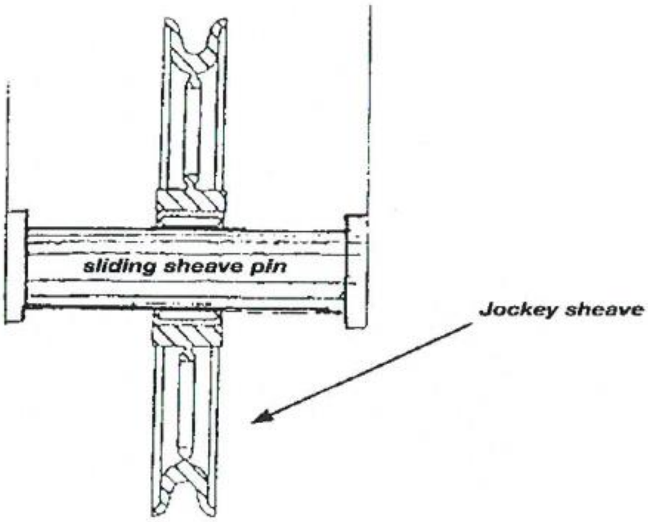
All sheaves should be checked for lubrication. Badly lubricated sheaves cause extra friction in the system and wear on the sheave pin and bearing.



The pin should be prevented from rotating with the sheave. Some sheave pins only have a small cotter pin which fits into a recess on the cheek plate. The cotter pin sometimes shears and allows the pin to turn with the sheave. Rotating pins are dangerous as they turn and can cut through the cheek plate.

A 'jockey sheave' is sometimes used as the first diverting sheave to reduce the fleet angle.

This sheave fits on an extended pin to allow it to slip from side to side reducing the fleet angle. The jockey sheave pin should be kept well-greased and free from grit and dirt to allow the sheave to slide across the pin.



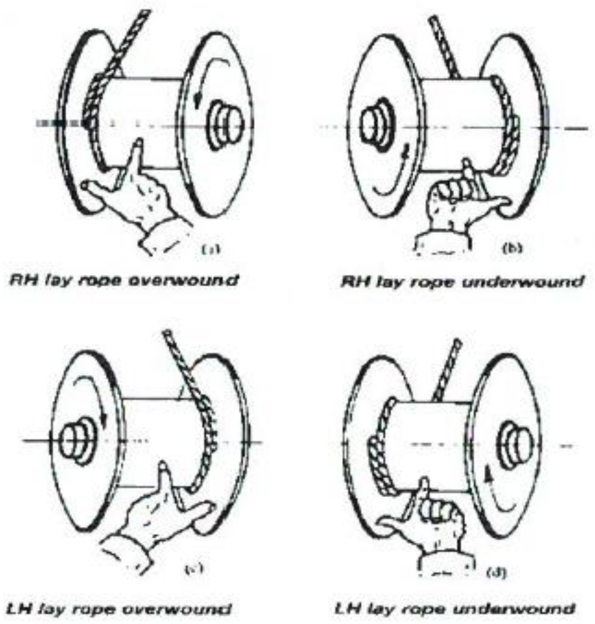
Drums

Drums are the pulling mechanism which rotates, hauls in and stores surplus wire. The braking mechanism is connected to either the drum or the gearing which is joined to the drive mechanism.

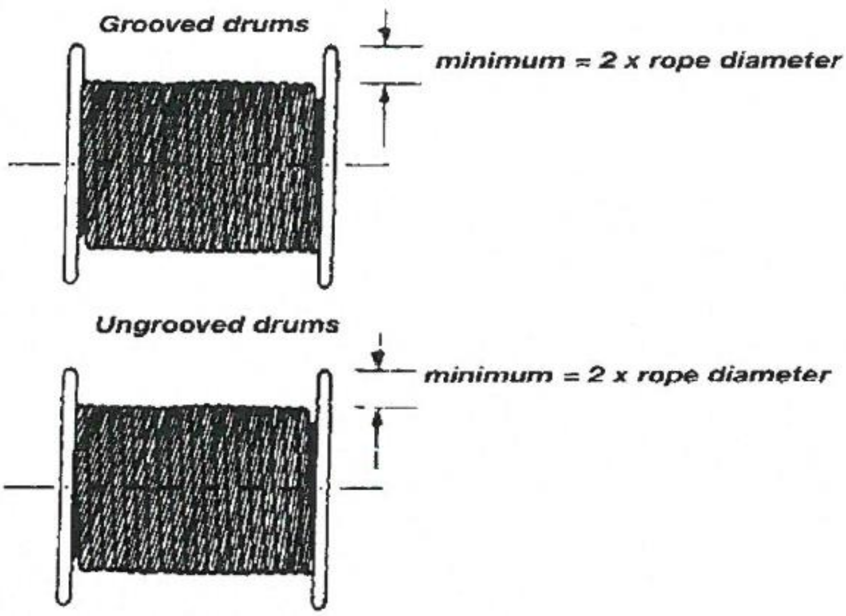
Drums are measured from the centre to the inside of the flange. A drum which measures 1m from flange to flange is therefore a 0.5m drum.

The rope should lay neatly on the drum and not be bunched up. There should be a minimum of two full turns on the drum at all times.

The rope must be anchored to the drum with a fixed mechanical anchorage. Be aware of the danger of not properly tightening an anchorage. Do not rely on the frictional grip relayed by the two turns on the drum (Reference AS1418.1-2002).



Drum Capacity



Comply with the crane manufacturer's recommendation about whether drums are overwound or underwound. If a drum is wound up incorrectly it can affect the anchorage, brake and drive mechanism to the drum, resulting in mechanical failure.

The lay of the rope and whether the drum is over-wound or under-wound determines where the rope is to be anchored.

Be especially careful when raising very heavy loads to a great height such as with long boom mobile cranes. The amount of turns on the drum determines the drum diameter. As the diameter increases the torque to the drive mechanism and brake increases. As a result, the higher the load is raised the faster it is raised, and the more difficult the load is to control.

Operators should ensure that the hoist brake is adjusted to take the extra torque when the load is raised to its maximum height. A brake which holds the load near the ground may fail when the load is high.

The top layer on a multi-layered drum must not be closer than two rope diameters to the top of the flange when the drum is full.

Multiple Layers on Drums

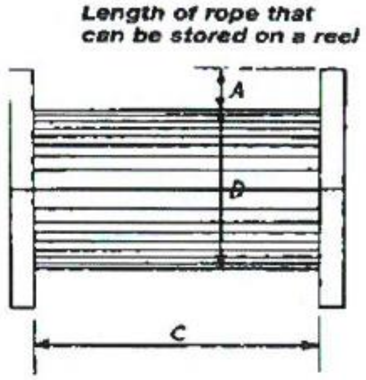
If a load is to be lifted to a height where multiple layers must be layed onto a drum, there are several safety precautions that should be taken.

Independent steel wire cored ropes should be used to prevent crushing. Do not use 6/37 construction ropes because the small wires will suffer badly from crushing.

The drum must have the capacity to take the amount of rope. The bottom layers must be tightly and neatly laid onto the drum.

In the absence of any test certificate it must be assumed that the rope is made from 1570 MPa and the safe working load should be calculated accordingly.

The Capacity of Drums and Storage Reels



Rope storage reels

There is a rule of thumb formula for determining the amount of rope that can be stored on a storage reel. This formula can be used when determining whether the winch drum has sufficient capacity to take the amount of rope needed in a purchase.

<u>Length of rope that can be stored on a reel</u>

Capacity L in metres = (A + D) x A x C ÷ 1000 x K

L = Length

A = Depth of reel flange in mm

D = Diameter of reel in mm

C = Distance between flanges in mm

K = A multiplying factor for various rope diameters

Rope Diameter In mm	Multiplier ‘K’	Rope Diameter In mm	Multiplier ‘K’
6	11.2	36	400
10	31	40	500
12	45	44	600
16	80	48	720
20	125	52	840
24	180	56	840
28	240	60	1120
32	315	-	-

Length of rope that can be stored on a drum

While a storage reel can be filled to the top of the flange a drum must not be less than 2 x rope diameters must be left from the top layer of rope to the top of the flange.

For drums A = Depth of reel flange in mm be less than 2 x rope diameter.

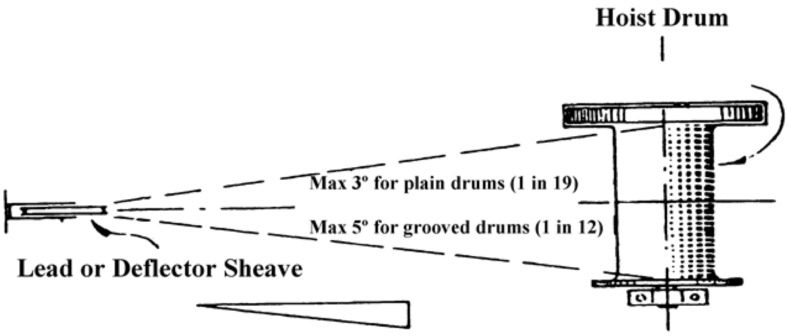
Fleet Angles

The maximum fleet angle is measured from the centre of the drum to the centre of the first diverting sheave then back to the inside flange at the middle of the drum.

The maximum fleet angle for a grooved drum is 5 ^{0} and for an ungrooved drum is 3 ^{0}.

To achieve these angles the distance from the drum to the first diverting sheave must be a minimum of:

- 19 times half the width of the drum for an ungrooved drum
- 12 times half the width of the drum for a grooved drum.



Example 1:

Width of the grooved drum = 1 metre

First Diversion: 12 x 1 x 0.5 = 6

Therefore, the first diversion sheave must be 6 metres from the drum.

Example 2:

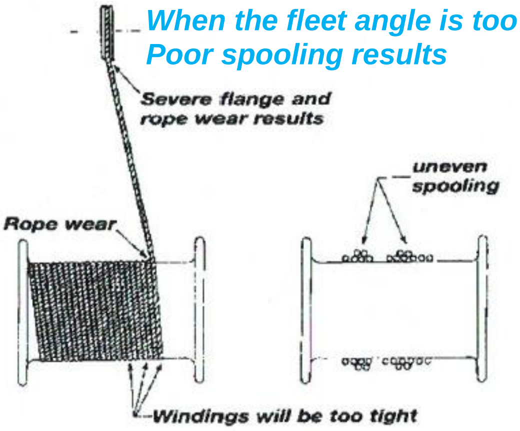
Width of the ungrooved drum = 1 metre

First Diversion: 19 x 1 x 0.5 = 9.5

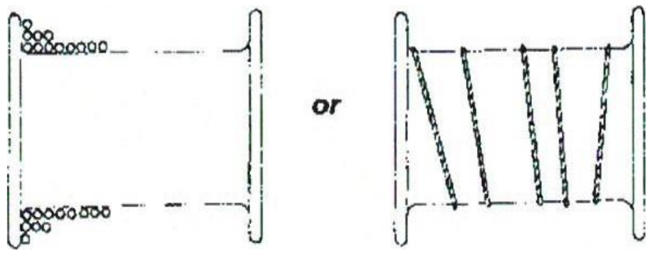
Therefore, the first diversion sheave must be 9.5 metres from the drum.

If the fleet angle is too large or the distance between the drum and the first lead or diverting sheave is too short, the rope will not lay neatly on the drum and will create severe wear on the rope and the sheave flange.

When the fleet angle is too large Poor spooling results



When the fleet angle is too small poor spooling results



Purchases

A wire rope reeved through sheaves to obtain a mechanical advantage is known in rigging as a 'purchase'.

Purchase and lead blocks should have the close-fitting cheeks pattern, or be the dished type where the sheave is recessed into cheeks.

Self-lubricating sheaves are recommended, but if reservoirs are used they should be filled periodically, and leathers and set screw washers checked for tightness.

Snatch blocks

Snatch blocks can be dangerous and should always be carefully watched. The gate must be properly closed and the split pin inserted and split open.

As the winch takes the weight, lead blocks stand up and lay into the strain. As snatch blocks stand up the split pin must be facing down and must be spread. There have been many fatal accidents because the split pin has been inserted face up and then dropped out, the gate opening allowing the hoist rope to drop out of the sheave.

The eyebolt and shackle type of block is preferable to the hook type. If the hook type is used it is important that the hook is placed into the sling with the hook facing down. If the hook faces up, it can drop out of the eye of the sling as the winch takes the strain. The hook must be properly moused to the sling.

Sheave blocks

Sheave blocks should be pulled apart, inspected and greased before each new set-up with particular attention given to the pin. If sheaves are not properly greased, friction increases dramatically through the system as the load is raised. This can overload the hoist rope at the winch.

Ensure that all cotters, nuts and bolts are tight. Lead blocks should be supported at the becket to prevent the block from twisting. Twisting would cause the rope to jam or ride on the rim of the sheave, and slip between the sheave and the cheek plate, jamming and destroying the rope.

The anchorage at the standing part of a purchase must be made at the becket at the bottom of the top block. If the becket is defective the eye of the standing part should be shackled to the head sling of the top block. Do not secure the end to the upper eye or shackle of the top block because the rope may cut where it passes over the cheek plate.

The screw pins of 'D' or bow shackles should be moused where used on standing rigging, and running rigging where the pin can become unscrewed, causing a serious accident.

When lifting loads by bridle or cock billing, make sure that lifting slings are 'stopped' and packing and lagging is lashed on. Head slings must not render or slip during fleeting operations.

The lead from the head block of any purchase must not foul its own block or any part of a structure. Head slings must be prevented from slipping by a 'stopper' lashing. Prevention from slipping must be against the pull from the load in the lead or from any fleeting action.

Where any fleeting action takes place, the load must be kept as low as possible to the ground or any supporting structure.

During fleeting do not stand in the line of pull from either set of blocks. Many people have been seriously injured because they were in the way of a surging load.

Timber packing or dunnage should be used if slings are likely to jam when landing a load.

Reverse Bends

Avoid reverse bends because they cause much greater fatigue than if all bends were made in the one direction.

A rope running in one direction over one sheave and then in a reverse direction (i.e. 'S' fashion) over another sheave will suffer early fatigue and deterioration. As the rope passes over a sheave it is bent, and as it leaves the sheave it is straightened, two distinct actions causing fatigue. This is made worse if the rope after being bent in one direction is then straightened, and again bent in an entirely opposite direction over another sheave after which it is again straightened.

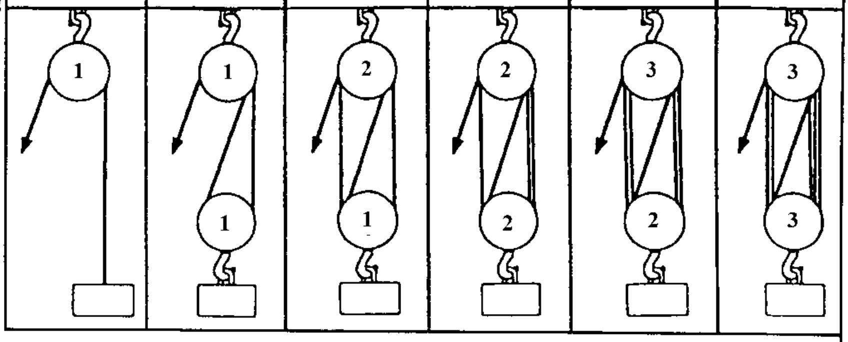
Safe Loads on Wire Rope Purchases

Use in connection with works of a temporary nature.

The figures in each diagram indicate the number of running sheaves in each pulley block.

Tabulated safe loads allow for one extra (lead) sheave (not shown in diagrams).

P = Pull in the lead rope (as fixed by size of rope) -t
D = Minimum distance at bottom of groove of sheave -mm
W = Safe load that may be lifted.



Rope Size Diameter	D	P	Parts of Rope Supporting load - tonnes W					
mm	mm	t	1	2	3	4	5	6
8	120	0.58	0.55	1.05	1.76	1.97	2.16	2.34
10	150	0.9	0.86	1.64	2.35	3.00	3.60	4.15
12	180	1.3	1.24	2.36	3.39	4.33	5.20	6.00
13	195	1.5	1.43	2.73	3.91	5.00	6.00	6.92
14	210	1.8	1.71	3.27	4.70	6.00	7.20	8.31
16	240	2.3	2.19	4.18	6.00	7.67	9.20	10.62
20	300	3.6	3.43	6.55	9.39	12.00	14.40	16.62
22	330	4.3	4.10	7.82	11.22	14.33	17.20	19.85
24	360	5.2	4.95	9.45	13.57	17.33	20.80	24.00
28	420	7.0	6.67	12.73	18.26	23.33	28.00	32.31
32	480	9.2	8.76	16.73	24.00	30.67	36.80	42.46

Friction loss of approximately 5% for each sheave has been allowed for.

Note: The above masses must not exceed those marked on the blocks as being the safe mass that may be lifted. Most blocks are limited by the size of hooks and other components and not the number of falls of rope.

A factor for friction has been added.

- The safe masses shown in this table are for rope of 6 x 24 construction.
- The working load limit together with any conditions of loading deemed necessary for safe use is to be stamped or otherwise marked on each block.
- Sheave diameters measured at the bottom of the groove may be as follows (temporary use only):
  - For power operated blocks: 15 x rope diameter
  - For hand operated blocks: 10 x rope diameter
- The beckets of blocks should be steel, preferably of drop forged or wrought construction. If welded, they should be to an engineered design and strongly made.
- The locking pins of hook nuts, where used, should be closely adjacent to the nut top surface.
- Hook shank collars should not be welded without an engineered design.
- Snatch blocks should incorporate a locking pin of positive type not requiring the use of any tool for its effective positioning. A drop nose pin used as a hinge pin is recommended and the locking device must be strongly made and suitable for the intended use of the block.

Note: The total load on the lower block includes the load to be lifted plus packings, slings, shackles, blocks etc. However as lifting commences friction causes the load in the rope falls to increase by up to 5 percent for each sheave the rope passes over, including lead sheaves (if any).

How to work out the load in a single part of a purchase

The greatest load on any rope in a purchase is the load in the lead rope to the winch. This is due to the friction between the rope in the groove of the sheave and the sheave pin. Friction is estimated at between 3 per cent and 5 per cent per sheave (i.e. up to one twentieth of the rope load that would occur if there was no friction).

The effects of friction, acceleration or deceleration are not usually included when dealing with work of a temporary nature unless a number of falls are used or the rope velocity is high, i.e. 0.6m/sec.

Formula for Becket Load Calculation (Steps):

1. Fleet Angle Distance (FAD):
   ½ Drum width x fleet Angle Factor (FAF) = Fleet Angle Distance
   Fleet Angle Factor for a grooved drum is 12
   Fleet Angle Factor for an ungrooved drum is 19

2. Becket Load (BL):
   Load on lower block ÷ Parts in purchase (PIP) = Becket Load

3. Friction Accounted for (FN):
   Becket Load x Total number of sheaves ÷ 20 = Friction

4. Lead Load (LL):
   Friction + Becket Load = Lead Load

5. Head Sling Load (HSL):
   Lead Load + Dead Load = Head Sling Load

6. Sling Anchorage (SA):
   Lead Load x Angle Factor = Sling Anchorage

Example: Ungrooved winch drum = 2.0m wide
Load on lower block = 8.0t
Number of sheaves in the purchase = 5
Number of diversion sheaves = 2
Angle between lead rope and lead line through first diversion sheave = 60º

Workings:

FAD 2m ÷ 2 = 1m (or 2m x 0.5 = 1m)
1m x 19 = 19m FAD

BL 8t ÷ 5 = 1.6t

FN 1.6t x 7 ÷ 20 = 0.56t

LL 0.56t + 1.6t = 2.16t

HSL 2.16t + 8t = 10.16t

SA 2.16t x 1.73 = 3.736t

The above calculations do not allow for sudden impact, acceleration and deceleration which can cause very high loads in the rope. These should all be avoided.

Where the angle in a lead rope is less than 90 degrees, the strain on the lead block is double the strain on the lead rope.

If the lead block is shackled to, or hooked into a sling which is reeved, the sling must have a capacity which is four times the load in the lead rope.

Purchase or Tackle Block?

Riggers must know the difference between wire rope purchase blocks and fibre rope tackle blocks. A fibre rope may be used in a purchase block, but a wire rope must not be used in a tackle block.

A fibre rope tackle block would be greatly overloaded if used for the WLL of a wire rope of the same size.

The difference between the two types of blocks is:

- The depth of the groove in a fibre rope tackle block should be not less than half the diameter of the rope used.
- The depth of the groove in a wire rope purchase block must not be less than 1.5 times the diameter of the rope used.
- The diameter of a fibre rope block is much less than that of a wire rope block for the same size rope.
- Pins and beckets are heavier and stronger in wire rope blocks.

1.3 Natural Fibre Rope and Slings

Fibre rope, also known as cordage, is used extensively for taglines, whips, tackles, lashings, and snotters for general lifting.

Natural or vegetable fibre ropes are grouped into those made from hard fibres and those made from soft fibres.

Hard fibre ropes are manila, sisal, coir and phormium tenax. Manila and sisal ropes are the main vegetable fibre ropes used for lifting in Australia. Coir is used where flotation is required and so is mainly used for boating.

Soft fibre ropes are jute, flax, hemp, and cotton. The fibres in these ropes are finer and very flexible and are used for ornamental purposes. They are often spun into twines or string for shop or household purposes.

Construction

The sequence of rope construction:

- Fibres are combed into slivers
- Slivers are twisted into yarns
- Yarns are twisted into strands
- Strands are twisted into the finished rope

Hawser Laid Rope

For right hand lay hawser rope a number of fibres are twisted into a right hand lay, or spiral (helix) into a yarn. A number of yarns are twisted in a left-hand spiral into a strand. Three strands are then twisted in a right spiral into a right-hand lay hawser laid rope. Left hand lay rope is laid up exactly the opposite.

The thickness of the rope depends on the number of fibres that are laid up into the yarn and then the number of yarns laid up into the strand. The opposite lay is put in to stop the rope from unlaying and pulling apart.

Marline

Marline is used extensively in rigging for seizings. Three or four yarns are spun together in an opposite spiral and tarred.

Shroud Laid Rope

Inspection shroud laid rope is a four-strand rope with a centre fibre rope heart. It is used for the manufacture of cargo, safety or scrambling nets, and rope ladders where there would be two strands either side of the tuck. The sectional area of four strand rope is less than three strand rope of the same diameter and the centre heart has a smaller spiral than the outer strands.

Shroud laid rope is therefore much weaker than hawser laid rope of the same diameter and should not be used for load lifting.

Cable Laid Rope

Cable laid rope is three hawser laid ropes laid up in an opposite spiral. They are used where great stretch is needed. They were used extensively in the shipping industry as mooring lines.

Inspection

Natural fibre rope is made from dried vegetable fibres and is subject to many deteriorating factors.

The whole rope should be inspected in a good light. Look at and feel the rope along the entire length. Open and inspect the lay and the interior every metre.

Look for the following defects:

- The effects of heat - If the rope has been exposed to more than 65^{0}c the rope could be brittle, charred, powdery or brown on the outside.
- Sun rot - The natural colour of the rope will turn to a dirty grey; the outside fibres will turn very brittle and the rope will be much lighter than normal.
- Mildew - Open the lay and smell the inside of the rope and examine it. A musty smell is a sign of mould/mildew. There may be no outside signs of mildew.
- Effects of acid and other corrosives - The outside will be faded yellow to brown colour and powdery.
- Overloading - The fibres will be shorter; the diameter will decrease and the lay will increase in length.

- Overworked over sheaves - When the lay is opened there will be fine powder in the centre of the rope. The powder is fine particles of the inside fibres worn and abraded away and locked inside.
- High stranding - One strand standing out above the others. It can be caused by faulty splicing or whipping.
- Kinks - Fibre rope will kink especially if it is wet. The outer fibres will be broken in one spot. This defect can be very hard to detect.
- Cuts - Fibre rope snotters should not be reeved around loads with sharp edges. Cuts are easy to detect but can be avoided by packing sharp edges.
- Defective splice - The eye splice in snotters should be carefully inspected. There should be three full tucks against the lay. The inside of the splice should be checked to ensure that there is no wear or broken fibres.

Fibre ropes which have defects should either be destroyed or if the defect is localised such as a cut, the rope should be severed at that point.

Maintenance

To maintain ropes in good condition free from attacks by mould and bacteria:

- Store new coils on dunnage in a well-ventilated area.
- Coil handlines and snotters and store on large wooden pegs above the ground.
- Keep rope dry and stored out of direct sunlight and never in an airtight box.
- Store away from any heat source, such as steam pipes, flame, sparks from welding or oxy cutting etc.
- Store away from acids or other corrosives, such as ashes, clinker, coke, oils, grease, steam, batteries etc.
- Protect from falling or sharp objects.
- Keep vermin away from ropes. Natural fibre ropes are prone to attack from insects which thrive on cellulose. The most common are clothes moths, beetles, ants, termites, silverfish and cockroaches. A trapped rat will gnaw through a rope to escape but in general rats are not attracted to rope for food or for bedding, always store ropes away from grit, rust, sand, dirt or other abrasive substances.
- Protect from adverse effects of weather such as sunlight, (sun rot) and mildew, caused by storing wet rope away in a toolbox or other area where there is no breeze to dry it out.

Handling

When a new coil of rope is delivered to the site it is covered with hessian bagging. Do not remove the cover. The coil is also tied with twine to keep it together.

If there is a turntable to uncoil the rope it can be unwrapped, and lengths cut as required.

Do not remove the hessian covering if there is no turntable. The best way to uncoil the rope is from the inside. Turn the coil so that the loose end is on the bottom. Cut the inside holding twine and pull the loose end out through the top of the coil. The rope will then be uncoiled left handed.

A rope that is uncoiled right handed will uncoil full of kinks and twists. If this happens, turn the coil over and push the loose end back through the centre and start again.

To remove kinks and twists re-coil the rope left handed or anti-clockwise on a piece of dunnage dipping the end through and under the coil and then re-coil. This may have to be repeated two or three times before all twists are removed (reverse for a left-hand lay rope).

Do not disturb frozen rope until it has completely thawed because frozen fibres can be easily damaged when handled.

Factors for Assessing the Capacity of Fibre Ropes

For safe use as lifelines, slinging and general lifting gear in factories and workshops where not subject to rough usage, the working load limit (WLL) is the guaranteed breaking strain (GBS) divided by six.

Do not use fibre rope of less than 12mm diameter for load carrying purposes.

Fibre rope hauled by hand under load must not be less than 16mm diameter (CR for tagline use)

Fibre rope must not be subject to heat greater than 65^{0}C.

Rope which has been shock or impact loaded or stretched by overloading must not be used for load carrying purposes.

The included angle between the legs of a sling attachment should not exceed 120^{0}.

Whipping

Whippings are put on the end of a rope to prevent the rope from unlaying. They are made by using waxed twine or rope yarn. The length of the whipping should be at least equal to the diameter of the rope.

Whippings are preferable to back splicing on the ends of tackle falls because they will pass through the blocks when reeving the tackle. A second whipping should be applied nine rope diameters from the end for permanent whippings.

Types of whippings:

- The 'Common' whipping is used to prevent the rope unlaying while measuring or splicing.
- The 'West-Countryman's' whipping and 'American' whipping are alternatives to the 'Common'.
- The 'Palm and Needle' (or sailmaker's) whipping is difficult to apply and is usually only made when a permanent whipping is required.

West Country Whipping 	American Whipping 
Common Whipping 	Palm Needle Whipping 

Splicing

Types of splicing:

- Eye splice - Can be either bald or with a thimble inserted. A fibre rope with an eye spliced either end for use in slinging is called a snotter.
- Cut splice - For joining two ropes leaving a loop between the splices.
- Short splice - For joining two ropes, or for joining two ends of a rope to make an endless rope strop.
- Long splice - For joining two ropes where the rope passes around a sheave. It should not be used where the rope supports loads or people. It may be used safely where a jockey, pilot, or dummy gantline is required to reeve off a FSWR purchase or similar use.

  Caution: It is possible for the tucked ends to come unlaid in use.
- Back splice. For preventing the end of a rope from unlaying. Back splicing is used when whipping twine cannot be found. Do not use if the rope has to be reeved into a tackle because the splice is too thick to pass through the sheaves. It is made by tying a crown knot then two or three tucks against the lay.

The short, cut, and eye splices can be used for suspending loads or people, but cannot pass through the sheave cheek plates. They should have at least three full tucks against the lay. After the three full tucks the ends of the strands can be reduced and tapered, and the splice served.

However, when a load is applied to the rope and the splice stretches, the seizing will become loose. It is better, stronger, and safer to dog knot half the strands with a neat seizing after completing the splice.

Fibre Rope Slings

Grommets

A grommet is an endless loop of fibre rope similar to a strop. It is formed by laying up a single strand. The length of the strand needed must be at least three and a half times the circumference of the finished grommet. The strand must be married at the required diameter then laid up until it is a three-stranded loop. The ends are then halved, overhand knotted, tucked and then reduced.

Strops

A strop is where the two ends of a piece of rope are spliced with a short splice making an endless sling. They are called strops whether they are made of FSWR or fibre rope.

They are used as tackles, whips, lashings, snotters, and general lifting gear where the rope is liable to rough usage. The WLL is the GBS divided by seven.

Snotters

A snotter is a fibre rope sling with eyes spliced into each end. The eyes of snotters should be properly spliced by a competent person with three full tucks against the lay. Snotters should not be reeved or choke hitched around sharp edges unless proper packing is used to protect the fibre rope. Snotters are used where FSWR slings or chains would damage a load or where the use of metal slings could be dangerous.

They are seldom used on construction sites and should not be used where the loads are lifted overhead.

Blocks and Tackles

A tackle is the term used when fibre rope is reeved around sheaves to gain a mechanical advantage.

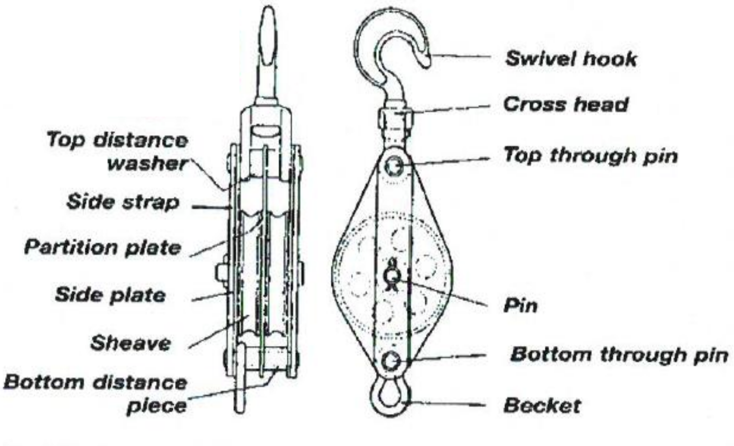
Caution: Fibre rope tackle blocks must not be used for FSWR purchases.

Blocks

Steel blocks are made of mild steel cheek plates secured to a yoke drilled for an eyebolt or a forged hook. Reinforcing plates often run down outside the cheek plates to the bottom, where they are drilled to take becket, spreader bolts and ferrules.

The sheave pin fits into holes drilled through straps, cheeks and partitions and is usually of mild steel with a flanged end and a spigot with a cotter retainer at the other end. Lifting hooks or eyes are the swivel type (not upset or riveted type).

Care must be taken when maintaining and inspecting to look for worn pins, sheave bushes, insecure fastening of the hook yoke to cheeks and yoke crosshead, securing of sheave pin, becket and pin and general soundness of the whole frame.



Double sheave block

Types of tackles:

- Gantline — a single fixed block
- Single whip — two single blocks
- Whip upon whip — two moveable and one fixed single block
- Luff tackle — single and double block
- Gun tackle — two double blocks
- light gin tackle — or handy billy — double and treble blocks
- heavy gin tackle — two treble blocks

Sheaves

The diameters of sheaves used with fibre ropes must be at least five times the diameter of the rope when hand operated. For power operated appliances the sheave diameter must be at least ten times the rope diameter.

The sheave diameter is measured from the bottom of the groove. If a rope sits too tightly in the bottom of the groove it can become damaged when wet or swollen. The depth of the groove should be at least half the rope diameter.

Reeving

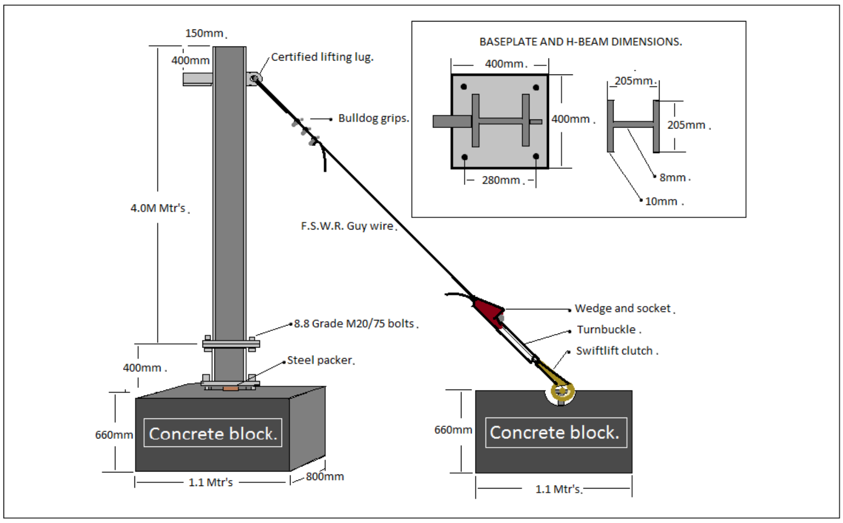
A tackle for right hand laid rope must be reeved right handed (clockwise from left to right) starting from the bottom. Lay the blocks down with the becket at the top and finish the reeve with a splice or a buntline hitch at the becket.

Tackles when rove should be left block against block with a tail rope for overhauling on the lower block. As the tackle is overhauled the fall rope should be kept free of turns allowing the tackle to run free of turns and twists.

When tackles are rove off left handed and turns are not shaken out of the running end, the tackle will spin full of twists. A lower block which has toppled will cause turns and twists, so care should be taken to dip the lower block back in the correct direction.

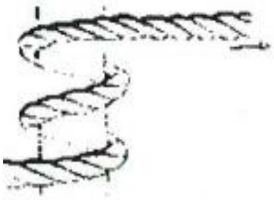
Guys

Do not use fibre rope for permanent guys. Natural fibre rope shrinks when wet and stretches when dry. Do not leave temporary fibre rope guys supporting or guying an object overnight. Use FSWR as guys wherever possible.



Bends and Hitches

Riggers must know how to secure loads and tag lines with bends and hitches. Learn those described and illustrated below.

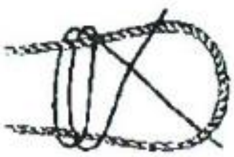


Snubber turns for holding and lowering heavy loads. Two, three or more turns should be used.

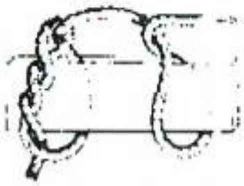
Rolling hitch – To secure stopper, or two ropes pulling in opposite directions. Very useful – preferable to clove hitch or blackwall hitch, providing rolling turns are put on in proper direction of pull. Safe.

Buntline or becket hitch – to secure ends of tackles to beckets. Foolproof; cannot come undone like half hitches.

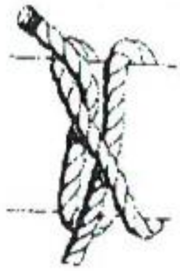
Sheet bend – to join two dry ropes of different sizes. Safer when double sheet bend is used. The smaller rope must be bent around the larger rope.



Double sheet bend.



Timber and half hitch – useful for hoisting lengths of timber. Only safe when additional half hitch is put on end of hauling part.



Clove hitch – used to commence rope lashing. Not safe for other purposes unless ends secured, with additional half-hitch.

Bowline single – used for making temporary eye in end of rope.

Bowline running – used for making a temporary eye to run along another part of rope.

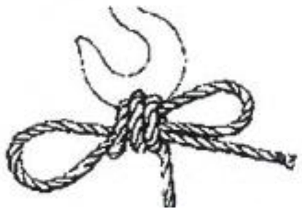
(i) Bowline on the bight.

(ii) Bowline on the bight.

Fisherman's bend and half hitch – useful for bending rope onto rings, handles of buckets, etc – requires the extra half hitch.

(iii) Bowline on the bight – the bowline on the bight is formed by making the first part of a bowline with the bight of the rope and passing the whole hitch through its bight.

Shortener for single part rope or snotter — to join rope to hook of tackle, etc and does not damage the rope. At least two full turns of the standing part are to nip the two bights before the bights are placed on the hook.

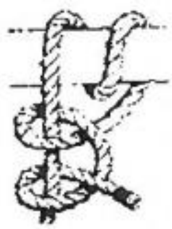


Single snotter shortener partly made. Two bights ready to be placed on hook.

Overhand knot – to make a stop on a rope, to prevent ends from fraying or to prevent it slipping through a block.

Figure of eight knot – as for an overhand knot, but easier to untie.

Single snotter shortener with both bights fitted on hook.



Round turn and two half hitches – widely used for securing running ends of tackles. The more turns made before hitches are made the more control is possible.

1.4 Synthetic Slings

All synthetic slings must have a WLL tag.

Synthetic slings com in two common types:

- Round webbing
- Flat webbing

Synthetic slings are made from nylon polyester or polyamide.

ROUND SLINGS AS 4497.2

FLAT WEBBING SLINGS AS 1353.2

WORKING LOAD LIMIT (WLL)

Sling Lifting Configurations	Straight Lift $L = 1$	Choked Lift $L = 0.8$	Basket hitch and 2, 3 & 4 leg slings Parallel $L = 2$	$\beta = 60°$ $L = 1.73$	$\beta = 90°$ $L = 1.41$	$\beta = 120°$ $L = 1$
Sling Colour as per Australian Standards						
Violet	1.0	0.8	2.0	1.7	1.4	1.0
Green	2.0	1.6	4.0	3.4	2.8	2.0
Yellow	3.0	2.4	6.0	5.1	4.2	3.0
Grey	4.0	3.2	8.0	6.9	5.6	4.0
Red	5.0	4.0	10.0	8.6	7.0	5.0
Brown	6.0	4.8	12.0	10.3	8.4	6.0
Blue	8.0	6.4	16.0	13.8	11.2	8.0
Orange	10.0	8.0	20.0	17.3	14.1	10.0
Orange	12.0	9.6	24.0	20.7	16.9	12.0

NOTE: Working Load Limit = L x WLL; L= Loading Factor; β = Included angle between the legs

Synthetic Slings and Chemicals

If unsure about the effects of a chemical on a synthetic fibre rope check the Safety Data Sheet (SDS) which should be available for all chemicals used or stored in the workplace.

Polyamide

Polyamide filament is generally resistant to chemicals but solutions of mineral or formic acids (used in insecticides and as solvents for perfumes) cause rapid weakening. Therefore, avoid any contact with acid solutions either hot or cold. Polyamide filament is unaffected by alkalis, such as bleach and detergents, at normal temperatures. It may swell in some organic solvents such as cleaning agents. Avoid exposure to fumes, spray or mist of acids. If contamination is suspected, wash out well in cold water.

Polyester

Polyester filament is generally resistant to chemicals although solutions of strong, hot alkalis progressively dissolve the fibre, causing gradual loss in mass and a corresponding fall in breaking strain. Therefore, avoid exposure to alkaline conditions.

Resistance to acid is good, particularly sulfuric acid, although concentration should not exceed 80 per cent. Therefore, even diluted solutions of sulfuric acid should not be allowed to dry off on a rope. If any contamination is suspected, the rope should be washed out well in cold water. Resistance to oils and common organic solvents is good.

Polyethylene

Polyethylene ropes are highly resistant to chemical attack from both acids, such as battery acid, and alkalis. At room temperature the chemicals which cause serious loss in strength are some oxidising agents e.g. hydrogen peroxide. At 60^{0}C there is also a loss in strength caused by some organic solvents such as turpentine. If contamination with any of these substances is suspected, the rope should be washed out well in cold water.

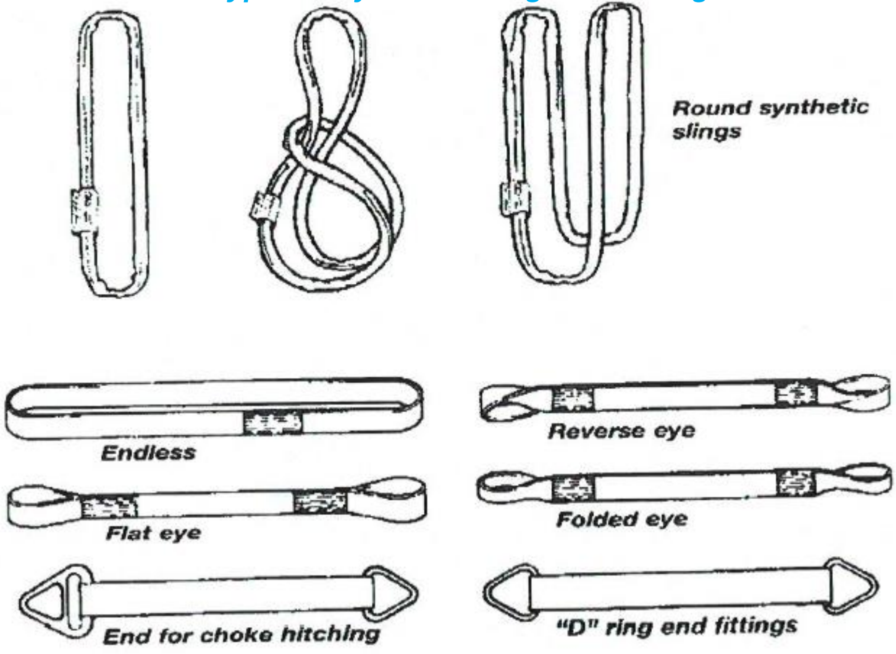
Polypropylene

Polypropylene ropes are unaffected by acids or alkalis but are attacked by organic solvents such as white spirit. Avoid rope contact with wet paint or coal tar or paint stripping preparations.

Flat webbing and round synthetic slings

Flat webbing and round synthetic slings are used for lifting where it is necessary to protect the load from damage and for protection from electrical hazards. They are made from nylon, polyester, polypropylene or aramid polyamide. Each sling must be labelled with the WLL.

Types of synthetic slings and fittings



Inspection

Synthetic slings must be inspected before each use. They must also be inspected at least once every three months. If a sling is subject to severe conditions the inspections should be more frequent. Send each sling for a proof load test at least every 12 months.

Look for:

- Any external wear such as abrasion or cuts and contusions.
- Internal wear which is often indicated by a thickening of the sling or the presence of grit and dirt.
- Damage to any protective coating of the sling.
- Damage caused by high temperatures, sunlight or chemicals (indicated by discolouration).
- Damage to the label or stitching.
- Damage to the eyes or any terminal attachments or end fittings.
- Where the sling is covered by a sleeve, the sleeve must cover the sling for the full length from eye to eye.

Discard a synthetic sling if:

- The label has been removed or destroyed.
- There is any damage to the sleeve or protective coating.
- A nylon sling comes into contact with acid.
- A polyester sling comes into contact with alkaline substances.
- A polypropylene sling comes into contact with an organic solvent such as paint, coal tar or paint stripper.
- There are any visible cuts on the sling, or if inner yarn is visible.

NB: A nylon sling will lose more than 10 per cent of its strength when it is wet.

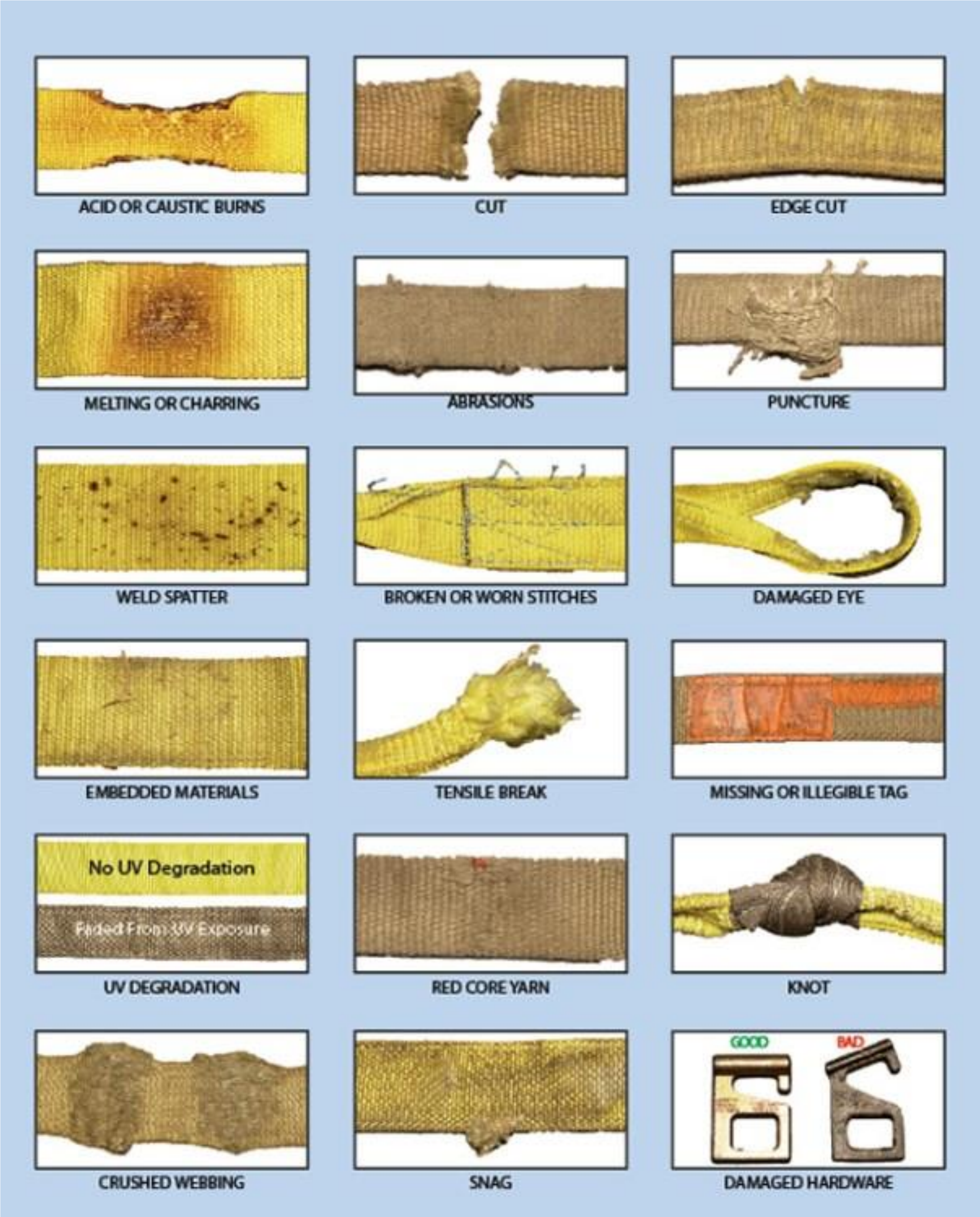
After six months continuous exposure to sunlight send a sling in for testing.

Synthetic slings must be stored:

- In a clean, dry, well ventilated place.
- Away from the ground or floor.
- Away from direct sunlight, ultra-violet light and fluorescent lights.
- Away from extremes of heat.
- Away from sources of ignition.
- Away from atmospheric or liquid chemicals.
- Away from the possibility of mechanical damage.

The working life of synthetic slings will be shortened if exposed to any of the above.

Examples of extreme damage to flat synthetic-webbing slings



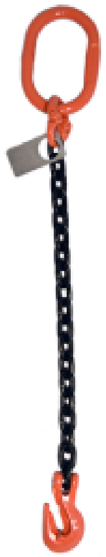
1.5 Chains

Riggers must have the knowledge and skills to recognise the types of chain used to safely lift loads and those which are not.

Lifting Chains

Lifting chain is uncalibrated, proof tested, short link chain. The barrel of short link chain requires a greater force to bend, provides greater strength, reduces the tendency to twist and provides better reeving performance.

Chain sling assembly



The outside length of the link does not exceed five times the diameter (of the link material) and the outside width does not exceed 3.5 times the diameter.

Lifting chain is produced on a special purpose automatic chain making machine to ensure uniformity and homogeneous welds. A continuous coil of carbon steel or alloy steel rod is fed into the machine which cuts and bends the link around dies, then electrically welds the specially prepared join in the formed link. The weld is then trimmed by two methods:

- The welding flash is removed from the outside of the material leaving a bit of weld on the inside of the link
- The welding flash is completely trimmed from all round the weld area.

Grade designation is then stamped or embossed on the chain. In some cases, every link is marked, but all lifting chain must show grade marking at least every metre or every 20 links, whichever is less.

Short link chain can also be calibrated to ensure uniform link pitch for running over a pocket sheave which is sometimes called a 'gypsy'. Calibrated chain gives a constant and uniform pitch throughout the length of the chain and improves its lay (it does not twist as much as uncalibrated chain).

Gypsy

Gypsies are used to raise or lower the chain in a chain block. They can be driven by hand, pneumatically or electrically. Although most manufacturers today produce chain for chain blocks of similar size and shape, it is important to obtain replacement chain from the manufacturer of the chain block to ensure correct fit.

If the chain does not fit neatly into the gypsy it will jam, ride out of the wheel pockets, or suffer wear or link damage. If this occurs it could lead to premature failure of the chain, damage to the gypsy pockets and possible accidents from the chain riding out of the pockets under load.

Unpocketed sheaves and drums designed to take chain must be at least 24 times the diameter of the chain. Link length should not exceed 6 times the diameter and the width should not exceed 3.5 times the diameter. Welds must be smoothly finished, and the diameter of the weld must not be less than the diameter of the material in the chain.

Types of lifting chains:

- Mild steel stress relieved chain — stamped L
- High tensile, quenched and tempered chain — stamped P
- Higher tensile, quenched and tempered chain branded T, 8, 80, (HA, 800), PWB, or CM
- Very high tensile, quenched and tempered chain branded 100, V or 10

High Tensile and Very High Tensile (Grade 80 and 100) are used extensively for lifting. Very little low-grade chain is used for lifting. Most, if not all, chain components are also High Tensile strength (Grade T or 800) and are branded to show grade and chain size.

If riggers do not understand the grade marking of a chain, they should check with the manufacturer or the manufacturer's supplier for clarification.

Look for the grade markings

CHAIN SLINGS AS 3775

GRADE T (80) – WORKING LOAD LIMIT (WLL)

Single Leg Slings | 2, 3, or 4 Leg Slings | Endless Slings

Chain Size (mm)	Straight Sling	*Adjustable Sling	Reeved Sling	Straight Sling			Reeved Sling			Basket Sling			Reeved Sling
				60°	90°	120°	60°	90°	120°	60°	90°	120°	
6	1.1	1.1	0.8	1.9	1.6	1.1	1.5	1.2	0.8	1.5	1.2	0.8	1.7
7	1.5	1.5	1.1	2.6	2.1	1.5	2.0	1.6	1.1	2.0	1.6	1.1	2.3
8	2.0	2.0	1.5	3.5	2.8	2.0	2.6	2.1	1.5	2.6	2.1	1.5	3.0
10	3.2	3.2	2.4	5.5	4.5	3.2	4.1	3.4	2.4	4.1	3.4	2.4	4.8
13	5.3	5.3	4.0	9.2	7.5	5.3	6.9	5.6	4.0	6.9	5.6	4.0	8.0
16	8.0	8.0	6.0	13.8	11.3	8.0	10.4	8.5	6.0	10.4	8.5	6.0	12.0
20	12.5	12.5	9.4	21.6	17.6	12.5	16.3	13.3	9.4	16.3	13.3	9.4	18.8
22	15.0	15.0	11.3	26.0	21.2	15.0	19.5	15.9	11.3	19.5	15.9	11.3	22.5
26	21.2	21.2	15.9	36.7	29.9	21.2	27.6	22.5	15.9	27.6	22.5	15.9	31.8
32	31.5	31.5	23.6	54.5	44.4	31.5	41.0	33.4	23.6	41.0	33.4	23.6	47.3

*Assumes the use of 100% Rated Shortening Hook

CHAIN SLINGS

VIP GRADE 100 – WORKING LOAD LIMIT (WLL)

Single Leg Slings | 2, 3, or 4 Leg Slings | Endless Slings

Chain Size (mm)	Straight Sling	*Adjustable Sling	Reeved Sling	Straight Sling			Reeved Sling			Basket Sling			Reeved Sling
				60°	90°	120°	60°	90°	120°	60°	90°	120°	
4	0.63	0.63	0.47	1.09	0.89	0.63	0.82	0.66	0.47	0.82	0.66	0.47	0.94
6	1.5	1.5	1.1	2.6	2.1	1.5	1.9	1.6	1.1	1.9	1.6	1.1	2.2
8	2.5	2.5	1.9	4.3	3.5	2.5	3.2	2.6	1.8	3.2	2.6	1.8	3.7
10	4.0	4.0	3.0	6.9	5.6	4.0	5.2	4.2	3.0	5.2	4.2	3.0	6.0
13	6.7	6.7	5.0	11.6	9.4	6.7	8.7	7.1	5.0	8.7	7.1	5.0	10.0
16	10.0	10.0	7.5	17.3	14.1	10.0	13.0	10.6	7.5	13.0	10.6	7.5	15.0
20	16.0	16.0	12.0	27.7	22.5	16.0	20.8	16.9	12.0	20.8	16.9	12.0	24.0
22	20.0	20.0	15.0	34.6	28.2	20.0	26.0	21.2	15.0	26.0	21.2	15.0	30.0
28	31.5	31.5	23.6	54.5	44.4	31.5	41.0	33.4	23.6	41.0	33.4	23.6	47.2

Caution: Industrial lifting chain is not normally sold through general hardware outlets. Chain from general hardware outlets is usually unsuitable for industrial lifting.

Other types of chain:

- Stud link chain - A special purpose marine chain with a stud across the centre of each link to prevent the chain from jamming when coming out of ship's chain lockers. Do not use for lifting.

  Stud link chain lacks the flexibility of a lifting chain. Under test, it shows no elongation, whereas open link chain shows considerable elongation.
- Bush roller chain - Including Reynolds, Morse, and Coventry types. It is used as the drive chain on bicycles, motorcycles or the load chain on fork lift trucks. It has no sideways flexibility, so should not be used for suspending loads unless the load is in between guides.

- Proof coil chain - Is not made for load supporting. It is used as load binder chains, skid chains, hand chain on chain blocks, or general purposes other than load lifting. Proof coil chain is usually not branded and not made to any standard. It is not made for lifting purposes and should not be used as lifting chain.
- Grade 65 is a high tensile load binder chain and is branded '65'. It is not a lifting chain and should not be used for lifting.
- Grade 70/75 is a high tensile load binder chain and is branded 70, 7, HI-FRT, or HiLITE and is sometimes supplied gold coloured plating. It is not a lifting chain and should not be used for lifting.
- Long link chain is made in various grades from mild steel to Grade 80 and is used on conveyors, as ship cargo chain and for lashing. It is not a lifting chain and should not be used for lifting.

Inspection of Chain

To prepare for inspection, clean the chain thoroughly, and lay it out in a good light on a table. Use a magnifying lens with a built-in light and examine every link. If the chain is made up into a sling, examine all of the parts of the sling assembly and look for the following defects:

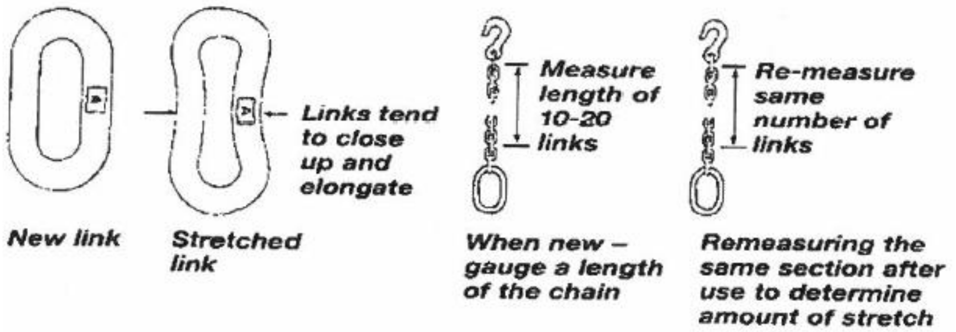
1. Stretching - Stretched links are a sign of overloading. Chain should be condemned if links show obvious signs of any stretching.

High tensile Grade T, Grade 100 and Grade 800 chain has been proof tested to 2.3 times its working load during manufacture. If chain has stretched in use it has been loaded more than 2.3 times its working load. Grade T, Grade 100 and Grade 800 chain only stretches a significant amount as it approaches its breaking strength, so stretched chain should never be used.

Oblong links or rings have been proof tested to twice the working load and stretching indicates overloading. If oblong links or rings have stretched more than 5 per cent, they should be condemned.

Chain hooks have also been proof loaded to twice their working load prior to supply, so if the hook has opened it is a sign of overloading or incorrect use. Hooks which have opened more than 5 per cent should be condemned.

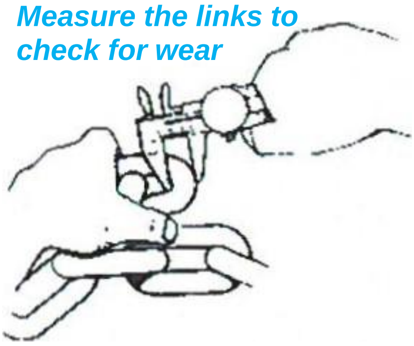
Look for chain stretch during inspections



2. Bent links - Links can be bent by reeving chain around square objects which are not properly packed. If the chain is bent at the link weld, the chain should be inspected very closely to ensure that the weld has not begun to fail.

Inspect all links for bends, twists and damage

3. Damaged links - Reeving around sharp edges without proper packing will gouge the chain link. Dragging chain along workshop floors can wear chain. Chain which is worn, nicked, cut or gouged to a point where the metal in the link diameter is reduced by 10 per cent or more should be condemned.
4. Rust - Most chains will develop discolouration meaning some surface rust. This should not be confused with deep rust which will make the chain unsafe to use.
5. Crack - To find cracks soak the chain in a light oil, wipe dry and apply a coating of powdered chalk or whiting to the surface. Leave for several hours and then examine. If a crack exists, the chalk will draw up the oil from the crack and become discoloured, showing up the shape of the crack. There are also special preparations available which can be used for showing up or locating cracks.
6. Wear - Where links seat on each other they wear. This wear is most prevalent in load chain in chain blocks. When the chain passes over the gypsy the links are subject to extreme friction. The links wear very quickly if the chain block is being worked continuously near maximum loading. If the tension cannot be released from the chain it should be checked for wear. Calliper across two links and divide by two to obtain the diameter. Then check this against an unworn part of the link. The chain must be replaced if wear exceeds 10 per cent of the diameter.



7. Inspection records of slings and sling leg lengths should be commenced when chain is new and maintained to give a reference check. The length of used sling legs may be greater than their original length due to wear, but caution should be taken to ensure no stretching has occurred.

Care and Maintenance of Chain

- Do not overload chain.
- Do not use a chain with locked or stretched links or which has links that do not have free movement.
- Do not hammer a chain to straighten a link or force a link into position.
- Do not use an excessively pitted, corroded, unduly worn, deformed, chipped, nicked, cracked, or otherwise damaged chain.
- Do not snatch or jerk loads being handled by chain slings, especially in cold weather. Sudden lifting can have the effect of doubling the load in the sling. Chain and chain slings should not be used in temperatures below —20^{0}C as this extreme cold could make chain brittle.
- Do not cross, twist, kink or knot chain.
- Do not drag a chain by force from under a load.
- Do not drop a chain from a height.
- Do not roll loads over a chain.
- Do not use a chain over sharp edges without proper packing on the edges. Hessian bagging is not good enough. Use cut lengths of rubber car tyre, half rounds of tube or timber. All packing should be secured when sending loads aloft. When the load is landed the slings go slack and the packing can drop out.
- Do not use lifting chain at temperatures over 400^{0}C without consulting the manufacturer. Lifting chain used at temperatures over 200^{0}C requires derating. Refer to table for the reduction factor.

Temperature Range ^{o}c	Temporary Reduction of WLL while heated
Up to 200	Nil
200-300	10%
300-400	25%
Over 400	Do Not Use

- Do not place the links of a chain so that they bear on the hook of a crane or hoist (except an endless chain sling).
- Do not join chain by using a bolt or a bulldog grip.
- Do not shorten a chain by twisting or wrapping it around a hook.
- When not in use all chain lifting gear should be stored on racks or pegs, under cover.
- Any screw thread used in connection with chain blocks must be securely locked.
- The load chain of a chain block should not be used as a sling.
- Any repairs to chain should be referred back to the manufacturer or supplier.
- Chain links and load chains of chain blocks should be frequently inspected and lubricated between uses, or more frequently for repetitive lifts at near capacity.
- Do not use chain in corrosive environments without reference to the manufacturer.

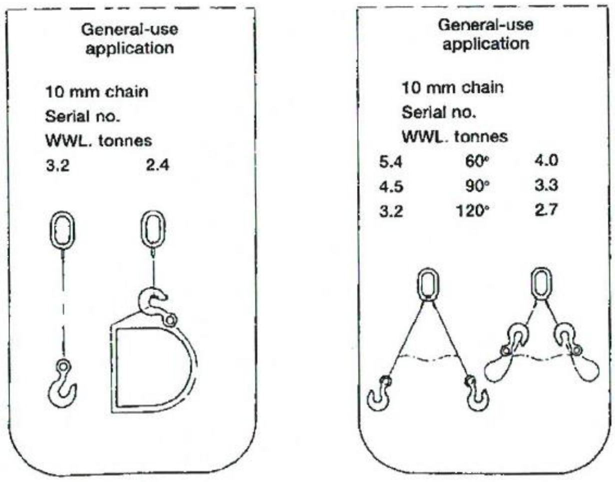
Chain Sling Assembly

Chain slings should be made up to AS 3775 Chain slings - Grade T or the manufacturer's recommendations. When ordering parts for chain slings ensure that they comply with the appropriate Standard.

Avoid making up slings from different grades of chain or fittings. Try to use only one grade of chain throughout the workplace. This will prevent confusion about the WLL of slings for given diameter chain slings, especially if a WLL tag is missing.

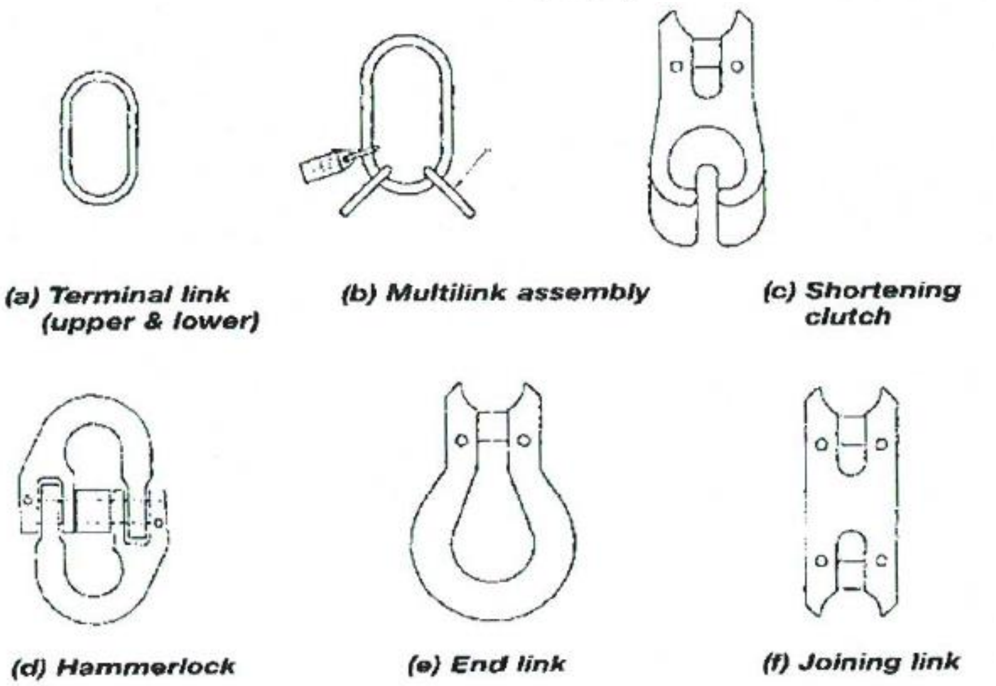
The chain, large oblong link, hammerlocks or couplers, and hook should all be of equal capacity or grade. Riggers should have the knowledge and expertise to inspect a chain sling to ensure that the grade and safe working load of all components match.

Typical marking for metal tag



Single-leg tag *Multi-leg tag*

Various types of chain sling links



The working load limit tag must be fixed on all chain assemblies, the tag must detail the SWL under all conditions of loading.

If a tag is missing the sling should be taken out of service, unless the necessary information is marked on the master link. Once the tag is replaced the sling can immediately be returned to service. The tag should be replaced by a competent person.

Coupling links, often branded Hammerlok or Kuplex are used to connect alloy chain to alloy rings and hooks. Make sure that the pin connecting the two halves is firmly in position and that there are no cracks running from the inside corners of the forked part of the links.

Twist the spacer in the centre of the link to ensure that it is free. A jammed spacer is a sign that the chain has been overloaded.

Four leg chain slings should be fitted with two intermediate links on the main ring.

Rings

A ring must be strong enough to safely handle the WLL of all attached chains or slings.

Rings must be inspected frequently. Do not use a ring which has stretched more than 5 per cent of its mean diameter.

Do not place a ring on to a hook unless it hangs freely over the bow of the hook.

Hooks

There are many different shapes and sizes of hooks. They range from mild steel to very high-grade alloy steel. The common factor is that they are all designed to support loads.

Hooks used with chain to make chain assemblies are usually Grade T or Grade 800 strength. Very few, if any, other grades are readily available. Hooks used on chain must not have a WLL marked on them as it will lead to confusion when slings are used. The tag is the only reference to loading of a sling. Chain hooks are marked with their chain size and should be matched to the same size and grade of chain.

Hoist hooks and crane hooks must be marked with the WLL. Some hooks, particularly crane hooks, are also marked with the weight of the hook block.

Inspection and Use

The opening of the gap between the 'bill' or point of the hook and the shank, must be large enough for any sling, link, ring, shackle, or lifting device to be placed on it. The inside of the bight of the hook should be rounded to avoid cutting any fitting placed on the hook.

Nothing should be placed on a hook which will put opening (stretching) forces on the bill.

Do not use hooks which have had the throat opening stretched more than 5 per cent.

Hooks which are stretched, bent, cracked, or distorted in any way should not be welded or treated by unqualified people. They should be replaced or sent back to the supplier for assessment. Welding can hide a dangerous crack or distortion in the hook.

Hooks should not have any attachments welded to them.

Use a safety hook if there is a chance that the load can become unshipped or displaced.

Caution: Using some spring-loaded safety hooks does not guarantee that slings will not be displaced in some circumstances.

Crane or hoist hooks must be able to freely rotate under all conditions of loading. If the load exceeds 2t, they must have a ball or roller thrust bearing between the trunnion and nut. Make sure that no dust or other foreign matter accumulates in the thrust bearing.

Replace any hook that has the bow worn more than 10 per cent.

Do not place multiple eyes of slings directly on the hook. They should be placed on to a bow shackle, and the pin of the shackle should be placed on the hook.

To avoid excessive forces on the bill of the hook place slings which are at a wide angle on a bow shackle and not directly onto the hook.

It is safer to 'back hook' to the main lifting ring. Taking the chain sling hooks back up to the main hook can be dangerous if the chain slings do not sit properly on the main hook.

1.6 Anchorages and Fittings

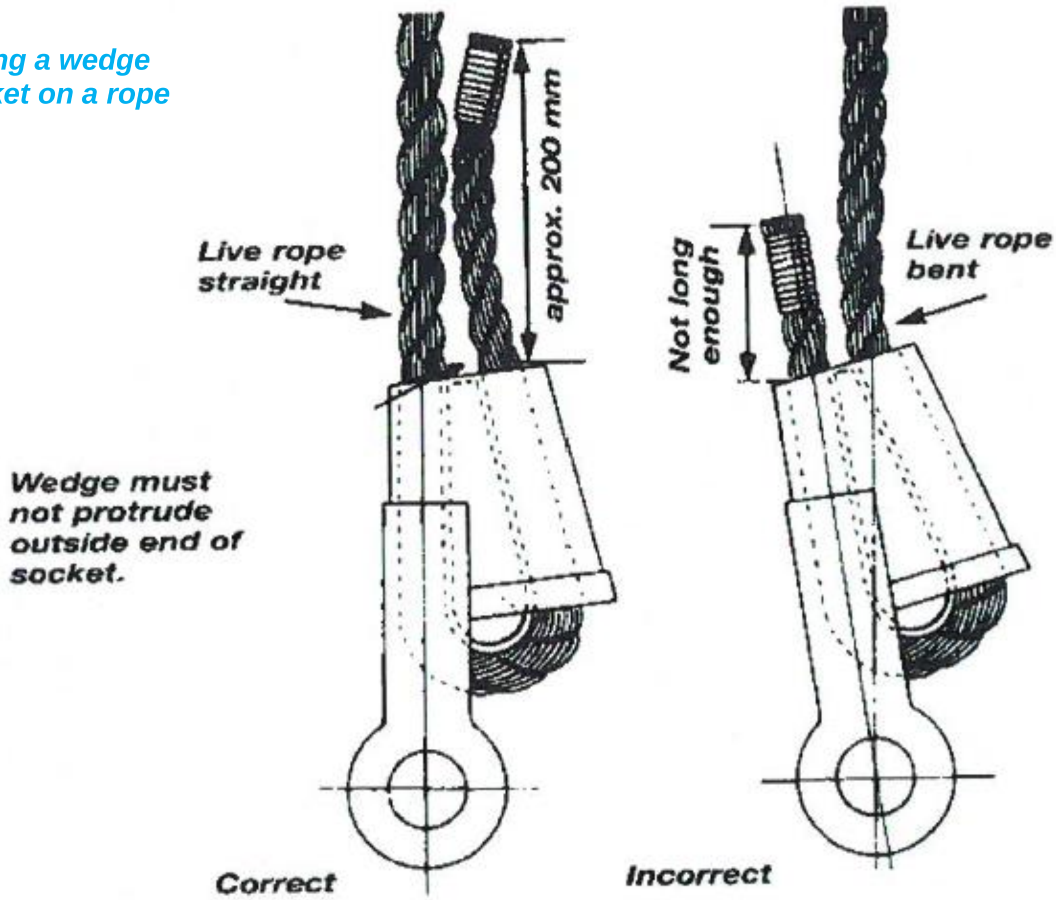
Wedge rope sockets

Anchorages are used for securing standing and running gear, such as attaching the wire rope to the drum, the head of the boom or the crane hook.

The eye on the anchorage for a non-moving rope (called a 'dead eye anchorage') must have a thimble. A splice with no thimble (called a 'bald eye splice') should not be used on an anchorage.

Wedge type rope socket anchorages are used extensively for cranes where the hoist fall is often re-reeved around the sheaves for extra purchase. These socket anchorages should comply with AS 2740 Wedge-type sockets.

Fitting a wedge socket on a rope



There are many dangers associated with wedge type sockets and riggers should ensure that they are set up correctly.

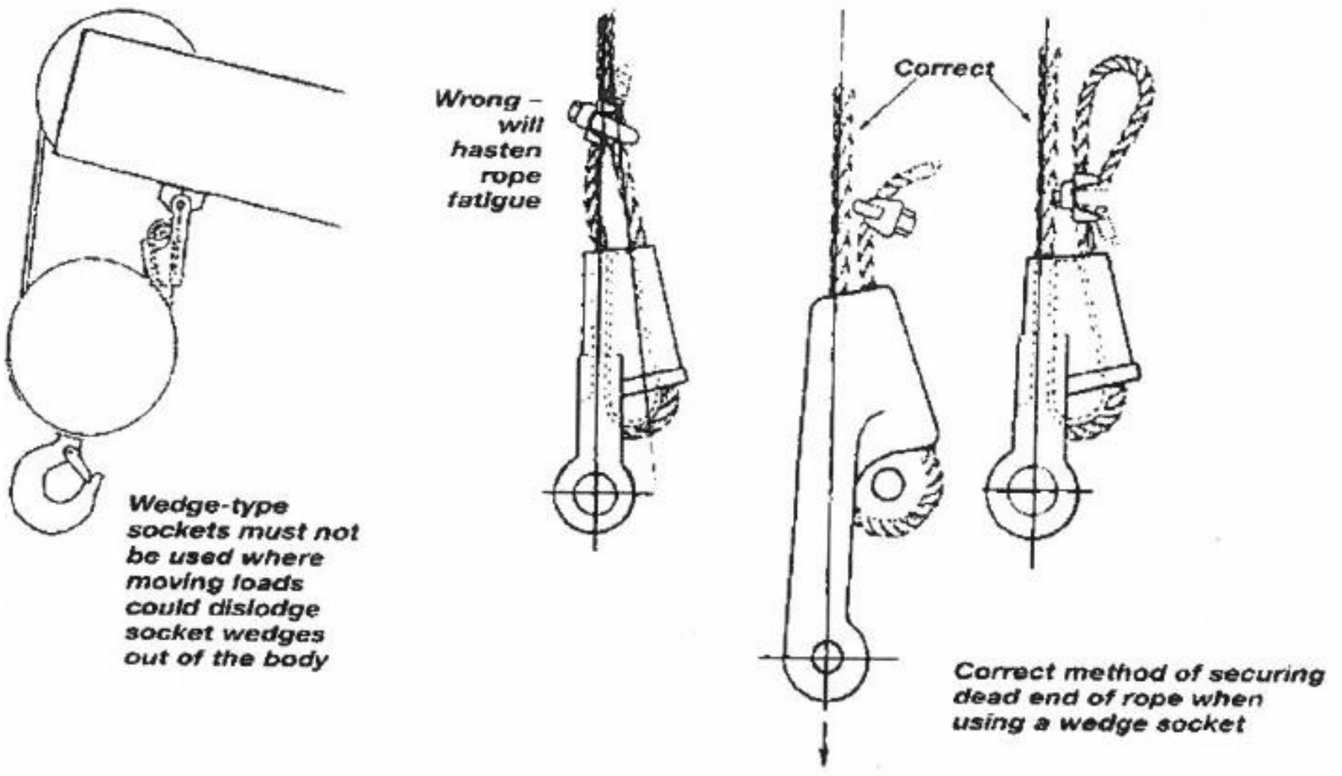
The rope diameter must be equal to the diameter inside the socket, and when the wedge is pulled tight the wedge must not protrude beyond the socket body.

The hoist rope must be reeved into the socket body so that there is a straight line between the live rope and the anchorage.

If the rope is reeved in the opposite direction so that the live end is on the sloping side of the wedge, the wire will fail at the point where the rope enters the socket.

Do not place rope grips (bulldog clips) across both live rope and the dead end because it can lead to severe damage to the hoist wire. Wedge rope sockets may be used when spliced eyes are difficult to reeve or they would have to be made after the rope is in place.

The wedge rope socket must be properly set up and used, and properly designed and accurately made. They must be designed so that when no rope is fitted the wedge will not pass through the socket.



The advantages of using wedge rope sockets as anchorages are simplicity, ease and speed of applying and detaching, and that they do not damage the rope to any appreciable extent.

Sharp edges must be rounded off at the point where the load bearing rope enters or leaves the socket.

The angle of the wedge should be slightly greater than that of the socket, so that it does not tend to nip the rope as it leaves the socket. The angle of the socket is important and should not be greater than 19 degrees.

Do not set up wedge sockets where a block being raised can hit and dislodge the wedge.

Socket bodies and wedges must be frequently inspected for excessive wear at the point the wire rope strands are jammed into them. Do not use wedge rope socket anchorages where they cannot be easily inspected.

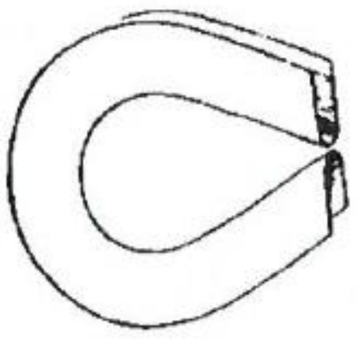
The dimensions of the wedge and socket must be such that when a wedge rope socket with rope is assembled, the narrow end of the wedge does not protrude outside the end of the socket. Do not use wedge rope sockets where moving loads can force the wedge out.

A wire rope grip should be applied to the tail (only) of the rope below the socket to prevent dislodgment of the wedge.

In earthmoving equipment such as drag lines and pile drivers the rope is usually initially much longer than required so that shortening can be carried out several times, quickly and easily, without recourse to splicing. The wedge is punched out of the socket, the bad rope cut off and re-reeved through the socket, the wedge replaced and pulled tight. The rope end should always be visible, protruding 150-250mm from the socket so that rope slippage will be evident.

Thimbles

A thimble is a fitting used in the formed eye of a rope and is designed to protect the bearing area inside the crown of the eye from chafing and distortion.



Thimble

Wire Rope Grips

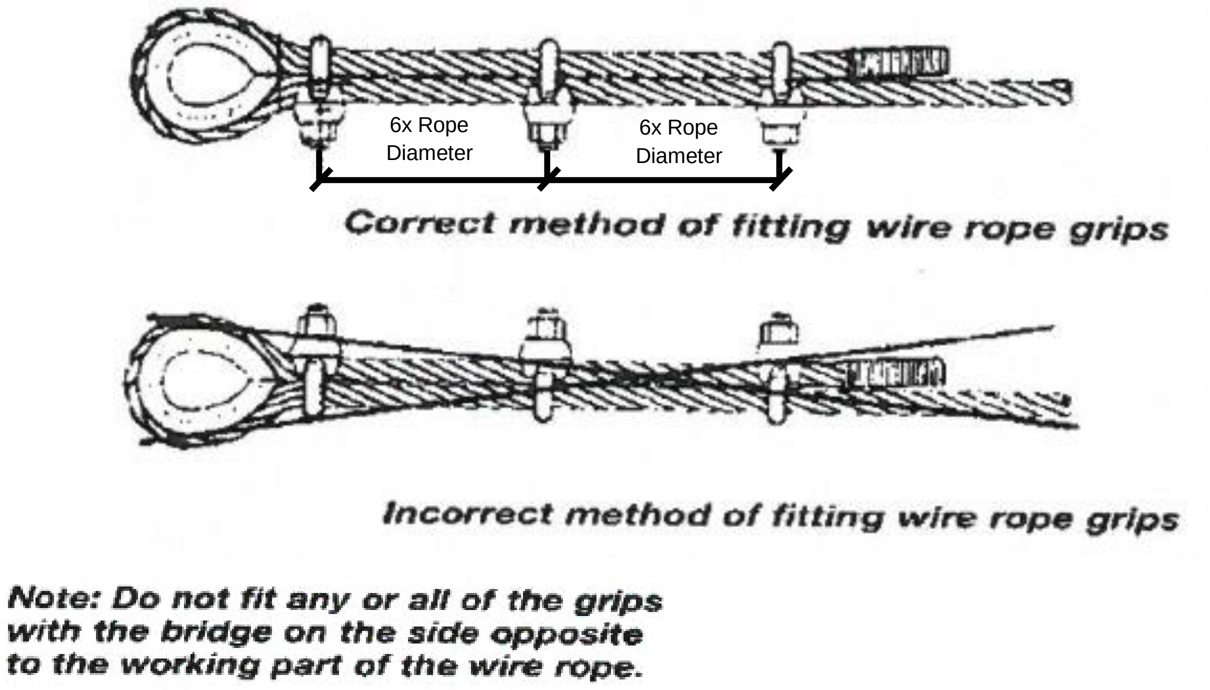
Wire rope (or 'bulldog') grips are only suitable for permanent fixed stays or guys.

They can be one of the most dangerous fittings used by riggers if not used correctly. If the bolts are over tightened the rope will be crushed or if the bolts are under tightened slipping will occur.

At least three wire rope grips should be used, with the saddles on the live part of the rope, and the U-bolt pressing on the less heavily loaded tail of the rope. They should be spaced at least six rope diameters apart.

Do not use them on temporary stays or guys that have to be shifted and re-fastened, because of the severe crushing and punishing action of the U-bolt. Do not use sections that are damaged by the clips and then straightened out to take the load.

Installation of wire rope grips (bulldog)



Do not use bulldog grips on any load hoisting ropes. When connecting a lizard to a stay or guy make sure that the crowns of the U-bolts press upon the lizard. Although they will damage it, they are easily replaced.

Correctly applied, bulldog grips may form an eye with 80 per cent of the breaking strength of the rope. If not correctly applied they may have no reasonable safe value.

Do not use a grip that is the wrong size or that has been strained or damaged.

Do not use a bulldog grip to directly connect two straight lengths of rope. If this is necessary, join two thimbles and then use the grips to make two thimble eyes

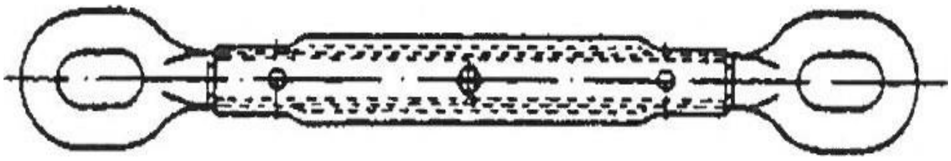
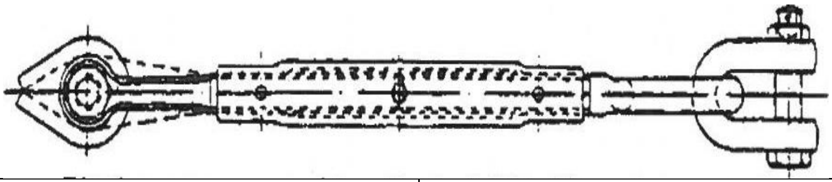
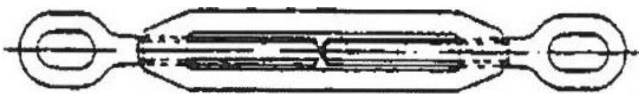
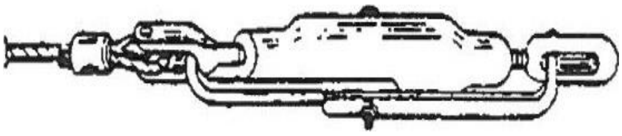
Turnbuckles or Rigging Screws

Turnbuckles or bottle screws all have a left-hand thread at one end and a right-hand thread at the other.

They can be shortened or lengthened by twisting the frame or bottle. They can be extremely dangerous where vibration causes them to unscrew. Locknuts should not be put on turnbuckles or bottle screws to prevent unscrewing under vibration.

The thread inside the bottle or frame must be examined for slackness or wear before use. The screw thread is easily seen and is not difficult to examine for defects.

Typical End Fittings

<table>
<tr><td colspan="2">Rigging screw assembly with elongated eyes
</td></tr>
<tr><td colspan="2">Rigging screw assembly with clevis/thimble and elongated eye/shackle
</td></tr>
<tr><td>Turnbuckle assembly with round eyes
</td><td>Turnbuckle assembly with elongated eyes
</td></tr>
<tr><td>Turnbuckle assembly with clevises
</td><td>Locking method for turnbuckles and rigging screws
</td></tr>
</table>

Do not use turnbuckles fitted with a hook to support a load.

Use only eye or clevis type turnbuckles to support a load.

On permanent fixings or anywhere where the rigging screw or turnbuckle may be subject to vibration, the frame should be locked out to prevent slackening.

Rigging screws must have inspection holes which give a view of the amount of thread left in the bottle. Do not use if the thread is absent or if the thread is not fully engaged.

Rigging screws or turnbuckles should never be subject to side pull. The line of pull must be straight.

The WLL must be branded on any turnbuckle or rigging screw that is used for load supporting. Do not use if the brand is absent.

Shackles

Shackles are a portable link, used for joining various pieces of lifting equipment.

The two main shapes for load lifting are:

- Dee Shackle
- Bow Shackle

“Dee” and “Bow” shackles are used to connect a sling or slings to the load or the crane hook.

Although all “Dee” and “Bow” shackles may look similar **ONLY CERTIFIED** shackles must be used when lifting.

Certified shackles have a larger diameter pin than, commercial grade shackles.

Commercial grade shackles are a mild steel shackle you would purchase from a hardware store e.g. Bunnings etc.

Almost all shackles are made of round bar and have circular eyes. The pin of the common shackle screws directly into one eye and should preferably have a collar. In some shackles, the pins pass clear through both eyes and are secured by a split pin forelock (i.e. split flat cotter pin) or nut and split pin.

The pin diameter on certified shackles are usually larger than the shackle body diameter – making them easily identifiable (see diagram below).

Certified "Dee" Shackle

Certified "Bow" Shackle

Shackles are made to AS 2741 Shackles. The grades range from grades L and M for small dee and bow shackles to grades S and T for large dee and bow shackles. In order to eliminate projections, shackle pins are sometimes counter sunk flush with the eyes.

The pin and forelock shackle is a safe shackle but is mainly used for standing rigging such as guys.

Always use the correct size shackle pin. Do not use a nut and bolt in place of the proper shackle pin. A bolt that does not fit tightly is likely to bend and break.

Condemn a shackle which is worn either in the crown or on the pin by more than 10 per cent of its original diameter.

Do not use a shackle or pin which is bent, strained, deformed or damaged. Tiny microscopic cracks may have developed during deformation. These can extend under quite small loads and lead to complete failure.

Screw shackle pins should be tightened then loosened very slightly, so that the shackle pin can be unscrewed when the weight is released. If the pins are tightened and the strain is taken on the shackle the pin often jams and is difficult to unscrew.

Where shackles are subject to vibration such as on luffing bridle pendants, mouse the shackle pin to prevent the pin from unscrewing.

Shackles are designed to take vertical forces only. Diagonal forces will strain the shackle and lead to eventual failure.

If any small object such as a single sling or another shackle is placed on the pin the shackle will 'cock bill' or can't. To stop this happening, pack the shackle pin with washers or ferrules to keep the load in the centre of the pin.

When using multiple slings, always use a bow shackle large enough to accommodate all of the eyes safely on the bow. The pin of the shackle should rest on the hook.

Do not use an unmoused screw shackle where the pin can roll under load and unscrew.

Shackles must be branded with the WLL. Do not use a shackle without the WLL clearly marked, for load lifting.

Knocking and leverage can cause vibration which works the pin out of the shackle. To prevent this use the forelock, or the pin with the nut and cotter pin.

Plate shackles are a special shackle made from steel plate with a hole drilled in either end. Two plates are joined by placing bolts through the holes. Plate shackles are used extensively for joining crane luffing bridle pendants. Make sure that the nuts have split pins and that the split pins are spread to ensure safety.

Eyebolts

Eyebolts are used extensively as lifting lugs on set pieces of equipment.

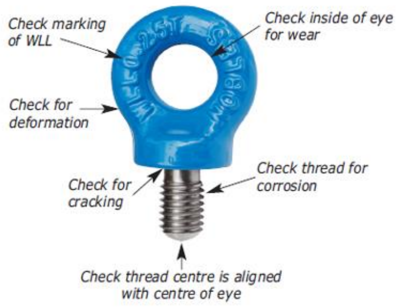
Eyebolts of sizes smaller than 12 mm should NOT be used for general lifting, staying or tensioning purposes, because high torsion stresses are easily induced in these smaller sizes by being screwed up too tightly.

The manufacturer must be consulted to obtain the SWL of eyebolts.

Remember the lowest SWL of the complete assembly, including eyebolts will be the SWL of the whole assembly.

There are two types of eyebolts:

- Plain / Non- collard – not extensively used for lifting today, with the exception of vertical lift only.
- Collard Eyebolts- used for lifting.
- Standard grade 60 eyebolt.



Collard Eyebolt
Grade 60

Plain/ Non-Collard Eyebolt
Grade 60

Collard Eyebolt
Grade 80

The safest eyebolt is a collared eyebolt. Uncollared eyebolts should only be used where the pull on the eyebolt is vertical.

Only collared eyebolts should be used where the pull is inclined from the vertical. The underside of the eyebolt should be machined and the seating upon which the eyebolt is tightened should also be machined. The eyebolt should be tightened so that both faces meet in a neat tight fit. If both faces are apart the collar is of no use.

Any diagonal tension applied to an eyebolt should be in line. The pull should never be across the eye.

Do not insert a hook into an eyebolt. Always use a shackle.

Where two eyebolts are used to lift a load, a pair of slings should be shackled into them. Do not reeve a single sling through two eyebolts and then put both eyes on the hook.

Where eyebolts cannot be kept in line with each other when tightened, insert thin washers or shims under the collars to allow the eyebolts to be tightened when in line.

Do not tighten an eyebolt using a heavy hammer. Use a light hammer or a podger bar. After tightening check the 'solid feeling' which indicates a properly fitted eyebolt.

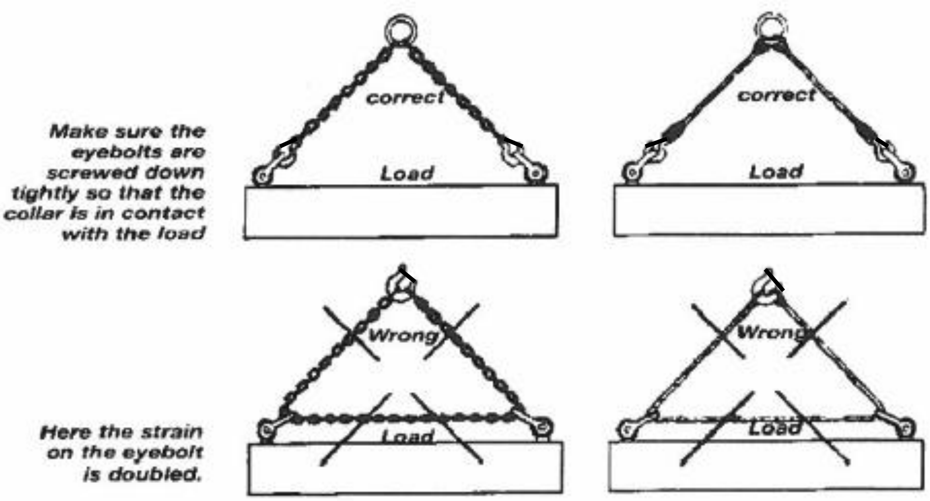
Loads can spin when lifted with a single eyebolt causing the eyebolt to unscrew from the load. Mouse the eyebolt to the load to stop unscrewing.

Eyebolts are often put on large motors or similar to lift the casing off. It can be dangerous to lift loads with the eyebolts that are provided on the load. If no information is provided about an eyebolt sling the load with slings.

Use of collared eyebolts

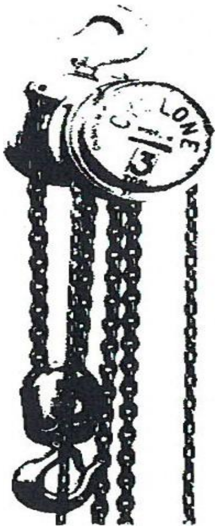
If rings are provided with the eyebolt depend on the WLL of the ring or screw thread, whichever is the weakest.

Where a nut is fitted to the end of screwed thread ensure that it bears evenly on the surface around the hole.



1.7 General Rigging Appliances

Chain Blocks



Chain blocks should comply with AS 1418.2 Serial hoists and winches. Some could be dangerous and fail under load. If in doubt check with the supplier.

Chain blocks are used for short lifts such as by small monorail cranes, fixed hoists. They are also frequently used by riggers for transferring or 'fleeting' loads from purchases.

Do not drop a chain block. The jolt may distort the casing causing the gearing to malfunction and the chain block to fail. The drive pinion could also part from the main driving spur wheel.

Make sure that the hook has not dipped through itself in a two part or multiple chain fall causing the load chain to twist.

Keep blocks away from sand, grit and dust. Some people keep the load chain lightly oiled to create less friction as the chain passes over the gypsy. If the chain is oiled and it becomes covered in sand or grit, the grit becomes a grinding paste which wears the chain very quickly.

The gypsy in one manufacturer's chain block may not be identical to another.

It is important when ordering replacement chain, that the chain and the gypsy are compatible.

Chain blocks with multiple falls are often very heavy on the opposite side to the block. It is a good practice to mouse the block to the head sling, to prevent the hook from dropping out of the head sling when the weight is released from the block.

Maintenance

Inspect the brake lining material for signs of wear and have it replaced if necessary, ensuring the retaining rivets (if any) are well countersunk.

Check the pawl for sharpness and alignment, the pawl spring for effectiveness, and the ratchet teeth for sharpness and wear.

Check the bearing bushes for wear and have them renewed if necessary.

Remove the gear case and inspect the gears for wear on the shafts, and also for bending, breakage, wear, and misalignment of teeth.

Check the load chain for wear and for stretch and the load sheaves for excessive wear. If the load chain does not fit accurately it should be replaced before using the block.

Inspect the load chain guide for movement. This guide should be the fixed type not a small roller. The purpose of the guide is to guide the load chain, free of turns, on to the gypsy. If a roller guide is fitted, hang the block up and while lowering the empty hook, gently twist the ascending chain as it approaches the guide roller. If it jams, a new guide must be fitted.

Check the hooks for opening out due to overloading or misuse. Examine the hook yokes, ball bearing swivels and anchorages of chain to clevis pins.

Where a chain block needs major overhaul or repair, advice should be sought from the supplier about the work to be carried out and should be done by people who are competent.

Chain blocks must be lubricated lightly. If too much grease is pumped into a chain block the grease could cover the brake and the chain block would fail.

Do not leave a chain block soaking in oil. The oil will saturate the brake.

Pull Lifts

There are two types of lever operated chain pullers:

1. Those fitted with bush roller chain
2. Those fitted with calibrated chain

A load supported by a bush roller chain pull lift should either be in guides or fixed into a position where side pull cannot be placed on the chain.

Calibrated chain puller

Do not extend the handle to give extra leverage. Doing this will overload the pull lift.

Inspection and maintenance is similar to chain blocks.

There are two types of FSWR lever operated pullers:

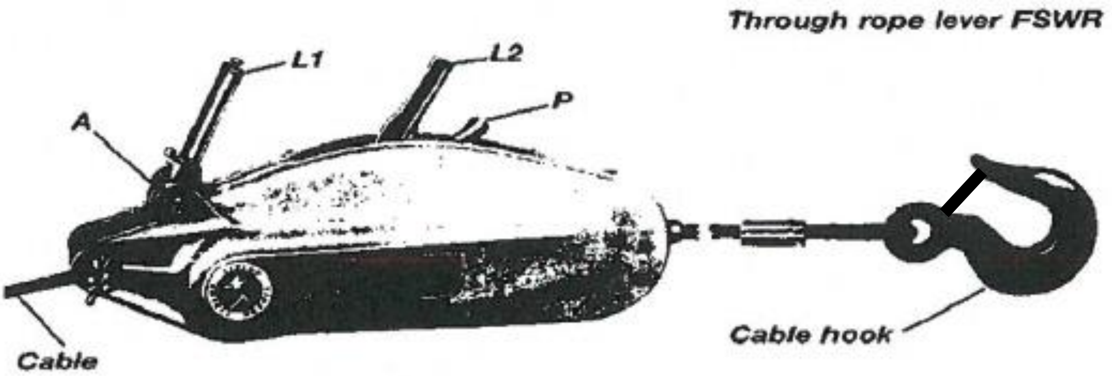
1. The drum type
2. The creeper type

The drum type has a safety ratchet and pawl. The pawl must be held by hand when lowering. Do not tie the pawl back because this can cause control to be lost.

The FSWR used in these winches must be the type recommended by the manufacturer.

The inspection of the FSWR and the anchorages must be done daily to ensure that the winch is safe to hold the load. A complete inspection must be done monthly, with particular attention to the hoist rope.

Creeper type lever operated pullers have an advantage over drum type pullers because they have unlimited drift.



Without gears, pawls and ratchets, the design enables the rope to pass through the unit in a straight line and is not wound on a drum.

Two pairs of forged steel jaws control the lifting and lowering of the load by a hand lever. The weight of the load actuates the jaws. The wire rope is at all times held by one pair of jaws while the other pair having been opened by cams, is moved by the lever for the next gripping or pulling motion. This method draws a wire rope of any length through the unit.

Caution: The rope can slip through these types of pullers because of the constant diameter in the cam gripping mechanism and because FSWR reduces in diameter under constant loading.

Operation

1. Place the hook on the ground, hold the machine at an angle and push down on the clutch release 'P' towards the anchoring hook until it is seated in the notch.
2. Pull the rope through the machine until the required length is reached.
3. Close clutch 'P'.

Forward or lifting motion. Place the handle on the lever 'L1', then pull and push alternatively.

Reverse or lowering motion. Place the handle on 'L2', and work with the same motion.

Release, pull and push alternatively on 'L2' to slacken the rope, then declutch 'P'.

Lifting Beams

Lifting beams are beams with a central top-lifting lug and two or more bottom lifting lugs.

A lifting beam transfers the load from the top lifting lug through the beam to the bottom lifting lugs. This has the effect of trying to bend the beam.

For this reason, lifting beams need to be manufactured from stronger (usually bigger) material than a spreader beam to achieve the same SWL.

The further apart the lifting lugs, the lower the SWL for the same beam (SWL is reduced). Lifting beams are usually used when there are headroom restrictions as the beam is attached via a single point, which reduces the need for a two-leg sling.

Spreader Beams

Spreader beams are beams with two or more top lifting lugs and two or more bottom lifting lugs. A spreader beam transfers the load through the lifting lug with the beam holding the load apart the distance of the lifting lugs.

Spreader beams achieve higher SWL than lifting beams made of the same material.

Spreader Beam

As with lifting beams, the farther apart the lifting lugs, the lower the SWL achievable.

Note: Both lifting beams and spreader beams must have a compliance plate installed containing the following information:

- Configuration as lifting beam or spreader beam
- SWL’s
- Serial number
- Tare weight
- Angle factor
- Test date
- Measurements between lifting points
- Manufacturers details

1.8 Slings and Working Loads

There are many variables in working out the safe method of slinging a load and placing it into position. These include the load weight, size, where the load is to be slung, the sling size, wind, rain and where the load is to be placed.

To ensure a safe lift the rigger or dogman should discuss the placement of the load and the capacity of the crane at that radius with the crane operator. It is then time to sling the load, tie on a tag line where necessary and then guide the crane operator to lift, move and place the load safely.

WLL tables are available for all types of slings and rope. Make sure that you consult the correct table before lifting.

Working load limit

The working load limit (WLL) of a sling is the maximum load that load limit may be lifted by that sling making a straight lift. The load factor for a straight lift = 1.

The WLL can be calculated by dividing the guaranteed breaking strain (GBS) by a safety factor. In general rigging work the safety factor for FSWR is 5.

For the exact WLL consult the tags on the FSWR or chain or the relevant WLL tables. If there is no tag on FSWR it must not be used, it must be tagged out of service, quarantined and reported to your supervisor and the rigging matrix must be updated to suit.

WIRE ROPE SLINGS AS 1666

1570 GRADE F.C. Single Leg	WORKING LOAD LIMIT (WLL)							1570 GRADE F.C. Two, Three and Four Leg				
	Direct loaded	Choke Hitch		Basket Hitch								
		Round load	Rectangular load	Round Load		Other than round load		Direct loaded			Choke hitch	
											Round load Single Wrap	Other Single Wrap
Method of Loading												
Included Angle α	–	–	–	60°	90°	60°	90°	0° to 60°	90°	120°	0° to 45°	0° to 45°
Loading factors	1	0.75	0.5	1.73	1.41	0.87	0.71	1.73	1.41	1	1.30	0.87
Nominal rope diameter (mm)												
8	0.55	0.41	0.27	0.96	0.78	0.48	0.39	0.96	0.78	0.55	0.72	0.48
9	0.70	0.52	0.35	1.21	0.99	0.61	0.50	1.21	0.99	0.70	0.91	0.61
10	0.86	0.65	0.43	1.50	1.22	0.75	0.61	1.50	1.22	0.86	1.13	0.75
11	1.05	0.78	0.52	1.81	1.48	0.91	0.74	1.81	1.48	1.05	1.36	0.91
12	1.23	0.92	0.61	2.14	1.74	1.07	0.88	2.14	1.74	1.23	1.61	1.07
13	1.47	1.10	0.73	2.54	2.07	1.27	1.04	2.54	2.07	1.47	1.91	1.27
14	1.70	1.27	0.85	2.94	2.40	1.48	1.21	2.94	2.40	1.70	2.21	1.48
16	2.22	1.67	1.11	3.85	3.14	1.93	1.58	3.85	3.14	2.22	2.89	1.93
18	2.80	2.10	1.40	4.85	3.95	2.44	1.99	4.85	3.95	2.80	3.65	2.44
20	3.48	2.61	1.74	6.03	4.91	3.03	2.47	6.03	4.91	3.48	4.53	3.03
22	4.20	3.15	2.10	7.27	5.92	3.65	2.98	7.27	5.92	4.20	5.46	3.65
24	5.01	3.76	2.50	8.67	7.07	4.36	3.56	8.67	7.07	5.01	6.52	4.36
26	5.88	4.41	2.94	10.18	8.30	5.12	4.18	10.18	8.30	5.88	7.65	5.12
28	6.81	5.11	3.40	11.79	9.61	5.93	4.84	11.79	9.61	6.81	8.86	5.93
32	8.90	6.68	4.45	15.41	12.56	7.75	6.32	15.41	12.56	8.90	11.58	7.75

Working Load Limit of Flat Webbing and Round Synthetic Slings

Flat webbing and round synthetic slings are labelled with the WLL.

WLL 1.0t

MATERIAL

DATE

TEST No.

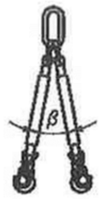
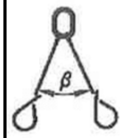
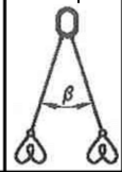
MANUFACTURER

- CONSULT SLING LOAD CHART FOR CONFIGURATIONS NOT SHOWN
- DO NOT USE SLING IF THIS TAG IS REMOVED
- INSPECT SLING FOR DAMAGE BEFORE EACH USE
- DO NOT USE SLING IF THERE IS ANY SIGN OF CUT WEBBING, SNAGGING, HEAT OR CHEMICAL DAMAGE, EXCESSIVE WEAR, DAMAGED SEAMS, ANY OTHER DEFECTS, OR PRESENCE OF GRIT, ABRASIVE MATERIALS OR OTHER DELETERIOUS MATTER
- DO NOT TIE KNOTS IN SLING WEBBING
- PROTECT SLING WEBBING FROM SHARP EDGES OF LOAD
- DO NOT EXPOSE SLING TO TEMPERATURES ABOVE 90
- DO NOT ALLOW ABRASIVE OR OTHER DAMAGING GRIT TO PENETRATE THE FIBRES
- CONSULTWITH MANUFACTURER'S RECOMMENDATIONS BEFORE IMMERSING A SLING IN A CHEMICAL SOLUTION
- KEEP AWAY FROM ...

Label for a flat webbing synthetic sling

Do not lift if the label is missing. Return the sling to the manufacturer for assessment and relabelling.

Synthetic slings are colour coded according to lifting capacity.

Round Synthetic Slings - AS 4497.2 and Flat Webbing Slings - AS 1353.2											
Safe working loads under general conditions of use											
			Basket Hitch				Two leg, three leg and four leg slings				
Method of Loading	Straight Lift	Choked Lift	Parallel				Direct Load			Choke Hitch	
										Single Wrap	Double Wrap
											
Included Angle (β)	N/A	N/A	N/A	60°	90°	120°	0° to 60°	90°	120°	0° to 45°	0° to 60°
Loading Factor (L)	1	0.8	2	1.73	1.41	1	1.73	1.41	1	1.38	
WLL in basic configuration (tonnes)	Safe working load (tonnes)										
1 (Violet)	1	0.8	2	1.7	1.4	1	1.7	1.4	1	1.3	
2 (Green)	2	1.6	4	3.4	2.8	2	3.4	2.8	2	2.7	
3 (Yellow)	3	2.4	6	5.1	4.2	3	5.1	4.2	3	4.1	
4 (Grey)	4	3.2	8	6.9	5.6	4	6.9	5.6	4	5.5	
5 (Red)	5	4.0	10	8.6	7.0	5	8.6	7.0	5	6.9	
6 (Brown)	6	4.8	12	10.3	8.4	6	10.3	8.4	6	8.2	
8 (Blue)	8	6.4	16	13.8	11.2	8	13.8	11.2	8	11.0	
10 (Orange)	10	8.0	20	17.3	14.1	10	17.3	14.1	10	13.8	
12 (Orange)	12	9.6	24	20.7	16.9	12	20.7	16.9	12	16.5	

Load Factors and Slings

The lifting capacity of a sling for a straight lift is the WLL. Once the WLL has been altered due to a particular slinging method such as an increase in the angle between two legs or a reeve it is then referred to as the safe working load (SWL).

The lifting capacity decreases as the angle between the legs of the sling attachment increases. Different methods of slinging will also alter the lifting capacity.

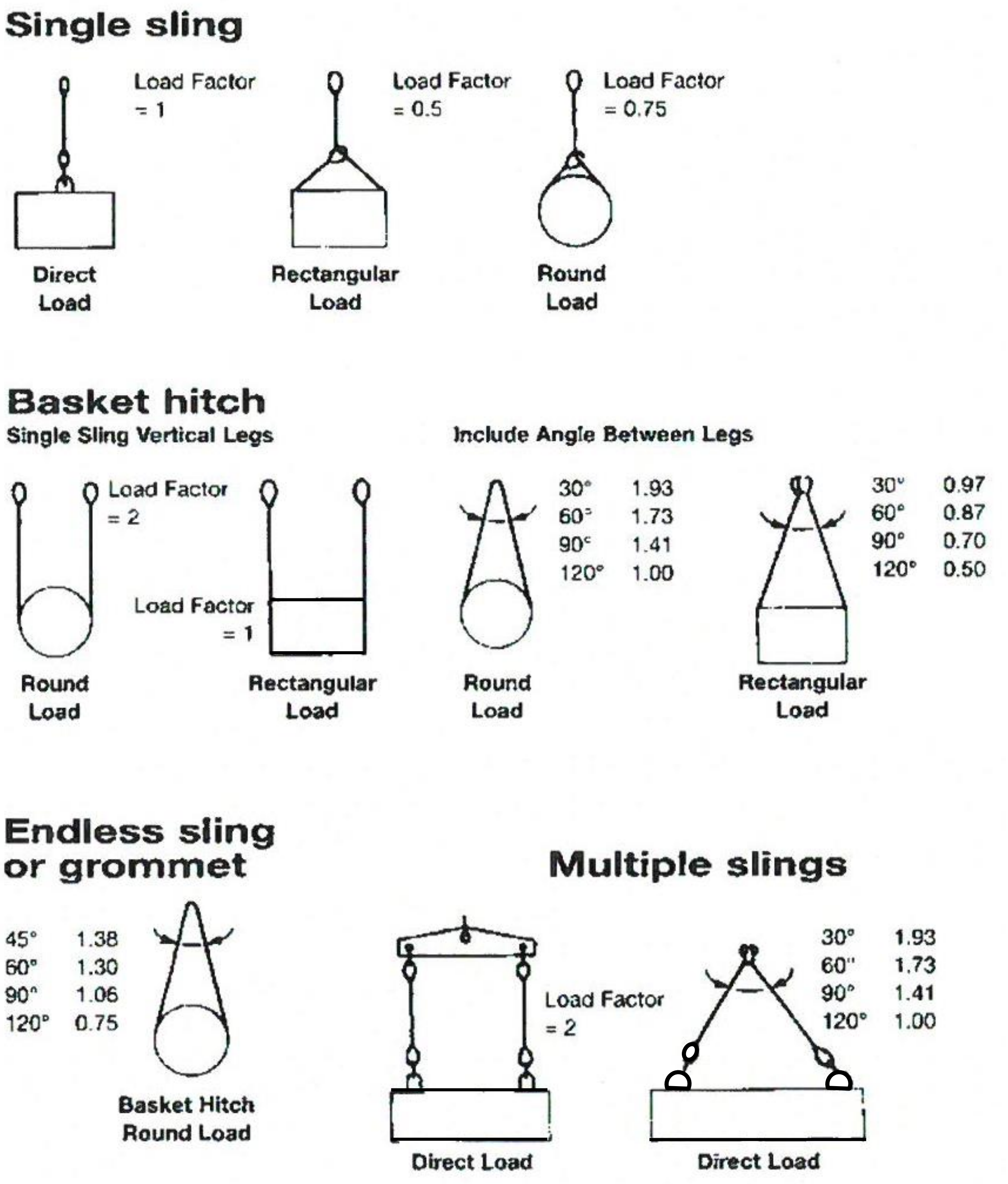
For example, a reeved sling around a square load will halve the lifting capacity of a sling. This gives a load factor of 0.5.

Riggers must know the load factors for each method of slinging shown on the next page.

The recommended maximum angle between the two legs of a sling is 90 ^{0}. The recommended maximum angle between the vertical and any leg of a sling is 45 ^{0}. At 90 ^{0} the slings will lift 1.41 times the WLL of one sling.

When slinging a rigid object with a multi-legged sling it must be assumed that only two of the sling legs are taking the load. Additional legs do not increase the SWL of the sling assembly. Therefore, each leg must be capable of taking half of the weight of the load.

The SWL of a multi-legged sling assembly is assessed on the diagonally opposite legs, which have the largest included angle.

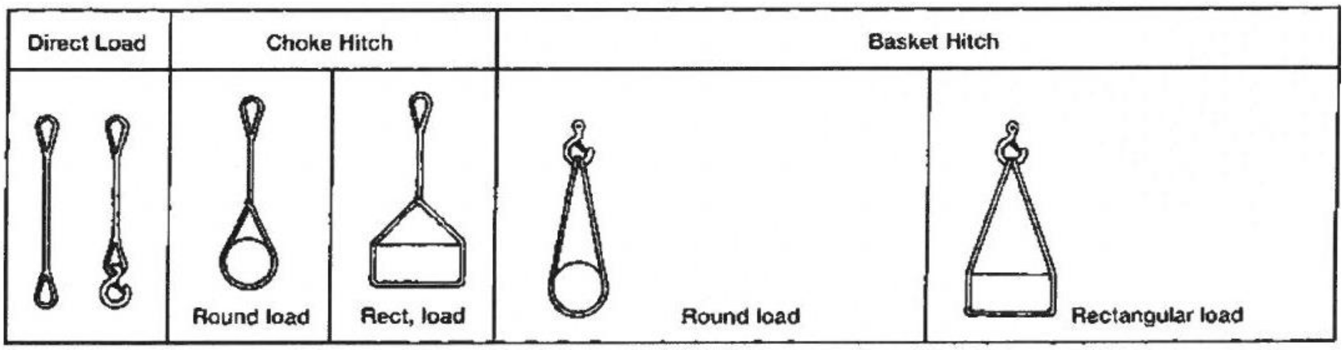


The SWL of slings decreases as the angle between the slings increases or if the slings are nipped or reeved. All factors must be considered when determining which sling is the correct one to lift a given load.

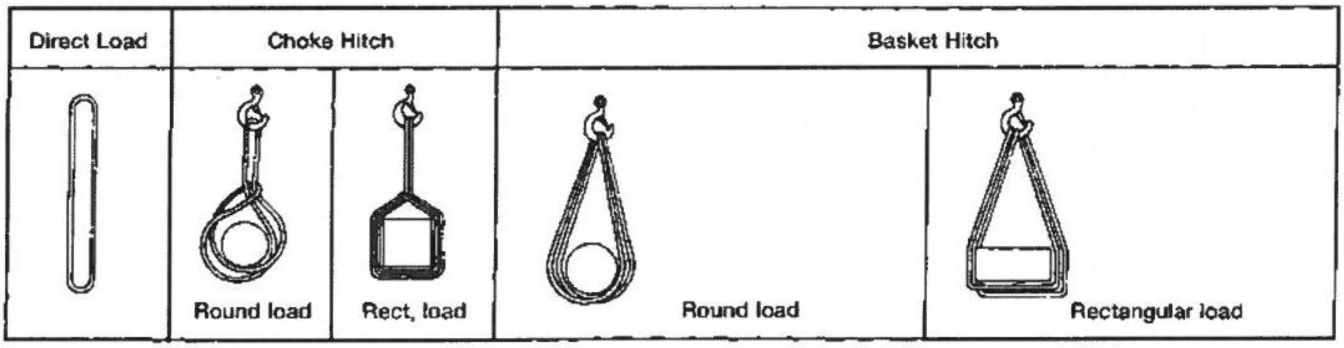
Remember that the rule of thumb method of working out the SWL of slings is not completely accurate. For an accurate SWL refer to the manufacturer's load charts.

Common Sling Arrangements

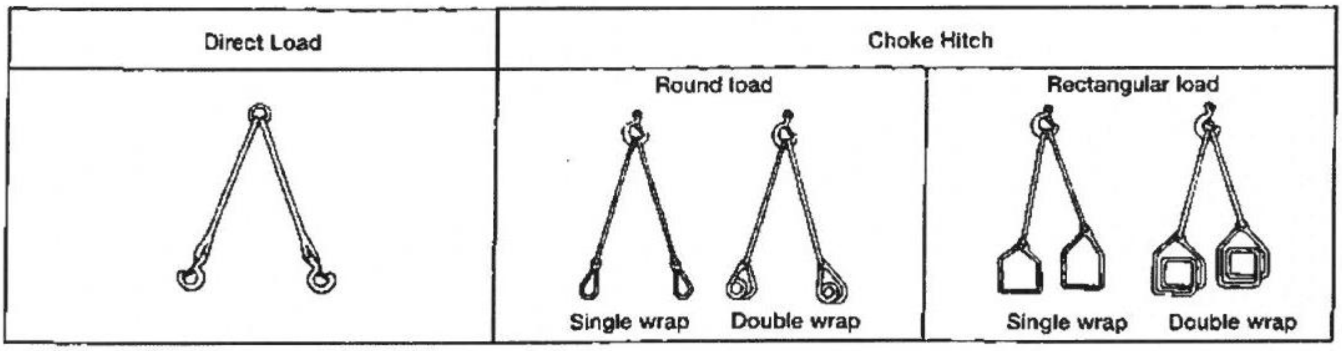
Single-part, single-leg slings



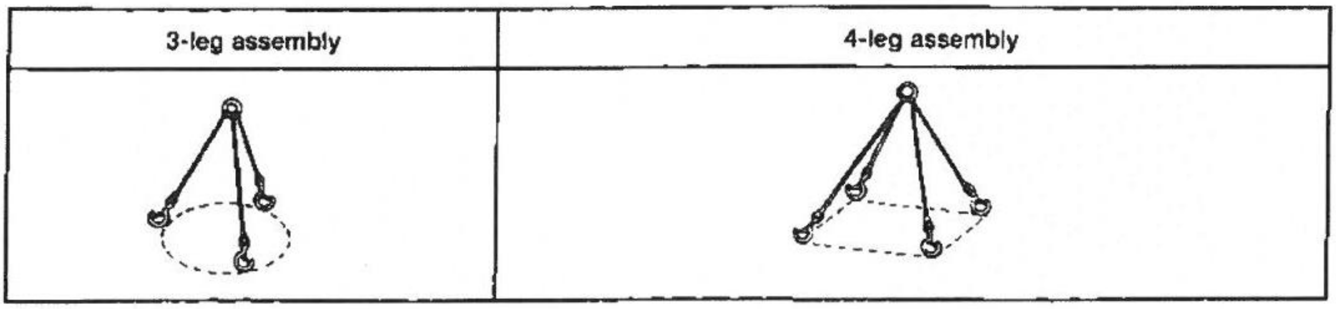
Double-part, single-leg slings



Two-leg slings



Three-leg and four-leg slings



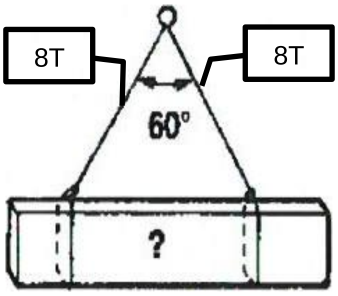
Sample Calculations

In the examples below all the load and reeve factors are for FSWR. The arithmetic is set out so that calculations can be easily worked out on a calculator.

1. To calculate the maximum weight of load that can be lifted multiply the WLL of the sling(s) by the angle factor and then by the reeve factor.

Formula: Max load = WLL (of sling) x angle factor x reeve factor.

For example: The WLL of each leg of a two-legged FSWR sling is 8 tonnes, the angle between the two sling legs is 60 ⁰ and they are reeved around a square load. This means a load factor of 1.73 for the angle and another factor of 0.5 for the reeve.



Sling WLL	8 tonnes
Angle Factor	1.73
Reeve Factor	0.5

Therefore:

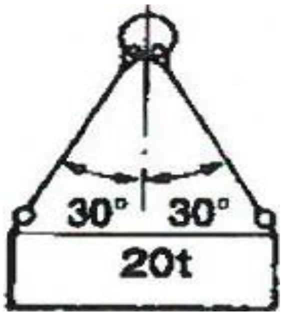
Max Load	= 8 x 1.73 x 0.5
	= 6.92 tonnes

Therefore, 6.9 tonnes is the maximum weight that can be lifted.

2. To calculate the WLL of multi-legged slings needed to lift a load divide the weight of the load by the angle factor and the reeve factor.

Formula for a calculator: WLL = Weight ÷ angle factor ÷ reeve factor

For example: The weight of the load to be lifted is 20 tonnes and the angle between the legs of a two-legged sling is 60 ⁰. This means that the load factor is 1.73 for the angle.



Weight	20 tonnes
Load Factor	1.73

Therefore:

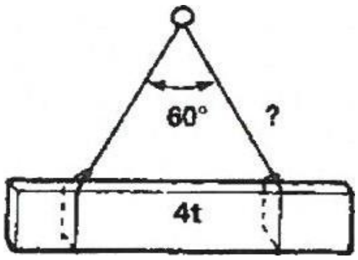
WLL	= 20 ÷ 1.73
	= 11.56 tonnes

Therefore, use a sling with a WLL greater than 11.56 tonnes.

3. To calculate the WLL of a sling needed to lift a load divide the load by the angle factor and divide by the reeve factor.

Formula for a calculator: WLL = Weight ÷ angle factor ÷ reeve factor

For example: Two FSWR slings have a 60 ⁰ angle between them and are both reeved around a 4-tonne square load. This means a load factor of 1.73 for the angle and 0.5 for the reeve.



Weight	4 tonnes
Angle Factor	1.73
Reeve Factor	0.5

Therefore:

WLL	= 4 ÷ 1.73 ÷ 0.5
	= 4.62 tonnes

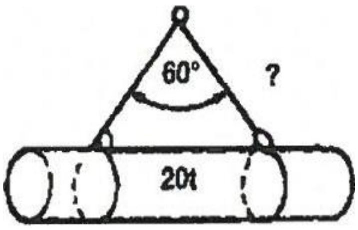
Therefore, use a pair of FSWR slings each with a WLL greater than 4.62 tonnes.

4. To calculate the WLL of the sling needed to lift a load divide the load by the angle factor and divide by the reeve factor.

Formula for a calculator: **WLL = Weight ÷ angle factor ÷ reeve factor**

For example: Two slings have a 60 ⁰ angle between them and are both reeved around a 20-tonne round load. This means a load factor of 1.73 for the angle and 0.75 for the reeve.

Weight	20 tonnes
Angle Factor	1.73
Reeve Factor	0.75



Therefore:

WLL	= 20 ÷ 1.73 ÷ 0.75
	= 15.41 tonnes

Therefore, use a sling with a WLL greater than 15.41 tonnes.

Weight of the load

Do not lift if the weight of a load is not stamped on the load or the delivery docket or it is not possible to calculate the weight.

It may be possible to calculate the weight of a load from the weighbridge certificate from the delivery vehicle.

Be careful of the load weight stamped on the load or delivery docket.

Timber for example, can be 50 per cent heavier when wet. In foundries when large castings are raised from a mould there can be suction created by the sand adding substantially to the weight. Pipes are often weighed down by sludge.

Fuel and water tanks may not always be empty. Check for this. When lifting a load for the first time watch the lifting equipment carefully for signs of strain in case the stated weight is incorrect. The operator can confirm the weight of a load using a crane load indicator, if one is fitted.

Direct Lifting

Direct the crane operator to position the head of the boom, jib or the bridge directly over the load. The load hook must be positioned directly above a load before slinging and lifting.

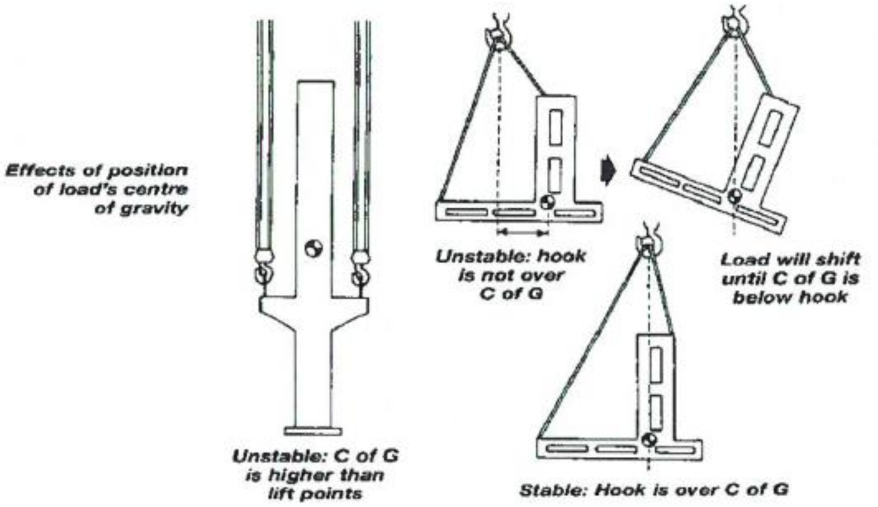
Always lift vertically. If the boom, jib or bridge is not directly over the load, the load will begin to swing dangerously as soon as it is raised, causing structural damage or instability or the crane.

Dragging a load can put undue strain on the lifting gear and crane boom especially if the load is dragged from the side.

General slinging

Make sure that there is suitable packing or lagging at all sharp edges of steel beams, and other hard materials.

Use packing to prevent the sling from coming into contact with sharp edges. This will lengthen the life of the sling and prevent damage to the slings, as well as the load itself.



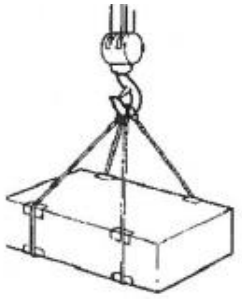
Make sure that packing or lagging is secure so that it will not fall out when the slings go slack. Before lifting a load make sure that it is not caught or trapped in some way.

Machinery, plant, personnel or material work boxes and fuel containers with lifting lugs must have the WLL clearly marked.

All loose loads delivered to a site that could be hazardous should be strapped or wrapped.

For example:

- Loads of pipe, metal, timber, purlins and wall girts should be strapped before lifting.

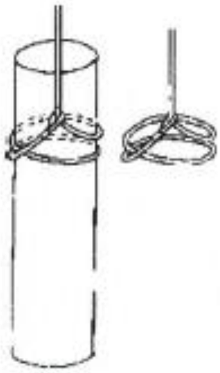


Use packing to prevent the sling from coming into contact with sharp edges

Spreaders are recommended for lifting lengths of timber, pipe or steel. If a spreader is not available — double wrap before lifting.

Spreaders are recommended for lifting lenghts of timber, pipe or steel

Correct slinging for an electric motor. Do not rely on precast lifting lugs.



When lifting vertical loads always use a round turn, i.e. 2 full turns and nip

Do not knock the "nip" down further than shown – it increases the angle and is dangerous

Do not bash the eye of a sling down at the nip point. This practice will decrease the SWL and damage the sling.

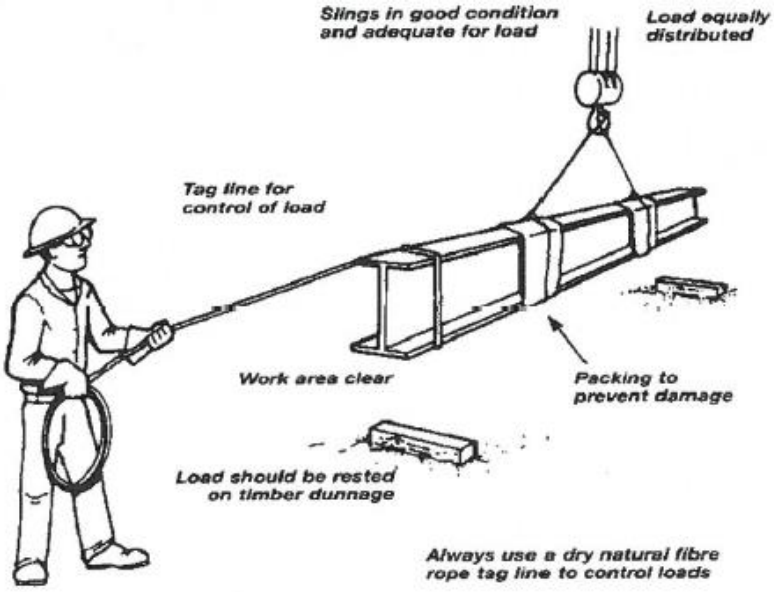
Structural Steel

Loads of structural steel (universal beams, RSJs) on trucks must have restraining spikes fitted in the truck to prevent them from falling out. Removing the chains or straps if there are no restraining spikes in place is very dangerous. Structural steel can be very dangerous. When a load arrives on site walk around the truck and check that the steel has not shifted into a dangerous position for lifting after the load binder chains were secured.

Many serious accidents have occurred as load binding chains were removed from steel beams. Deep beams that are narrower in width than height are unstable and can inflict especially severe injuries.

Always lift bundles of steel reinforcing, beams, pipes and purlins level. Do not lift it vertically or at a slope. It is not possible to make the inside section in a bundle tight enough to prevent them falling out if the bundle is at an angle. Steel reinforcing can kill if it falls.

As the load is lifted keep hands well away. Steel beams tend to snap together or roll up as the sling bites into the nip.



Loose Items

Loads of loose items such as scaffold clips must be raised in properly constructed boxes branded with the SWL.

Do not lift loads of this kind in 200 litre drums unless they are in a properly constructed lifting frame with a solid metal base, because:

- These drums have no rated lifting capacity.
- It may not be possible to know the condition of the base of the drum (they have usually been discarded because they are unfit to hold liquid).
- The holes cut into the sides for the sling or hooks can pull through under the weight.
- The sharps edge of the holes can cut through a sling.

Rubbish bins

Rubbish bins should have proper lifting lugs and be branded with the WLL. Rubbish bins that are overloaded must not be lifted. Where rubbish can be blown out or spill from a bin, secure the load before lifting (especially in windy conditions).

Sling rubbish bins with a four-legged sling. To tip the bin, release the two front slings and raise the bin with the two back slings.

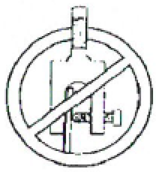
Do not stand behind a bin when tipping rubbish out. It will whip back suddenly as soon as it is clear of the ground.

Handling Steel Plate

Steel plate can be lifted with:

- Plate clamps that are designed to increase the purchase on the plate as the plate is lifted.
- Hooks or shackles where there are lifting holes in the plate.

Typical plate clamps



Do not use homemade type plate clamps or plate dogs. Remember that steel plate can injure or kill.

Eagle Clamp

Lifting, turning over, moving, suspending, tensioning, and clamping fixtures.

Marvellous, universal high-technology clamp which does the work of several models, all by itself.

EAGLE CLAMP Model SBBE

Marked with a line to confirm that the bolt is clamping

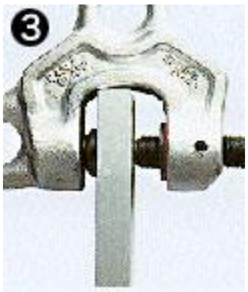
1. Vertical lifting of flat steel plates.
2. Vertical lifting of oddly shaped steel plates.
3. Horizontal lifting of thick steel plates.
4. Lifting flanged steel.
5. Lifting H steel at an angle.
6. Lifting oddly shaped, flanged steel at an angle.
7. Lifting large steel pipes.

Vertical, horizontal and tilted lifting

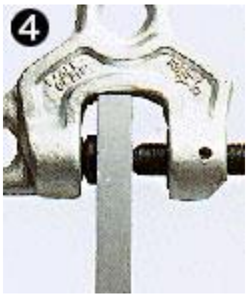
How to attach the clamps and to use them.

1. Loosen the clamping screw, and open the clamp opening until it is slightly wider than the thickness of the steel item to be lifted.

2. Insert the edge of the steel item deeps into the clamp opening.

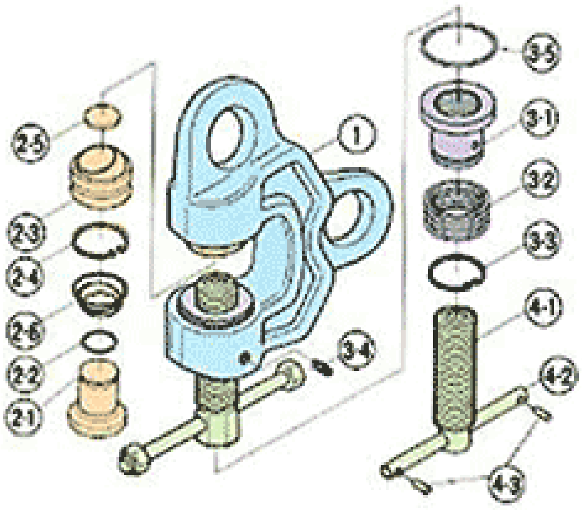


3. Secure the clamp on the item using the clamping screw. When tightening the clamping screw, special care should be taken not to tilt the swivel jaw.



4. Tighten the clamping screw sufficiently so that the spring built into the pressure nut can work properly to provide a secure grip. (Tightening torque: 150 kg-cm or more).

Components

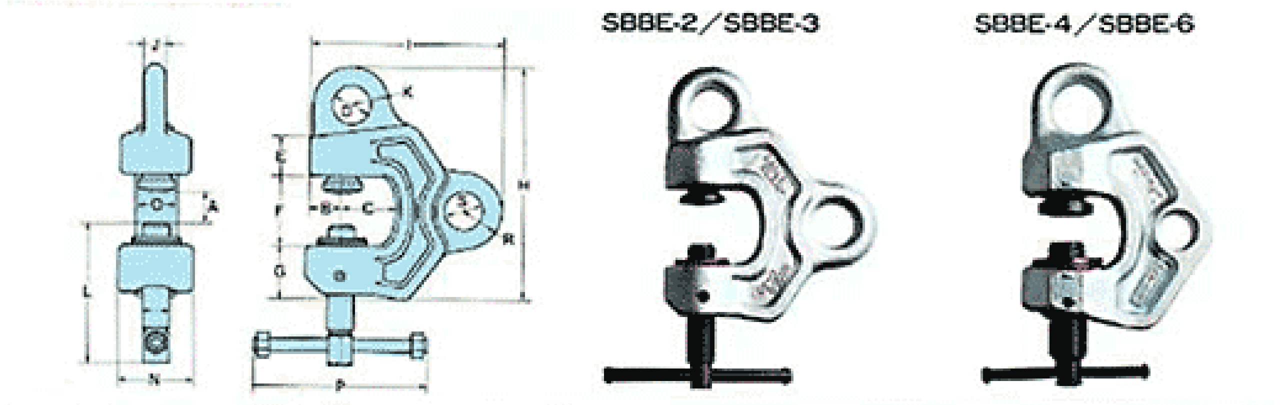


ITEM	ASSEMBLY NAME	PART №	PARTS NAME
1	MAIN BODY		
2	SWIVEL JAW	2-1	JAW
		2-2	CIRC RING
		2-3	BEARING
		2-4	SNAP RING
		2-5	BOTTOM PLATE
		2-6	RED RING
3	PRESSURE NUT	3-1	PRESSURE NUT
		3-2	SPRING
		3-3	SNAP RING
		3-4	SET SCREW
		3-5	CIRC RING
4	CLAMPING SCREW	4-1	TIGHTENING BOLT
		4-2	CLAMP HANDLE
		4-3	ROUND PIN

⚠ WARNING

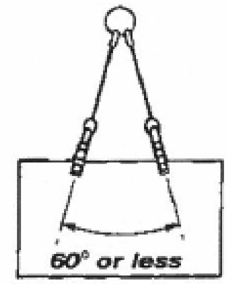
(1) Before using any clamps, be sure to read the instruction manual thoroughly.
(2) Be sure to insert the item to be lifted deep into the clamp opening.
(3) When you are securing a steel item with a clamping screw, be careful not to tilt the swivel jaw.
(4) Using a tightening torque of 150 kg-cm or more, tighten the clamping screw completely until it no longer turns.
(5) Before starting any lifting operation, double check that the bolt clamping safety check line cannot be seen.
(6) These clamps cannot be used to lift or move steel items with HRC32.2 (Hv 330) or more.

Specifications



Model	W.L.L. (tons)	Jaw opening A (mm)	Dimensions (mm)																	Tightening torque	Weight
			B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q*	R	S	(150kg·cm or more)	(kg)
SBBE-2	2.0	0~40	30	45	32ø	31	61	46	203	166	18	34	124	24ø	55	36ø	150	22ø	34	32ø	150	3.7
SBBE-3	3.0	0~40	37	43	36ø	43	66	45	210	183	25	38	134	32ø	70	44ø	150	25ø	36	32ø	150	7.6
SBBE-4	4.0	5~35	40	47	45ø	40	60	60	240	170	30	42	137	36ø	80	50ø	150	30ø	30	31ø	150	7.6
SBBE-6	6.0	10~40	48	55	50ø	45	70	70	276	213	35	47	150	40ø	96	60ø	150	35ø	45	37ø	150	14.5

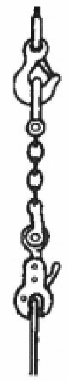
Use a spreader beam if the angle between the two legs is likely to be more than 60^{0}.
Steel plate can be lifted vertically or horizontally.



Always use a spreader beam for lifting steel plate if the angle between two slings exceeds 60°

Lifting vertically:

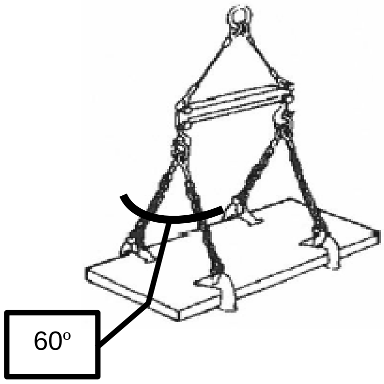
- Use a plate clamp where a sling cannot be attached and there is no lifting hole. An example is the dished and flanged end plate for a pressure vessel.
- ***Note:*** It can be difficult to remove or attach a sling where plate is stored vertically in a rack or is to be fed into bending rolls.
- As a plate touches the ground and the tension is released from the slings a single hook can come out of the hole causing the plate to fall. To prevent this lift with a hook put through a ring attached to short length of chain that is shackled to a plate clamp.
- Always make sure that the tension remains in the slings until Correct set-up for lifting steel plate vertically the plate is in place.



Correct set-up for lifting steel plate vertically

Lifting horizontally:

- It is recommended that a minimum of four plate clamps and a spreader beam are used for lifting steel plate horizontally. For horizontal lifts use appropriate plate clamps. Use a spreader beam for long thin plates to prevent dangerous flapping, sagging and vibration.



Make sure that the angle between slings when lifting plate is 60° or less

Pallets
A wide variety of loads are delivered on pallets. Before a palleted load is lifted from a truck check that:

- The pallet is free from defects.
- The load is secured so that nothing can fall off.
- The load is properly slung.

The WLL of a standard hardwood pallet is 2000kg. The WLL can be dramatically reduced if there are any missing boards or any other defects. Note: Some pallets are designed for packaging not lifting.

Do not lift a pallet that has defects. To lift a load on a damaged pallet, raise the load just enough to slide an undamaged pallet underneath. Then lower the load and sling properly before lifting and moving the load to the desired place.

If no spare undamaged pallets are available send the load back to the supplier to be re-palleted.

Always raise palleted bricks inside a certified brick cage to prevent loose bricks falling.

Loading Formwork
When placing concrete out of a kibble onto formwork spread the flow out. Dumping the whole load in one spot can overload the formwork especially if it is also taking the weight of workers and vibrating equipment. Formwork is only designed to take concrete spread out evenly over the whole area.

Make sure that the concrete is poured gradually. The sudden release from a kibble attached to a mobile or tower crane can cause a 'whip back' and the kibble will bounce dangerously.

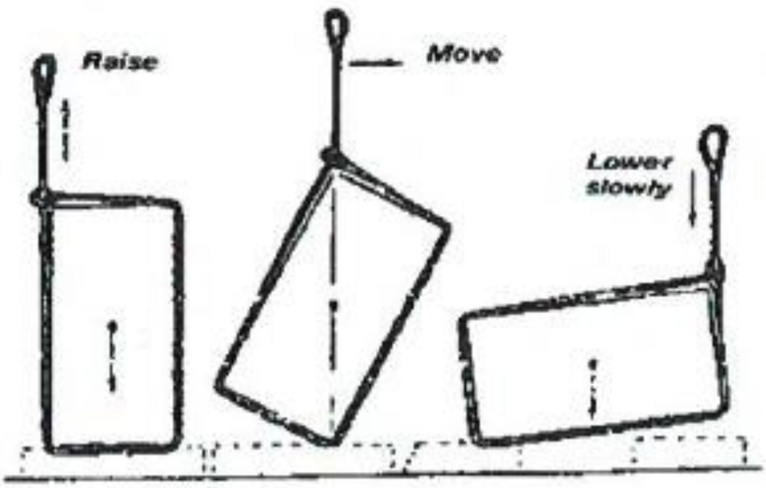
Turning Over Loads
When turning over a load such as a steel beam the sling must be attached to the hook on the side of the load that is to be lifted. This will ensure that it will be raised on a diagonal through the centre of gravity.

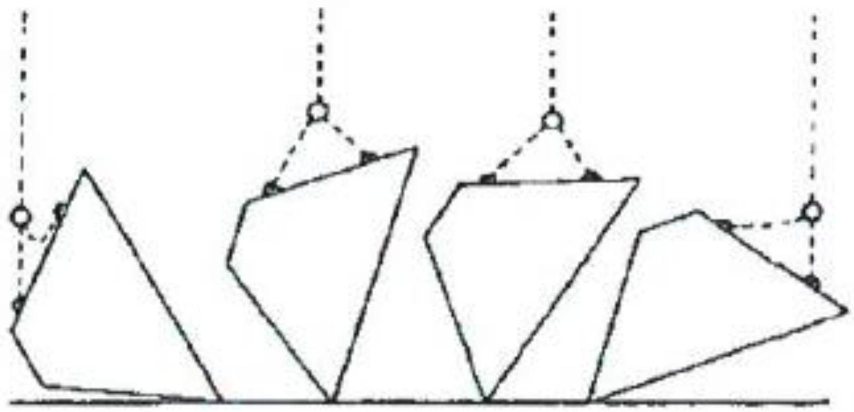
It is then a simple matter to lower the hook, turning the beam over in a safe and controlled manner.

It is important that the beam is slung so that when the beam is lowered the nip will pull against the eye.

Structural steel members such as universal beams and RSJ's have a high centre of gravity and a narrow base when standing on their flange. If a sling is nipped incorrectly the beam will flop, topple over and possibly break the slings.

The same principles apply when turning over all loads.





1.9 Selection and Use of Mobile Cranes

Before commencing a job with a mobile crane, go to the work site with the supervisor and the crane operator and assess the crane suitability for the whole job. Assess access, operating space, ground conditions, lift capacity, lifting equipment and the load specifics.

Decide where to set up and how to set up.

Mobiling

Some mobile cranes are better suited than others to travel over rough surfaces. Always check the load chart and the manufacturer's recommendations before mobiling.

Cranes are more likely to overturn 'off-road'. Before leaving the road check:

- For potholes and soft or rough ground.
- For overhead obstructions.
- For powerlines.
- For personnel working in the area.
- Blind corners.
- Traffic flow.
- Underground services.

Always check grassy surfaces for potholes hidden by long grass. Walk over the whole area before guiding a crane across.

Make sure spring lockouts (where fitted) are set before mobiling a load.

Do not direct the operator to slew unless the surface is firm and level. Booms are not made to withstand sideways forces.

Slewing can be very dangerous if the crane is attached in any way to another crane or tackle. (The whole operation must be under the control of one person.)

The load should be connected to the crane by a tail rope to prevent sway that could cause the crane to overturn. Do not mobile heavy loads with crawler cranes unless the ground is firm and level.

Take extreme caution walking a load into position with the load high and close to the boom. The load can swing back and hit the boom causing it to collapse as the crane moves forward.

When a crane is used as a winch make sure that the crane is secured in position and immobile.

All mobile cranes with wire rope luffing gear must have a luffing overwinding limit device.

The load must be secured in a fore and aft position unless the load is too long. Long loads must be secured in a diagonal position with the boom fore and aft.

Warning lights (where fitted) must be turned on when the crane is moving.

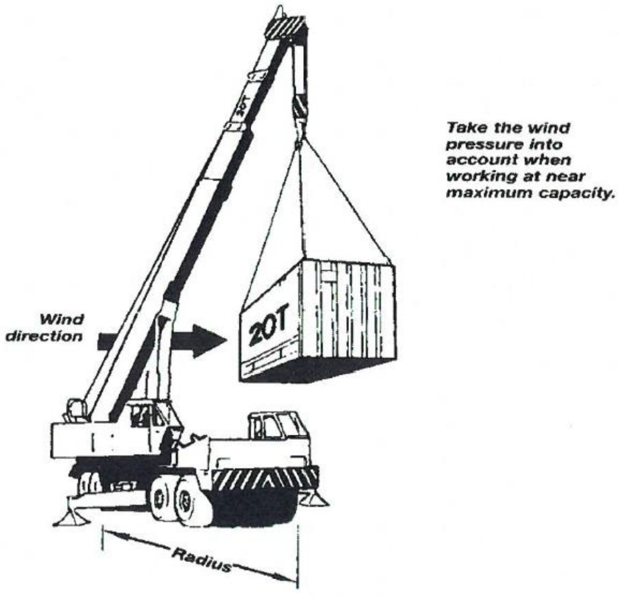
Travel slowly to prevent excessive swing.

Always carry the load as close to the ground as possible.

Do not direct the load higher until it is almost in position.

Avoid travelling the crane over potholes, depressions, soft ground or across a slope, road cambers or shoulders, rail tracks, or any objects or dunnage wood, which could destabilise the crane or load.

Observe traffic rules, watch intersections, and avoid pedestrians. Instruct the operator to use the warning horn or whistle when approaching pedestrians or workers.

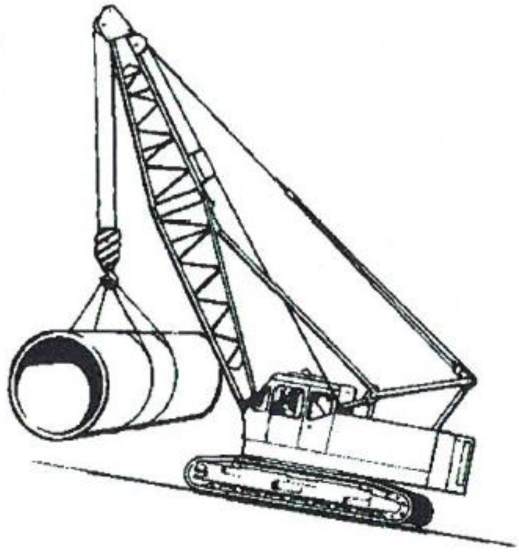


Warn everyone in the area of your intention before moving the load. A person can be easily knocked from a structure or crushed by a moving load.

General rules for mobiling up and down slopes:

- Take the slope and angle of the boom into account when moving up or down a slope.
- The load must face uphill.
- When mobiling on a slope with the boom facing uphill ensure that the boom angle does not become too close to vertical. This is to prevent the boom toppling over backwards.
- Do not travel across a slope with a load.
- Crawler cranes are very dangerous on sloping ground. Direct the operator to boom down before mobiling a crawler crane up a slope. Once the crane reaches the top the operator must boom up to compensate.
- Where necessary use another crane to steady heavy crawler cranes when they are travelling downhill.

The load must always face uphill as close to the ground as possible



Crane Safety

Make sure that the WLL of the hook is at least equal to the maximum load that can be safely lifted by the crane at the given radius and boom position.

Check the hook block for corrosion in the shank and for distortion, cracks and wear in the hook.

Make sure that the hoist rope is completely without twists and turns before lifting where the hook block is supported with multiple falls of rope.

Keep well clear of the lower hoist block sheaves to prevent fingers or hands from jamming in the sheaves.

Make sure that all tyres are inflated to the correct air pressure.

When lifting heavy loads, the boom will pull down (boom deflection) as it takes the weight thus putting a forward swing into the load when it is raised. To allow for this, take the strain then boom up or alternatively position the hook slightly closer to the crane.

Make sure that when lifting broadside with a mobile crane on a slope, the downside wheels are raised by solid packing so that the crane chassis is level.

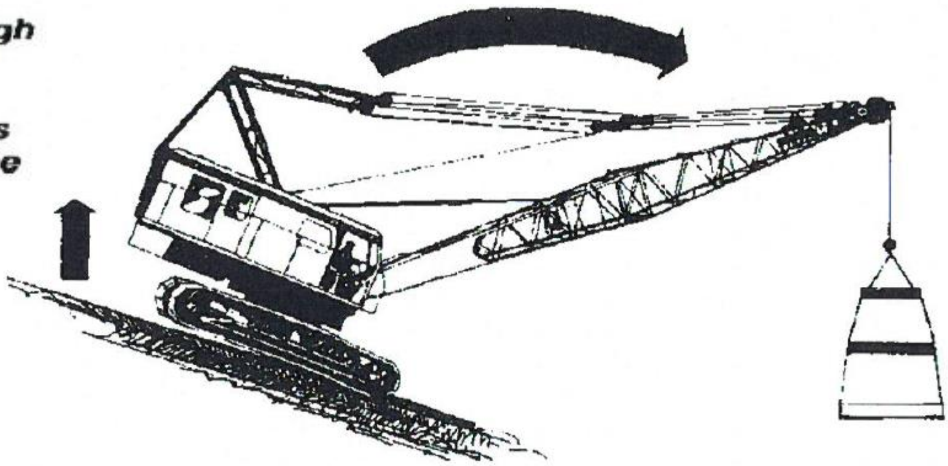
Always stand clear of loads being lifted or handled.

Make sure that slewing cranes are clear of all obstacles, loads and people. Bystanders can become jammed between cab, counterweight and chassis.

For cranes of less than 5 tonne capacity, the lower hoist block must be safeguarded to prevent injuries to hands or fingers.

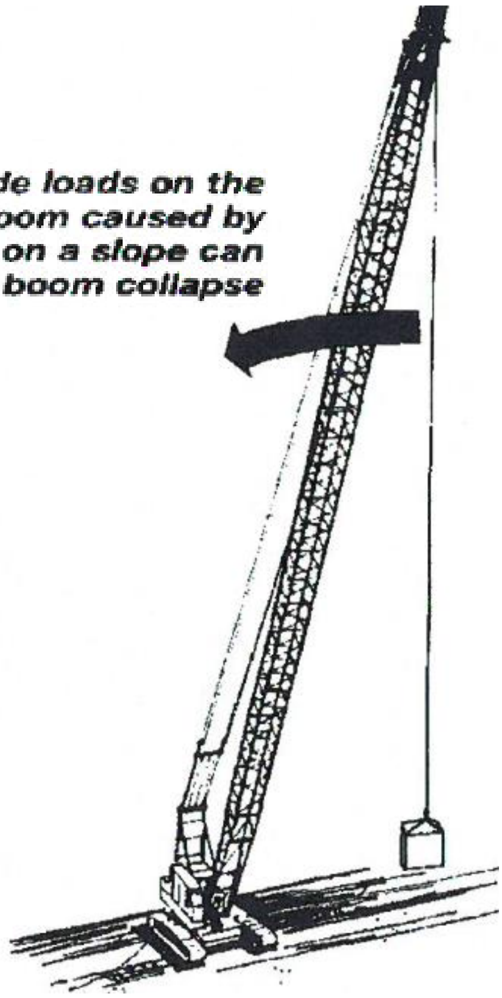
Swinging from the high side to the low side without altering the boom angle increases the radius — can cause overturing.

Always stand well clear of a slewing crane



Swinging from the high side to the low side without altering the boom angle increases the radius – can cause overturning

Swinging from the low side to the high side with a high boom angle can cause the boom to collapse back over the crane



The side loads on the boom caused by working on a slope can result in boom collapse

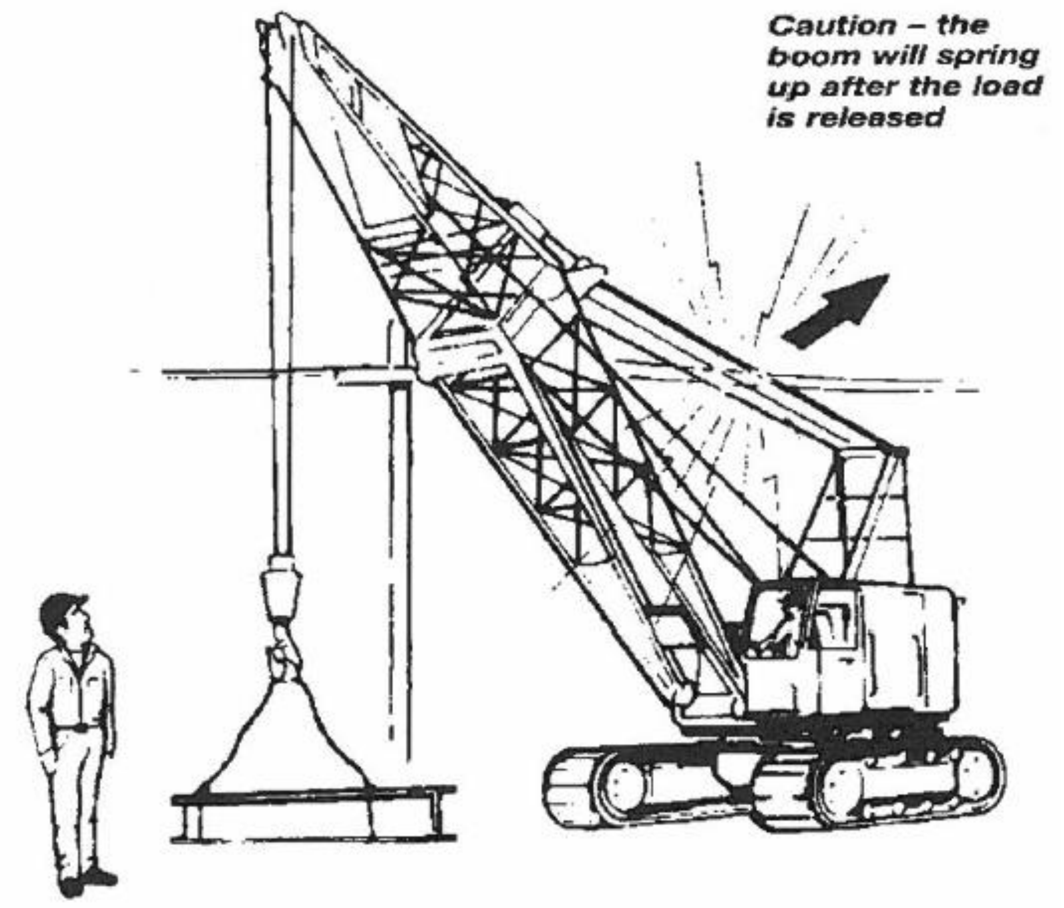
When lifting a load on a floating vessel carry out the operations quickly and cleanly.

When placing a load onto a floating vessel 'inch' the load slowly into place to prevent the vessel surging.

Crane hoist falls must not be secured to floating vessels for towing or mooring purposes.

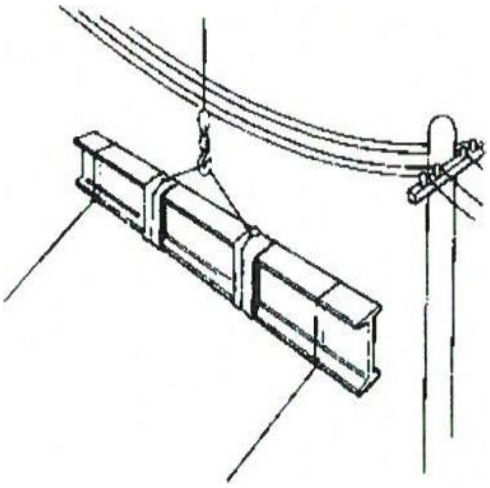
Electrical Hazards

Always maintain a safe distance from electrical wires when travelling with the boom raised.



The head of a long boom will spring up when the load is released. Make sure there is a safe distance from any electrical conductors or other obstructions before releasing the load. Do not set cranes up close to any electrified equipment or apparatus unless there are safeguards to ensure the safety of persons using the crane.

All types of crane must not approach closer than the distances specified in each individual State/Territory or Jurisdiction.



Caution: In some cases, transmission lines can be found on poles.

Keep a look out for possible contact with electrical equipment at all times while operating or travelling the crane. If the crane could come within any of the above distances to electrical apparatus during operation, an observer must be appointed to keep watch and if necessary to warn the dogman/rigger.

Advise the crane operator if the crane is in close proximity to electrical equipment. If unsure about the voltage maintain a distance of 6 metres from wires.

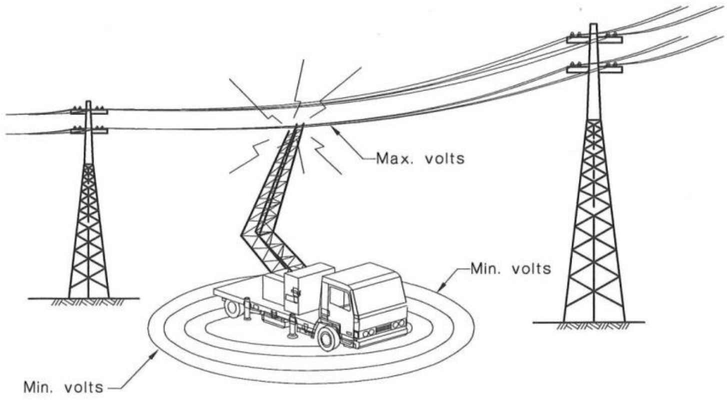
Where possible de-energise electrical equipment or use buffers or stops to prevent any part of the crane from coming close to electrical equipment. This is the responsibility of the contractor and the local electricity supplier.

Always use a 16mm dry natural fibre rope as a tag line. Some synthetic fibre rope can conduct electricity in some circumstances.

WA OCCUPATIONAL HEALTH AND SAFETY REGULATION 3.64 and

3.64 (1) In this regulation – "danger zone" means anywhere that the boom, mast or the machine can enter the following distances from power lines:

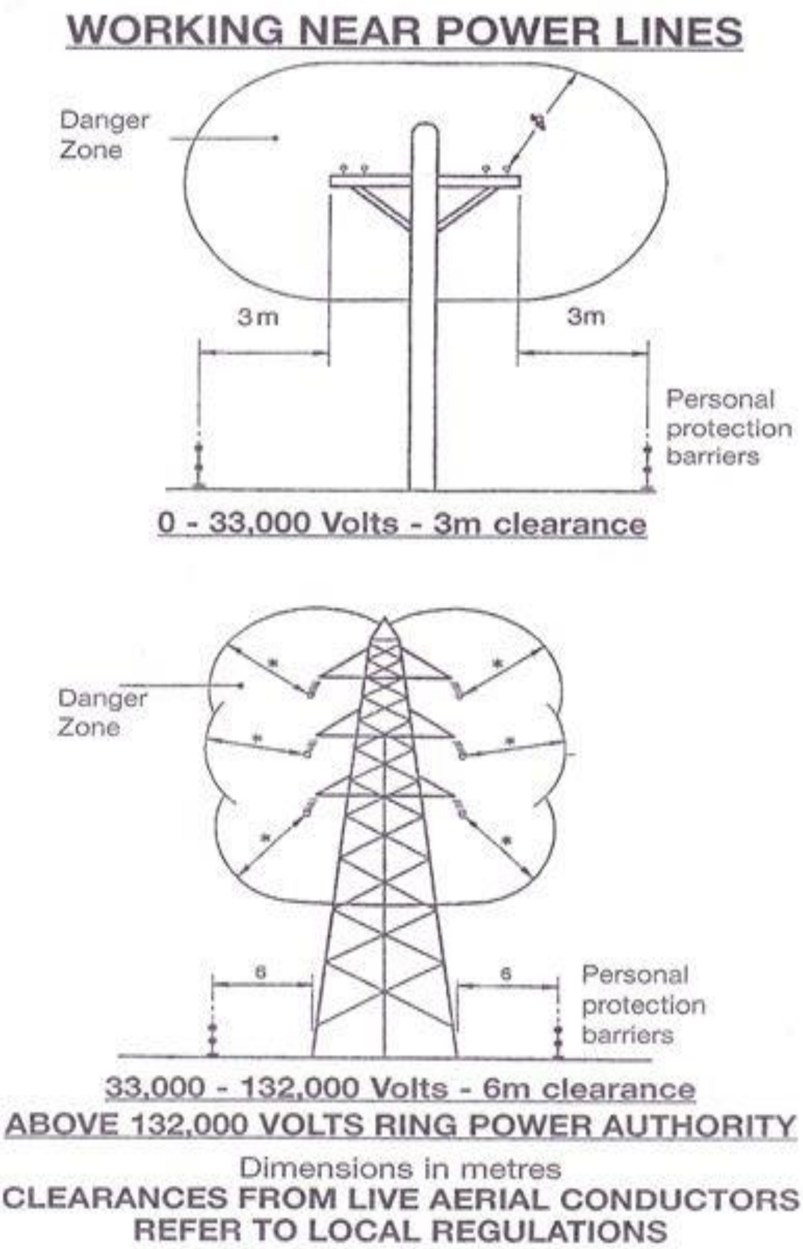
- Up to 1,000 volts insulated 0.5 mtr
- Up to 1,000 volts uninsulated 1 mtr
- Up to 33,000 volts 3 mtr
- Over 33,000 volts 6 mtr



WA MINES SAFETY AND INSPECTION REGULATION 5.28

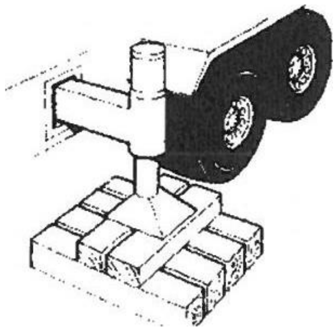
Power Corridor 10m

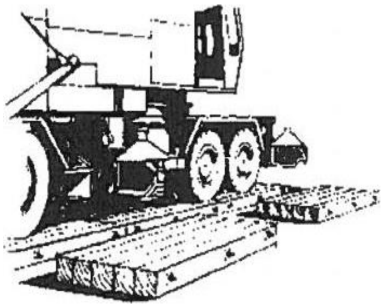
The best method of determining the voltage of overhead electric lines is contacting the power authority.



Outriggers

Outriggers are hinged or sliding beams that are usually secured with locking pins or check valves. They must be secured when they are retracted.





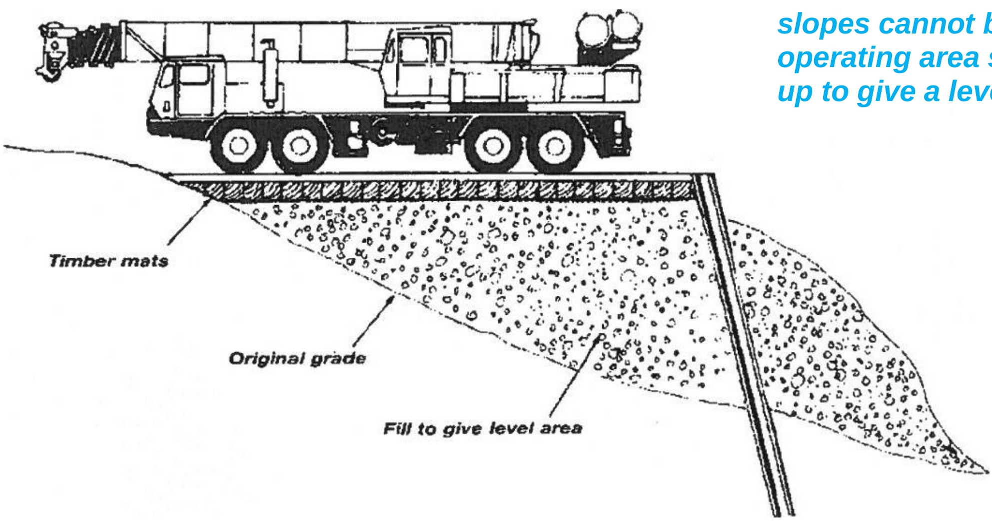
Outriggers should be packed to keep the crane level and stable when in use. General rules for packing under outriggers:

- Outriggers should be fully extended wherever possible.
- Make sure that the ground under the packing is firm and can bear the load.
- The packing must cover as much area as possible to distribute the load.
- The base layer of packing should be laid closely together and be at least 75mm thick.
- The top layer of packing must be at right angles to the direction of the outrigger beam and at least 200mm wide.
- The packing should be hardwood free from defects. Where Oregon is used, beware of cracks.
- The packing must be 'pigstyed' (each layer at right angles to the next).
- Check the condition of the jacks and packing regularly during crane operation – packing will often loosen up during initial use as the ground settles.

Consult the load radius (or boom angle) indicator and load chart to find the maximum load that can be lifted:

- When the crane is on outriggers.
- When it is not on outriggers.

In cases where operation on slopes cannot be avoided, the operating area should be built up to give a level base



The load chart on the crane must display the maximum load that can be lifted in all areas of operation. These may typically include

- The working zones of slewing cranes.
- With any length of boom or jib.
- At any radius of the load from the centre of the crane.
- With no packed outriggers at the ends.
- With no packed outriggers at the sides.
- With the crane stationary on outriggers.
- During mobiling.

To tighten packing under non-hydraulic outriggers, raise the boom high and slew the boom broadside, then tighten the packing under the boom. Repeat for the other side.

Slewing must be carried out slowly. Slewing places great strain on the boom, clutch, pinion and races. The strain is greater still if the load develops excessive swing.

It is important that the area of the base of the outrigger packing is large enough to safely take the load. To make an estimate of the area needed use the formula below.

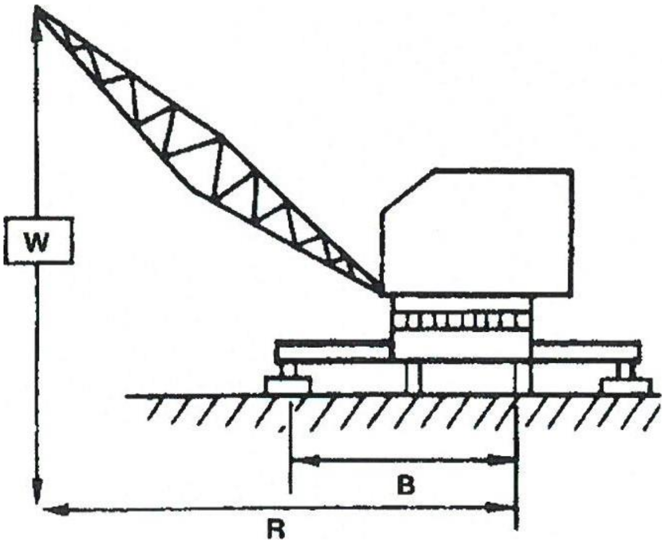
The formula for calculating the area of each outrigger base of lattice boom cranes in square metres:

$$\text{Area of Base} = \frac{W \times R}{B \times N \times V}$$

For a Calculator:

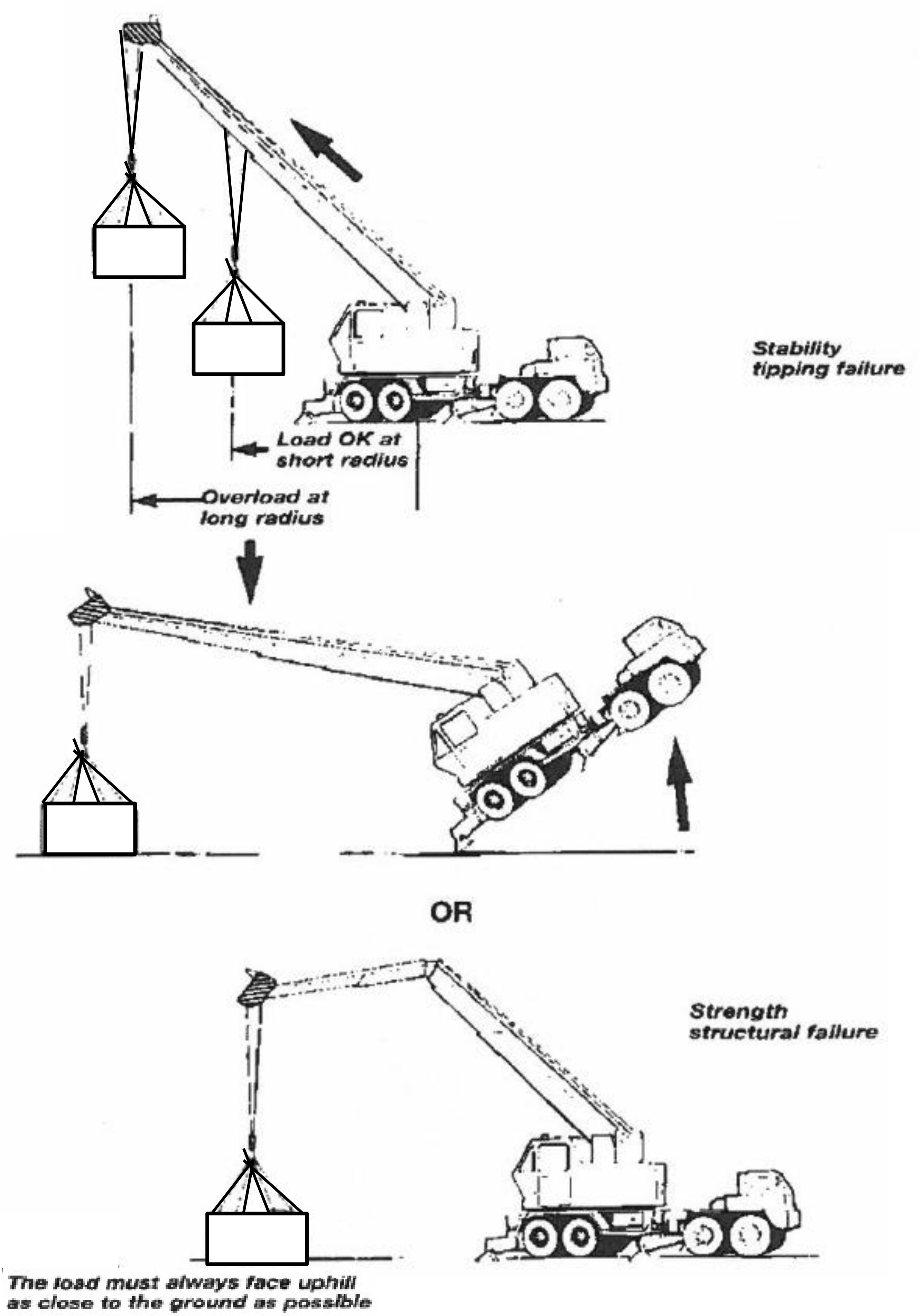
Area of Base = W x R ÷ B ÷ N ÷ V

W = Load plus half the mass of the boom in tonnes
R = Distance from load to back wheel support in metres
B = End of outrigger to back wheel in metres
N = Number of outriggers on the loaded side
V = Bearing pressure of soil



Use the table below for estimating the load bearing pressure (V) of different soil types.

SOIL TYPE	Pressure (V) Tonnes per sq. metre
Soft clay or loam	10
Ordinary clay and dry sand mixed with clay	20
Dry sand and dry clay	30
Hard clay and firm coarse sand	40
Firm coarse sand and gravel	50
Shale rock and sandstone	80
Hard Rock	200



Load OK at short radius
Overload at long radius
Stability tipping failure
OR
Strength structural failure
The load must always face uphill as close to the ground as possible

1.10 Packing, Securing and Moving Loads

Packing

Packing must be able to support the load and the base of the footings of packing should be hard and level. If the footing is earth, a layer of sand should be spread over the area. Make sure that the base area of packing is large enough to support the load.

Check that there are no services such as large diameter pipes, tanks and cellars under the packing, especially if a heavy load is to be placed on the packing.

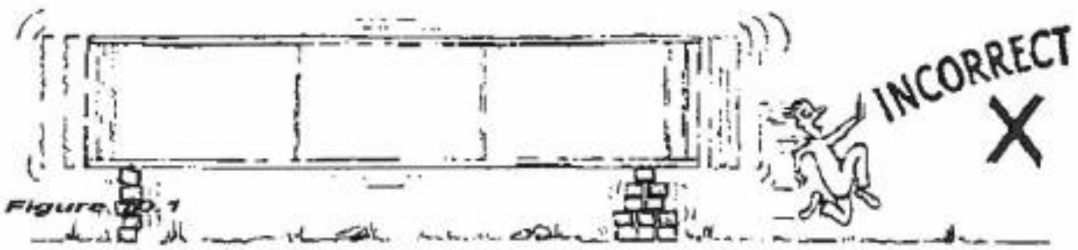
Do not place bearers in line above one another, as the packing can roll and collapse.

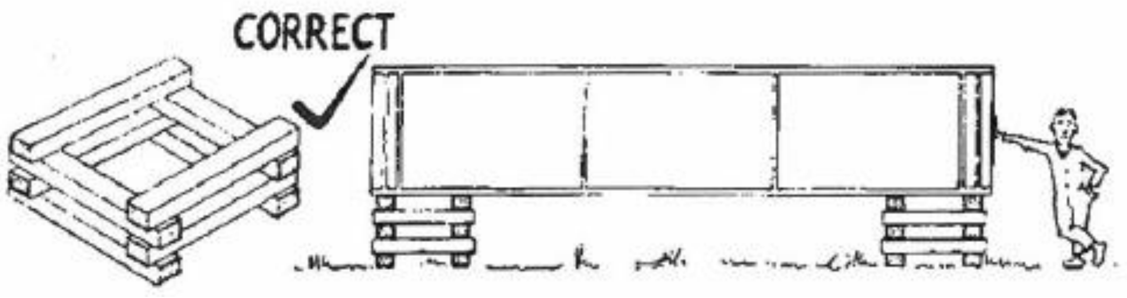
During lifting operations, keep filling the gap with packing until larger bearers can be inserted. Follow up packing must be adjusted as the load rises.

Pigsties or Cribbing

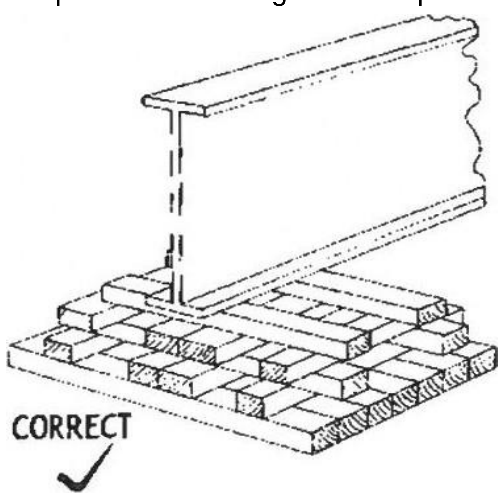
Pig stying is an effective method of supporting a load with criss-crossed timber packing. Each layer is set at 90^{0} to the layer below.

The footing base must be large enough to support the load and the main load support bearers must be at right angles to the load.





Sleepers which are all slightly different sizes are often used for pig stying. To ensure there is no movement the second layer must be packed with wedges or thin packers (gluts).



SECTION 2 – Basic Rigging

2.1 Steel Erection

The use of structural steel in the construction of multi-storey buildings was very common until the development of concrete reinforced design. Over recent years, however, structural steel design has started to make a comeback in multi-storey work. Portal frame construction is also widely used for low rise factories and warehouses. Structural steel is used extensively in the construction of powers stations, smelters, refineries, bridges, transmission towers, communications towers and other industrial projects.

Certification

Those engaged in (or directly supervising) steel erection must hold a Basic Rigging High Risk Work Licence (HRWL) as a minimum.

Where steel erection involves multiple crane lifting operations or the use of load equalising gear, the Intermediate Rigging HRWL is required. The erection of permanently guyed structures (such as some communications towers) requires the Advanced Rigging HRWL.

Riggers must be familiar with the common erection methods and be able to recognise the typical hazards associated with this type of work. They must be able to read and understand construction drawings and specifications. They must also have the skills necessary to use the tools and equipment needed to erect steel and they must be able to work safely and confidently at heights.

Steel Erection

Structural steel is basically a skeleton, designed to support a building. The first section must be fully plumbed, and wind braced to ensure stability for the rest of framework.

As erection progresses, the wind bracing must be fitted. In some 'A-Frame' or 'Saw tooth' type buildings, which are long and narrow, the building may have to be guyed for support until each wind brace bay is erected.

Columns should be guyed to prevent the holding down bolts from pulling out causing the column to collapse. The concrete in the plinth that the column stands on is usually green.

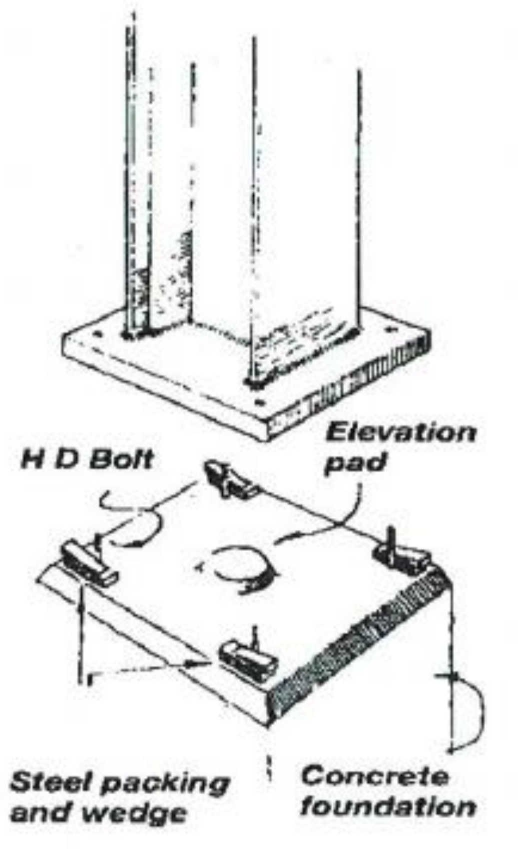
Guys that are left on overnight must be FSWR guys. Fibre ropes shrink when they are wet and stretch when they are dry and are therefore dangerous to use as guys.

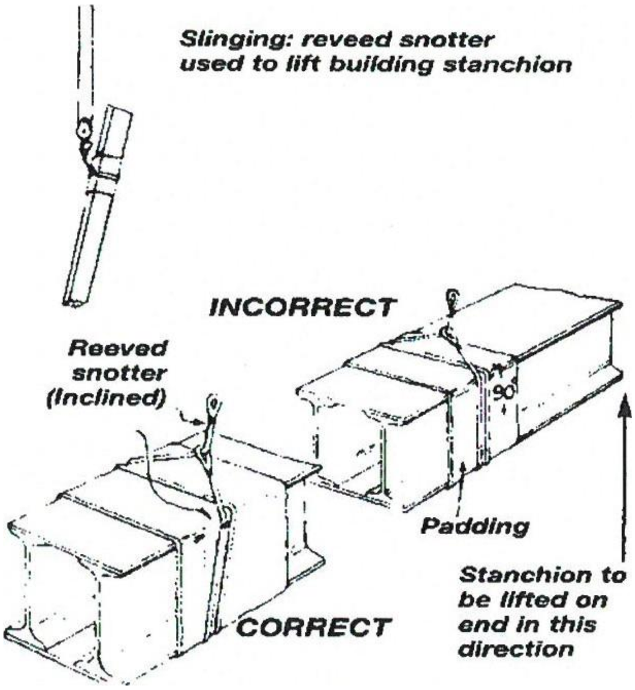
The foreman or a competent person should ensure that every column base is level using a theodolite or a dumpy level before starting to erect the columns. Bush jobs could use a spirit level.

There should be a packer (elevation pad) underneath every column. If the column bases are not level the steel will not be plumb. It can be very difficult to wedge up steel especially if the steel is heavy.

Steel packers approximately the same height as the elevation pad should be placed adjacent to each holding down bolt. Use steel wedges if necessary for plumbing purposes.

The mass (weight) of any steel must be known before lifting into place. When ordering cranes to raise columns, a second crane may be required to 'float' in the base.





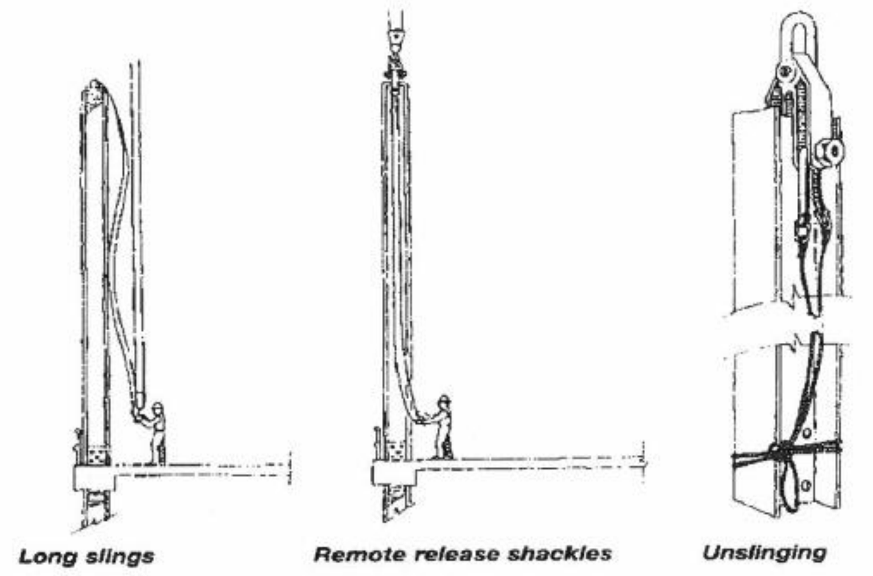
When raising a column with two cranes at the column head each crane should be capable of lifting the total weight of the column. If this is not possible, equalising gear must be used.

To ensure that columns hang vertically they should be slung as near to the top as possible.

When lifting columns with a reeved sling ensure that the sling is wrapped around twice then nipped (round turn). As the sling is wrapped around, incline the sling toward the nip, stopping the sling from slipping when the column becomes vertical.

The column must be packed to prevent the sling from being Steel Packing Concrete and wedge foundation damaged by the sharp edges of the column. The packing has to be tied or secured to prevent it from dropping out when the slings slacken as the column is landed.

Heavy columns which are erected and spliced in the air must have scaffold brackets or bearers fitted before erecting the column.



Beams and Girders

The mass (weight) of each beam or girder must be known.

Make sure that the crane is capable of lifting the beam to the required height. That is, check the crane drift before lifting.

Ensure that the correct capacity and size slings are used and see that the beam is adequately packed. Ensure that the packing will not drop out when the weight is released from the slings.

Lift the beam level unless it is intended to be canted. Take special care with lattice beams, because the sharp edges of gussets can easily cut through slings.

Attach tag lines to each end of the beam to control it during the lift, even when setting steel on multistorey jobs. Short hand lines at either end will allow the top hands to control the beam more easily.

If a crane has to be boomed out to land a beam the crane must be capable of lifting the beam at that radius. Booming out with a load in the air is dangerous especially if the load is heavy. Lift the beam as close as possible to its final position.

The end of a beam nearest to rigid steel must be fixed first, then if necessary adjust the steel at the other end. The old saying 'get the first podger hole and let your mate worry, is not good practice.

Field bolted beams must be bolted on diagonally opposite sides to prevent the beam from rolling.

Position the beam onto the podger when lowering so that if the crane over runs slightly, the top hands have control. It is dangerous to set the podgers while raising the beam. If the crane operator over runs slightly the sling could be overloaded and broken.

When setting steel beams into the web of other beams make sure that the crane operator 'inches' the load very slowly allowing reaction time for the crane operator to stop.

Do not use shifting spanners for tightening bolts when working aloft. Use proper set or ring spanners (preferably the podger type).

Do not work on wet or wet painted steel. Do not set steel in gale force winds.

Tapered drifts should be held by hand when being driven in to stop them being driven right through.

Hammers should have a restraining lanyard to stop them from being dropped from aloft.

Spliced columns have to be aligned directly above one another when being positioned.

When landing a beam, experienced riggers will push a drifting beam across and drop their podgers in.

To lift a beam at the centre by two cranes with a mass greater than the capacity of either crane, use a properly rigged, equalising bridle or equalising beam.

The WLL must be stamped on all lifting gear including equalising beams, shackles, rings and hooks.

Before lifting bowstrings, turnbuckles and rigging screws should be fitted to long beams which may flex excessively. The screws must be fitted with a locking device or preventer lashings.

Bolts, Nuts and Washers

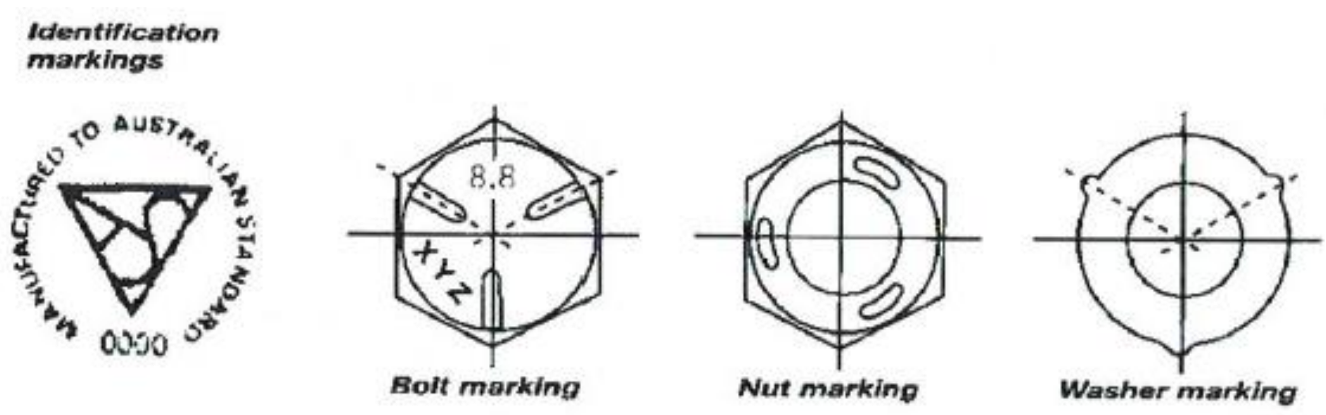
There is a huge variety of fastenings available for structural connections. The rigger must know which fastenings have been specified by the structural designer for the various members. This involves a careful reading of the drawings and specifications.

Riggers must also be able to recognise different grade, diameter and length fasteners by visual inspection. If the wrong bolts are used the strength or stability of the steel structure can be seriously affected.

Bolts

Structural bolts are generally categorised by their nominal diameter, overall length and thread length. The nominal bolt diameter in millimetres is designated with the letter M followed by a number. For instance, an M 16 bolt has a nominal diameter of 16mm.

High strength structural bolts have their heads marked '8.8' (for the steel property class). They also carry three radial lines and the manufacturer's identification or trademark.



Nuts

High strength structural nuts can be identified by the three arcs indented or embossed on the non-bearing faces. With some brands of double chamfered nuts, the markings may appear on both faces.

Washers

Washers can be either flat round or square taper. Flat round washers designed to be used with high strength structural bolts and nuts are manufactured with three protruding nibs around their perimeters.

Square taper washers are used less frequently in modern structural design but are still generally available. They are usually manufactured with taper angles of either 5 ^{0} (for use with taper flange channels) or 8 ^{0} (for use with taper flange beams or RSJ’s).

Further information

Further information on the specifications and allowable tolerances for structural bolts, nuts and washers is given in AS 1252-High strength steel bolts with associated nuts and washers for structural engineering.

Torqueing Bolts and Nuts

The fitting of additional bolts and the correct tensioning of all bolts should be carried out once the structural members have been set in place and field-bolted. This is often done by a 'follow-up' crew while the steel-setting crew moves on to the next stage of the erection sequence.

Tools used during the consolidation of the structure include tension wrenches and impact wrenches (commonly referred to as rattle- guns). Impact wrenches can be electrically powered or pneumatic. 'Gunning-up' can be very dangerous unless the necessary precautions are taken, and the recommended operating procedures are strictly followed.

Caution: Using an impact wrench for long periods of time can cause hand damage called 'white knuckle'.

When using impact wrenches, observe the following rules:

- The socket and tool should be kept in line.
- Do not hold the socket.
- Do not use a worn-out socket.

Working Aloft

Background

In the past, steel erectors were often expected to work at heights with nothing to protect them from falling except a sense of balance and a lot of luck. Shinning up and sliding down steel columns, walking the top flange of narrow beams, running purlins up roof trusses and riding crane lifted loads were often regarded as standard work practices.

Not surprisingly, this led to high fatality and injury rates among steel erectors.

Since the introduction of modern occupational health and safety laws by the Australian States and Territories, the old methods of working at heights are no longer acceptable.

Minimising the risks

Careful planning can and should reduce the amount of work needed to be carried out at heights. Where space permits and cranes of sufficient capacity are available, entire sections of the structure can be prefabricated on the ground. Using remote release shackles wherever possible can also reduce the need to work at heights.

On large scale industrial projects and bridges, it is often possible to fix scaffolds to structural members or sections of the structure before they are lifted into position. Despite these and other measures, many of the rigger's tasks need to be carried out at heights.

Wherever working aloft is necessary, the work method and means of access should minimise the risk of falling, and the risks to other people in the vicinity.

The area below the work should be barricaded or cordoned off to prevent unauthorised access by other workers or the general public. Where this is not possible, overhead protection decks such as temporary gantries, covered ways, cantilevered catch platforms, perimeter safety screens or debris nets may be necessary.

All hand tools (such as podgers, ring-spanners, drifts and hammers) should be securely stowed on a purpose designed rigger's belt constructed from sturdy leather, canvas webbing or synthetic webbing and attached to a tool lanyard. Where safety harnesses are used, these generally incorporate loops for the stowing of tools. Bolts, nuts and washers should be kept in a pouch attached to the belt. One handed flogging hammers should be fitted with wrist straps.

There are many ways of providing steel erectors with a safe working platform and safe means of access which can prevent dangerous falls.

These include the use of:

- Elevating work platforms (EWP’s) such as scissor hoists, travel towers and boom lifts.
- Scaffolds.
- Portable ladders.
- Crane lifted work boxes.
- Safety line systems.

Safety line systems require a high degree of planning, training and supervision and rely heavily on the steel erector always 'doing the right thing' and not taking short cuts. For these reasons, they should only be used where none of the other methods are practicable.

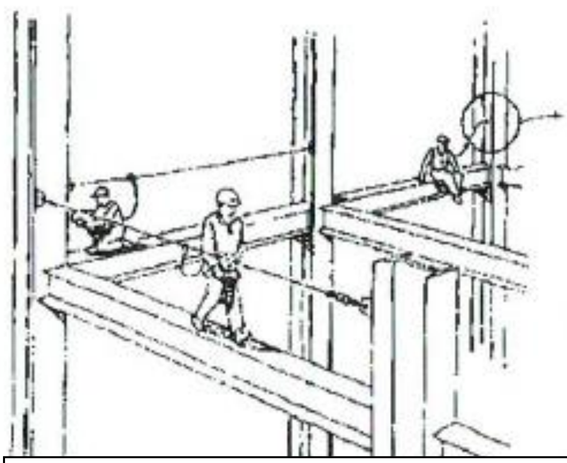
Safety Nets

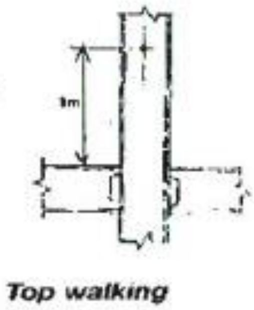
Industrial safety nets are suitable for some types of structures such as bridges and very high portal frames. They can provide an effective means of fall protection while allowing the steel erectors freedom of movement on the structural framework.

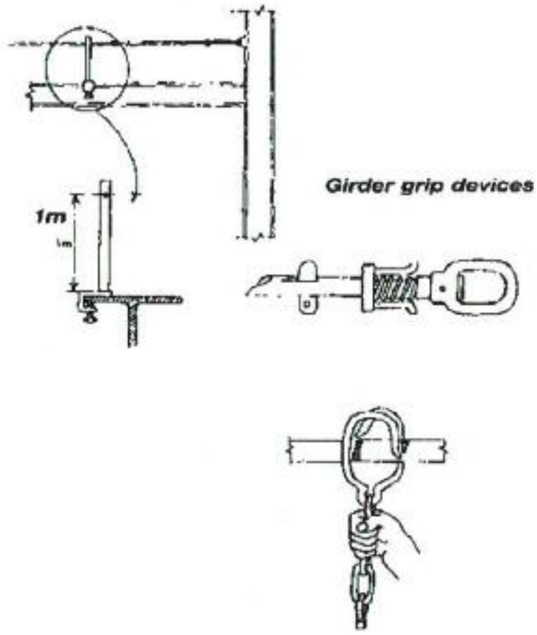
Safety Line Systems

Safety line systems involve the use of safety harnesses and can include various methods of anchorage including static lines, life lines and fixed anchorage points for inertia reels or lanyards.

The use of these systems as a primary means of fall protection is not generally recommended and should only be considered where none of the other methods mentioned previously are practical.







The static line should be located at least 2.1m above the beam and lanyards should be connected to the rear D-ring between the shoulder blades. There must be a shock absorber incorporated with the lanyard.

Elevating Work Platforms (EWP’s)

EWP’s should be designed and manufactured to meet the minimum requirements of AS 1418.10 Elevating work platforms. The design of all powered boom-type EWP's or any powered EWP designed to lift people more than 2.4m must be registered with a State or Territory regulatory authority.

Providing there is a suitable supporting surface and there is sufficient access, EWP’s can provide a very effective working platform for steel erection. There are various types available including self-propelled scissor hoists (some of which have cantilevered rolling platform sections), manually powered cherry pickers, trailer-mounted or truck-mounted travel towers and self-propelled boom lifts.

Your employer must make sure you have been properly trained in the use of the particular type of EWP to be used. Make sure you have read and understood the machine's operating instructions and are aware of its limitations before you use it for the first time. Make sure all the necessary checks have been carried out before each use.

Power operated boom type EWP’s with a maximum boom length of 11m or more require a HRWL to operate without direct supervision. The boom length is the greater of the vertical distance between the EWP's supporting surface and the underside of the workbasket at its highest possible elevation or the horizontal distance between the boom's centre of rotation and the outer edge of the workbasket at the greatest possible radius.

Note: With the introduction of the nationally uniform HRWL, some States and Territories have allowed a phase-in period for this HRWL class. If in doubt, check with the local certifying authority.

Observe the following rules when using an EWP:

- Make sure the supporting surface has enough load-bearing capacity for the EWP.
- Do not overload the platform or basket.
- Do not use the EWP on ramps or inclines which are steeper than the supplier's recommendations.
- Where fitted, outriggers should be fully extended with pads bearing evenly and the EWP levelled before being elevated.
- For self-propelled EWP’s, make sure the area of operation is free from obstructions and traps such as holes, penetrations, drains or upstands. Where these cannot be removed make sure they are securely barricaded or guarded.
- Whenever you are elevated, make sure another person who is competent to operate any override controls is always in the immediate area so you can be quickly retrieved in an emergency. Never work in total isolation from another person.
- Make sure you maintain the recommended clearances from powerlines.
- Do not climb out of, or into the EWP while it is elevated unless the unit has been specifically designed for this and the supplier's information allows it.
- Do not try to gain extra height by climbing up the guard railing, placing planks on the guard railing or placing ladders, trestles or boxes on the platform.
- Do not use the EWP as an anchorage for lifting gear unless it has specifically designed attachments for this.
- Make sure everyone in the basket of a boom type EWP is wearing a safety harness attached to the anchorages provided within the basket. This may save your life in the event of a boom failure. Do not disconnect your lanyard until the basket has been fully lowered.

Further information on the selection and safe use of EWP’s is given in AS 2550 Cranes-Safe, use Part 10 - Elevating work platforms.

Scaffolds

Scaffolds should be designed and constructed to comply with the minimum requirements of AS 1576 Scaffolding. The design of prefabricated scaffolding systems (including modular, frame and tower frame types) must be registered with a State or Territory regulatory authority.

As a general rule, the erection of a scaffold from which a person or object could fall more than 4m must be carried out or directly supervised by a person holding the appropriate scaffolding HRWL. However, fabricated hung scaffolds and suspended scaffolds may also be erected by persons holding the Advanced Rigging HRWL.

There is a wide variety of scaffold types ranging from simple trestle scaffolds to highly complex tube and coupler arrangements. They are all capable of providing a stable and safe temporary working platform provided the right type of scaffold is selected for the particular work of scaffolds which have been set up for other work tasks such as wall cladding, bricklaying, concreting, roof work or services installation.

Scaffolds can also be provided specifically for the setting of steel and associated consolidation tasks such as welding, insulation and sheeting. These may include bracket scaffolds attached to large structural members, perimeter safety screens, formwork shutters or large storage tanks, trestle scaffolds for low level work, cantilevered or spurred scaffolds projecting from the face of the structure, purpose designed hung scaffolds, and suspended scaffolds such as swing stages, work cages and boatswain's chairs. One of the most common forms of scaffolding used during the erection of low-rise portal frame buildings and modern structural design multi-storey construction is mobile prefabricated tower frame scaffolds.

Observe the following rules when using scaffolds:

- Make sure the scaffold has been completed and is ready for use. Carefully read all tags or notices attached to the scaffold. Make sure it has been provided with properly secured means of access such as single ladders or temporary stairways.
- On a mobile scaffold, make sure the lower access ladder is clear of the supporting surface.
- Make sure the operational area for a mobile scaffold is a hard, flat surface free of penetrations or obstructions which could destabilise the scaffold during relocation.
- Do not place a mobile scaffold closer than 1m to a slab edge, penetration or step down unless a fixed barrier is in place to prevent it crossing that point.
- If the supporting surface for a mobile scaffold is sloped, make sure the scaffold is fitted with adjustable castors with brakes and use the adjustment to level the scaffold before use. Where the surface gradient exceeds 5º, separate adjustable baseplates or similar must be used to take the load off the castors while the scaffold is in use.
- Make sure all approaches, access points and platforms have effective lighting without glare or deep shadows.
- Do not interfere with a scaffold by removing ties, braces, guard railing, platform planks, toe boards or other members. Any alterations needed to the scaffold must be carried out or directly supervised by a person with the appropriate HRWL.
- Apply the wheel brakes to the castors of a mobile scaffold before use. Do not release the brakes while anyone is on the scaffold.
- Do not climb up the framework of the scaffold. Use the access provided.
- Make sure the access ladder of a tower frame scaffold is always on the inside of the scaffold with the access opening in the working platform protected by a hinged trapdoor, sliding hatch or similar.
- Make sure that, wherever a person or object could fall more than 2m, rigid guardrails, mid rails and toe boards are securely fixed to the edges of all platforms and ladder landings.

- Do not attach shade cloth or other sheeting to a scaffold unless you know it has been designed for the extra dead loading and wind loads.
- Do not use the scaffold as an anchorage for lifting gear unless it has been designed for the additional loading.
- Do not overload the working platforms. If you are unsure of the scaffold's duty classification, assume it is light duty. The maximum allowable light duty loading is 225kg per platform per bay. This includes the weight of persons and materials.
- Any materials and equipment deposited on working platforms should be positioned to maintain clear unobstructed access along the full length of the platform at all times.
- Maintain platforms in a tidy condition by frequently removing surplus material and debris.
- Where platform decking units are constructed from aluminium grid mesh and the material or tools you are using could fall through the gaps in the grid mesh, cover the platform surface with non-slip sheets of plywood.
- Do not try to gain extra height by climbing on the guard railing, placing planks across the guardrails or placing a step ladder or trestle on the working platform.
- Do not move a mobile scaffold while anyone is on it.
- When relocating a scaffold by crane, make sure it is slung from the base and that the slings are long enough to enclose the scaffold. Additional scaffold tubes may need to be fixed to provide suitable lifting points. For large scaffolds, a purpose designed lifting frame may be required to prevent the scaffold from distorting during lifting. Make sure all members are secure against dislodgment and all loose materials have been removed from the platforms.

Portable Ladders

Portable ladders should be designed and constructed to meet the minimum requirements set out in AS1892 Portable ladders.

Portable ladders are available in two grades — Industrial and Domestic. Never use a domestic grade ladder for industrial use because it is not required to be as robust and strong as an Industrial Grade ladder.

Ladders can be constructed from steel, aluminium, timber or reinforced fibreglass and are generally classified as being one (or a combination) of the following types:

- **Single ladders** - available in lengths of up to 9m.
- **Extension ladders** - in two or more stages and available in maximum working lengths of up to 15m.
- **Stepladders** - available in lengths of up to 5.5m.
- **Trestle ladders** - used to support scaffold planks and available in lengths of up to 5m.

Trestle ladders are not generally suitable for steel erection, but the other types of portable ladders can often be used for unslinging beams and for bolting up structural members.

Ladders can be checked for serviceability by:

- Taking each end of the ladder in turn and trying to push the stiles apart and then together. Movement indicates insecure rungs or loose tie rods.
- Laying the ladder flat, raising one end and attempting to push one stile while pulling the other. If the stiles move relative to each other, the rungs are loose.
- Tapping timber rungs with a mallet. A dull sound indicates a defective rung.

Damaged or unsound ladders should not be used until they have been repaired and passed re-inspection.

Do not use a ladder with any of the following faults:

- Timber stiles warped, splintered, cracked or bruised.
- Metal stiles twisted, bent, kinked, crushed or with cracked welds or damaged feet.
- Rungs, steps, treads or top plates which are missing, worn, damaged or loose.
- Tie rods missing, broken or loose.
- Ropes, braces or brackets which are missing, broken or worn.
- Timber members which, apart from narrow identification bands, are covered with opaque paint or other treatment that could disguise faults in the timber.

When using portable ladders, observe the following rules:

- Place single and extension ladders at a slope of four to one and set up step ladders in the fully opened position.
- Do not handle or use ladders where it is possible for you or the ladder to make contact with power lines. In particular, metal or metal-reinforced ladders must not be used in the vicinity of live electrical equipment.
- Do not set up a ladder within the arc of a swinging door.
- Single and extension ladders should be footed by another person or secured top and bottom.
- Do not use a step ladder near the edge of an open floor or penetration. If the ladder topples, you could fall over the edge.
- Do not set up ladders on scaffold platforms or EWP’s to gain extra height.
- Always have two hands free to ascend and descend the ladder. Any materials or tools which cannot be safely stowed on your belt should be independently transferred or hoisted to the work location.
- Always face the ladder when climbing.
- Your feet should never be higher than 900mm from the top of a single or extension ladder, or the third tread from the top plate of a step ladder.
- Do not have more than one person on the ladder at any time.
- Do not work over other people.
- Make sure there is no danger of crane lifted loads trapping or striking you.
- Do not overreach. Your belt buckle should be within the ladder's stiles throughout the work.
- Do not use a ladder for work involving restricted vision or hot work (such as welding or oxy-cutting).

Crane Lifted Work Boxes

Crane lifted work boxes are often suitable for very high work or isolated parts of the project where it is difficult or impractical to provide scaffolds or EWP’s.

The work box must be specifically designed for the purpose of lifting people. The work box design must be registered with a State or Territory regulatory authority.

The work box must be stamped or be provided with a stamped metal data plate, securely and permanently attached to it a prominent position, and providing the following information:

- The maximum hoisted load (kilograms).
- The safe working load (kilograms).
- The tare mass (kilograms).
- Minimum allowable (rated) crane capacity (kilograms) identification reference.

The work box must also be marked permanently and legibly with letters and numerals not less than 25mm high in a colour contrasting with the background, with its safe working load in kilograms.

The work box must be painted in high visibility colours. The lifting slings must be permanently attached to its lifting lugs with moused shackles, or similar. An access door, if fitted, must only open inwards and be provided with a means to secure it shut.

The number of people supported in the work box must not exceed the number specified on the side of the box and, in any event, should not be more than three.

At least one person in the work box must hold a dogging or rigging HRWL to coordinate crane movement through radio communication with crane operator.

Any crane used to lift people in a work box must be:

- Fitted with a safety hook.
- Equipped with controls that return to neutral and stop the crane when released.
- Equipped with power lowering.
- Equipped with a lockout control to prevent free fall.
- Fitted with an up-limit switch on the hoist motion.
- Fitted with a down-limit switch where the work box is to be lowered below the crane's supporting surface.

The following rules must be observed when using crane lifted work boxes:

- Use the work box solely for lifting persons and their equipment. Structural members are to be independently lifted into position.
- The crane operator must remain at the controls throughout the operation.
- All crane movements must be carried out under power.
- When the work box is at the maximum intended radius, the crane's SWL must be at least twice the total load of the work box, or 1.5t, whichever is the greater.
- There must be an effective means of instant communication between the dogman or rigger in the work box and the crane operator.
- Where a mobile crane is used, it must not travel while anyone is in the work box.
- Every person in the work box must wear a safety harness which is attached to the crane hook or hoist rope termination or to purpose designed anchorages within the work box.
- Where it is necessary to carry oxy acetylene cylinders or any flammable liquids, these should be in the minimum necessary quantities, correctly secured and housed in a compartment separate to the work box. Make sure a suitable fire extinguisher is carried inside the work box.

Climbing in and out of work boxes at heights can be a dangerous practice. However, where there is no alternative the work box must be securely attached to the structure before anyone enters or exits.

2.2 Cantilevered Crane Loading Platforms

Cantilevered crane loading platforms (CCLP's) are temporary platforms which are often used during the construction or demolition of multistorey buildings and structures so that materials and equipment can be shifted to or from floor levels.

The platform is generally cantilevered from the face of the building to allow loads to be directly raised or lowered by tower cranes or mobile cranes.

CCLP's can also be used for other purposes such as catch platforms to contain falling debris at the building perimeter and as supporting structures for scaffolds constructed at the building perimeter. They are sometimes setup in a simply-supported mode such as over penetrations or voids, for use as loading platforms, access platforms Six rolling CCLP's or protection decks.

CCLP's are available in a variety of designs including fully fabricated and demountable types. They may have either fixed platforms or rolling platforms. Their needles can be anchored to the supporting structure in several ways, such as through bolting, bolting into cast in inserts, or reveal propping. Reveal props may be purpose designed, integral components or they may be general purpose adjustable building props laced together with scaffold tubes and couplers.

Certification

The installation and dismantling of CCLP's must be carried out (or directly supervised) by a person holding either a Basic Rigging or Intermediate Scaffolding HRWL.

Whenever a CCLP is located or removed by a crane, the slinging and load direction must be controlled by a person with a Dogging or Rigging HRWL.

The propping of CCLP's with adjustable building props and scaffold tubes and couplers or other types of scaffolding equipment must be controlled by a person with an Intermediate Scaffolding HRWL.

The Platform

The platform needles should be positively secured against lateral displacement.

A minimum of two signs stating both the maximum uniformly distributed load and the maximum concentrated load that the platform can carry must be in clear view on the platform.

The platform decking should be flush with and abutting the floor slab, otherwise suitable ramps should be fitted.

There should not be any gap between the platform and the site handrails.

Platforms located on the side of a building facing a public roadway should not extend beyond the line of the overhead protection provided for the public.

Relocation of Crane Loading Platforms

The floor area where the platform is to be moved to, and the floor area where the platform is to be moved from, should be barricaded to prevent unauthorised persons from entering into the area while the change is made.

Perimeter fencing handrails must be removed while the change is made.

No person should work near the unfenced perimeter edge unless attached to the building by a safety harness.

The area below the platform relocation must be barricaded and spotters provided where necessary.

Clear all loose objects from the platform before the platform is lifted by the crane.

Perimeter fencing (handrails) should be replaced immediately after moving the platform.

All bolts must be placed back in the respective vacant holes when erecting or dismantling.

The lifting position must be clearly marked with signs painted on the platforms.

The lifting lugs should be engineer designed to lift the platform.

Props must be correctly secured at the top and also at the base by bolting, welding, or other suitable securing method to stop any lateral displacement.

The tare weight of the platform must be displayed on the platform.

Some platforms have a rubbish bin inserted under the platform deck. The rubbish bin must be removed and emptied before the platform is shifted.

A waterproof sheet with instructions should be attached to the platform showing all operational and safety instructions of how to use and lift the platform.

Use

Before the platform can be used:

- All bolts or connectors must be secured and tightened in position.
- All props must be plumb and have the rear ties in position.
- Adjustable props must be adjusted to ensure minimal adjustable jack extension . rear handrails must be in position.
- The side panels and gates must be positively fixed in position.

Gates must be closed at all times except for long loads. All platforms must be kept clean and clear of loose materials.

Platforms should only be used in the manner for which they were designed. Any alterations or different use of the platforms should be to an engineered design.

Rolling Platforms

Rolling CCLP's are platforms which can be rolled inside the building and back out again for ease of loading and unloading.

The two braces at the front of the platform, and the two locking pins on the left and right side must be in position and secured at all times for lifting, transporting and use as a loading platform.

The tie bar at the rear of the platform is to be used at all times when lifting or transporting the platform.

The spreader bar under the platform is to be secured and in position at all times.

Move the platform deck forward until it connects with the end of the beam. Secure the left and right-side locking pins. Close the gates and place the left and right brace in position. To move the platform backwards, reverse the procedure.

2.3 Erection of Hoists and Mast Climbers

Riggers are required to erect, dismantle and carry out maintenance on various types of hoist. These are the external guided cantilevered platform materials (one or two barrow) hoist and the mast climbing work platform. Both types are widely used in the building and construction industry but can also be used effectively in other industries.

Certification

The installation, dismantling and maintenance of cantilevered platform materials hoists and mast climbers must be carried out or directly supervised by a person holding either a Rigging or Scaffolding HRWL of the relevant classes as stated below.

The Basic Scaffolding HRWL can only be used where the WLL of the hoist does not exceed 500kg. A Intermediate Rigging or Intermediate Scaffolding HRWL is needed where the WLL is over 500kg.

The Cantilevered Platform (one or two barrow) Materials Hoist

Cantilevered platform materials hoists run up and down the outside of the tower and are powered by electricity or an internal combustion engine. They are designed for the erection of small multistorey buildings and should be designed and constructed to comply with AS 1418.7 Builder's hoists and equipment.

The working height of the platform is 30 metres or less and some have a maximum height of only 16 metres. Check the manufacturer's specifications.

Under no circumstance can these hoists be used to carry passengers. Only qualified personnel carrying out erection, dismantling and maintenance can ride on the platform of a materials only hoist. There must be a notice on the platform clearly displaying the words - **NO PERSONS RIDING**.

Set Up

The hoist must not be set up over a trench or excavation. When setting up near a trench the distance between the base of the tower and the edge of the trench must be greater than the depth of the trench.

The hoist must not be set up on bricks. It must be set up on solid timber packing. Where outriggers and screw jacks are fitted they must be tightened to maintain the hoist in a vertical position.

At the base of the tower the handrail must be set back at least 800mm from the working platform to stop people from leaning over and being hit by the platform coming down.

There must be an effective gate in the handrail such as a moveable or sliding rail to allow access to the platform.

On the floors above, a handrail must be placed 800mm from the edge of floors to prevent people falling off. Do not stand inside this barrier unless the platform is at your level.

There must be an overhead guard for the protection of the driver/operator. The hoist must not be set up in front of any access way to a building unless it is blocked off.

The gap between the platform and building floor must be secured and made of solid timber or metal. The gap must be no less than 25mm and no more than 100mm. Do not use loose bridging plates.

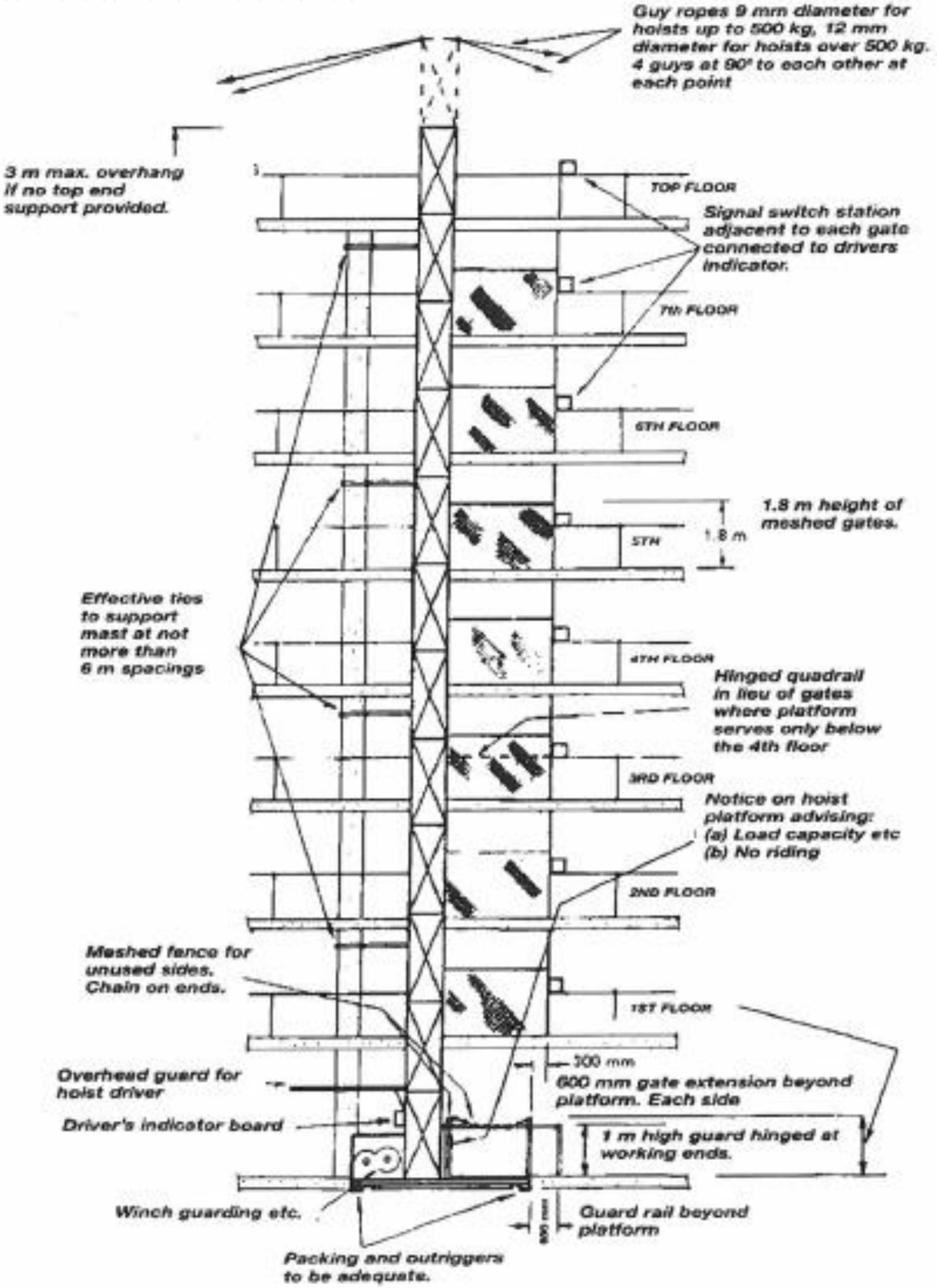
There must be a meshed gate installed at every landing, at a minimum of 1.8m in height.

If the hoist goes past any window or opening in the building, the opening must be blocked off to prevent people leaning out and being struck by the platform. Two barrier chains or gates must be in place on either end of the platform.

The tower must be guyed or tied every 6m and have no more than 3m free standing above the top tie, irrespective of the working height of the platform. The guys must extend diagonally from the four corners of the tower and the platform must not foul any guy rope. Guy ropes must be at least 9mm in diameter for hoists to 500kg capacity and at least 12mm for more than 500kg (and 6 x 19 construction).

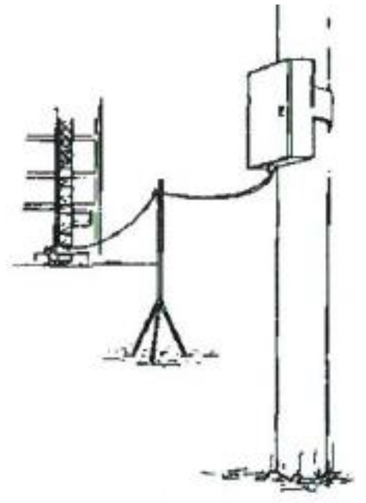
Ties must be at least the same strength as the guys and rigid enough to stop the tower flexing. Fibre rope guys must not be used because they shrink when wet and stretch when dry.

Cantilevered Platform Materials Hoist



Electrical

If the electrical power lead from the main box is loose it must be tied up clear of the ground. There have been many serious and fatal accidents because of leads lying in wet ground becoming entangled in, or severed by equipment. All electrical equipment must be protected against water.



Powerlines must be secured well clear of the ground

Wire Hoisting System

All materials only hoists (cantilevered platform and tower) use a wire rope hoisting system for raising and lowering the platform.

There must always be at least two turns of wire rope on the hoist drum. The wire must be fixed mechanically. It must be at least 6x19 construction flexible steel wire rope (FSWR) and have no condemnable defects.

The hoist wire must lay neatly on the drum. Do not allow the wire to show loose turns. In the event of a rope failure there is a cam or a gripper to stop the platform from falling.

A top limit switch must be installed to stop the platform approaching closer than 1.5m from the head sheave on the hoist. A floor indicator must be installed where the platform travels more than six floors or 15m or if the driver's view is obstructed.

Working Load Limits

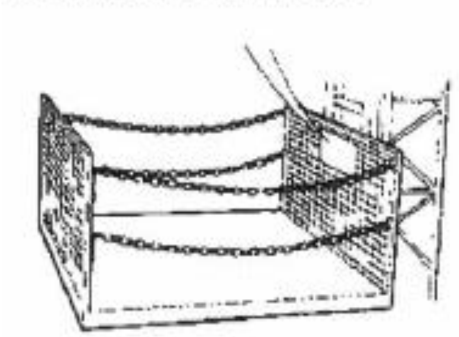
The safe working load (SWL) must be displayed on the platform. The hoist SWL will be either a 'Single barrow 250kg' or a 'Double barrow 500kg'. Do not allow the load to exceed the SWL.

Pre-checks

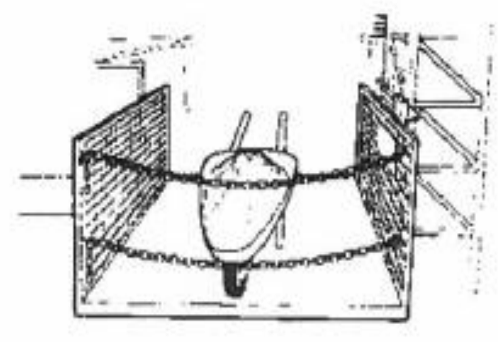
Prior to operating the hoist, carry out the following pre-checks:

- Make sure that the ties are in place and the tower has secure foundations. Check that the tower is vertical.
- The hoist rope must lay neatly on the drum.
- The lead from the power source must be secured well clear of the ground and in good order.
- The tower guides must be clean and rust free.
- The SWL and NO PERSONS RIDING signs must be in place and readable.
- The attachment points for the barrier must not be bent or damaged.

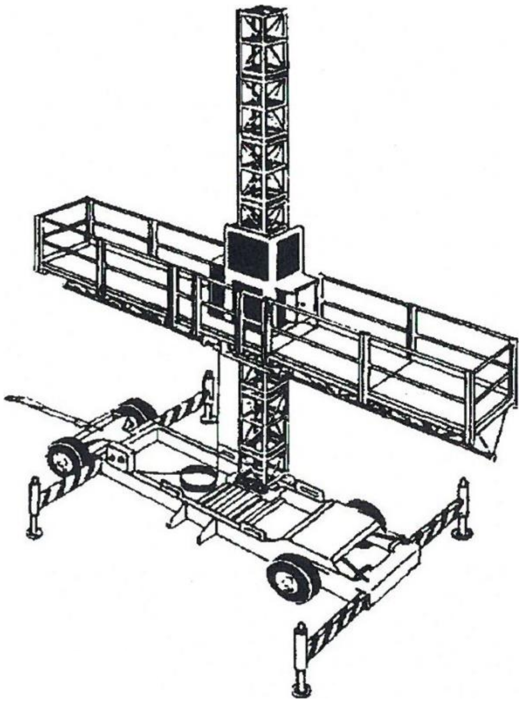
Make sure the SWL and 'No Persons Riding' signs are readable and in place



Wheelbarrow handles should face the building



Mast Climbers



Design and construction

Mast climbing work platforms should be designed and constructed to comply with AS 1418-10 Elevating work platforms. The design must be registered with the local regulatory authority.

Mast climbing work platforms are available for use as either freestanding single or multiple tower units tied to the supporting structure as they are erected.

The supplier's information for a particular mast climber should:

- Confirm that the design has been registered with the local regulatory authority.
- Include sufficient instructions to enable the rigger or scaffolder to erect, alter and dismantle the unit safely within its design limitations.
- Include testing requirements, pre-operational checks and servicing requirements.

Any variation to the supplier's recommendations should be to an engineered design.

Before preparing to set up a site for mast climbers, the distance from electric power lines must be known. If the distance is too close the power must be re-routed, the wires covered or the power cut off.

The ground must be checked to ensure that there are no underground services such as large drainage pipes directly under where the base or outriggers are to be situated.

If a mast climber is to be situated on a suspended concrete slab, the capacity of the concrete slab must be checked to ensure that it will take the total weight of the loaded machine. The floor must be supported by propping down the required number of floors, if the concrete is not strong enough. The builder or person in charge must be able to produce an engineer's certificate regarding the strength of the concrete slab.

If the mast climber has to sit on bare ground, the bearing pressure of the ground must be checked to ensure that adequate packing is provided to support the machine.

The area should be level or the base packed so that it is level before the mast is placed and erected.

The site where erection is to take place should be barricaded or roped off to prevent unauthorised persons entering the area.

Erection

The manufacturer's manual should be carefully studied before erection starts.

Loose fitting clothes or ties should not be worn as they could be entangled in the moving parts.

Platforms must not be erected or dismantled in high winds.

Base units are fitted with lifting lugs which must be used according to manufacturer's recommendations for the various lifting methods used for cranes, fork lift trucks etc.

The base can be either placed with mast outwards for free standing or with the mast inwards where the mast is tied to the building.

The outriggers must be extended and locked as per manufacturer's recommendations for the actual setup of the machine. Packing must be placed under the screw jack feet to distribute the load required for local ground conditions.

The manufacturer's recommendations should be checked for the free-standing height and jack loadings of various models.

A free-standing mast should not be used in high winds. The mast must be anchored at the top to ensure stability because high winds can occur suddenly. The building must be checked to ensure that it can withstand the forces of reaction that may occur in high winds.

If the building is not strong enough to support the mast at the top tie position, the anchor (tie) should be lowered to a point where there is enough strength to provide adequate support. The top anchor is usually designed so that it can be removed and turned over the top of the mast if the platform is to be driven to the top.

The platform should be lowered to the lowest position when it is not in use.

Anchoring of Mast

Masts which exceed the maximum freestanding height must be tied to the building or structure. When ties are used the base must be placed so that the mast is toward the building.

Tie spacing must be according to the manufacturer's specifications or engineer's design.

The building must be capable of taking the forces imposed by the mast climber at the anchoring points.

The base does not have to be set up on a mobile frame, it may be set up anywhere to suit a particular need.

If the machine is to be set up on needles on the outside of a building, the set up must be done according to an engineered design.

2.4 Industrial Safety Nets

Industrial safety nets are sometimes used as an effective means of fall protection for those working at heights where it is not practicable to provide scaffolds or temporary guard railings. When combined with overlay nets of finer mesh size, they can also be used to contain falling debris.

Certification

The installation or dismantling of industrial safety nets must be carried out or directly supervised by a person with either a Basic Rigging or Basic Scaffolding HRWL.

Although safety nets can be attached to, or supported from scaffolds, they are often secured directly to the structural framework of buildings, bridges, towers and similar structures.

The advantages associated with safety nets include their ability to provide a comparatively inexpensive means of protecting people from injury due to falling or falling debris without adding considerable loads to the supporting structure.

Their advantage over individual fall arrest systems such as safety harnesses is that they allow unrestricted movement for workers.

The disadvantages are that safety nets can suffer from damage or misuse and are vulnerable to cutting, chafing and damage from sparks. Nets should not be used where they are likely to be exposed to chemicals.

Manufacture

Safety nets should comply with the design, manufacturing and test requirements of BS 3913, Industrial Safety Nets.

They are manufactured from synthetic fibre knotted lines with a 100mm mesh size. These lines are attached to perimeter cords. Safety nets are usually available in sizes of 4m x 3m or larger, and nets can be joined to cover larger areas.

The label attached to each net will state a maximum fall distance for which the net has been designed. This will be either 1m or 6m.

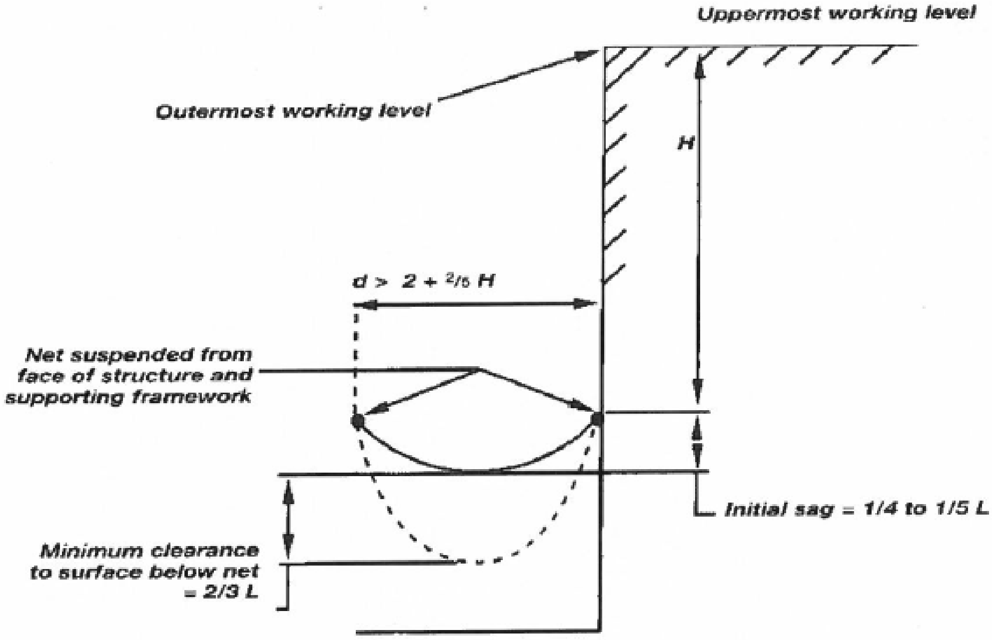
Installation

Prior to the installation of a safety net, the intended configuration, method of attachment and strength of the supporting structure should be verified as adequate by a competent person such as an engineer experienced in structural design. The verification should be in writing and retained on site until the net has been dismantled.

In particular, where nets are to be cantilevered from scaffolds, the scaffold must be designed for the additional loads and additional ties to the scaffold's supporting structure may be required.

The installation design should include detailed information regarding the exact positioning of the net, the fixing and tensioning methods and the erection and dismantling procedure.

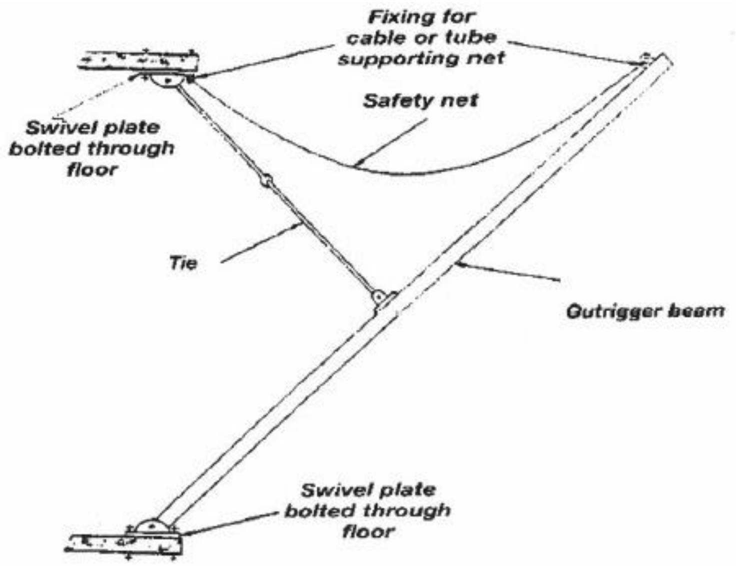
Where possible, fabrication of the net assembly should be carried out on the ground or on an adjacent floor and lifted into place with a crane, hoist or purchase.



KEY
H is the vertical distance in metres between net and uppermost working level above net for which the net has been designed
L is the length of shortest side of net in metres
d is the horizontal projection from outermost working point in metres

NOTES
1 Supporting framework not shown
2 The minimum net dimension should be 2 m

Typical arrangement of outrigged or perimeter nets



(b) Attached to the structure

Nets should be installed as close as possible to the working levels and in no case further below than the maximum fall distance stated on the net's label.

The gap between a net and the building or structure should be as small as practicable, but never greater than 200mm.

Nets should not be stretched taut when erected. They should have an unloaded sag of between one quarter and one fifth of the length of the shortest side.

Sufficient clearance should be maintained at all times below the net to allow for stretch when a person falls into the net. This clearance should be at least two thirds of the length of the shortest side or 2m, whichever is greater.

When erected, nets should project beyond the outermost working point a horizontal distance of at least two fifths of the maximum fall height plus an extra 2m.

Nets should be sited so that a person who has fallen can be quickly rescued. For example, nets erected adjacent to a working platform, floor or other access point are easily accessible. Where this is not possible, it may be necessary to cut the net to quickly and safely retrieve a fallen person. Where there is any possibility of debris falling into the net, the installation design should allow debris clearance which does not require walking in the net.

Nets should be securely attached to the supporting framework using tie cords, hooks, rings or thimbles equally spaced at intervals not more than 750mm along each side and at the corners. They should be fixed to the border cords and adjacent mesh cords of the net.

Where cords are wrapped around sharp edges they should be packed to prevent damage.

Use and Maintenance

A net which is used for the safety of persons should never be subjected to a loading test. The net should incorporate test cords which can be removed and tested in accordance with BS 3913.

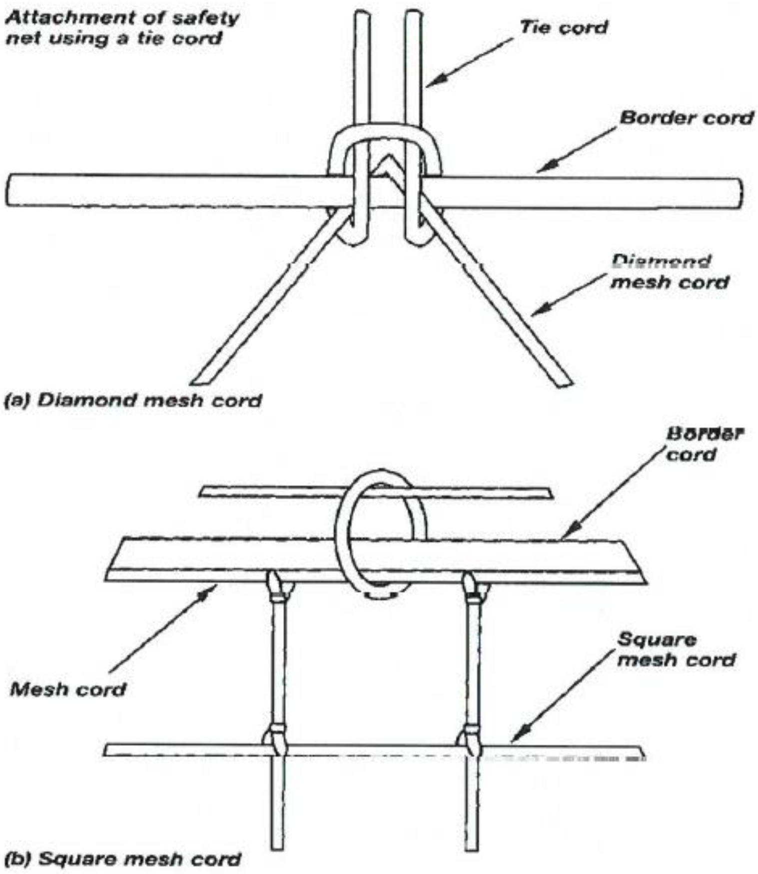
After a net is put into use, these tests should occur at regular intervals dictated by site conditions, but in any event, at least every three months.

The test cords should not be used for any other purpose and should remain fixed to the net until they are required for testing. A record of the test results should be kept.

Nets should be thoroughly examined on both sides by a competent person immediately before they are erected. When a net is spread out for examination, particular care should be taken to avoid it coming into contact with cement mortar or other corrosive substances.

The net supporting framework and all anchorages should be inspected by a competent person immediately following erection, at weekly intervals, and immediately following any incident which may affect the strength of the net.

It is important that nets are kept free of all debris which may cause injury to persons falling into them.



The following situations should be avoided wherever possible:

- Dragging the net over rough surfaces.
- Contact of cords with sharp edges.
- Stacking materials on the net.
- Accumulation of debris in the net.
- Persons jumping or throwing objects into the net.
- Sparks or flame from welding or oxy-cutting, hot gases from blow torches and hot ashes from chimneys or furnaces.
- Chemical attack.
- The supporting framework being struck by moving loads.
- Unauthorised interference with any part of the net assembly.

Expert advice from the supplier or a competent person should be sought where there is any doubt regarding the suitability of the net following contamination or severe shock loading. Expert advice should also be sought on the serviceability of any net which has been in use for two years or more.

Damaged nets should be repaired only by specialists.

When they are not in use, safety nets should be stored under cover where they are protected from the weather and strong sunlight, as well as heat sources and chemicals.

2.5 Safety Line Systems

Safety line systems are used to prevent falls from multi-storey buildings when work has to be carried out in the absence of safety screens or handrails.

The installer designs the system based on the number of persons on the line at any given time taking into account whether or not energy absorbing lanyards are to be used and any other restrictions on the use of the line system.

Riggers and other users of the systems must also be aware of all the restrictions on the system.

Permanent installations must have any restrictions on the use of the system shown on sign posts at the access points.

Certification

The installation of safety line systems may be carried out or directly supervised by a person with either a Basic Rigging or Basic Scaffolding HRWL as a minimum requirement.

Specifications

The safety line system may be purpose designed or the following specifications may be used.

Single spans

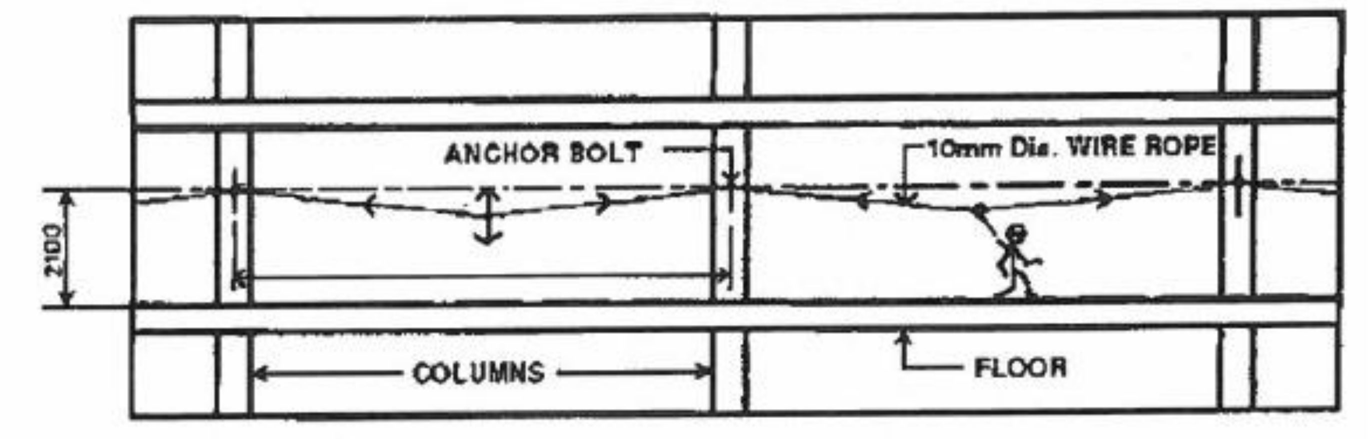
For single spans of four to six metres, where no more than two people are on the line at any one time, and both persons are using lanyards with energy absorbers rated at 600kg (6kN) or less the specifications are:

- FSWR 10mm diameter (minimum).
- Sag — approximately 50mm per meter i.e. 6m span — 300mm sag.
- Anchorage — capable of supporting an imposed load of 4t (40kN).
- Tensioning turnbuckles — minimum 16mm diameter threaded section.

Multiple span

The specification for multi-span systems are the same as a single span system with the following exceptions:

- Sag for two or three continuous spans - approximately 30mm per mete, i.e. 6m spans = 180mm sag.
- Sag for four or more spans — no minimum sag required but the line should not be over tensioned.
- Corner supports or intermediate supports where the FSWR is not free to slide through the support end anchorages (i.e. they should be capable of supporting an imposed load of 4t).



Static line spans

The static line is the supporting safety line attached to the inside of the perimeter columns. The line should be supported at each column or in accordance with an engineer's specification.

The line should be placed to eliminate the risk of tripping. Where practicable the line should be located no less than 2.1 metres above the floor of the work area. The point of attachment to the safety line system should be within reach of the user standing on the floor.

Anchorages and lines between supports should be positioned on the inside face of columns where practicable and used to anchor static lines, or the static line may pass through a cavity tube cast in concrete for that purpose.

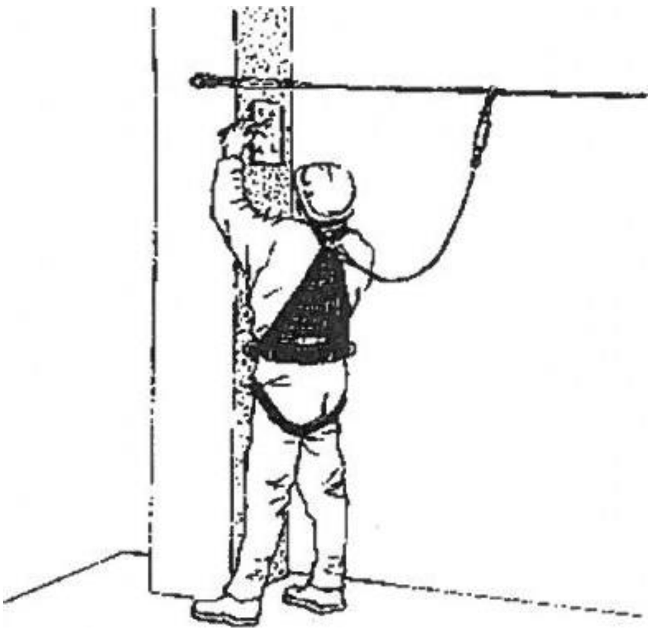
Static lines between supports must be free of obstructions to allow uninterrupted movement for persons who may be attached to the line.

If a line passes around a column, corner, or other sharp edge, it should be packed to prevent damage to the line.

Do not use bulldog grips on static lines.

Tensioning should be achieved by turnbuckles or other appropriate means such as wire rope pullers and creeper winches.

If ratchet and pawl devices such as creeper winches are used for tensioning, remove them from the system after tensioning is completed in accordance with the manufacturers specification.



Joining Static Lines

One method of joining static lines:

- Terminate one end with a thimble and three double saddle clamps and allow a 200mm tail.
- The second line should be passed through using a second thimble and three evenly spaced double saddle clips allowing a 200mm tail and shackle between each rope end.
- Line joins should be located at or adjacent to supports or anchorage points.
- Lapped joins on lines must not be used under any conditions.

Line systems for vertical travel

When using vertical lifelines (droplines) or other vertical fall arrest systems in connection with work from boatswain's chairs or ladders, only one person should be attached to any one lifeline. Vertical lifelines should comply with AS 1891.3 Fall arrest devices.

Termination of static lines

The termination of the static line should be by eye and thimble. Where practicable ends should be secured by one of the following methods:

- Double saddle clamps with a minimum of three equal spaces with a minimum 200mm tail past the last clamp.
- Hand splice with thimble eye.
- Machine splice with thimble eye.
- Suitable wedge sockets.
- Purpose designed fittings such as swaged or pressed fittings.

Lines and fittings may be secured directly to anchorage points with dee or bow shackles which should have a minimum WLL of 2t. The pin of the shackle should be moused (lashed) to the shackle.

Installation of anchorage points

Anchorage points used should be located as high as equipment permits, as it is safer to work below the point of anchorage.

The span between the intermediate supports of static lines should not exceed the engineer's or supplier's specification. All bolts should comply with AS 2317-1984 Collared eyebolts.

The following types of anchorages are acceptable when used in concrete:

- Cast-in anchors (in situ). A wall tie (shee bolt) purpose designed. An engineer designed anchorage.
- Chemical and friction type anchors. Chemical and friction type anchorages should be positioned so the load from a fall is taken in shear. They should be proof tested in tension to at least one third of the design load prior to use. Collared eye bolts should be used.

All anchorages should be visually checked prior to use.

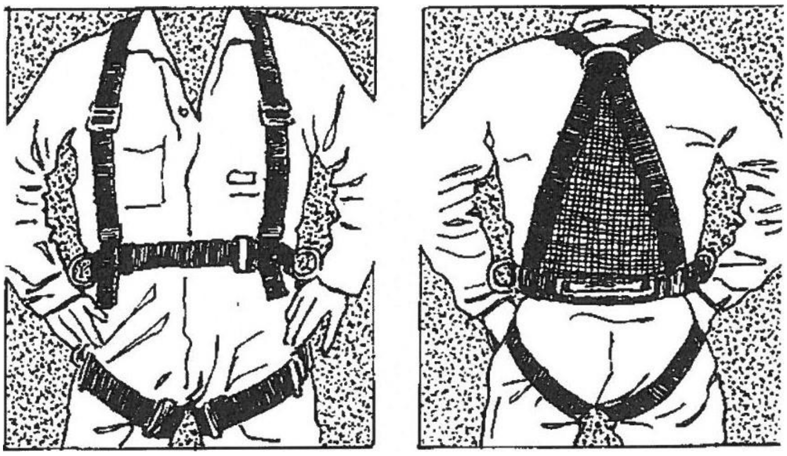
Turnbuckles

Only framed turnbuckles of an open type design which allow visual inspection of the condition and extension of the threaded sections should be used.

The frame should be locked or moused to the eye bolt to prevent slackening due to vibration, shock or spin in the line attached. Hook type turnbuckles should not be used. Only clevis or eye type should be used on lifelines.

Harnesses, Lanyards and Equipment

Body type harnesses and lanyards which comply with AS 1891 Industrial safety belts and harnesses should be used. The harness should be connected to the lanyard or lifeline at the rear dorsal position.



If a life line and rope grab device is used on steeply sloping surfaces, the user needs to have the device located on the front attachment ring of the harnesses. This will allow safe manual operation of the mechanism.

Do not connect into a single D-ring on the side of the harness belt. Both side D-rings may be used for pole straps if a fall of 600mm or more is not possible. Do not use waist type belts.

Safety harnesses should be selected and used in accordance with AS/NZS1891.4 2009 Industrial safety belts and harnesses — Selection use and maintenance. Always follow the manufacturer's information and advice.

There should be a minimum of slack in the lanyard between the person and the attachment to the anchorage. The length of the lanyard should restrict the fall distance to a maximum of 2m.

Where an anchorage point is above the harness connection point a 2m lanyard will achieve this result. Where the anchorage point is below the harness connection point a shorter lanyard, or other means of restricting the fall distance may be required.

Do not use homemade lanyards. Do not join lanyards together. If extra reach is needed use an inertia reel or similar equipment.

Do not connect lanyards with inertia reels. Snap hooks or other connectors should have a locking device and be compatible with all anchorages.

Those using safety harnesses should not work alone. In the event of a fall it is vital that the person is rescued as soon as possible to prevent further injury by the harness restricting blood flow.

To reduce injuries caused by a fall, energy absorbers should be used as part of the lanyard.

Equipment used with static lines should be compatible with the original system specification, such as manufactured travellers or energy absorbing lanyards.

Inertia Reels

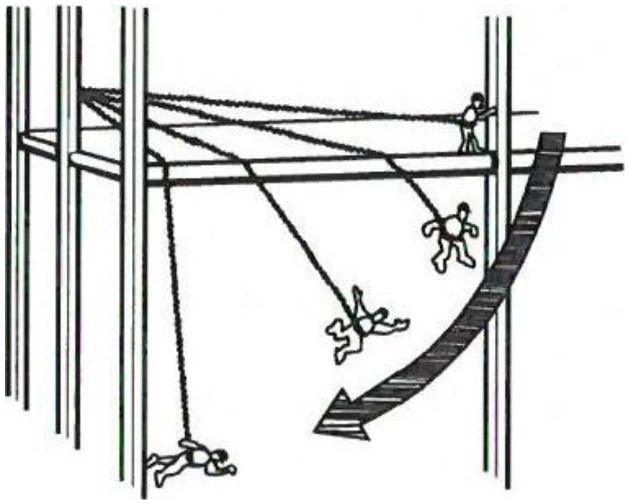
Inertia reel systems can be used to arrest falls where workers are required to carry out their work near an unprotected edge. They must comply with AS 1891.3 Fall arrest devices.

Inertia reels are not designed for continuous support but become effective in the event of a fall. They should not be used as working supports by locking the system and allowing it to support the user during normal work. Inertia reels may be less effective for certain applications, e.g. stopping a person from sliding down an inclined surface.

When inertia reel anchorages are located lower than head height or a person is located at a horizontal distance from the anchorage, the line of the inertia reel will strike an edge if the person falls from the structure. The damage this may cause to the line could result in its failure. To avoid this, inertia reels should be used in accordance with the manufacturer's instructions.

Inertia reels may be connected to a static line with a snap hook fitted with a locking device.

Pendulum Effect



Pendulum effect: Following an arrested fall at this extreme diagonal, the inertia line moves back along the roof, dropping the worker dangerously down to the ground.

This is a potential hazard connected with the use of individual fall arrest systems. The pendulum effect may also occur if the positioning of the inertia reel allows for a significant length of unsupported line connected to the user.

Swing down can occur if an inertia reel is extended out diagonally so that the line makes an extreme angle with the perimeter edge of the structure. In this situation, the forces generated in an arrested fall over the edge will cause the line to rotate back along the perimeter edge until it reaches a position directly in line with the inertia reel and at right angles with the perimeter edge.

As the line moves back in this way, the unsupported section lengthens, dropping the attached worker further than the original (arrested) fall distance. If the length of the unsupported line equals the height of the building then the worker will hit the ground. Even if the worker does not reach the ground they may collide with obstructions on the side of the building.

To eliminate the pendulum effect, place the inertia reel anchorage point square to the position of the line at the perimeter edge. A mobile anchorage helps here.

2.6 Handling Pre-cast Concrete

Pre-cast concrete is commonly used in a wide range of modern building and construction projects. Precast concrete includes pre-tensioned beams, pre-cast concrete floor and facade panels.

Certification

The placement of pre-cast concrete must be carried out or directly supervised by a person holding a Basic Rigging HRWL.

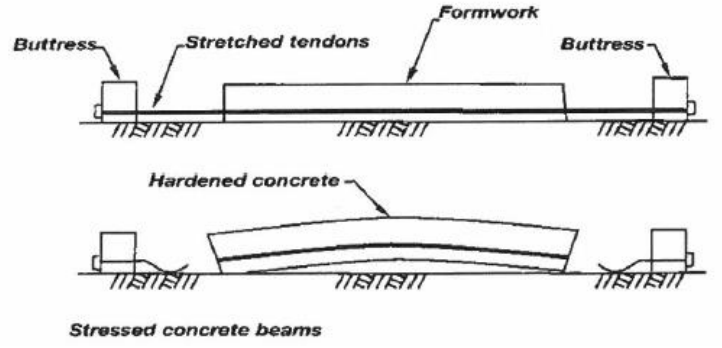
Work associated with tilt up panels is covered under the Intermediate Rigging HRWL but excluded from the Basic Rigging HRWL.

Pre-stressed concrete beams

Pre-stressed concrete beams are designed so that stressing strands allows the concrete to hold a given load over a larger span.

The strands are often put into the beam in an inverted arc. When placed into position the beam is usually slightly arched, which allows the beam to straighten out when it is loaded.

Pre-stressed concrete beams are very sensitive to the direction in which they can be loaded. They are generally designed to take forces in a vertical downward direction only and have little or no resistance to forces in any other direction. Turning a pre-stressed beam on its side or upside down can cause it to collapse particularly when it is suspended.



Transfer beams

A different hazard applies to a special class of post-tensioned, pre-stressed beams known as transfer beams. These are usually located at the first-floor level of multi-storey buildings and are designed to transfer loads from the upper storeys to more widely spaced supports below to create large open spaces at ground floor level.

During the construction phase, the tendons in these beams are partially stressed in progressive stages to balance the loads as they increase over the construction period. Final stressing and grouting occur when the building reaches full height.

If no action is taken to reverse the effects of this procedure during demolition, the beam will tend to bow upward an increasing amount as the load from above is reduced. This can lead to local failure of the structure at, or just below the working level. A reverse bending failure and collapse of the beam well below the working level can cause a collapse of the entire structure.

Riggers must be extremely careful when choosing the slings and lifting equipment because of the dangers associated with handling pre-stressed concrete beams.

The beams should be lifted by their ends, and from as near as possible to the position where they are to be placed.

It is recommended that a spreader beam is used to lift the beams to avoid having slings at an excessive angle. Spreader beams should be properly designed by an engineer to the length required and the weight of pre-stressed concrete beams.

Pre-cast concrete facade panels

Pre-cast concrete facade panels should be delivered to the site sitting on a frame so that they only require one erection crane and can be top lifted. If they are to be stored on site they should be stored on frames.

They should not be erected in high winds.

Although they are usually erected by specialist contractors, riggers should be aware of the hazards.

The lifting inserts must be cleaned out to ensure that the lifting media can be fully bolted.

The lifting media (lugs etc) must be to an engineered design.

Panels should be lifted with a spreader beam so that the pull on the inserts is direct.

The angle between the slings during lifting should not be more than 60 ^{0}.

Do not work under the panel to put slings around it, if an insert pulls loose.

Contact the panel manufacturer and/or designer to have the insert positively fixed (welded) to the reinforcing steel if it is loose.

People who work outside a handrail, or if a handrail is removed, must be attached to a lifeline and be wearing a safety harness.

One person is to be in charge of the crane when lowering a panel into position.

The crane operator must be instructed to lower as slowly as possible when lowering a panel into final position.

When lowering panels by radio, if any person under any circumstances cuts across the channel, operations must stop until their reason for cutting across is discussed. If that reason is not safety they must be informed not to repeat an extreme safety breach.

Operations must cease immediately if the radio channel being used for giving directions for lowering a panel is cut into from a person not involved in the operation.

SECTION 3 – Intermediate Rigging

3.1 Tilt Up Panels

Tilt up panels are widely used in the construction of low rise factories, warehouses and apartments.

Concrete wall panels are cast horizontally, either on site or in a casting yard. They are crane lifted into position and fixed with temporary bracing until the structure becomes fully self-supporting.

Tilt up panels are designed as vertical members. If a panel is incorrectly rigged, it can be overstressed or may even break when it is being lifted from the horizontal to the vertical position.

Certification

The rigging of tilt up panels must be carried out or directly supervised by a person holding the Intermediate Rigging HRWL. The use of load equalising gear, which is also frequently applied during tilt up panel erection, is also covered by the Intermediate Rigging HRWL.

Panel Design and Casting

The design and casting of tilt up panels should comply with AS 3850.2 Guide to design, casting and erection of tilt up panels, which requires the panel design to be certified by an engineer.

Rigging Gear

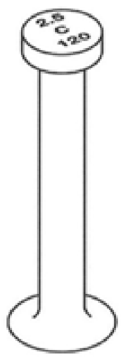
Rigging gear used in the erection of tilt panels include lifting inserts, lifting clutches, spreader beams, equalising sheaves, slings, bracing inserts, panel braces, bracing anchors and shims.

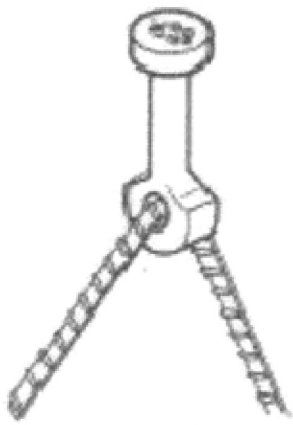
Riggers involved in tilt up erection need to know the following:

- Lifting clutches have a safety factor of 5.
- Lifting clutches should be proof tested to their WLL every 6 months.
- The minimum safety factor on the WLL of lifting inserts and bracing inserts is 2.5.
- The minimum safety factor on the WLL of panel braces is 2.
- The locking pins of adjustable panel braces must be fitted with retaining devices to prevent them being knocked out.
- The information available onsite regarding panel braces must include their WLL at zero extension and the WLL at their maximum possible extension.
- The maximum load on any expansion anchors used to secure a panel brace must not exceed 65 percent of the first slip load (or 0.65 x first load slip).
- Deformation controlled expansion anchors are not recommended to fix braces to the floor.
- Where chemical anchors are used to fix braces, they must all be individually proof tested to their WLL.
- The maximum height of shims under a panel edge should not exceed 40mm.

General Lifting - 1.3T, 2.5T, 5T, 10T, 20T and 32T Conlift

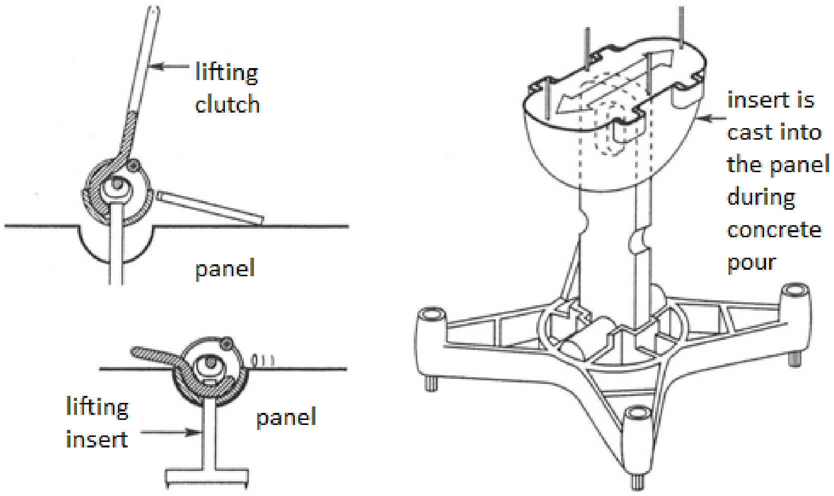
Do not mistreat or weld lifting inserts





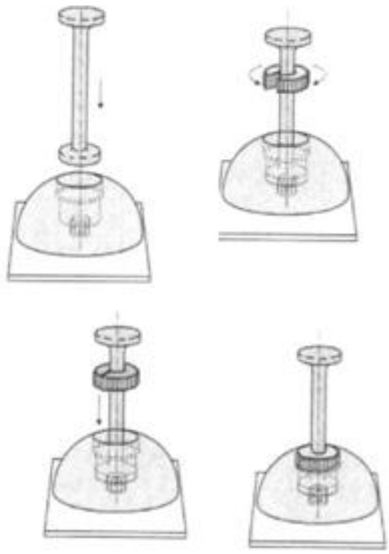
Mushroom Head Foot

Eye Anchor

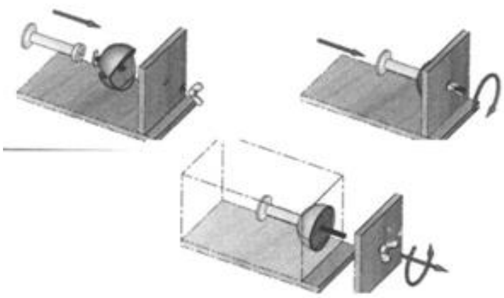


Steel Recess Former

The slit rubber ring is placed around the throat of the Anchor. The Anchor Head is placed in the recess of the Steel Former and the rubber ring is pushed down.

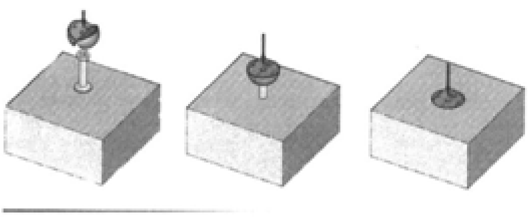


Rubber Recess Former



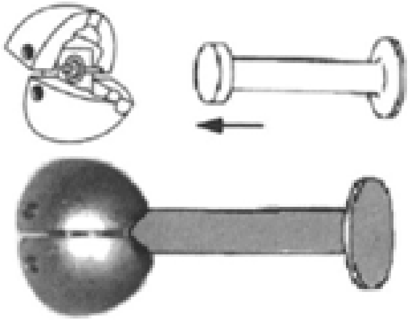
The Recess Former comes with a threaded rod welded to a plate and a wing-nut. The plate sits in the Former and the threaded rod passes out the back of the Former and through a hole in the Formwork. The wing-nut is tightened to hold the Former against the Formwork. The Anchor head sits inside the opening Former

Sometimes the Anchor and Recess Former need to be "puddled in".



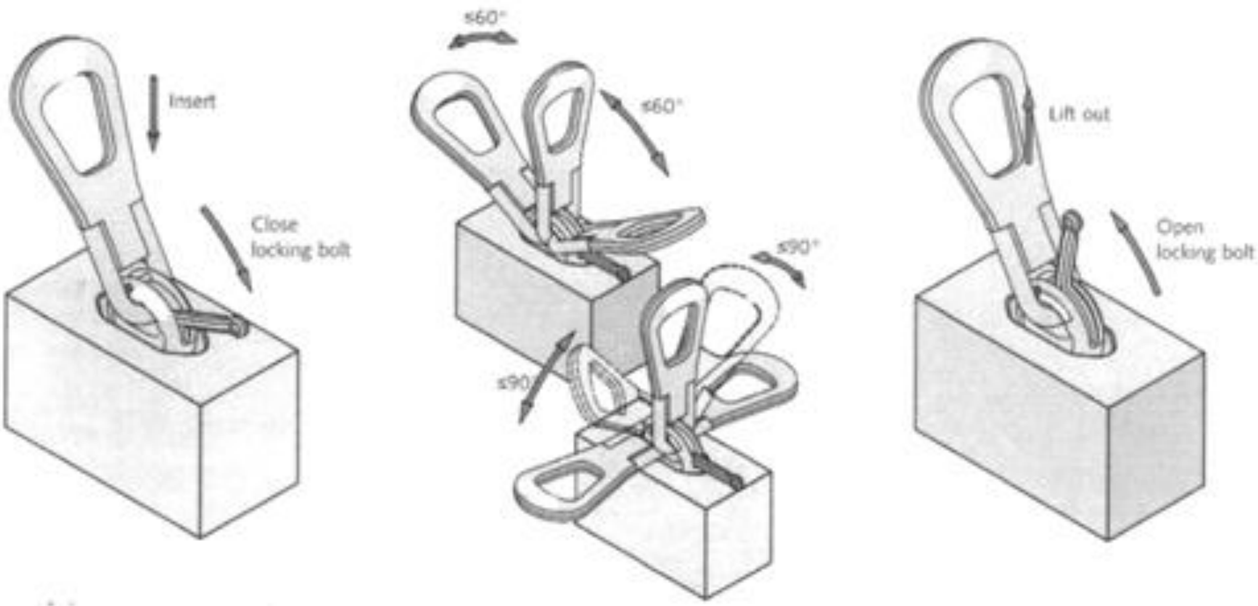
Articulated Steel Recess Former

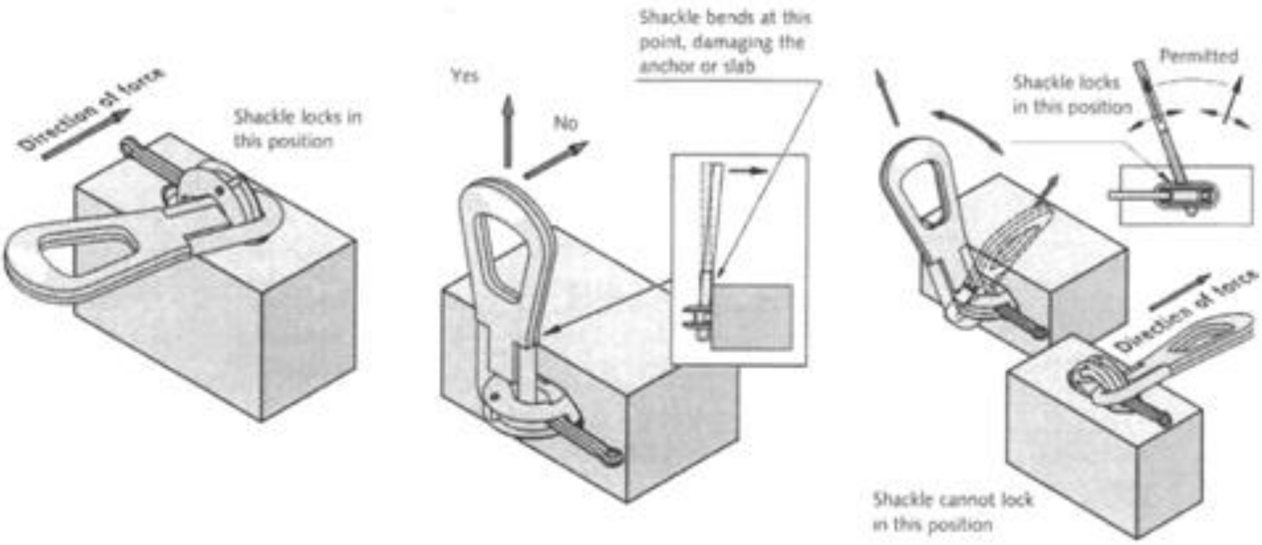
The Recess Former is opened and the Anchor Head is placed in the recess and it is closed.



Conlift Donut Clutch Installation and Correct Lift Direction

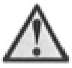
Place head into the void and close the locking arm

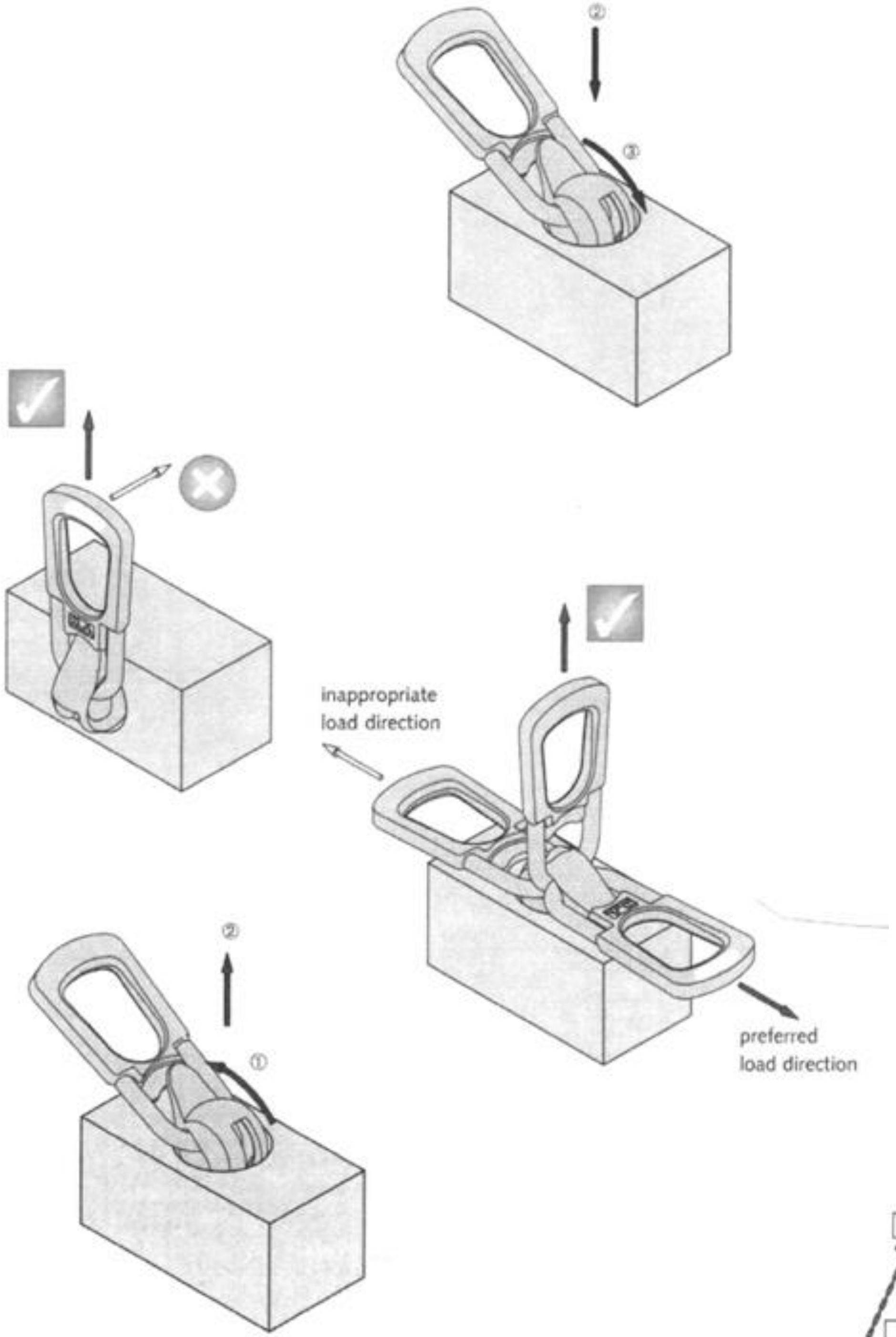




Conlift Mushroom Clutch Installation and correct Lift Direction

Rotate the slot in the clutch into the void and over the head of the anchor until the tab on the clutch rests on the concrete.

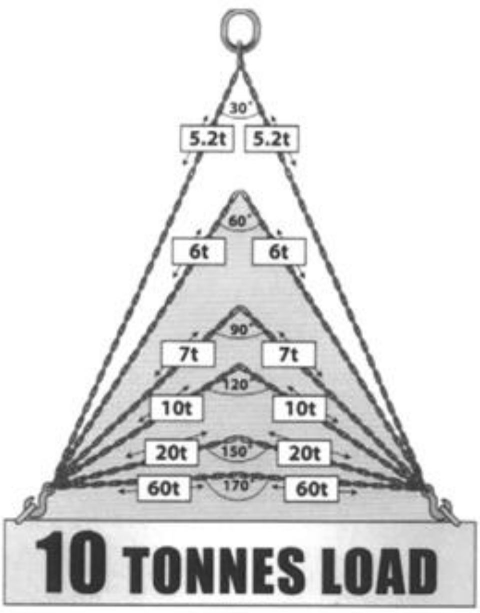




Rigging

Incorrect rigging angles may result in anchor failure.

- It is recommended that the sling angle be kept under 60 degrees.
- Longer slings decrease the load on the anchor.
- The slings must be even to produce balanced loads.



Common Rigging Confirgurations

1. Lifting beam as above.

2. Using a triangular spreader beam with shackles and two set of chains will ensure legs are equally loaded.

3. First using a lifting beam and two FSWR slings, equalising sheaves and lifting inserts and clutches, second will ensure legs are equally loaded.

Terms Used

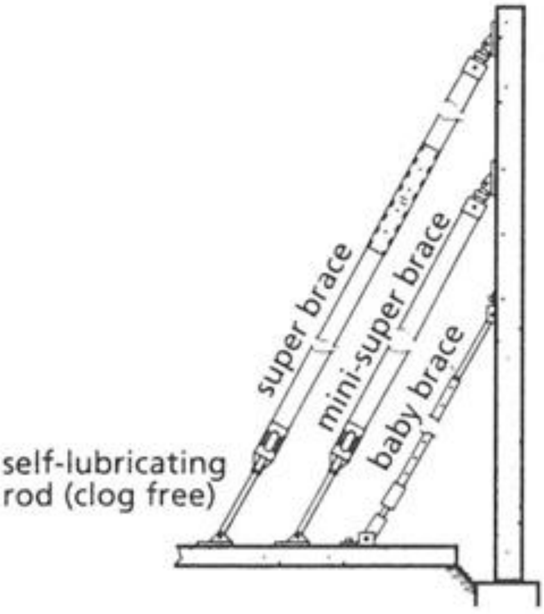
Brace floor fixing: a recommended mechanical fixing, expansion anchor or chemical anchor that can be cast in a bracing insert. An expansion anchor must be of the load-controlled type and not the deformation controlled type.

Bracing insert: an insert cast or fixed into a panel for the attachment of a brace during placement.

Casting bed: a surface on which the tilt-up panels are cast.

Concrete shear cone failure:

type of panel failure that occurs when the tension is applied to an insert cast into the panel until tensile failure of the concrete occurs and a 'cone' of concrete is pulled out from the panel with the insert. The released insert and concrete do not necessarily form the shape of a cone.

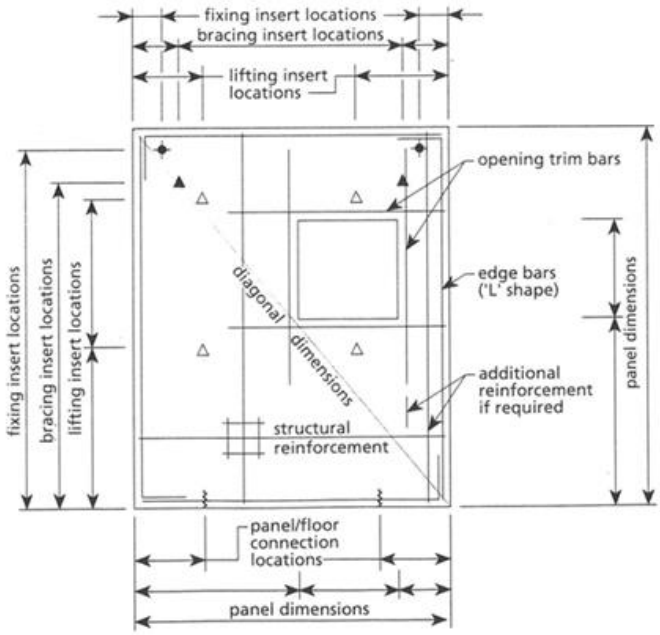


Shop Drawings

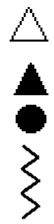
Carefully examine the shop drawing for the panel before it is rigged.

The shop drawing should indicate the type of rigging configuration needed, the position of lifting inserts, bracing inserts and fixing inserts and floor to panel connection points.

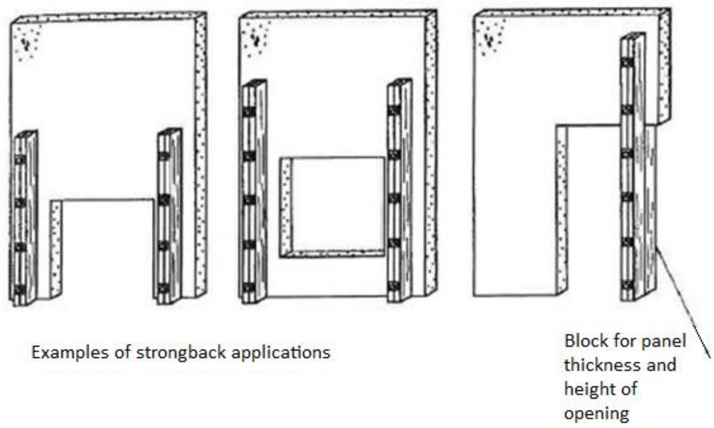
Riggers must be able to read shop drawings. In particular, riggers must know the following symbols used on shop drawings:



- An outlined triangle –indicates a lifting insert.
- A blocked-in triangle – indicates a bracing insert.
- A blocked-in circle – indicates a fixing insert.
- A screw thread – indicates a panel to floor connection.



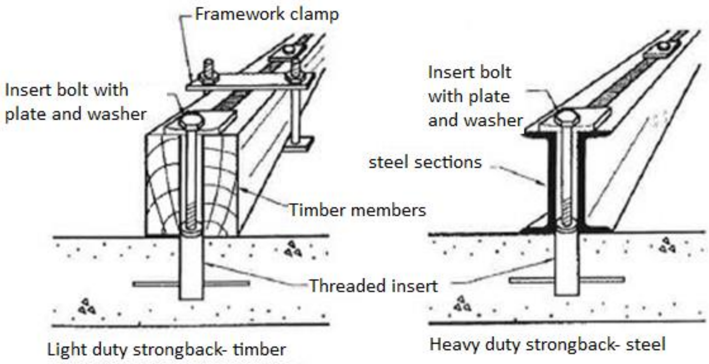
Strongbacks



Examples of strongback applications

The drawing will also specify where the strong backs or additional bracing is needed during lifting and erection.

Strongback: a temporary member used during the erection to locally strengthen a panel.

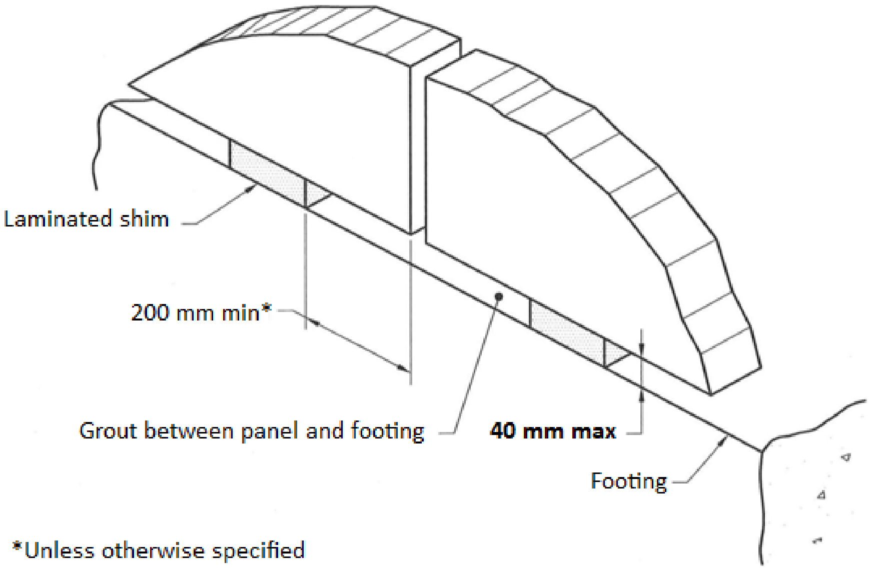


Strongbacks

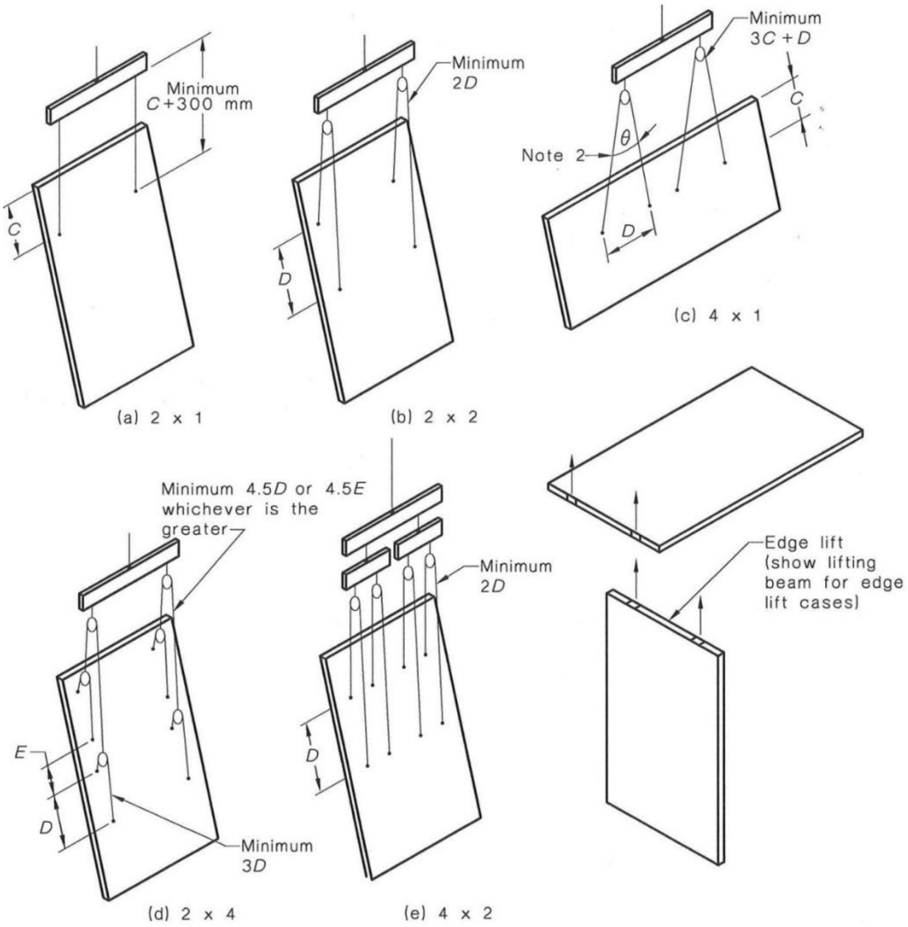
Levelling Pads and Shims

Levelling pads and shims shall comply with the material requirements of Clause 2.7 and shall be installed in accordance with the shop drawings.

TYPICAL SHIMMING DETAIL



Common Rigging Configurations



When lifting beams and equalising sheaves are used, the minimum lengths of the slings must comply with the formulas shown in the following illustration.

Although the loads in the slings attached to each insert are equal, the components of the sling load in the plane and perpendicular to the panel may not be equal for each lifting insert because of the differing inclination of the slings to the panel.

The sling loads, and their in-plane and perpendicular components, will also vary during rotation of the panel.

Note: Incorrect slinging of a tilt panel can result in over stressing and the possibility of breaking the panel being lifted.

Lifting Panels

- When calculating the total load on the crane, allow for the weight of the panel, the weight of any braces and strongbacks and the weight of spreader beams, equalising sheaves and other lifting gear.
- The effect of suction will increase the load on the crane by 40%, when a panel is being face lifted from its casting bed, therefore, multiply the dead load of the panel by 1.4 in loading calculations for the start of the lift.
- The centre of gravity will be at a greater working radius when a panel is face lifted than when it has been secured in position. To allow for this, add at least 1.5m to the final panel position when calculating the cranes working radius. This may need to be increased for very tall panels.
- Make sure all site personnel are at a safe distance from the panel when it is being lifted from the horizontal to the vertical. When taglines are used to control panel swing, work well clear of the panel edges because it may slew sideays.

Cranes

The requirements for cranes shall be in accordance with Clause 2.8

When placing face-lifted panels, the true working radius of the crane should include and allowance over the radius to the finished panel position to take account of the hang of the panel from the lifting inserts and any lifting beams etc.

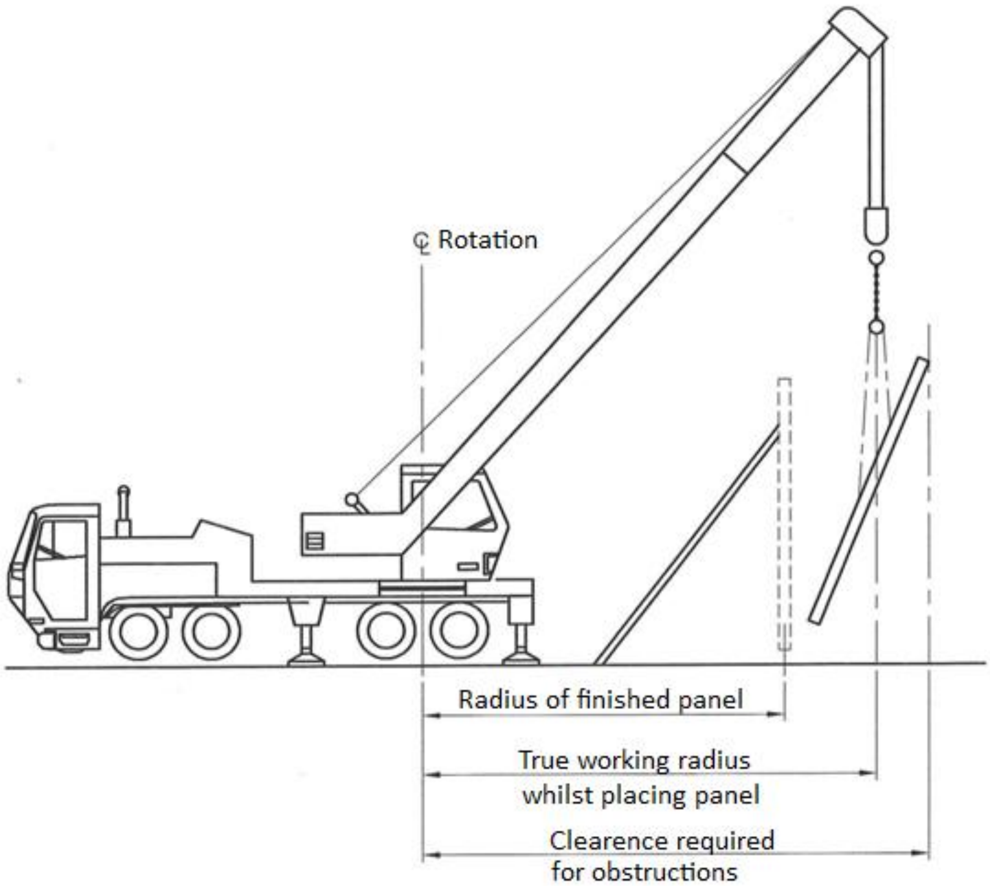
An assessment should be made depending on the individual panel details.

Items that may be required when conducting a tilt slab erection on a building site

- Crane
- Bracing
- Work platform
- Lifting clutches
- Lifting equipment
- Communications
- Lifting attachments for slab
- PPE

The increase in radius may be 1.5m or greater.

CRANE WORKING RADIUS



Panel release (lift-off)

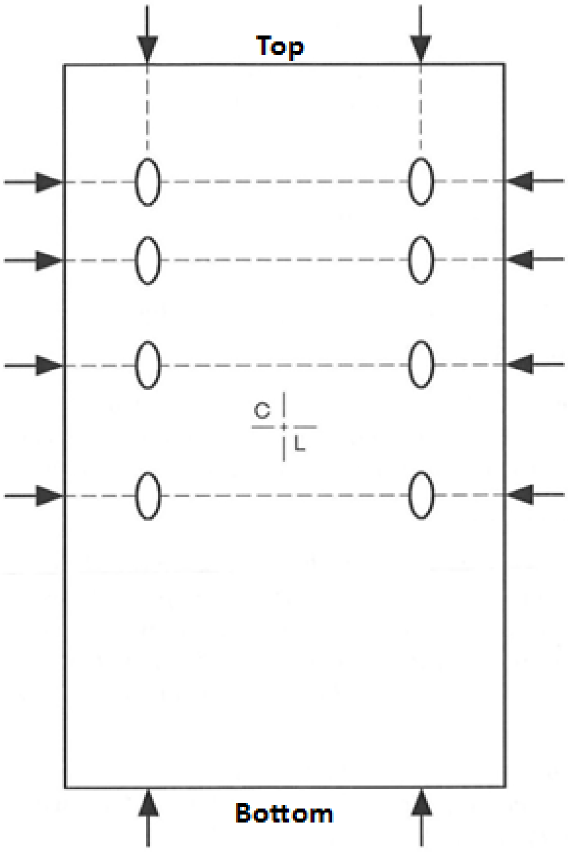
During the lifting process of tilt-up panels, the adhesion of the panel to the casting bed has to be broken. If the panel does not come free when the crane load indicator registers the maximum value of the lift load specified on the drawings, the load on the crane shall not be increased.

Where the panel does not come free, advice should be sought from the panel designer or panel manufacturer about the appropriate procedures to be used. Procedures such as wedging or jacking should be undertaken by or under the direction of a competent person, such as a qualified rigger. After the panel is free, the panel should be checked for damage. If the panel is damaged, it should be inspected by the panel designer.

Where used, long tapered wedges should be located between the panel and the casting slab so as to follow the line of drifting inserts.

The first wedges should be driven at the top of the panel in line with the lifting inserts. If the panel does not readily come free, pairs of wedges should be driven opposite successive rows of lift points down the edges of the panels.

Where used, wedges should be aligned with the lifting inserts unless written instructions state otherwise.



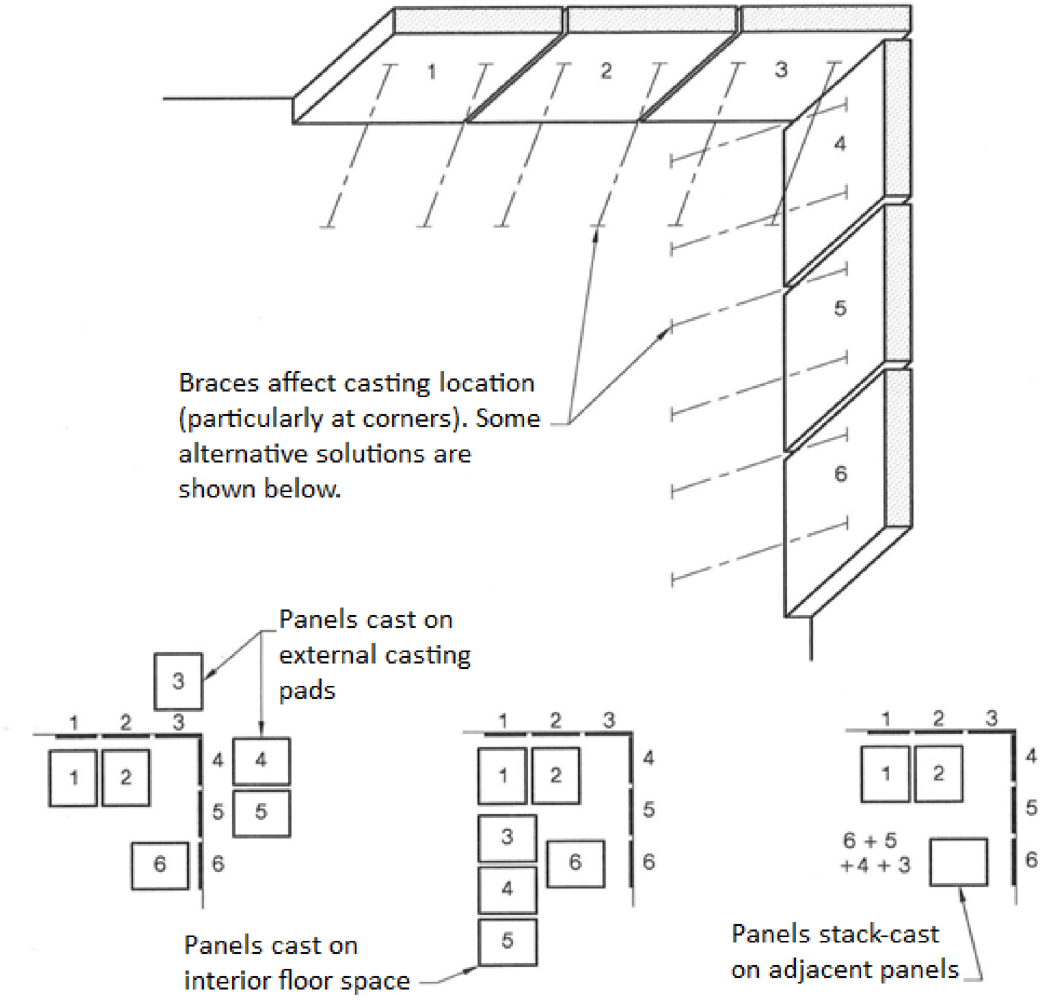
WEDGING OF STUCK TILT-UP PANELS

Job planning

Before lifting tilt up panels, observe the following rules:

- Select a crane with sufficient capacity and drift.
- Make sure the crane is fitted with a load weight indicator which has been calibrated in accordance with the manufacturer's instructions.
- Make sure the site is cleared for crane access and mobility, with sufficient room for the cranes outriggers and for the panel bracing, and sufficient clearance from overhead powerlines.
- Confirm that the concrete has been cured to reach its specified strength.
- Clean out all lifting, bracing and fixing insert recesses.
- Check the orientation and location of the lifting inserts.
- Refer any wrongly located lifting or fixing inserts to the certifying engineer.
- Check that shims have been set to the correct height and location.
- Check that the rigging configuration is as specified on the shop drawing and check that the slings are the correct length for that configuration.
- Wherever possible, secure the braces to the panel before it is lifted.
- Confirm that the crane's supporting surface will take erection loads.

A number of accidents have occurred where a slewing crane's superstructure has struck a brace to a panel that had been installed subsequent to the crane's setting up, resulting in the panel collapsing on the crane.



BRACING INFLUENCE ON CASTING LAYOUT

(Extracted from: Cement and Concrete Association of Australia, (1990) Tilt-up Manual, T27)

Do not remove any braces until it has been verified that the structure can free stand and connections have been made to the adjoining panels.

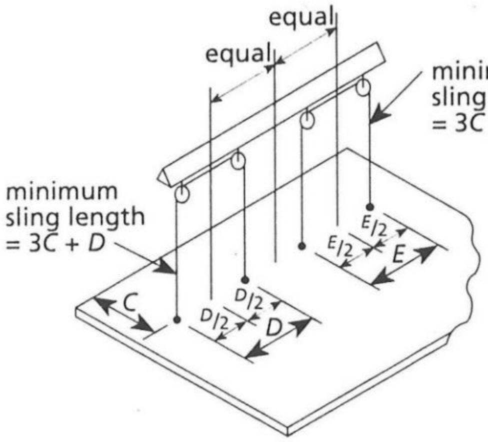
Lifting and Placing

Lifting shall not be undertaken until the concrete in the panel and bracing footings have attained their specified strength.

During lifting and placing:

- All personnel shall be outside the drop zone when lifting, tilting or rotating the panel from horizontal to vertical.
- When taglines are used to control the swing of the panel, personnel shall work clear of the panel edges as the panel may slew sideways.
- The lifting and placing method shall be such that sudden failure of the panel or rigging will not endanger the crane or crane operator.
- Panels shall not be lifted in winds that prevent control of the panel in all stages of erection.
- When it is necessary to attach the braces to the panel after the panel has been positioned, the panels shall be held firmly and safely by the crane while the braces are attached.
- At no time shall any panel lean on any braced panel or other part of the structure without prior approval from the designer.
- Clutch release ropes shall not be used as taglines.

Other Configurations



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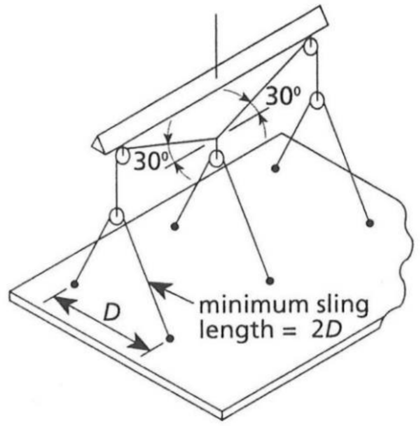

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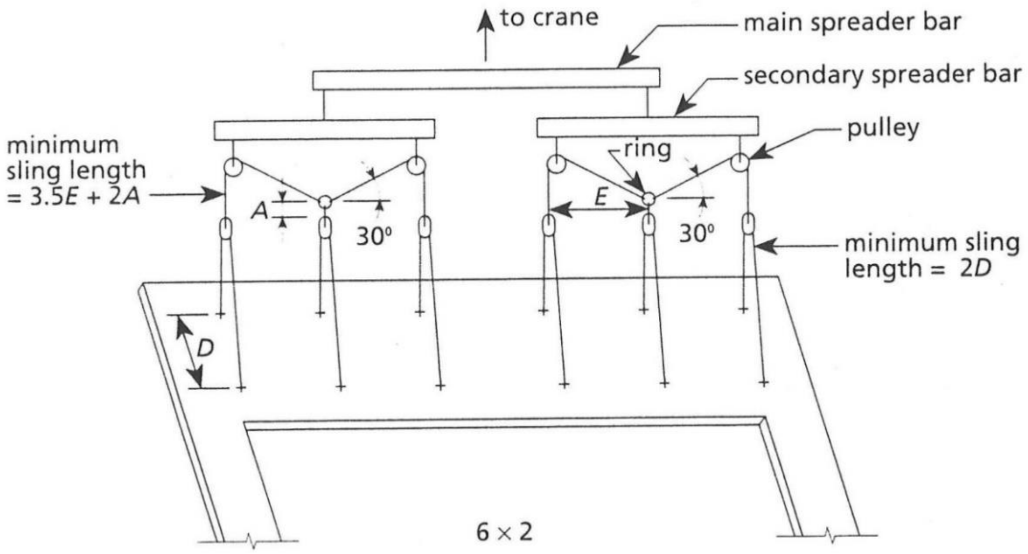
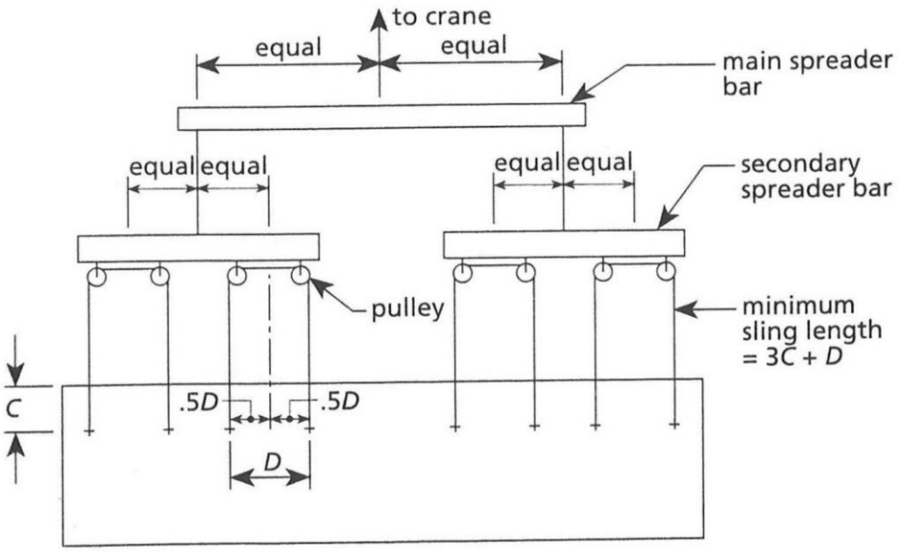


6 × 2



8 × 1

Futher checks of the torque of bolts are recommended at regular intervals after installation. Daily visual inspection is recommended on all braced and bracing elements.

Two temporary braces on a panel may be adjusted in alternate directions to ensure a minimal pre-load in the braces, which will reduce vibration under cyclic loading.

Fixing Panels

Braces should be fixed to the panels before lifting. Where this is not possible, make sure the panel is held firmly and safely by the crane while braces are attached.

Each panel should have at least two braces of equal capacity at right angles to the panel face.

At regular intervals during the erection process, re-check the tightness and security of the braces and their anchorages.

Do not remove the braces from a panel until it has been fully incorporated into a self-supporting structure.

Unless otherwise specified in the drawings, the maximum tolerance on the alignment of a panel fixed in its final position is 5mm.

Superimposed Loads

Superimposed loads shall not be applied to panels in the temporary braced condition unless such loads have been specifically allowed for in the design. These include loads from erection of steelwork and other attachments.

Designers should be aware that pitched rafters can exert significant outward loads onto braced panels. In some cases these forces are sufficient to cause failure of the bracing inserts/bolts.

Lateral outward forces on panels during the erection of pitched roof rafters can result in the overloading of the temporary bracing and its connections.

During release of the rafters weight from the crane, the braces adjacent to the rafter being erected should be monitored and adjusted accordingly.

Refer to designers and structural engineers.

3.2 Multiple Crane Lifting

The use of two or more cranes to move and position loads can be very hazardous and should not be considered where a single crane is capable of doing the job.

There are, however, occasions when multiple crane lifts are necessary. They are often required during the construction and assembly of oil and gas rigs and in the construct ion of bridges and large scale industrial projects such as power stations, smelters and refineries.

Certification

The person with direct responsibility for coordinating and directing a multiple crane lift must hold an Intermediate Rigging HRWL.

For very complex lifts, the advice of an experienced structural engineer may be required to properly plan the operation, but the qualified rigger must maintain immediate supervision at all stages.

Planning and Co-ordination

The importance of careful planning and the need for a thorough briefing of all personnel involved in the lift cannot be overstated. Many multiple crane lifts have come to grief through oversights, wrong selection of cranes, incorrect siting of cranes and misunderstandings between crew members.

If the weight of the load, its centre of gravity and the weight of the lifting gear is not known in advance, they must be carefully calculated.

Whenever possible, a 'dummy run' should be staged prior to the lift to check that the cranes can perform all stages of the operation within radius while maintaining sufficient clearance from obstructions and powerlines. This exercise should also be used to confirm that the agreed communication method is understood and is suitable.

Crane Selection and Siting

Whenever possible, select cranes of equal capacity and similar characteristics. This will make the synchronisation of crane movements easier to achieve. This does not necessarily apply to all designed lifts planned in accordance with Section 6.26 and Appendix D of the 2002 edition of AS 2550. 1.

Each crane must have additional capacity over and above its share of the load at all times during the operation. This is to allow for the possibility of the hoist ropes deviating from vertical or other loads transferred through imperfect synchronisation of crane movements.

The minimum capacity requirements for each crane are:

- When two cranes are used - 20 per cent greater than the share of the load.
- When three cranes are used - 33 per cent greater than the share of the load.
- When four or more cranes are used - 50 per cent greater than the share of the load.

Crane siting must be carefully considered so that crane movements are reduced to the minimum necessary. The crane siting can be limited by the nature of the worksite, the position of obstructions and powerlines, or the existing position of tower cranes.

Wherever possible, site the cranes to avoid slewing motions. Always use luffing up in preference to luffing down. Luffing down is dangerous because it can easily lead to the load swinging one or more of the cranes outside the safe operating radius. Wind loading adds to the dangers of luffing down.

Where the cranes are required to pick and carry, they must be aligned in the same direction. If they are out of alignment, the movement of one crane can push or pull the other cranes and stability may be lost.

When cranes are close together and are required to lift a large column, an equalising beam must be used.

In multiple crane lifts, the effects on the load radius while luffing down are:

- Increased load radius.
- Decreased load capacity.

Directing a Multi-Crane Lift

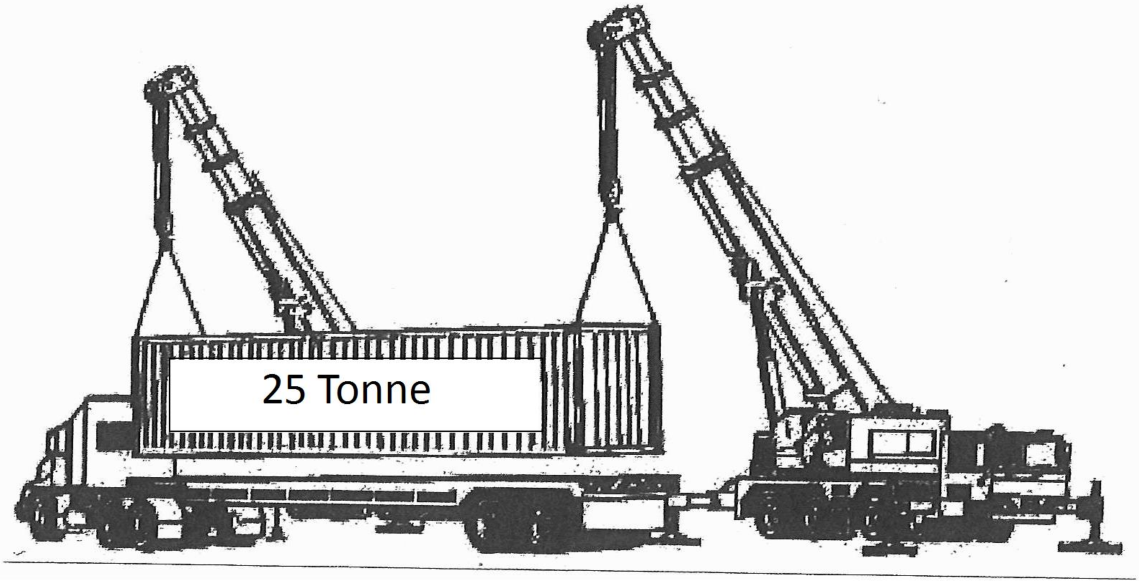
When directing a multiple crane lift a rigger should observe best practice and safety rules.

AS 2550.1 Section 6.28 1-6 Multiple Crane Operations shall be adhered to reduce risks of accidents.

Key points to determine are:

- Mass of the load.
- Mass of the lifting gear.
- Centre of gravity of the load.
- Size and characteristics of the load.
- Number of cranes involved.
- Load share of each crane.
- Synchronization of crane movements.
- Communications.
- Pick and carry operations, ensure the axis of each crane remains fully aligned with each other.
- Weather.
- Supervision.
- Crane hoist rope remains vertical and use instruments to monitor the force in each hoist rope.
- Only one motion at a time.
- Movements carried at slow speed.
- Where you cannot observe all necessary elements of the lift, place intermediate rigger to observe and report on the lift.
- Avoid slewing movements wherever possible.
- Luffing up in preference to luffing down.

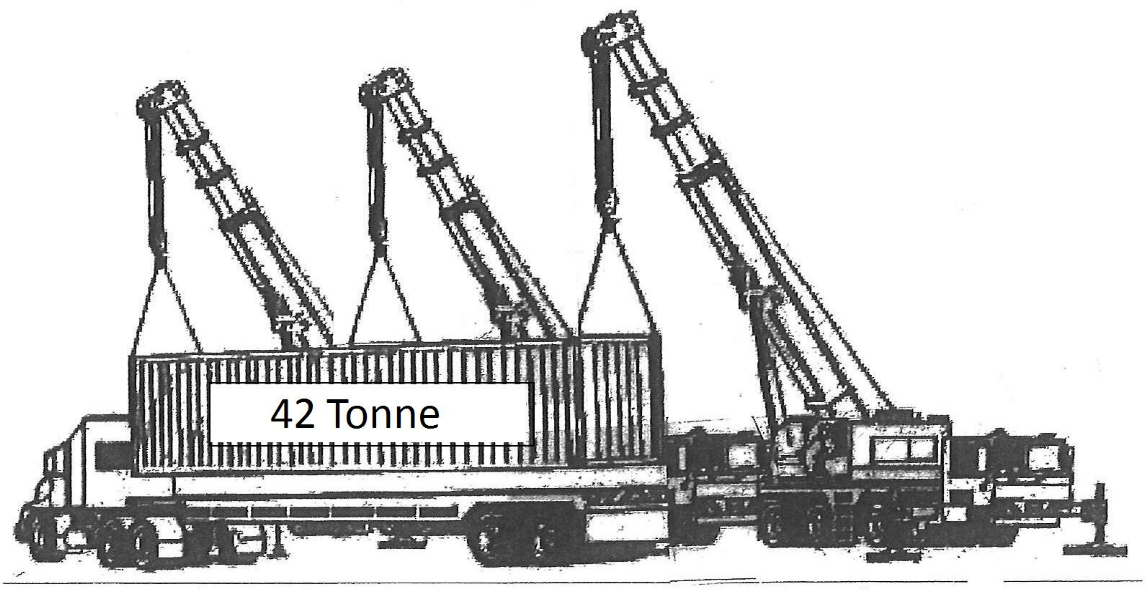
2 Crane Lift



A load of 25 tonne is to be lifted by 2 cranes. The total weight of the laod is 25 tonne. The load share of each crane is the total load divided by number of cranes. The load share is multiplied by 1.2 (20%). Each crane must be set up for ..

25t divided by 2 multiplied by 1.2= 15 tonne.

3 Crane Lift



A load of 42 tonne is to be lifted by 3 cranes. The total weight of the laod is 42 tonne. The load share of each crane is the total load divided by number of cranes. The load share is multiplied by1.33(33%). Each crane must be set up for ..

42 t divided by 3 multiplied by 1.33= 18.62 tonne

Dual Crane Lifts Using Equalizing Beams

Calculating Load Share

Where the load to be lifted is beyond the capacity of any of the selected cranes, equalising gear may be required to ensure that each crane supports its correct portion of the load.

Equalising gear is needed when the cranes are close together, such as for lifting large columns and similar objects. It also acts as a lever.

When the cranes are of differing capacity, the load to be lifted should be slung away from the centre of the equalising beam so that the load taken by each crane is proportional to its capacity. The load is slung closer to the end of the equalising beam supported by the larger capacity crane, to increase its share of the load and reduce the part of the load carried by the second crane.

Sample Calculation for Load Share

Mass of Beam	= 19.5T
Capacity Crane A	= 18T
Capacity Crane B	= 22T
Length of Beam	= 28m
Weight of lifting gear	= 500kg

Step 1 Mass of load + mass of lifting gear		19.5T + 0.5T	= 20T
Step 2 Total Load with required Increase *			
Multiply total load by 1.2 or add 20%		20T x 1.2	= 24T
	OR	20T + 20%	= 24T
Step 3 Divide total load by combined capacity of both cranes			
		24T ÷ 40T	= 0.6
Step 4 Multiply each of the cranes capacity by the answer of Step 3 to work out the load each is lifting			
	Crane A	18T x 0.6	= 10.8T
	Crane B	22T x 0.6	= 13.2T

* Increase percentage:	Two cranes	20% greater than the calculated share load
	Three Cranes	33% greater than the calculated share load
	Four or more cranes	50% greater than the calculated share load

Sample Calculation for Sling Points

Step 1 Divide total load by length of load		24T ÷ 28m	= 0.85T per metre
Step 2 Divide length of load by total crane capacity		28m ÷ 40T	= 0.7
Step 3 Multiply each cranes capacity by answer to Step 2			
	Crane A	18T x 0.7	= 12.6m
	Crane B	22T x 0.7	= 15.4m
Step 4 Divide answers from Step 3 by 2 to identify sling points in from end of beam			
	Crane A	12.6 ÷ 2	= 6.3m
	Crane B	15.4 ÷ 2	= 7.7m

3.3 Demolition Rigging

The practical skills needed to carry out rigging work associated with demolition are essentially those used in general rigging. However, the rigger involved in this type of work must have a thorough understanding of the additional precautions and required to safely carry out the rigging operations.

Typical demolition rigging includes the dismantling of lift cars, the cutting and removal of large structural beams and the use of winches to fell columns, walls and towers.

In some States, the person with overall responsibility for the demolition of certain types of buildings and structures must be licensed as a demolisher with the regulatory authority. If in doubt, check with the local authority.

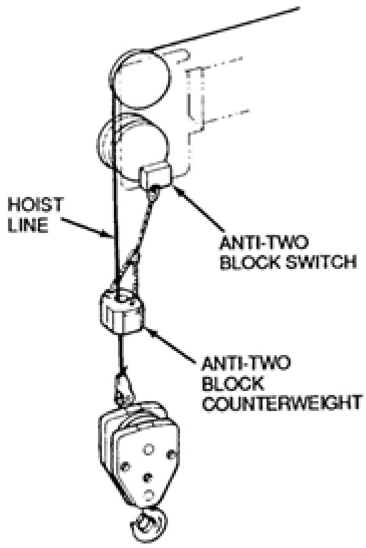
Certification

The person carrying out, or directly supervising rigging work in connection with the demolition of structures must hold an Intermediate Rigging HRWL.

Cranes and Rigging Gear Used in Demolition

All power cranes used for hoisting and lowering demolished material must be fitted with:

- A load weight indicator (load cell).
- A hoist limiting (anti two block) device.



A crane which has been used for lifting products of demolition or for swinging-ball demolition must be thoroughly inspected before returning to general duties.

Flexible steel wire rope used as felling ropes must have a minimum diameter of 12mm.

Grade 80 chains used as felling chains must have a minimum diameter of 8mm.

Estimating Loads and Forces in Demolition Rigging

The actual loads and forces applied to cranes, winches and rigging gear in demolition work are much more difficult to assess than in general rigging.

In demolition, things are not always as they seem to be, so nothing should be taken for granted. The weight of particular structural members is often uncertain therefore the centre of gravity may not be as it appears and long-term deterioration may have reduced their strength or the strength of their connections.

Structural members are often subjected to unknown forces caused by the structure shifting out of alignment, poor fabrication or poor construction methods.

Wherever practicable, test samples should be cut and weighed using the crane's load weight indicator. This will help to make your loading estimates more accurate.

All load estimates of in-situ members and materials must be increased by 50 per cent when calculating the SWL for cranes, winches and all rigging gear. This means the SWL must always be at least 1.5 times greater than the estimated loads.

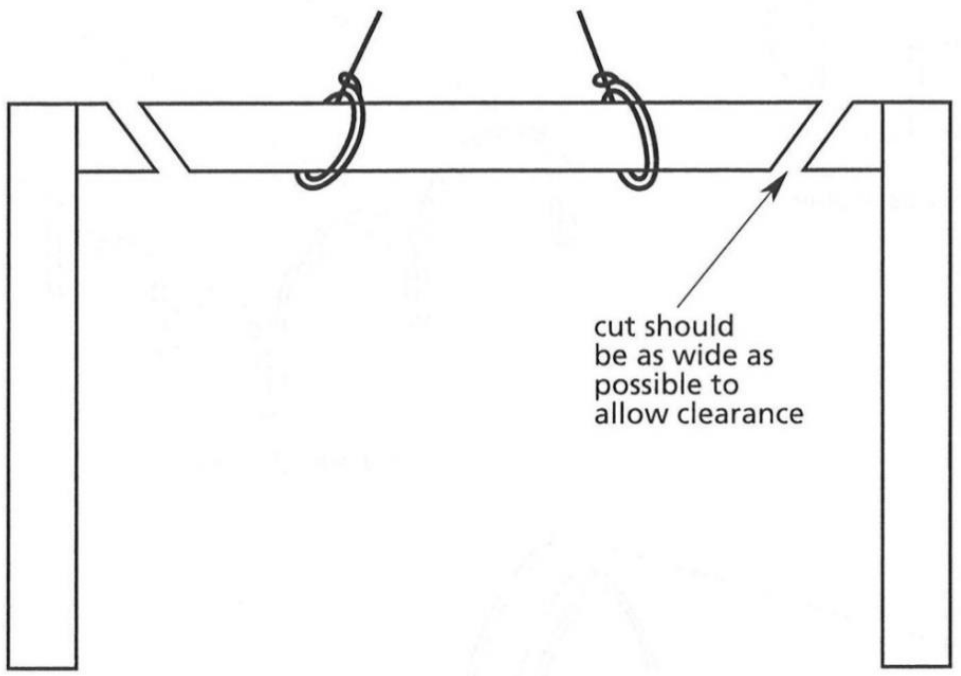
For example, a crane with a load chart rating of 15t at a given radius must not be used to lift a load estimated at anything greater than 10T.

Example:	A pair of slings are fixed to a beam with an estimated weight of 6T.		
	Therefore	6T x 1.5	= 9T
	This means the sling assembly must have a SWL of at least 9T		

Cutting a Beam Diagonally to Lift It

Cuts should be made diagonally in beams so that the remaining ends will support the beams if necessary, and they can be lifted free more easily.
If the beam is to be lowered directly to the floor or ground level below, the cuts should be made in the opposite direction.

The main beams are removed in the same way.



If beams support walls, they must not be removed until the walls are supported by shortening, bracing or guying. Columns and lateral beams must be similarly supported to maintain the structures stability.

Often during steel erection, beams and columns have to be pushed apart or pulled together. Be aware of this when disconnecting beams as the columns may spring away. For this reason, the person cutting the beams must have a safe platform to work from. A mobile scaffold is a good means of access.

Taglines should always be attached to beams before they are disconnected. This enables you to control the beam when the crane has taken its full weight. Temporary guys can also be used.

Equipment such as temporary guy wires should be used to control springing or sudden shifting out of level for a beam being cut free for demolition work.

Felling with Winches, Ropes and Chains

One form of demolition rigging is felling columns, walls and towers by pulling them over. Winches which can be used for this type of work include electrically or pneumatically powered general purpose winches, truck or crane mounted power take off winches and manually powered winches, including drum types and creeper types, tracked mobile plant may also be used to pull felling ropes and chains.

Rope, chains, shackles and other load bearing gear must be carefully inspected for damage before and after each use. Unserviceable equipment can easily result in failure under load, causing the hauling rope to whiplash dangerously or structural collapse to occur in an uncontrolled or unintended manner.

General guidance

Make sure there is sufficient clear space in the direction of collapse to contain all collapsing material within the site confines.

Check that the area where the collapsing materials will fall is strong enough to withstand the impact without collapsing. When in doubt, seek advice from a competent person, such as an engineer.

Make sure the collapse will occur well clear of all site personnel and will not be fouled by any obstructions.

Check the winch anchorages and fixings to ensure they will safely take the estimated load and prevent movement of the winch. Vehicle mounted winches should be set up on a hard, level surface, vehicle brakes should be applied and wheels chocked. Additional means of securing the vehicle may also be needed.

Never fell structural members by snatch loading. Always apply the tension gradually.

Make sure the horizontal distance from the winch to the demolition work is at least 1.5x the vertical distance from the winch to the load.

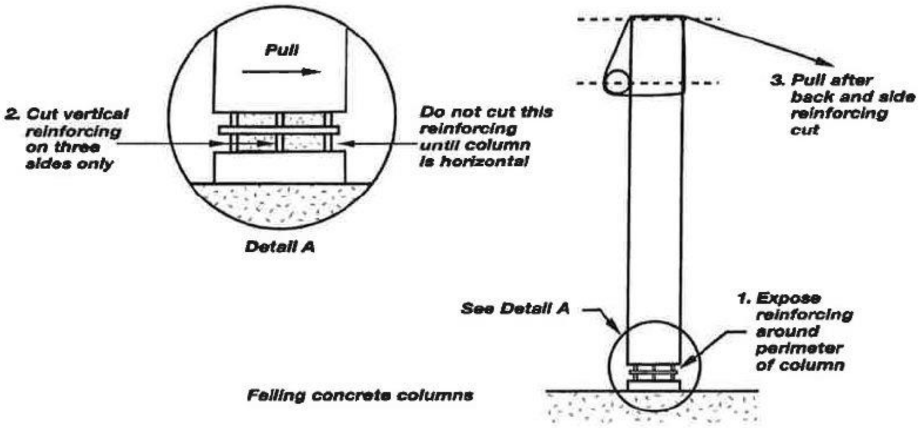
No person can stand closer to the sides than 0.75 or 75% of the horizontal distance.

Once the collapse has been completed, make sure the slings, hauling rope and other gear involved in the operation are carefully inspected for signs of overstressing or damage.

Reinforced Concrete Columns

The following procedure should be used for freestanding square or rectangular reinforced concrete columns:

1. Secure the ropes or chains around the top of the columns, use a fixing method which will ensure they don't become dislodged at any stage of the pulling.
2. Remove the concrete cover on all sides of the base of the column and enough to expose the vertical reinforcing bars.
3. Cut through all exposed reinforcing bars, except those closest to the direction of fall.
4. Steadily apply tension to the felling ropes or chains so the column hinges over the uncut reinforcing bars.
5. When the column has been felled, cut the remaining reinforcing bars.



Felling concrete columns

Masonry Walls

The following procedure should be used for long masonry walls:

1. Where necessary subdivide panels small enough for the capacity of the winch and rigging equipment. This can be done by cutting vertical slots through the wall.
2. The felling ropes or chains should be attached to the wall panels at a height no more than half the unsupported height above the intended cut off level, strong backs such as C-section channels may be needed to ensure that all of the panel is felled in a single operation.
3. Attach felling ropes or chains to all of the subdivided panels before starting to demolish any of them. Make sure all free ends are left at a safe distance from the wall. This avoids the need for anyone to approach the wall once the demolition of the panels has started.
4. Fell each panel separately.
5. Once the panels have been felled, remove the rope and chains.

Concrete Walls

Cast-in-situ reinforced concrete walls of 200mm or more thickness usually have two reinforcing grids, one in each face. Walls with two grids can be felled in the same way as reinforced columns.

Walls less than 150mm thick generally have only one reinforcing grid. This may be centrally located or towards one face. For walls with one grid, its location should be determined at the cut off level.

Walls with only one grid should be felled in the same way as masonry walls, with the reinforced cut after the wall is lying flat.

Walls with a single grid (reinforced mesh) which is close to the face should be felled towards the reinforced face.

Tilt Up Panel Structures

Buildings which have reinforced precast panel walls, including tilt up panel types, should be dismantled in the reverse sequence to their original erection.

Do not commence the dismantling and removal of wall panels until the nature and condition of their fixings to the rest of the structure and of the joining between panels has been determined.

Where the wall acts as bracing to other parts of the structure, temporary replacement bracing must be installed prior to the removal of those wall panels.

If the original inserts are intended to be used to lift and lower a wall panel, a careful examination of their condition and the condition of the surrounding material must be made. If there is any doubt regarding the adequacy, use another slinging method or provide backup slings.

Multistorey Buildings

During the demolition of multistorey buildings rigging gear may be needed to provide temporary support or bracing to parts of the structural framework to maintain stability at particular stages of the demolition process.

In general, free standing columns and walls above floor levels are to be demolished before demolition of the floor.

Precast Wall Panels

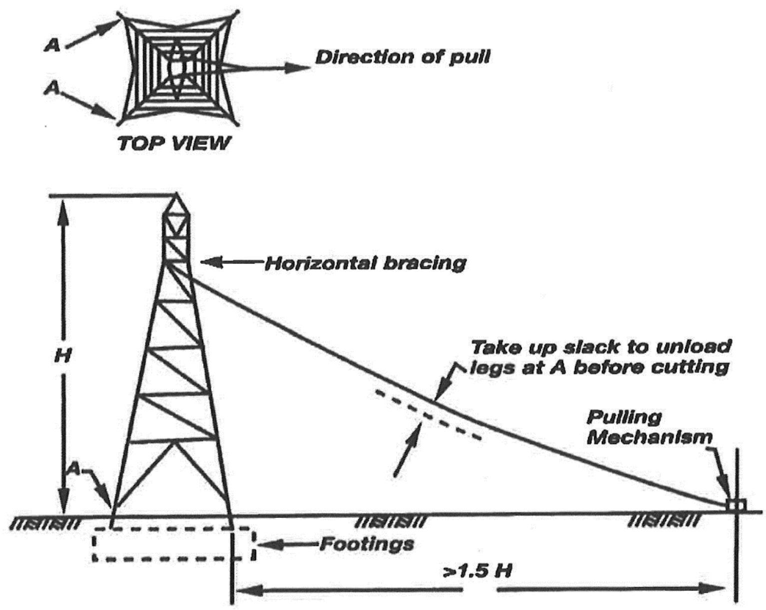
Where the building facade incorporates precast wall panels, the relevant guidance given previously for tilt-up panel structures should be followed.

Lattice Towers and Masts

Where electricity transmission line towers are to be demolished, the transmission line cables must first be deactivated and then removed in a way which prevents unbalanced lateral loading on the tower at the cable attachment points.

Caution: Suspended cables must not be cut under any circumstances.

When demolishing a guyed mast, first remove all freestanding portions of the mast down to the level of the guys. Make sure each set of guys is progressively slackened and removed in a way which prevents the remaining portions of the mast from becoming unstable. The mast may require temporary bracing before the lowest level of guys is slackened.



Felling of lattice towers and masts

Lifts

When demolishing a lift use the following procedure:

1. Support the lift car by shoring or other suitable means so that it is independent of its hoisting cable.
2. Make sure all lift door openings are barricaded.
3. Check that electrical power to all areas of the lift machinery has been disconnected.
4. Do not allow lift counterweights to free fall from the upper levels. Where applicable lower counterweights to a convenient level before disconnecting them.
5. Unwind lift cables in a controlled manner.
6. Before removing lift machinery and lift cars, make sure protection decks have been installed in the lift shaft not less than two levels immediately below the work.

Recognising Prestressed Members

Pre-stressed members can often be easily identified by their length, slenderness or camber.

Most concrete beams with spans greater than 9m and slabs with spans greater than 8m will be pre-stressed. Suspended pre-stressed members are usually more slender than normally reinforced members. Precast floor sections that have been pre-stressed will often have a slight upward camber.

Post-tensioned members generally have a surface recess on one or both ends to allow the tendon anchorages to be protected with a mortar covering. This is usually a different colour to the concrete and hairline cracks are frequently visible around their presence.

The cut of pre-tensioned tendons are usually covered with a protective cement render. Light scabbling of the rendered face should reveal their presence.

Hazards

The demolition of structures incorporating pre-stressed members can be very hazardous. The rigger responsible for the slinging and removal of pre-stressed members must be aware of the potential problems so that the rigging method selected can prevent them from occurring.

Post-tensioned members with unbonded or badly bonded tendons are the most dangerous. If a tendon is cut or an anchor plate is damaged, the member may suddenly lose it's strength and collapse. This can be prevented by a propping under the entire length or area before any tendon is cut.

There are also several other dangers which are often beyond the riggers competence to identify and control. Therefore, ungrouted post-tensioned members should never be demolished without consulting a structural engineer or the supplier of pre-stressing equipment.

Maintain the orientation of the beam when pre-stressed beams are removed. The beam has been stressed to take load, including its own self weight, in a particular direction.

If the beam is turned over or upside down, the forces in the beam will be acting in a different way. This may be enough to cause sudden and catastrophic collapse of the beam.

The structure above any post-tensioned transfer beam should not be demolished without consulting a structural engineer or the supplier of pre-stressing equipment.

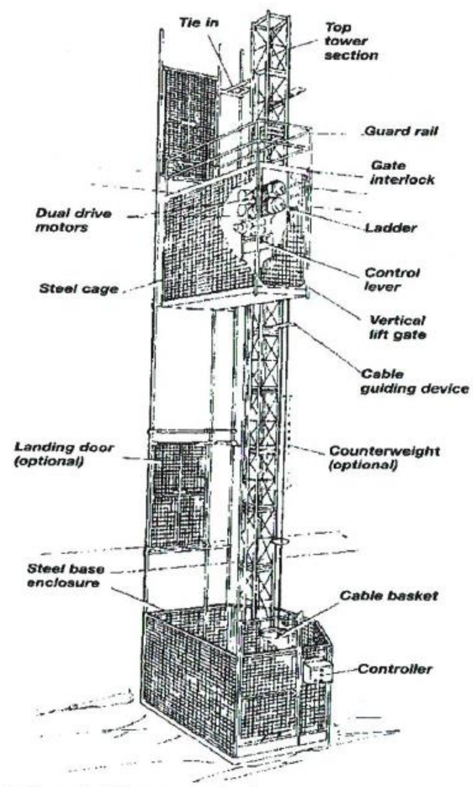
Unless special counter measures are taken, the demolition and removal of the upper floors and the consequent reduction in the imposed loads can cause the transfer beams to fail and may even trigger a collapse of the entire structure.

Unattended Free Standing Structural Members

The stability of partially demolished structures can be severely affected by high winds and heavy storm conditions. Therefore, the planning and control of the demolition sequence must ensure that the freestanding elements of the structure are not left in a hazardous condition when work ceases.

The following rules should be observed:

- A freestanding masonry wall must not be left outside working hours without lateral support if it's height is greater than 15 times its least overall plan dimension.
- A freestanding reinforced concrete column must not be left outside working hours without lateral support if its height is greater than 20 times its least overall plan dimension.
- A freestanding uncased steel column must not be left outside working hours without lateral support if its height is greater than 25 times its least overall plan dimension.



Cantilevered platform personnel and materials hoists

3.4 Rigging Cranes and Hoists

An Intermediate Rigging HRWL, is necessary to perform the rigging of:

- External guided cantilevered platform (personnel and materials) hoists
- Hoists with jibs
- Self-climbing hoists
- Mobile crane booms
- Tower cranes

Cantilevered Platform (Personnel & Material) Hoists

The cantilevered platform (personnel and materials) hoist is the most commonly used hoist in the construction industry. It uses a rack and pinion driven by at least two electric motors to raise and lower the platform.

Load Plates

Load notice plates must be displayed in the cage with the following details:

- Materials _______KG
- Passengers _______KG
- Combined Materials & Passengers _______KG

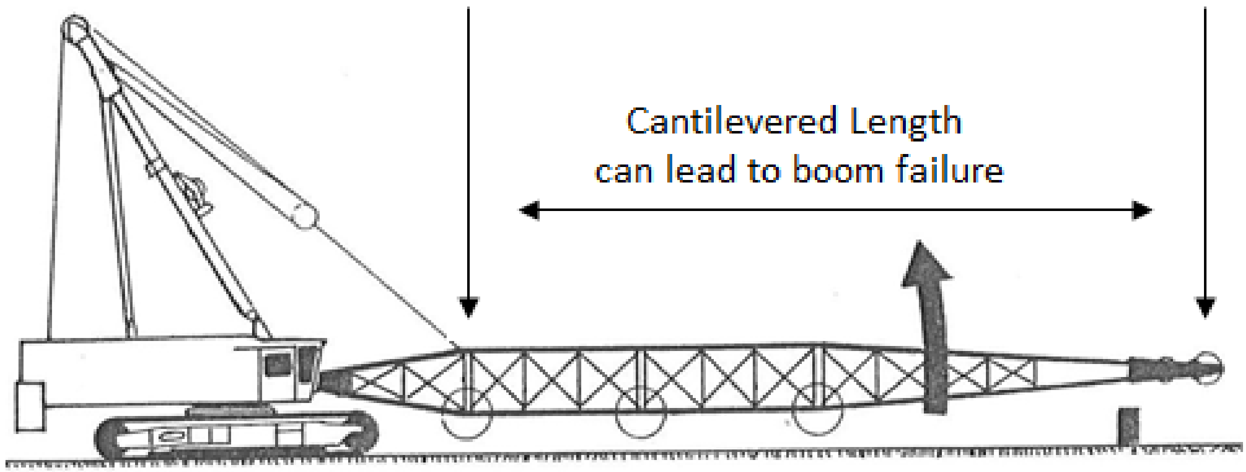
Pre-checks

Prior to operating a hoist for repairs or maintenance carry out the following pre-checks:

- Make sure that there are no obstructions such as pipes in the path of the hoist platform.
- Make sure that the lift car alarm and communication system are functioning.
- Take the hoist on a check run to check the operation of the stopping limits. Show caution when approaching the top or bottom landings.
- Test the operation of all gates including the trap door. Make sure that the hoist will not operate while the trap door or any of the gates are open.
- Make sure that the rack and pinion are well greased and that the teeth are in good order.
- The switch that controls the operation of the cage must be inside the cage and return to the stop position when it is released, although control may be switched to an alternate switch on the roof for rigging uses.

Cantilevered Crane Boom

Caution: Maximum cantilvered boom length varies with crane manufacturers, refer to crane manufacturers' operators manual for maximum cantilvered lengths.



Be sure that the boom hoist pawl is always engaged except when lowering the boom. Don't rely on the boom hoist brake alone to hold the boom, wear, improper adjustment, water or oil on linings, and other factors may reduce the ability of the brake to hold the boom.

Check the manufacturer's procedure and follow the instructions precisely. The following method is common to most manufacturers for pinned boom connections but may not apply to all.

Check the cranes manual before attempting this job.

- If so equipped, extend all outrigger beams fully and extend outrigger jacks until wheels are clear of ground.
- Level the carrier.
- Check the amount of counterweight required on the load chart for the lifts to be made and the length of boom being installed. Check also to ensure that enough counterweight is installed to lift the boom off the ground.
- Check to see if the front bumper counterweight is required.

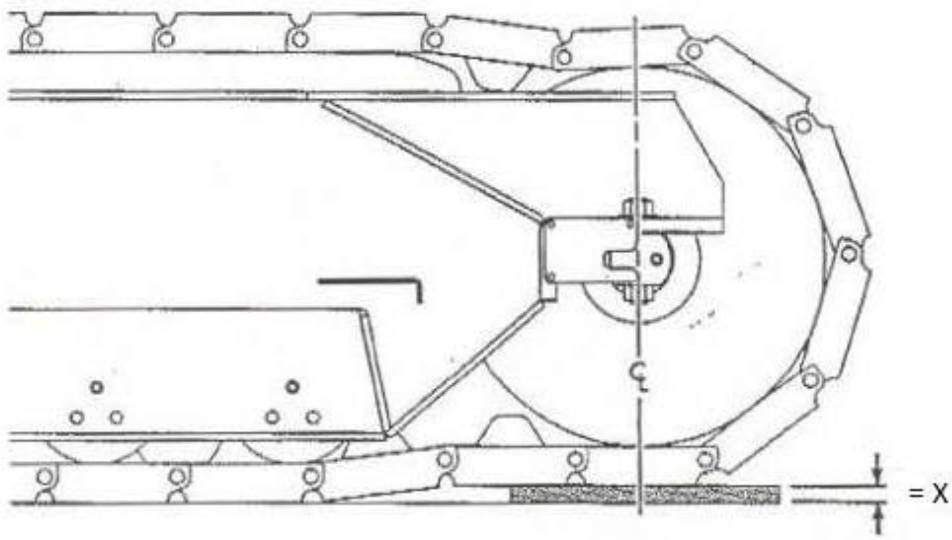
- If so equipped, the extendible counterweight must be extended.
- Rotate the upper works to face “over the rear” or in the direction of maximum stability.
- Set the swing lock.
- Fully extend the gantry. If the machine has a live mast, check the load chart to see if it must be used.
- Until the boom is solidly supported on its blocking never touch the top pins ahead of the pendants.

CRAWLER BLOCKING DIAGRAM

This diagram illustrates proper blocking of the crawlers for the following operating conditions:

- Raising and lowering the boom and tower attachments which require increased stability as per the capacity chart.
- Capacity chart ratings which require front of crawlers to be blocked (limited swing).

Hardwood or steel plate below centerline of both front idler rollers must be thick enough to maintain



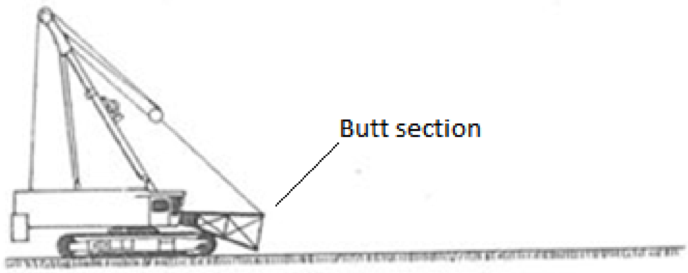
dimension X after ground and blocking have been compacted. Blocking ensures that centerline of front rollers become the tipping fulcrum.

Example: Some models of Manitowic cranes

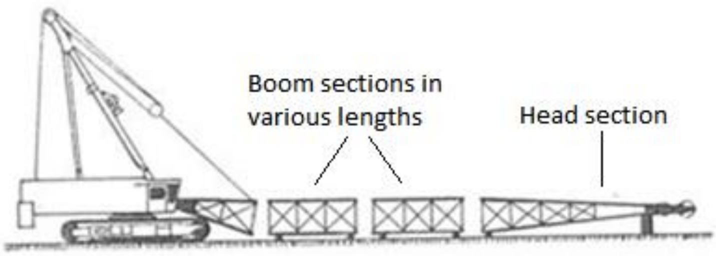
Model	Dimension X	
	Inches	Millimetres
M-50W	1-3/8”	35mm
M-65W	1-1/2”	38mm
M-80W Series 1	1-1/2”	38mm
M-80W Series 2	1-1/2”	38mm
30000W	1/2”	13mm
3900	3/4”	19mm
3900W	1/2”	13mm
3950W	1/2”	13mm
4000W	1/2”	13mm
4100W S-1/S-2	1/2”	13mm
4600 S-3	1/2”	13mm
4600 S-4/S-5	1/2”	13mm
6000W	1-1/4”	32mm
6000 S-2	1-1/4”	32mm

Assembly of Lattice Booms

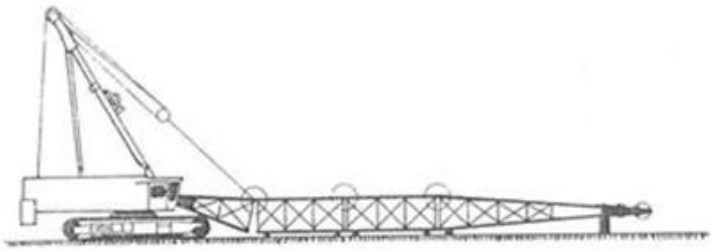
Install the butt section of the boom and install the heel pins. Attach the bridle to the butt.



Lay out the boom sections in the correct order specified by the manual (unless otherwise specified by the manufacturer). If there is no rigging drawing for the boom assembly, then the shortest section goes to the butt and the longest section goes to the head.

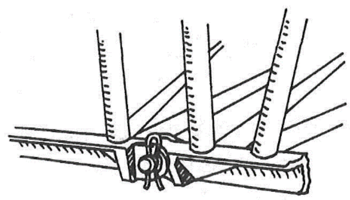


Draw all of the sections together. Line up the holes for the sections, insert boom pins to connect the sections. The bottom boom pins connecting the butt section to the first section from the butt are the last two pins to be inserted.

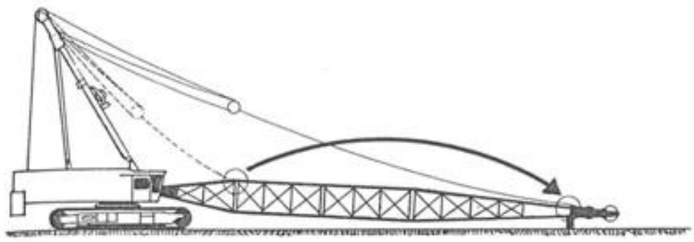


When connecting boom sections, the boom pins should be fitted from the inside to the outside.

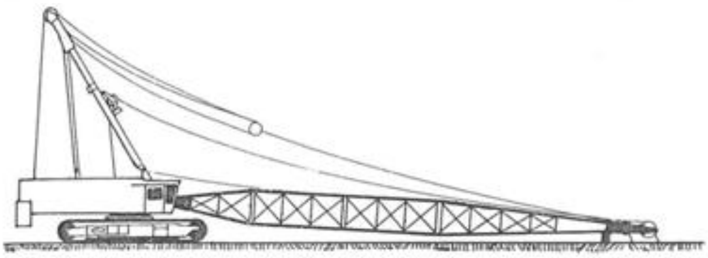
Note: Follow manufacturer's specifications.



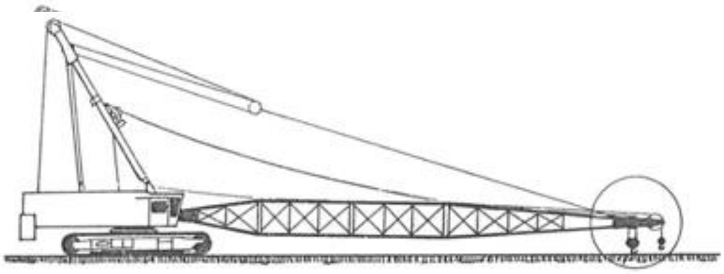
Disconnect bridle from the butt section. Connect the bridle to the pendant ropes.



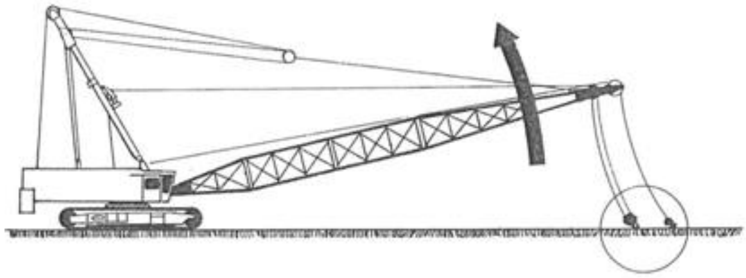
Rig the main hoist line (and auxiliary or whip hoist line if necessary) to the hook blocks.



At this point the boom pawl must be engaged before raising the boom.



To gain extra stability, do not lift the load block when raising the boom. Pay out the hoist line to keep the block on the ground. Raise the boom slowly and smoothly in one continuous lift.

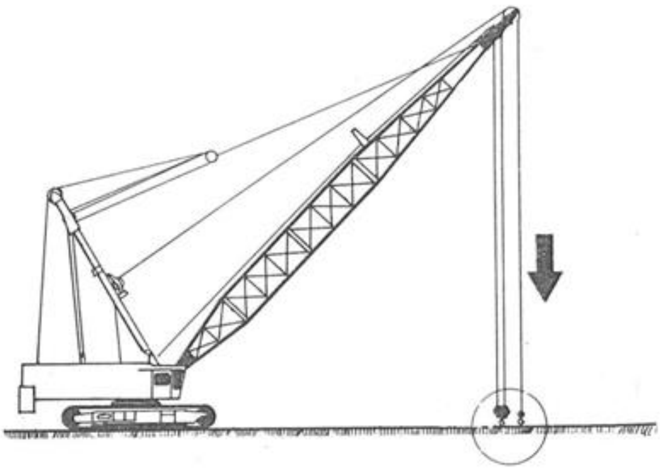


Dismantling Lattice Boom

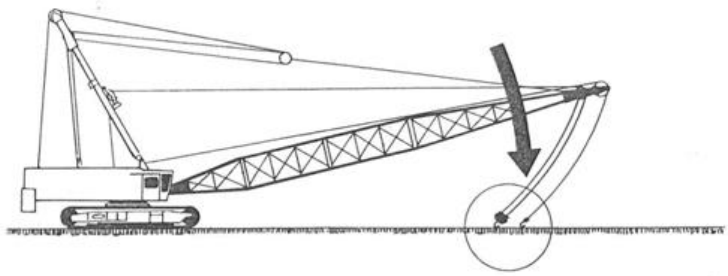
The following method is common to most manufacturers for pinned boom connections but may not apply to all; check the crane's manual before attempting this job.

Move the rig into a clear, level area.

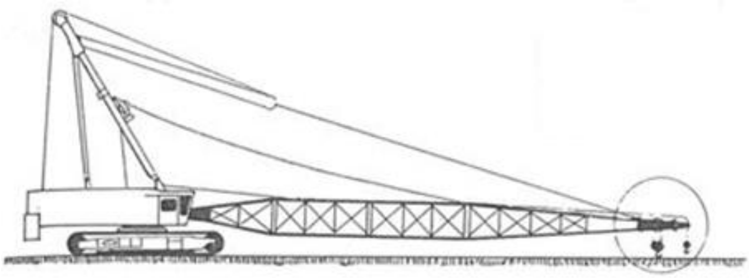
If so equiped, extend *all* outrigger beams *fully* and extend outrigger jacks until the wheels are clear of the ground.



Before lowering the boom block the front idlers with steel plate approximately 30mm thick. Slew the boom to bring it slightly off center to the front, boom down to approximately 20° where the hook block will make contact with the ground. While continuing to boom down slew the boom directly over the front until the boom head is approximately 1.5 metres off the ground. Engage the boom pawl.

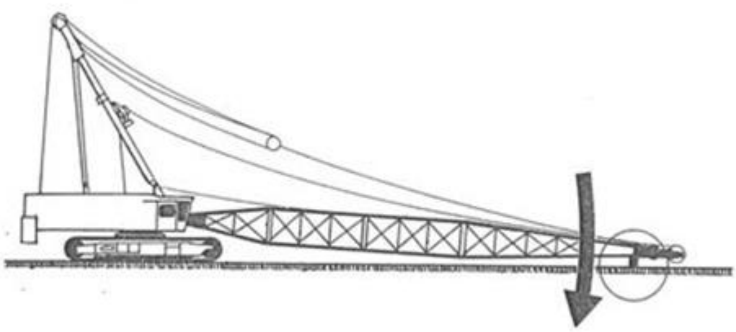


While the boom pawl is engaged unreeve and remove the blocks and winch up the hoist lines onto the winch drums.

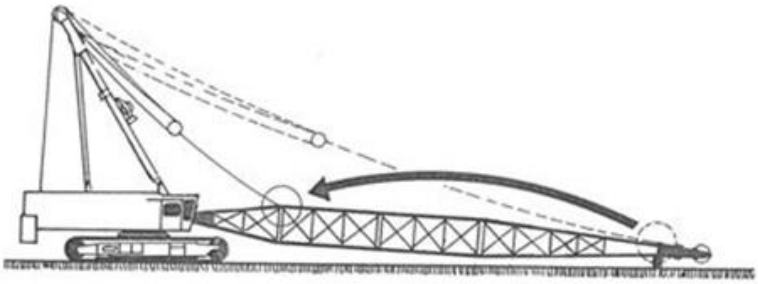


Lower the boom tip onto solid blocking until the pendants are slack.

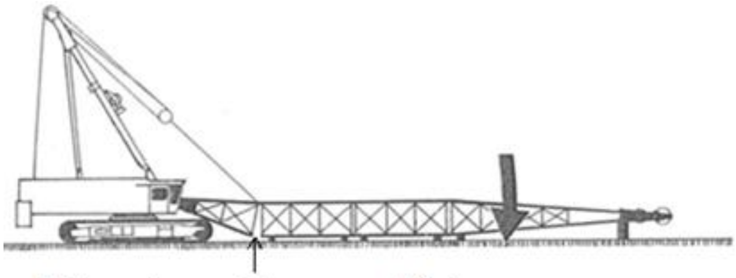
Note: A hazard of removing boom pins whilst working from inside the boom or from under the boom is sudden boom collapse causing injury or death



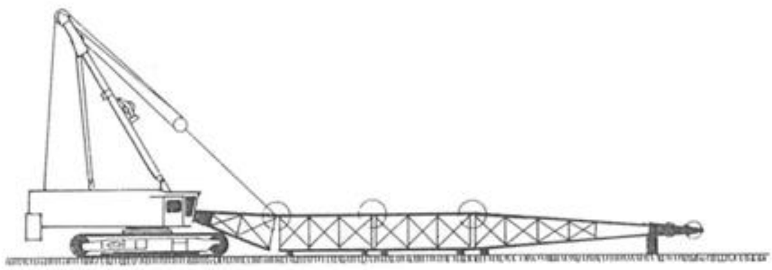
Disconnect the pendant ropes from the bridle. Attach the bridle to the butt section.



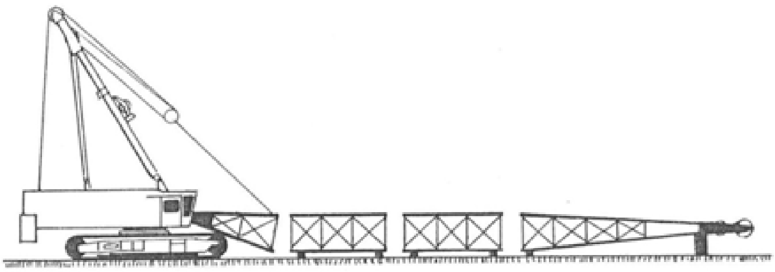
Remove the bottom pins first, connecting the butt section to the first section from the butt. Lower the boom onto blocking. Ensure that every section is supported.



Remove the pendant rope pins and remove all of the boom pins.



Separate the sections.

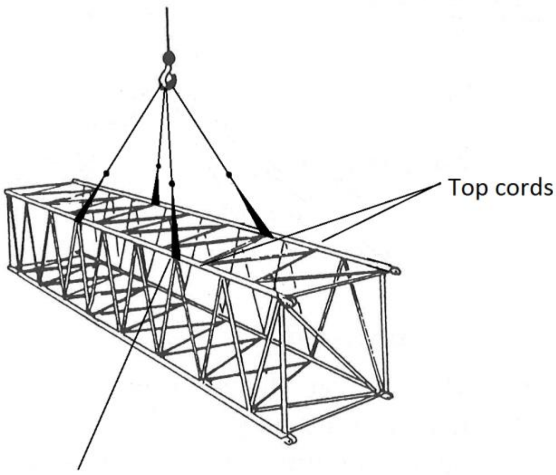


Caution: Never walk, work, or lean under the boom at *any* stage of this procedure.

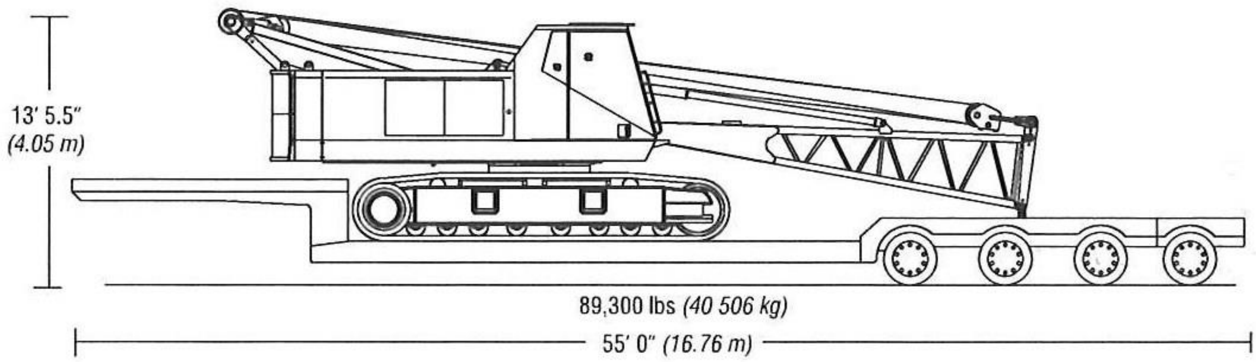
Lifting Boom and Jib Sections

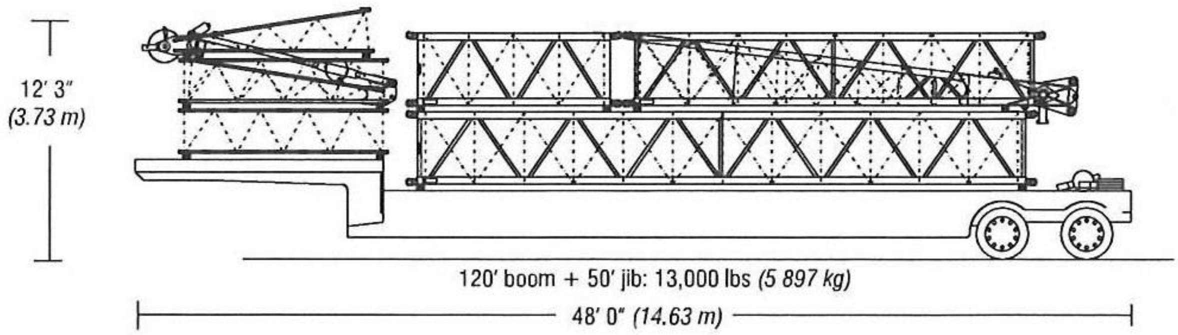
Boom and jib sections are lifted by the top cords using soft slings, however the manufacturer may provide lifting lugs on the top cords.

NB: Do not attach the slings to the lacing

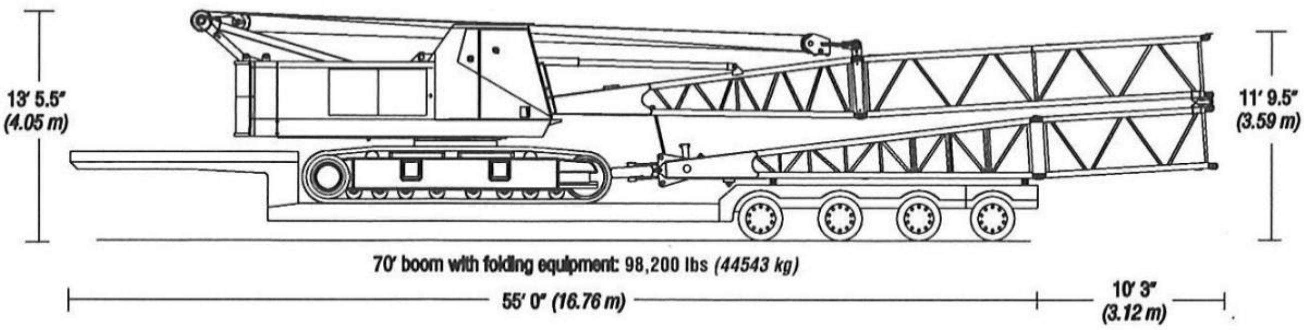


Alternative boom breakdowns and transport (Linkbelt 108H5)





*w/30" track shoes option



Lengthening the Boom on Mobile Cranes

Make sure that when the boom extensions are loaded onto the truck they are in sequence and properly packed.

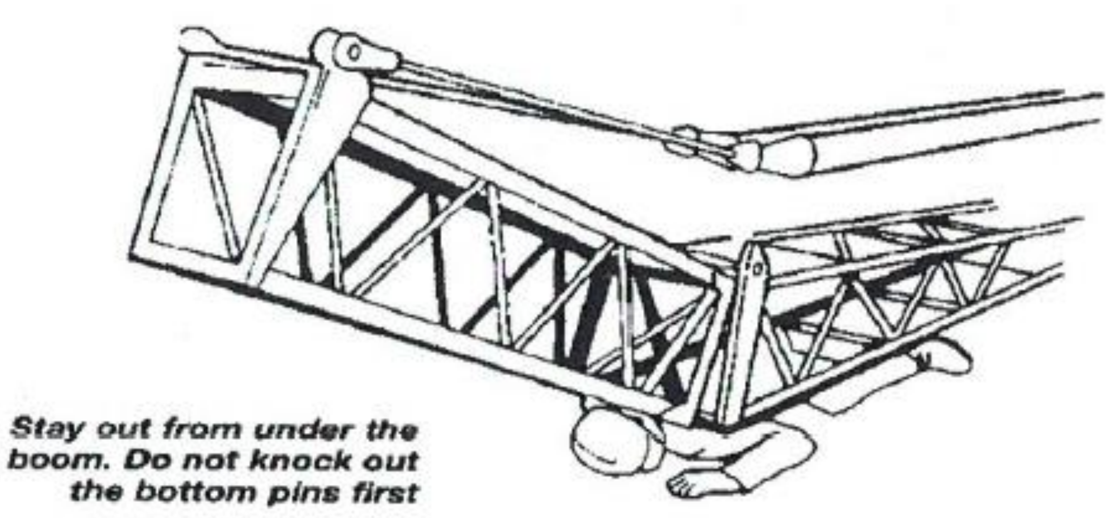
Attach the luffing bridle to the end of the boom with a sling.

Lower the boom into line with the extension. Make sure that the level of the truck is lower than the horizontal level of the boom. This will allow the top joint pins to be inserted first.

When the top pins are in place raise the boom until the new section is in line and then insert the bottom pins. The boom can now be raised and the process repeated if necessary.

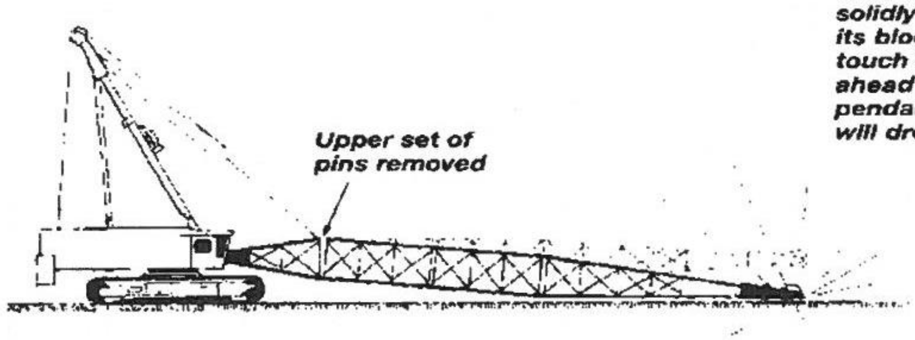
If a boom is 18 metres or longer a second crane and trestle supports must be used for boom changes. Make sure that correct slinging procedure is used for attaching boom sections to the assisting crane.

Fit the pins from the inside to the outside when connecting sections of boom.

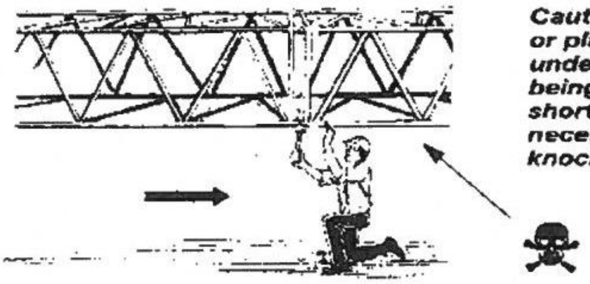


Do not stand under the boom to insert or remove pins. This is very dangerous. Do not permit any person to stand under the boom.

Before raising the boom check every pin, bolt, and shackle connection on the boom and jib pendants and rope anchorages. Make sure that all fittings are in good order, tight and secure.

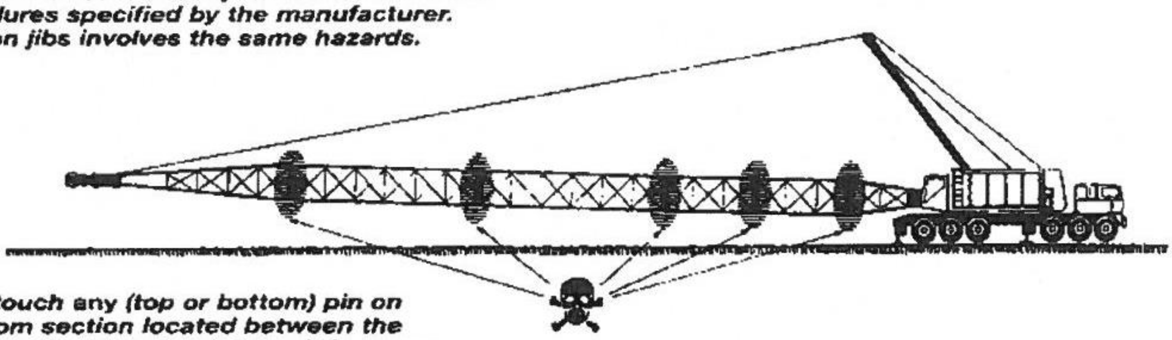


Until the boom is solidly supported on its blocking never touch the top pins ahead of the pendants. The boom will drop.

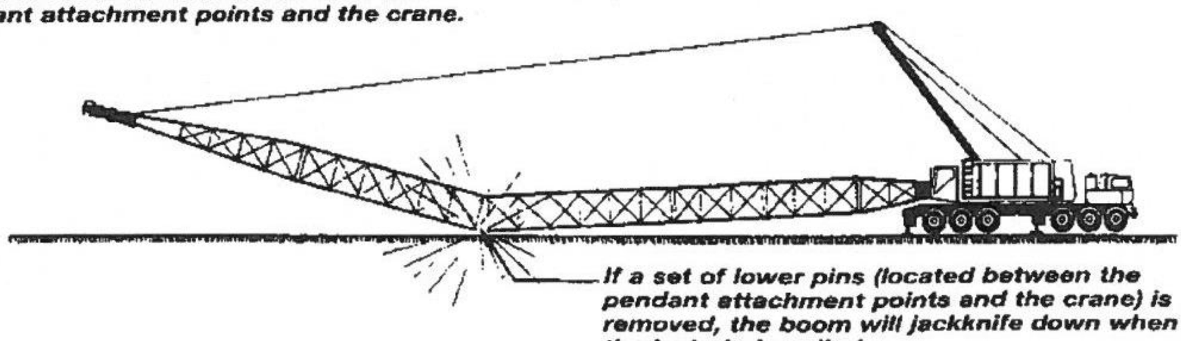


Caution: Never walk, work, lean or place any part of your body under the boom when it is being assembled, dismantled, shortened or lengthened. If necessary, use a long bar to knock the far side pins out.

Many operators and riggers have been killed when dismantling or shortening booms and the main cause is usually failure to follow the procedures specified by the manufacturer. Work on jibs involves the same hazards.



Never touch any (top or bottom) pin on any boom section located between the pendant attachment points and the crane.



If a set of lower pins (located between the pendant attachment points and the crane) is removed, the boom will jackknife down when the last pin is pulled.

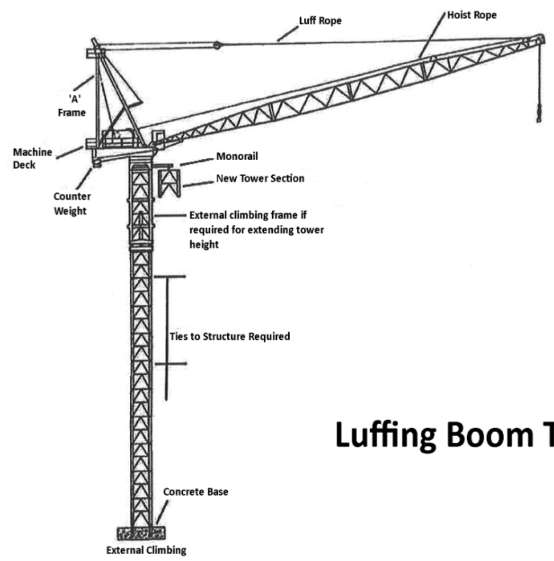
Tower Cranes

The person carrying out, or directly supervising rigging work involving the erection and dismantling of tower cranes must hold an Intermediate Rigging HRWL.

Tower crane design should comply with AS 1418.4 *Tower Cranes.* Each individual tower crane must be registered with the state or territory regulatory authority.

Tower cranes are widely used in the construction of multi-storey buildings and high rise industrial projects. There are two main types of tower crane:

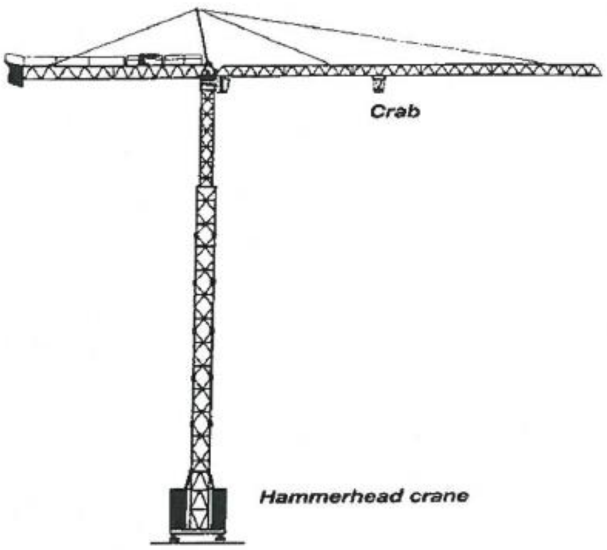
- Luffing boom
- Hammerhead



Luffing Boom Type

Both of these can be climbing, fixed or rail mounted. Climbing tower cranes can be internal or externa l to the building structure. Fixed and rail mounted cranes do not climb.

The most common type of tower crane used in Australia is the luffing boom type which can be either rope assisted hydraulic luffing type or entirely rope luffing. They are usually powered by diesel motors mounted on the machine deck at the top of the tower.



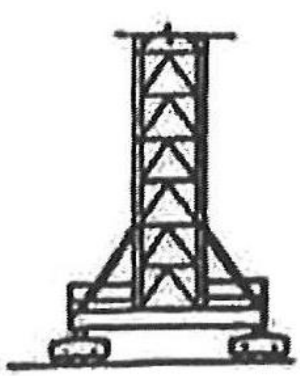
The hammerhead crane which has a horizontal jib is less common in Australia but widely used in Europe. They are usually powered by electric motors and have a crab which travels along the jib to achieve the required radius.

Tower crane design should comply with AS 1418.4 Tower cranes and designs must be registered with a State or Territory regulatory authority. Each individual tower crane must also be registered.

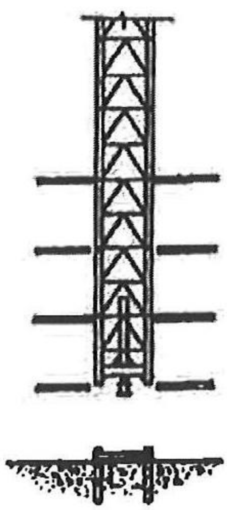
The addition or removal of sections of external climbing tower cranes must be carried out by riggers with an Intermediate Rigging HRWL. The complete erection and dismantling of tower cranes is done by rigging crews undertaken specialist training in particular types of crane.

Base Supports

The base of the tower crane sits on top of a concrete pad, which can vary in thickness based on the height and weight of the crane. Large anchor bolts are used to fasten the base of the tower to the concrete, and may also extend several feet into the ground. This keeps the tower safely supported to help reduce the risk of collapse.



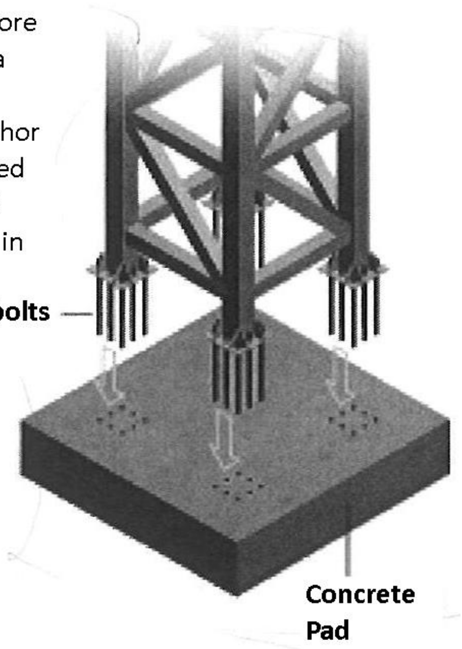
Rail Mounting

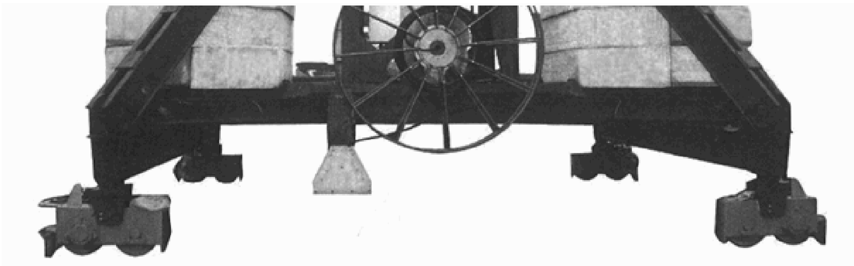


Internal Climbing

Standard base

Several weeks before the crane arrives a concrete pad is poured. Large anchor bolts are embedded deep into the pad holding the crane in place.

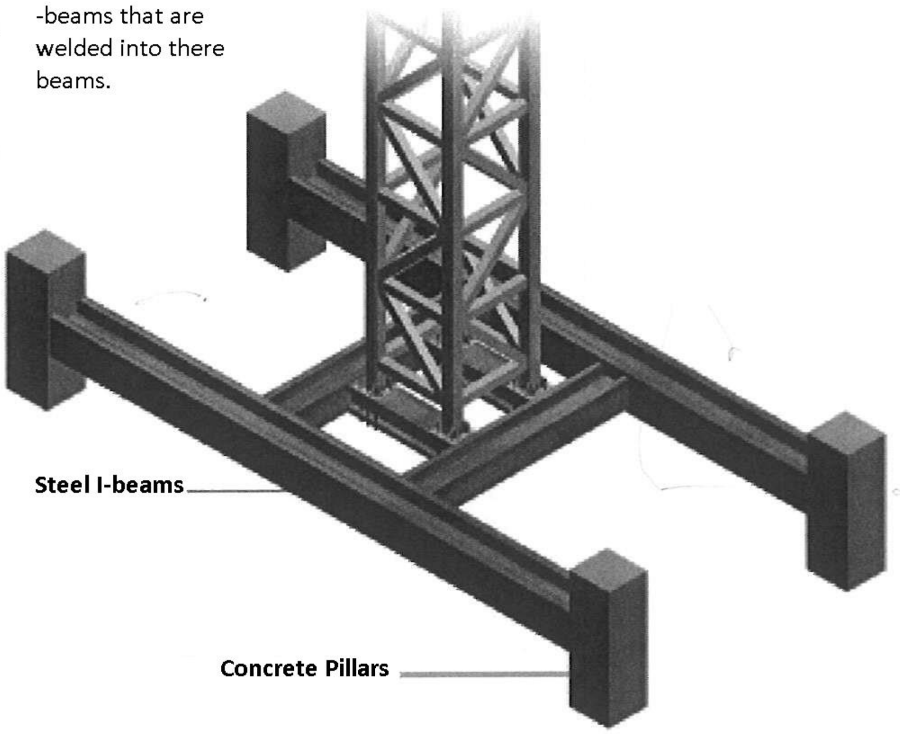




Rail Base

Tower 333 Base

The crane is bolted into steel I -beams that are welded into there beams.



General Safety

Tower cranes consist of a square tower which is bolted to a concrete foundation, support beams or a rail carriage. The slewing platform, hoist, mast and jib are mounted on the tower. For external climbing the climbing frame is fitted around the top of the tower. For internal climbing the rams and beams are fitted within the base of the tower.

All potential hazards should be considered before erecting a tower crane on site. The installation of the crane should be well planned and carried out in accordance with the manufacturer's instructions. The sequence of installing the jib (or boom) sections and counterweights is critical. Using an incorrect sequence could result in collapse.

Engineers consider the type of soil and rock under the crane, the cranes capacity and various radii before deciding on the exact site.

There is a maximum free-standing height which is designed by the manufacturer. This should not be exceeded without the manufacturers and engineers' approval.

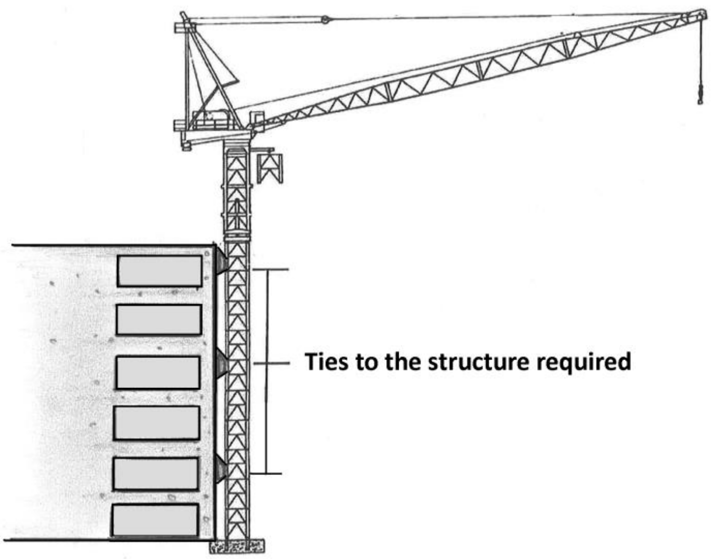
During the erection, climbing or alteration of a tower crane the following rules should be observed:

- Use barricades or other effective means to prevent unauthorised access to the operational zone.
- Use lanyards to restrain tools when work at height.
- Use safety harness whenever there is a risk of falling.
- Make sure that each boom connection pin is fitted with chain or wire rope attached to both the boom and the pin head.
- The effects of wind loading must be taken into account including the funnelling effects between adjacent buildings. Large sections of tower cranes should only be handled in calm conditions.
- The sequence of erection and dismantling must be carried out in strict accordance with managements instructions as well as in line with the cranes specifications.
- Tower erection bolts must be of the type specified by the manufacturer and be correctly torqued to their recommendations.
- All loose tools, nuts and bolts must be removed from the crane or effectively stored after erection and before operation.

External Climbing Tower Cranes

External climbing tower cranes are tied to the building or structure and are climbed by adding sections to the top of the tower.

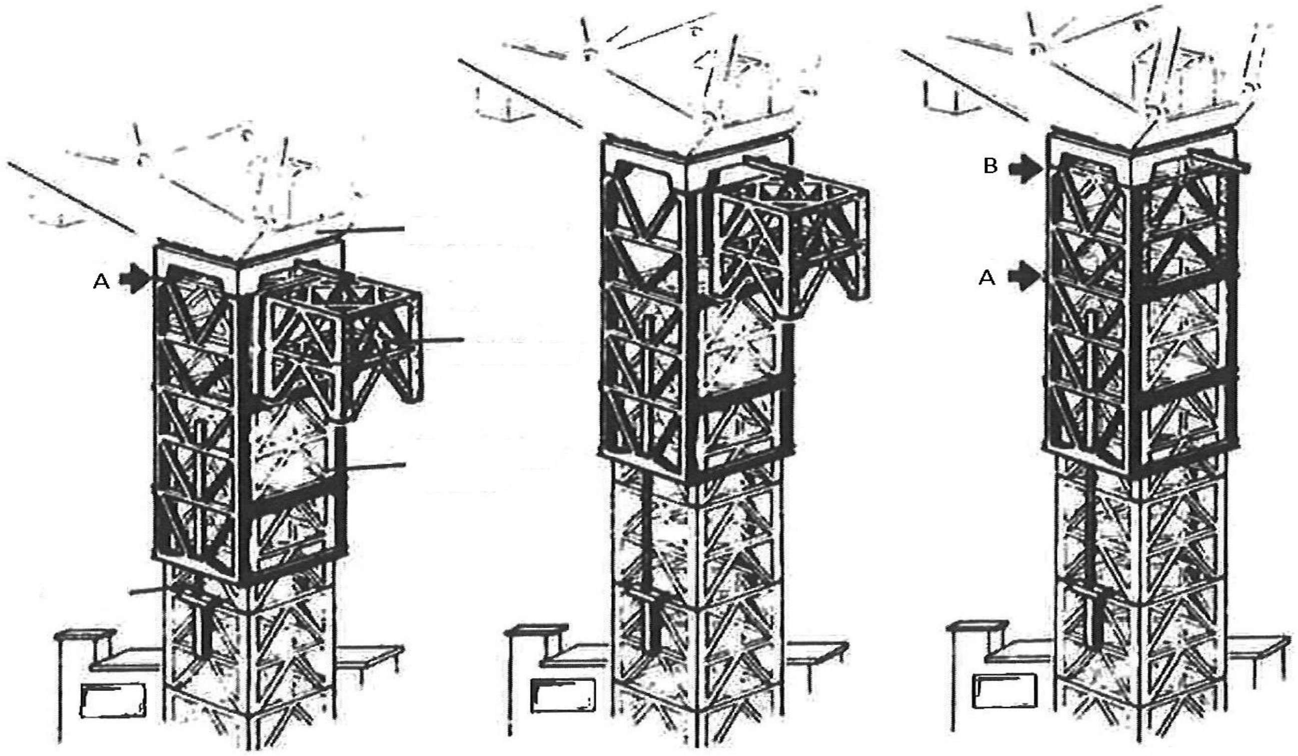
Note: Tie spacing's will be verified and installed as per engineer specifications. This is due to variations in the structure being tied into, the height of the crane and the forces applied during operation.



Use the sequence below as a general guide:

1. When adding sections unload and place sections close to the crane at the foot of the tower so there is no need to slew the crane to pick up another section.
2. Install the monorail if it is not already in place.
3. Connect the climbing hoses from the climbing control on the machine deck to climbing rams in climbing frame. Take directions from the fitter as it may be necessary to stop the engine.
4. Slewing motions may not be available during the climbing process, because some cranes use the slew pump to supply the necessary oil pressure for the climbing rams. This is a simple matter of taking the slew hoses off the slew motor and fitting them to the climbing rams controlling the oil flow with the slew control.
5. Lift the section and hang it on the monorail by transferring from the crane hook onto a four-legged sling attached to the trolley on the monorail.
6. Ensure that the sling legs are the correct and equal length so that the section can run freely when pulled into the aperture at the correct height.
7. Lock the counterweights and make sure that the jib is upright.
8. Remove the tower section bolts and ensure that the fitter has connected hoses before trying to climb.
9. The rigger in charge must direct the driver to balance the crane by luffing the jib out or travelling the crab. The driver should make note of the radius or crab position so it is possible to return to this point.
10. The crane is now ready to climb. The rigger in charge, controlling the climbing valve and the driver in the cabin in charge of the throttle must all be in radio contact.
11. At the signal, ‘rams down’ the crane will start to lift. The tower sections may jam in the climbing frame. It may be necessary for riggers to adjust the guides in the climbing frame several times during climb to ensure the frame slides freely over tower sections. Do not simply increase pressure to force it through.
12. Once the crane has reached the full extent of the rams (full climbing height), the section can now be pulled into the space and bolted into place.
13. Please note: on some cranes raising the tower to the required height will need four climbing cycles of the rams.
14. The rams are then retracted to protect the piston shafts, keep them out of the way and return oil to the reservoir.
15. Once retracted, disconnect the hoses if necessary and coil them out of the way on the machine deck (usually under hoist drum).
16. Counterweights can now be reconnected and the limits reset if necessary.
17. Counterweights must be installed strictly in accordance with manufacturers specifications to ensure maximum stability of all stages of erection and dismantling.
18. The monorail may have to be removed, depending on design.
19. The height that a tower crane can free stand above the last tie will be determined by an authorised engineer or manufacturer.

Removing a section is essentially the reverse of the above sequence



1
1. Crane lifts additional tower section and suspends it from extendable monorail. Bolts of top tower section are removed at A.

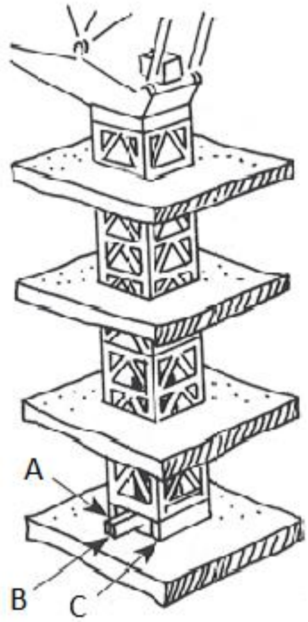
2
2. Hydraulic ram lifts top section of crane and climbing frame.

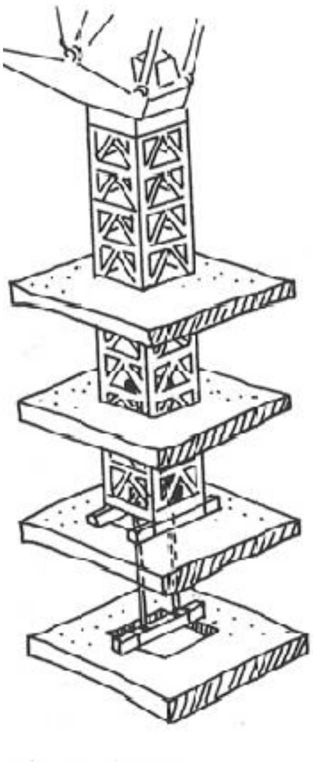
3
3. Additional tower section is drawn into the climbing frame and bolted at B and A.

Internal Climbing Cranes

Internal climbing cranes sit in the lift well, stairwell or in a well especially designed into the building. The climbing and erection method of the crane is designed into the building because a working crane subjects the building structure to great stresses.

1. Extendable beams "A" and "C" are retracted

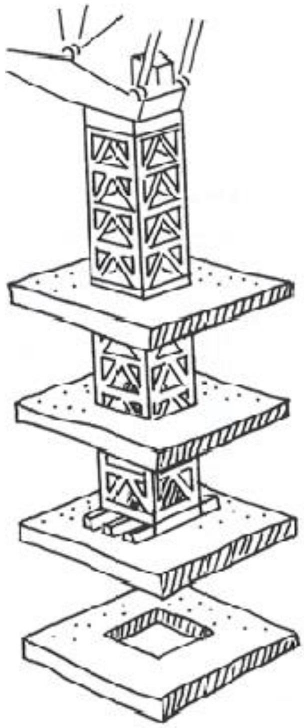




2. Crane, tower and climbing frame, to which extendable beams “A” and “C” are attached, are lifted by hydraulic rams.

Extendable beam “A” and “C” are extended on the new level once in position to support the crane.

3. Extendable beam “B” is retracted. Hydraulic cylinders lift beam “B” to the level of beams “A” and “C”. Extend beam “B” once in position at new level.



The internal type tower crane is supported inside the building or structure by a series of extendable beams according to design requirements.

Raising and Lowering

- Engineers’ certificates must be checked to ensure that floors are of sufficient strength to take the total weight of the crane, the support structure and all loadings imposed by the crane working.
- If the lift shaft is not used, the floor reinforcing is left protruding through the cut-out section of the floor. The hole can later be formed up and poured, sealing the hole after the crane is raised higher.
- Release shaft guides from the lift shaft to the minimum measurement required. Ensure the guides are placed at the set measurement in accordance with engineer specifications.
- Ensure the tower has reached equilibrium before jacking or retracting has commenced.
- To equalize the tower, luff the boom down to get the required radius which will achieve equalised balance or equilibrium.
- Communication from the pontoon operator (bottom of the tower) and hydraulic operator (on the upper machine deck) must be clear and effective to ensure correct climbing procedure. E.g. extend or retract hydraulic rams.
- Ensure steel packing plates are inserted under the pontoon beams for distribution of loads on the shaft walls.
- Check for any jamming of the tower in the lift shaft before and during any movement.

Self-Erecting Tower Cranes

There are also various types of self-erecting tower cranes that also require Intermediate Rigging HRWL.

GCI- 5400 Self Erecting Tower Crane

Capacity 26 tonne at a maximum height of 54 metres free standing.
From the ground to fully erected in 17 minutes.

SECTION 4 – Advanced Rigging

4.1 Fabricated Hung Scaffold

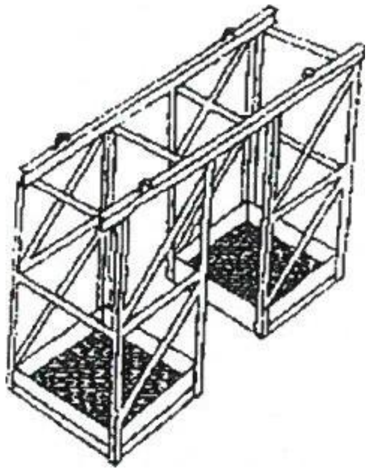
Fabricated hung scaffolds are purpose designed temporary structures which are anchored to a permanent structure to support a working platform. Unlike suspended scaffolds, they are not capable of being raised or lowered while in use.

They are usually installed as a static structure but are sometimes hung from girder trolleys or mobile suspension rigs so they can be horizontally travelled.

Fabricated hung scaffolds are usually constructed from structural steel, aluminium or timber components. Typical working platforms include checker plate, grid mesh or timber flooring.

This type of scaffolding is used during the erection of large structures such as power stations, to provide platforms for steel erection and consolidation and to provide temporary access ways between parts of the unfinished structure. They are also used during the construction of oil and gas rigs and are often slung under bridges for maintenance and repair work.

Fabricated hung scaffolds are either fixed to structural members on the ground prior to lifting, or are independently lifted into position by cranes, winches, chain blocks or fibre ropes and tackle blocks.



Certification

The installation and dismantling of fabricated hung scaffolds must be carried out or directly supervised by a person holding either an Advanced Rigging or Advanced Scaffold HRWL.

Hung scaffolds which are not fully fabricated such as those constructed from tubes and couplers, require the Advanced Scaffolding HRWL.

Design and Construction

Design Compliance

The design of a fabricated hung scaffold and the strength and condition of the supporting structure should be verified in writing by a competent person such as a structural engineer as complying with the minimum requirements of AS/NZS 1576.1 Scaffolding-General requirements.

The written verification should specify the duty classification of the working platform and specify the method(s) of anchorage to the supporting structure.

Before installing the scaffold, make sure you have sighted the written verification and have carefully read any of the limitations and conditions attached.

Duty Classifications

Fabricated hung scaffolds are classified as:

- Light duty – with a maximum allowable live load of 225kg per platform per bay and a minimum platform width of 450mm.
- Medium duty – with a maximum allowable live load of 450kg per platform per bay and a minimum platform width of 675mm.
- Heavy duty – with a maximum allowable live load of 675kg per platform per bay and a minimum platform width of 900mm.
- Special duty – with a maximum allowable live load as specified in the design verification (but greater than heavy duty) and a minimum platform width as specified (but at least 1m).

Platforms used for through access of person and materials must be designed to at least heavy-duty specifications, but the platform width can be reduced to 450mm (for persons and hand-tools only) or 675mm (for general materials movement).

Platform Construction

The platform of a fabricated hung scaffold must be closely decked with an even, slip resistant surface which is free of trip hazards. The platform must be secured so as to prevent uplift or dislodgment.

As a general rule, the platform should be horizontal. In some cases, the scaffold may be designed to have a sloping platform (such as for continuous access under sloping structural beams).

All working platforms and closed platforms shall be erected level with a nominal tolerance of 3º in all directions, unless otherwise specifically designed.

The traverse slope shall not exceed 3º.

The longitudinal slope shall not exceed 20º. Where the longitudinal slope is greater than 7º from the horizontal, it shall incorporate slip restraint. Slip restraint shall be of a similar performance level that can be achieved by the use of cleats that are:

- Nominally 25mm thick;
- Nominally 50mm wide;
- Spaced at intervals of nominally 450mm;
- Securely fixed to the upper surface of the platforms; and
- The full width of the platform other than a 100mm wide gap for a wheel of a material transporter, if required.

Edge protection is required at the open sides and ends of all platforms from which a person or object could fall more than 2m. Edge protection includes guard railing and toe boards.

Guard railing must be constructed from rigid components. Fibre rope, chain and steel wire rope is not permitted. The height of the guardrail must be not less than 900mm and not more than 1100mm above the platform surface.

Toe boards may be timber or metal kickplates. They must extend at least 150mm above the platform surface and any gap between a toe board and platform must not exceed 10mm.

The gap between the guardrail and the toe board must be protected by either a mid-rail or infill such as meshed screens or construction grade plywood sheets.

Where a mid-rail is used and material stacked near the platform edge extends past the toe board, additional infill (such as extra toe boards fixed above the existing toe boards) must be fitted to prevent the possibility of any material being knocked over the platform edge.

Access to the Working Platform

A safe means of access must be provided to the working platform. Where direct access at the same level from the existing structure is not available, means of access such as ladders, stairways or ramps must be incorporated.

Portable ladders used for access must be single ladders. Extension ladders are not suitable as access ladders. Ladders must be industrial grade. Domestic grade ladders are not to be used.

Access ladders must be fixed at a slope not less than 6:1 and not more than 4:1. They must be secured against movement in any direction and they must extend above landings by at least 900mm.

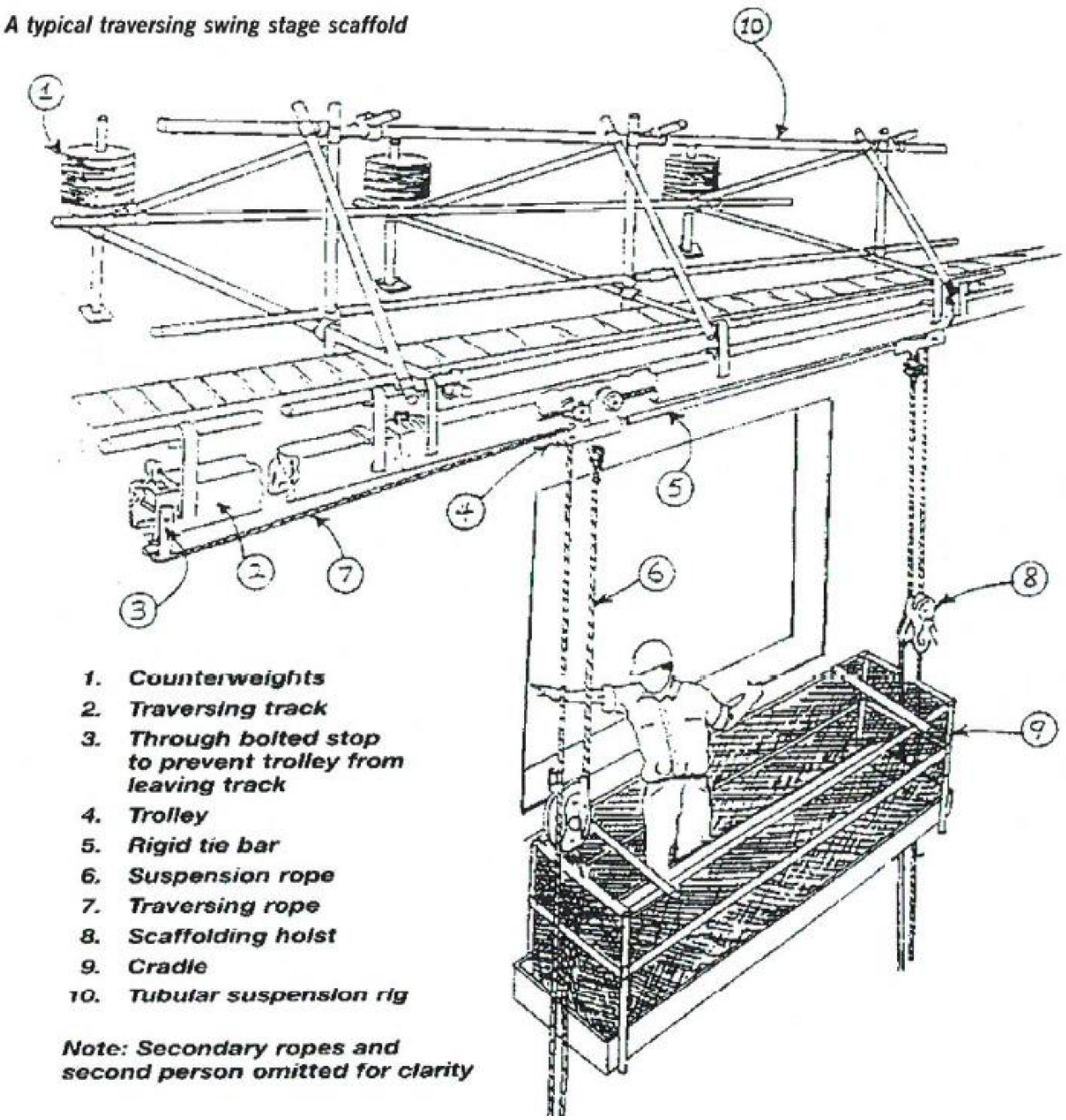
4.2 Suspended Scaffolds

A suspended scaffold has a suspended platform that can be raised and lowered during normal use. It is generally suspended from temporary overhead supports by flexible steel wire ropes to which scaffolding hoists are fixed.

Types of suspended scaffolds include swing stages, double rope suspended platforms, work cages and boatswain's chairs.

Suspended scaffolds are often used to carry out work for short periods on the sides of tall buildings or structures. They are also used inside lift shafts, large boilers and chimneys.

Suspended scaffolding should be designed to comply with AS/NZS 1576.4 *Suspended scaffolding.*



Certification

The erection, alteration and dismantling of a suspended scaffold must be carried out or directly supervised by a person holding either the Advanced Rigging or Advanced Scaffolding HRWL.

The erection, alteration and dismantling of suspension rigs for a suspended scaffold constructed from tube and coupler scaffolding requires the Advanced Scaffolding or the Intermediate Scaffolding HRWL.

Scaffolding Hoists and Protective Devices

The design and manufacture of scaffolding hoists should comply with AS 1418.2 *Serial hoists and winches.* The design of a power operated scaffolding hoist must be registered with an Australian regulatory authority.

Scaffolding hoists are usually electrically powered, but pneumatically powered models and hand operated models are also available.

Scaffolding hoists can be either a drum type hoist, where the FSWR is stored on the winch drum, or a climber type hoist, where the winch climbs a suspension rope and the rope tail hangs below the hoist.

Electrically powered scaffolding hoists must be fitted with load limiting devices set at no more than 1.25 x the WLL of the hoist.

This is because modern electric scaffolding hoists can have an ultimate stalling torque which is far greater than their rated capacity.

A load limiter will prevent the hoist toppling the suspension rig or destroying the suspension rope if the scaffold is jammed by an obstruction while it is being raised.

There must be a protective device for each scaffolding hoist, supporting the cradle. They can be built into the hoist unit or independently mounted above the cradle. They act as an emergency brake if the suspension rope is severed inside the scaffolding hoist. Depending upon the make and model, they can act directly on the suspension rope above the hoist or they can be rigged to an independently anchored secondary rope.

Each scaffolding hoist and protective device must have a data plate which includes:

- The type, model and serial number.
- The manufacturer's name or identification mark.
- Details of the FSWR to be used, including rope diameter, grade and construction the rated load.
- Reeving requirements, where applicable.
- Power supply requirements, where applicable.

Suspension Ropes and Secondary Ropes

Make sure that suspension ropes and secondary ropes are the correct diameter and the correct construction for the particular scaffolding hoist or protective device. Suspension ropes used with climber type hoists often have unusual rope constructions which give them enough flexibility and durability to bend over the small diameter sheaves inside the hoist. If the wrong construction of rope is used, the sheaves can 'chew up' or sever the rope.

The WLL of a suspension rope intended for use with a hand operated scaffolding hoist must not be more than one seventh of its GBS. The WLL of a suspension rope intended for use with a power operated scaffolding hoist must not be more than one tenth of its GBS.

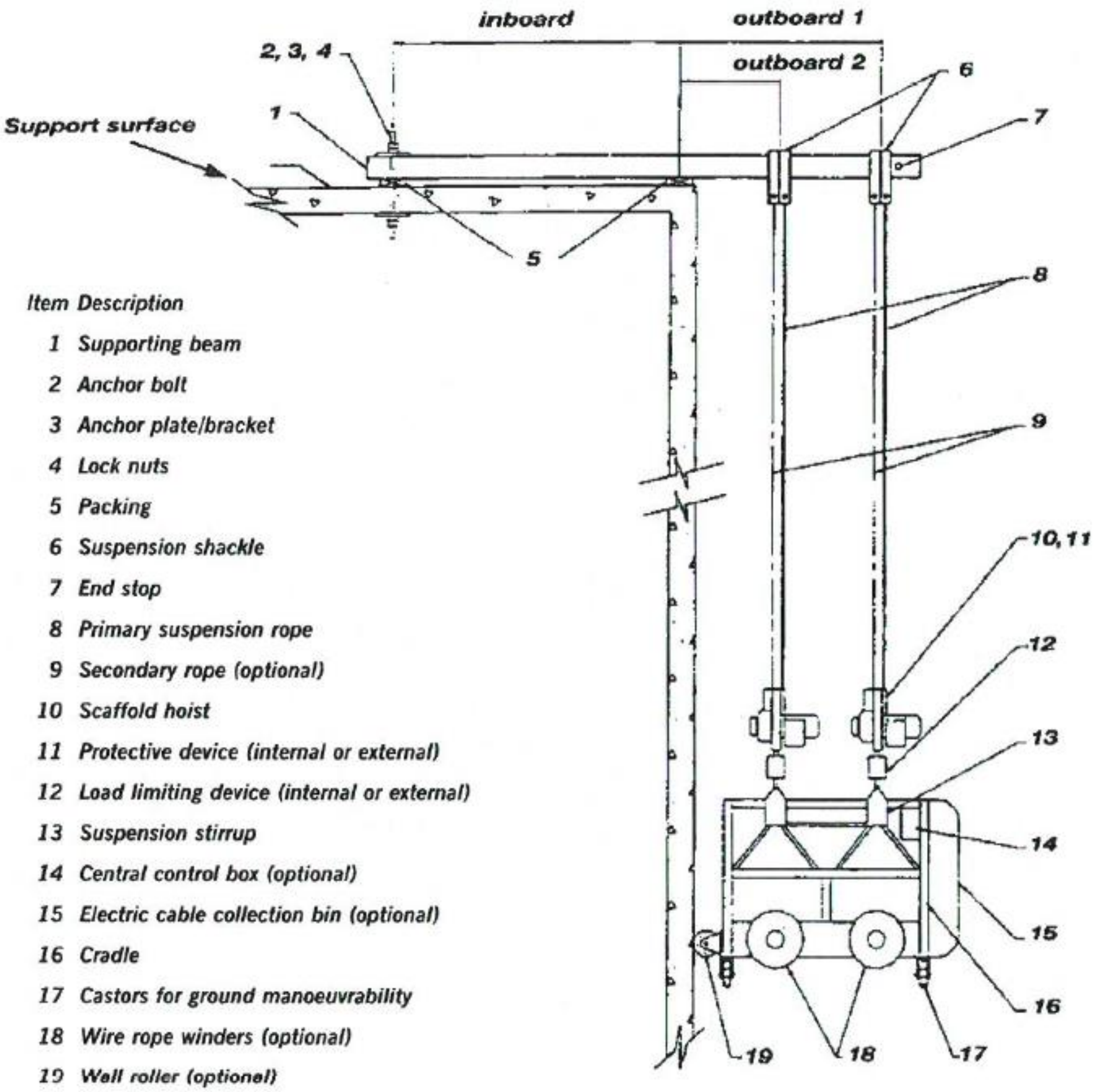
Suspension ropes and secondary ropes should be each marked with a recorded identification number. They should have a swaged and thimbled eye at one end and no part of the rope construction should be removed to facilitate swaging. Ropes used with climber type hoists should be bullet-headed to help reeving.

For drum type scaffolding hoists, make sure there are at least three full turns of rope on the drum when the scaffold is at its lowest point. The flange of a fully loaded winch drum should extend at least two rope diameters above the built-up rope to prevent the rope jumping over the drum flange.

There should be at least 1m of spare rope when climber type scaffolding hoists are at the lowest point. Excess rope should be carefully coiled and tied to hang freely below the scaffold or inserted into a rope winder to avoid kinking. Do not fix the rope ends back to the scaffold as this may cause kinking or bird caging and can lead to rope failure.

Do not use bulldog grips on suspension ropes or secondary rope because they can damage the ropes.

Also bulldog grips do not take a SWL or WLL.



Cradles

The internal width of a cradle must not be less than 450mm.

As a general rule, a swing stage cradle should not exceed 900mm in width. Cradles for double rope systems should have a width not less than 900mm and not more than 1.7m.

Work cages should have a width not less than 750mm and not more than 1.5m. Stabilising sheaves mounted on work cages for suspension ropes and secondary ropes should be at least 2m above the cage floor.

A sign clearly displaying the SWL must be fixed to the inside of the cradle. Articulated cradles should have a SWL sign on the inside of each bay. Multi-tiered cradles should have a SWL sign on the inside of each bay at each level.

Safe access should be provided between the levels of a multi-tiered cradle. Such access should be:

- Protected on both sides with securely fixed mesh.
- Fitted with hinged trapdoors or sliding hatches.
- Installed in a manner which provides clear access at least 450mm in width along each working platform.

Where access between the levels of a multi-tiered cradle is not provided, each scaffolding hoist must be capable of being operated from each level, including the operation of the manual descent facility on power operated hoists.

Where netting is used to prevent debris falling from a cradle, it should be galvanised wire mesh with wires at least 1.5mm thickness spaced at no more than 25mm apart. It must be securely fixed between the guardrail and toe board on all sides and ends of the cradle.

Electrical Equipment

All electrical equipment and controls should comply with AS 3000 *Electrical installations.* Central control boxes, where fitted, should be fully enclosed, lockable, shatterproof and weatherproof and should include:

- Socket outlets for scaffolding hoists an emergency stop button.
- A power on light.
- A Type I or Type II residual current device complying with AS 3190 *Approval and test specification- Residual current devices.*

All operating buttons and levers should be the spring loaded 'dead-man' type.

The control box should be removable for safety and security. When in use, it should be securely attached to the inside of the cradle guardrails on the side of the cradle away from the working face.

Electrical cables should be purpose designed and should only be suspended from built in thimbles. Do not use electrical cable with an outer covering damaged so that the insulation covering the wires is exposed.

The main supply cable should be plugged into the control box with separated yokes leading to the scaffolding hoists.

Construction and Operation

An assessment of the supporting structure in relation to the intended loads should be made by a competent person prior to the erection of a suspended scaffold.

A copy of the statement of assessment or design should be made available to the person erecting, altering or dismantling the suspended scaffold.

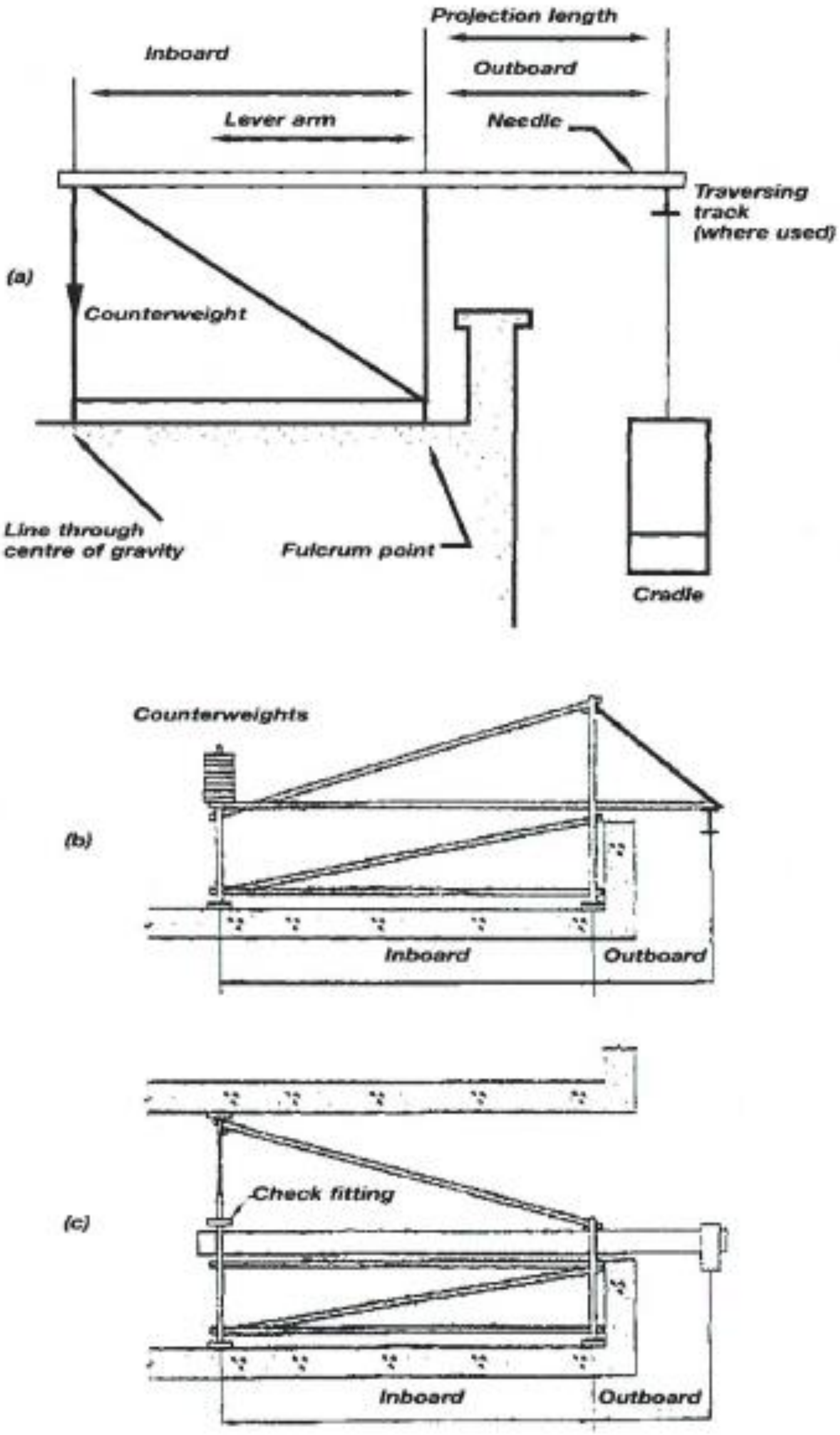
Suspension Rigs

The outboard end of a needle should never be lower than the inboard end. A beam spanning between only two supports should always be horizontal.

A needle or supporting beam should always be mounted with the greater dimension vertical.

There shall be a ratio of 3:1 or 3 x inboard of outboard dimension.

Typical suspension rigs



Anchored Needle Suspension Rigs

Anchorage design should take into account the nature or the materials in which the anchorage is fastened. Anchorage bolts should be provided with lock nits or other suitable means to prevent loosening.

Friction anchors and chemicals insert anchors should not be used in tension in anchorage systems.

The design of the suspension rig should take into account any likely lateral forces including wind forces and surge.

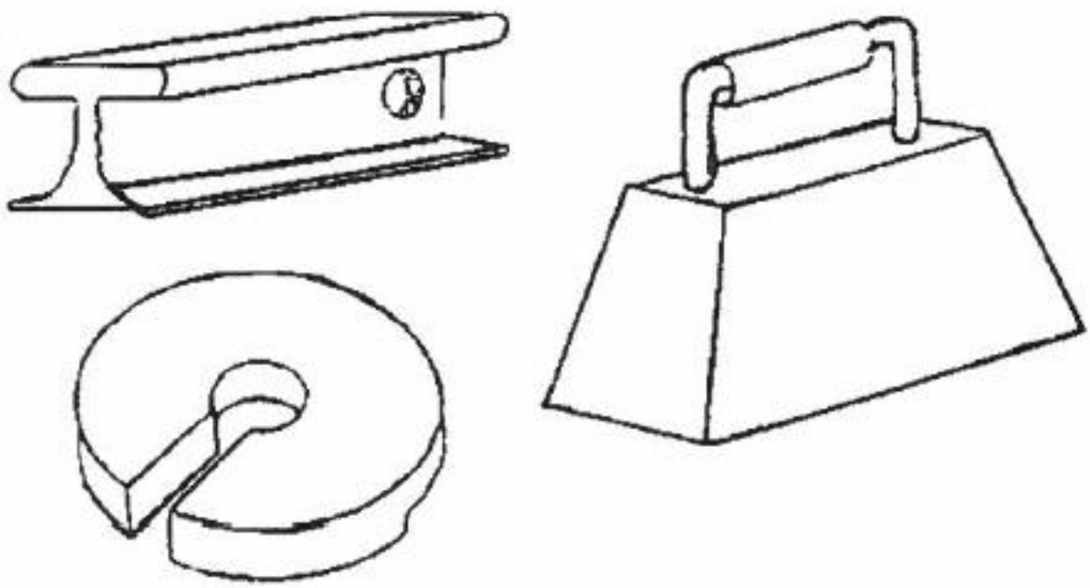
Reveal Propped Needle Suspension Rigs Construction

The suspension rig should incorporate at least two rows of uprights fixed with ledgers and transoms and be provided with longitudinal, transverse and plan bracing systems.

The needles should be positively fixed under or to the reveal props. In the case of needles that are rolled steel joists or universal beams, close fitting U-heads may be used.

Counterweighed Needle Suspension Rigs

They should not be used to stabilise a needle attached to two or more suspension ropes.



Typical counterweights for counterweighted needles

Counterweights should be secured to the suspension rig in such a manner that they cannot be displaced or removed without the use of a tool. Counterweights should be placed directly on the needles or on the innermost supporting components to the needles.

A beam that spans between only two supports is often used to support a suspended scaffold in a shaft, boiler or chimney, or through grid mat flooring and like situations. The supporting beam should be fixed or located to prevent the possibility of dislodgment or slippage.

The built-up framework on a suspension rig should be purpose built to engineering principles or constructed from scaffold tubes and couplers tied together with braced ledgers and transoms, to form a rigid and stable structure under working conditions.

Overhead Fixing

The maximum rope tension applied to a shackle, strap, bolt, sling, chain, trolley, beam clamp or other device used to attach a suspension rope or secondary rope to overhead support should not exceed 80 per cent of the WLL.

The maximum rope tension applied to a choked sling should not exceed 40 per cent of the WLL. Where a strap is used around a needle or supporting beam it should be made to an engineered design.

Shackles may be used to secure suspension ropes and secondary ropes to suspended scaffold tubes, beam clamps and various other devices. The pin should be moused to the body of the shackle with wire to prevent accidental unwinding.

Chains or slings supported over a beam with sharp edges should be protected with beam chaffers. A positively fixed stop should be fixed at the end of each needle to prevent ropes from sliding off.

A check coupler should be fitted on either side of the suspension point of suspended scaffold tube needles to prevent movement.

In the case of a steel or aluminium beam, a bolt not less than 12mm diameter should be fitted through the needle with pipe washers.

Traversing Tracks and Trolleys

Traversing tracks are suspended beneath needles or simply supported beams to help horizontal movement of a suspended scaffold. The ends of the traversing track should be fitted with through bolted stops to prevent any trolley running off the track.

Trolleys to support suspended scaffolding must have a SWL hoisting of at least 500kg.

Trolleys supporting a swing stage should be connected with a spacer tie or spreader bar at the same centre to centre distance as the suspended scaffolding hoists to prevent spreading.

Trolleys supporting a double rope suspended scaffold should be rigidly connected longitudinally and transversely and plan braced to prevent twisting.

To prevent cradles from colliding on the traversing track or excessive load on the rig and structure, fit a buffer zone with intermediate stops to the traversing track.

Ropes used for horizontal movement of a suspended scaffold should be at least 12mm diameter fibre rope.

Calculating Maximum Rope Tension

For electrically powered suspended scaffolding hoists the maximum rope tension should be assessed as the sum of:

- The mass of the suspension rope.
- Any stabilising weights attached to the suspension rope.
- The rated working load of the scaffolding hoist as limited by the load limiting device.

For pneumatically or manually powered suspended scaffold hoists, the maximum rope tension should be the sum of:

- The mass of the suspension rope.
- Any stabilising weights attached to the suspension rope.
- The self-weight of the scaffolding hoist.
- Any secondary rope device.
- That portion of the cradle weight supported by the rope.
- The rated live load of the cradle taking into account grouping of live loads.

The Ratio of Stability for Cantilevered Suspension Rigs

The ratio of stability of a suspended scaffold incorporating a cantilevered suspension rig must be no less than 3. The ratio of stability is:

- The sum of the moments acting on the inboard portion of the suspension rig, divided by,
- The sum of the moments acting on the outboard portion of the rig.

The formula for calculating the number of counterweights needed on each needle of a cantilevered suspension rig is:

No. of Counterweights

$$= \frac{\textbf{3 x rope tension (kg) x outboard (mm)}}{\textbf{Inboard (mm) x mass of each counterweight (kg)}}$$

For Calculator:

3 x rope tension x outboard ÷ inboard ÷ counterweight mass

For example:

For example:	Counterweights	= 25kg each
	Max rope tension	= 700kg
	Outboard	= 900mm
	Inboard	=3600mm

Therefore:

3 x 700 x 900 ÷ 3600 ÷ 25 = 21 counterweights per needle

Include these factors in calculations of the inboard moments:

- The self-weight of the inboard portion of the suspension rig, including any counterweights.
- The design load of anchorages and props.
- The strength of the supporting structure.
- The distance between the fulcrum and the inboard distance to the centre of the counterweights in position.

Consider these factors in calculations of the outboard moments:

- The self-weight of the outboard portion of the suspension rig, including trolley tracks and trolleys.
- The mass of secondary ropes, traversing ropes, electrical cables and compressed air cables.
- The distance between the fulcrum and the suspension rope attachment points.
- The maximum rope tensions.
- Where suspended scaffolds incorporate trolley tracks the most adverse horizontal position of the cradle should be considered when calculating the ratio of stability.

Inspection and Records

Six monthly inspection and test notations should be maintained in the maintenance workshop or base office and include:

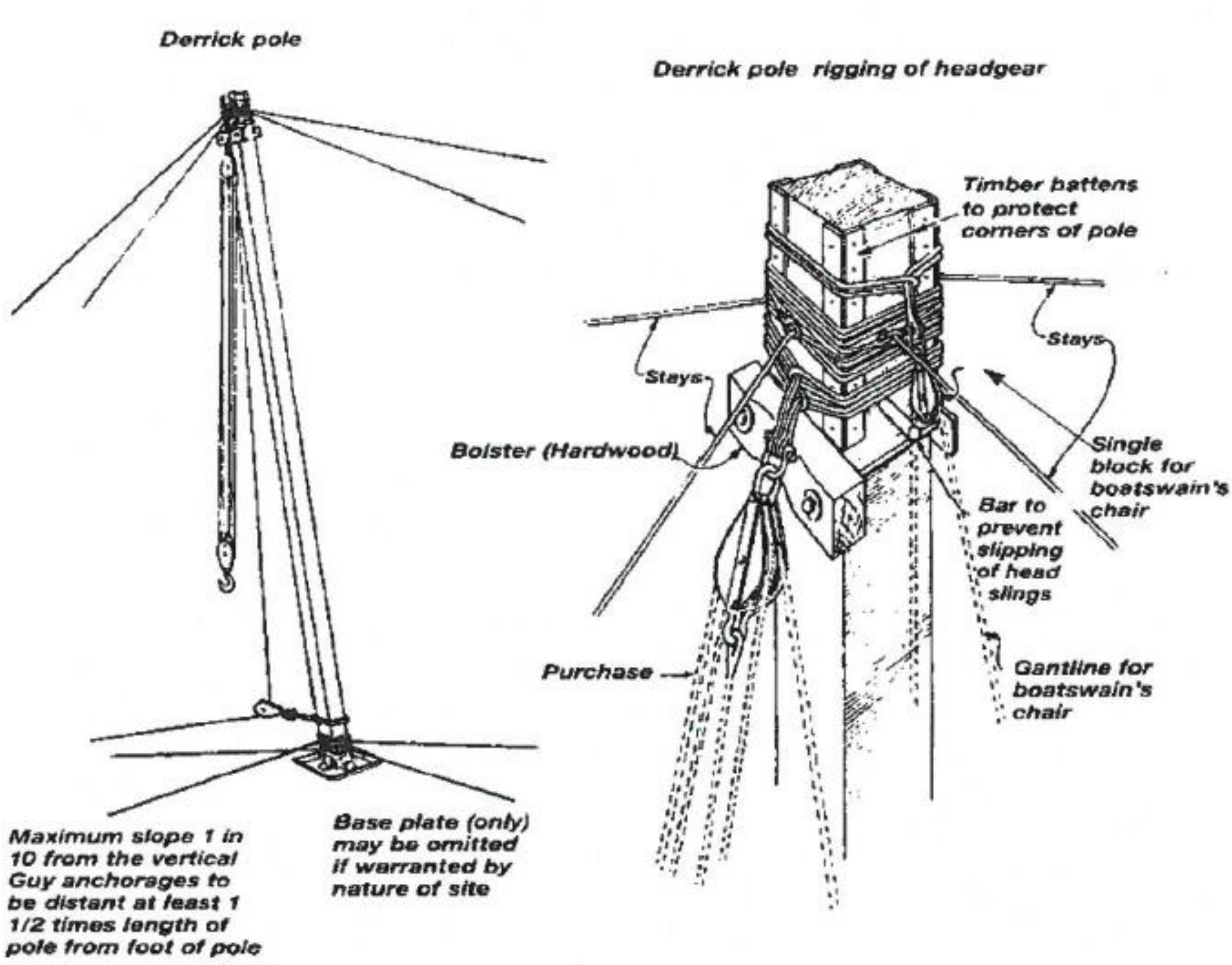
- Date of service and test.
- List of parts replaced or repaired.
- Test load and rated working load of the hoist in kilograms statement that the hoist passed the test.
- Name and signature of servicing or testing person.

Each protective device should be returned to a maintenance shop for a thorough inspection and maintenance program at periods nominated by the manufacturer and not exceeding six months. The program should include a test where the device is loaded w ith a static load equal to the rated working load of the scaffolding hoist, plus a factor of 1.25, to allow for the effect of impact. It should show no sign of change.

4.3 Gin Poles and Derricks

The gin or derrick pole is an apparatus used for raising loads which is now not widely used in erection work. Its function has been replaced by mobile, derrick or tower cranes.

It consists of a vertical pole or derrick, stayed or guyed and often fitted with a several part purchase. It is capable of being leaned slightly forward or sideways as necessary and may be tracked along to a new position.



Certification

The rigging of gin poles, guyed derricks and sheer legs must be carried out or directly supervised by a person holding an Advanced Rigging HRWL.

4.4 Span Ropes and Flying Foxes

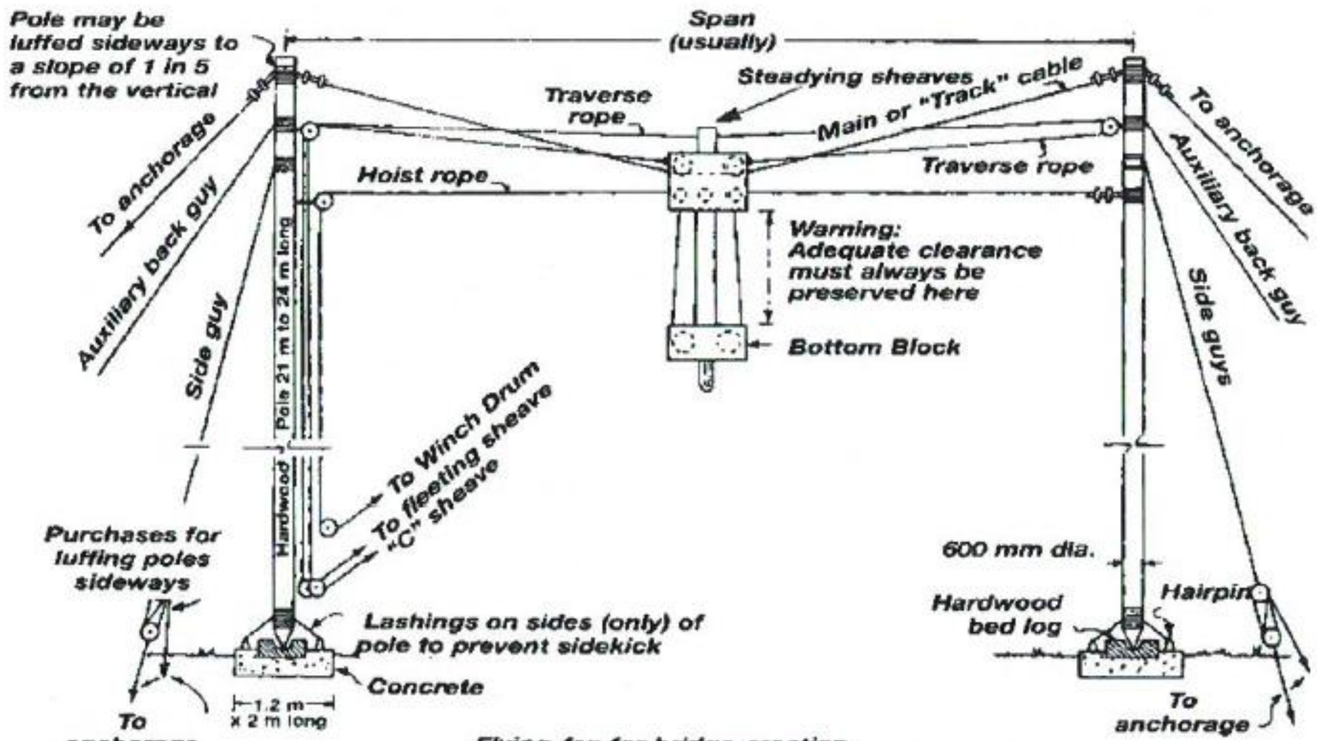
A flying fox is an apparatus which is used to traverse a span while maintaining a load at a constant height.

A flying-fox consists of a more of less horizontal fixed overhead steel cable (called the 'main cable'). A trolley or 'fox' which runs on the cable is used to raise, lower and transport loads.

A flying fox consists of only a single span. There is only one main cable which is supported at the extreme ends. One end is often much lower than the other such as when materials are raised or lowered from a cliff or gorge.

Certification

The rigging of flying foxes and cableways must be carried out or directly supervised by a person holding an Advanced Rigging HRWL.



Flying-fox for bridge erection (as generally used for about 6 to 10 tonne loads)

Installation

The natural curves and slopes of the main cable make it necessary to control the fox by an endless rope or equivalent device. The endless control or 'traverse' rope should only be omitted upon the advice of an engineer.

This is partly because the pull of the hoisting rope tends to move the fox into unexpected positions. This movement can be sometimes offset by reeving the hoisting rope to relieve the fox of forces which move it along.

The main cable bends under the wheels of the fox as the load travels. If there are too few wheels the bending action may become localised greatly reducing the safety of the cable. Foxes usually have four or more wheels so that the bend in the main cable is spread over a considerable length.

When measured at the bottom of the treads the diameter of the wheels should be eight times the diameter of the main cable, though in large foxes carrying loads of 10t or more they may be as small as six diameters.

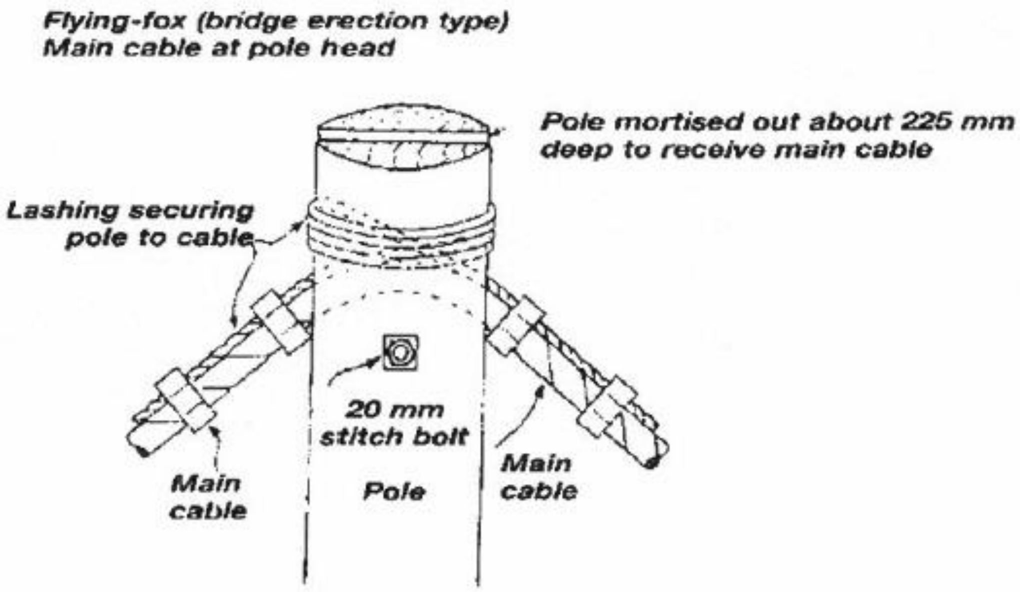
In most applications there should be no more than about 2.5t of load on each wheel although in bridge building, loads of double this figure are quite usual.

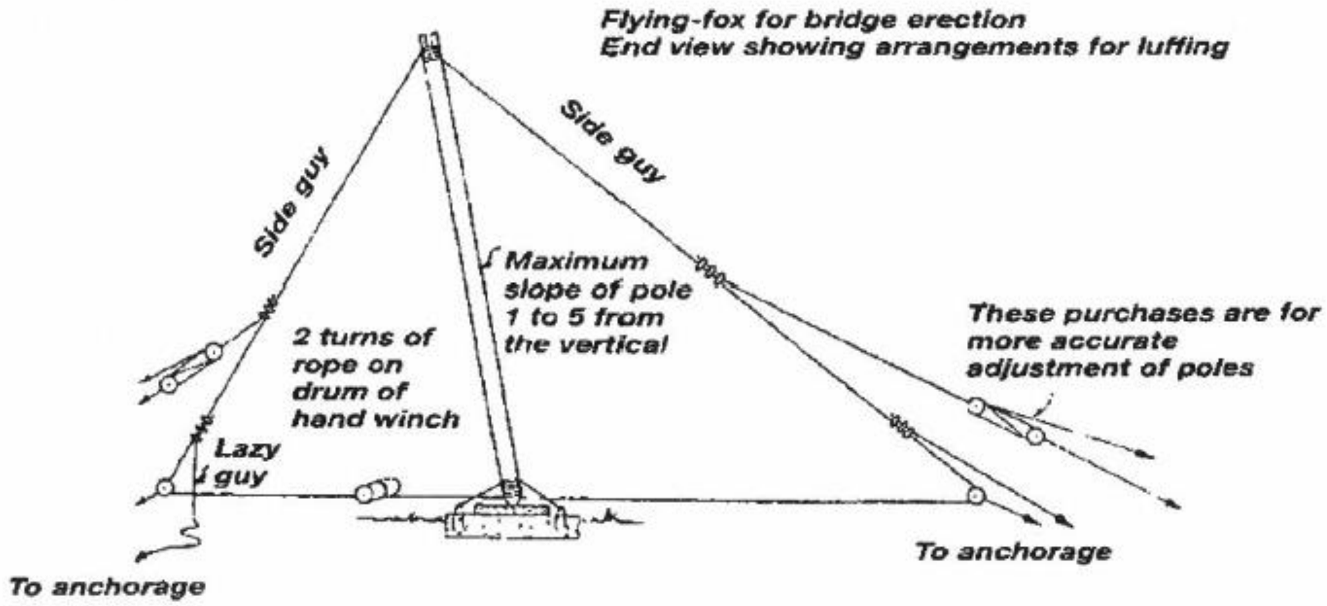
The 'no load' sag of the main cable, measured vertically at half span from a straight line joining the respective ends of the span should be 5% or one-twentieth of the span, when the unloaded fox is at half span.

The 'pull' or tension in the main cable under maximum working load should not exceed one-sixth of the breaking strength of the cable.

For large permanent cableways such as those used in dam construction a maximum working load of one-quarter (or even less) is common, but this is not recommended for rough temporary cableways.

Where the span exceeds about 200m, fit carriers, in the form of steel links or loops to support the hoisting rope from the main cable. Without the carriers the unsupported hoisting rope will sag and interfere with the control of the lifting hook, and may make it impossible to lower an empty hook.





The carriers have a wheel running on the main cable. As the fox traverses the span it leaves behind a carrier at each of the points the hoisting rope is to be supported. The carriers are unshipped from the fox, and located where required by an overhead rope known as a 'button rope' because of the various stops or buttons attached to it for engaging carriers.

The fox collects the carriers on the return trip and transports them until they are needed again.

Where spans are less than about 200m the bottom block (hook block) is made heavy enough to overcome the pull and drag of the ropes whilst being lowered without any burden.

In bridge work it is often necessary to raise and lower loads not directly below the main cable. The poles supporting the main cable should be inclined sideways to bring the fox immediately above the load.

Preventer ropes must not be clamped to operating ropes by bulldog grips, but by properly constructed double-seated clamps.

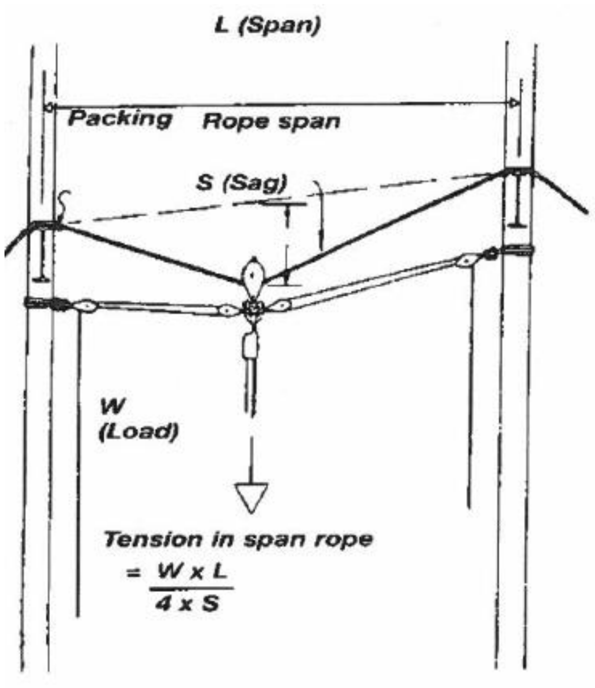
Span Ropes

Span ropes must have a minimum safety factor of six allowing for reeving, sharp bends at anchorages and point of load attachment.

The sag should never be less than five per cent of the length of span. The greater the sag the less the tension in the rope.

The span should be securely anchored at both ends and if standing guys are used, these should be of sufficient strength to match the span rope and suitably protected and anchored.

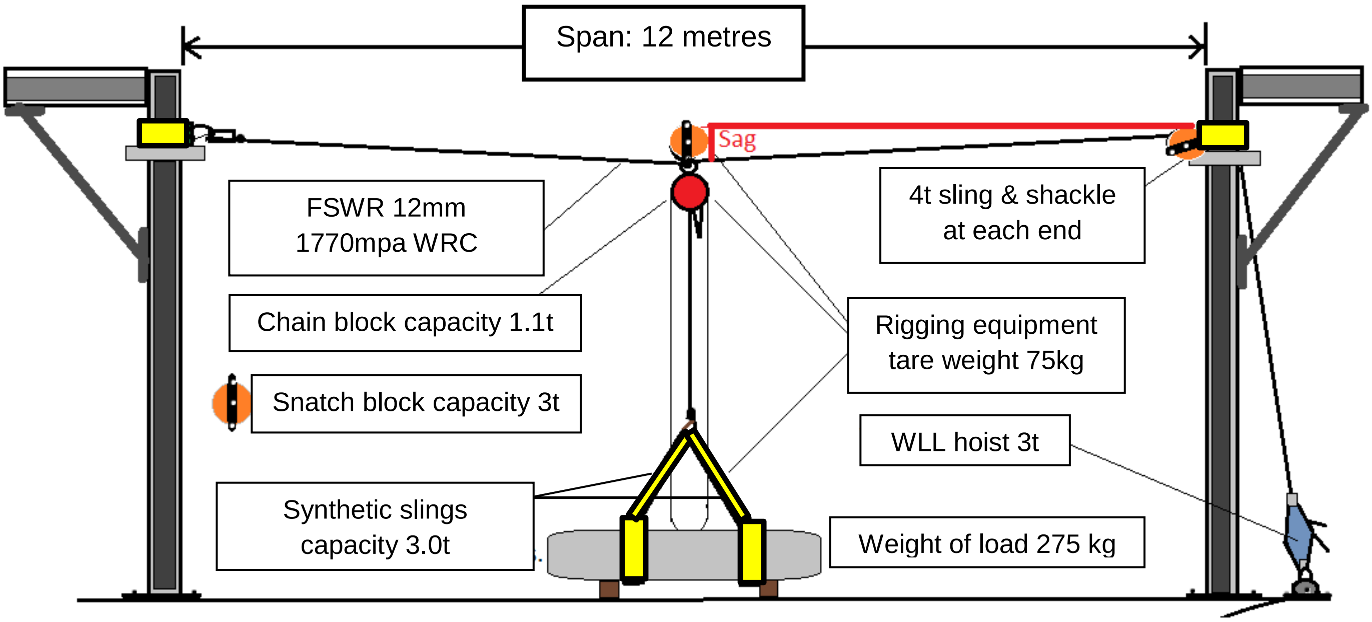
Sheaves of fox block should be at least ten times the diameter of the span rope, with close fitting cheeks. Running control lines should lead as close to line of span as possible.



To determine the amount of Sag, multiply the span distance by 5%.

Formula:

Span Distance x 5% = Sag



Example:

Calculate the minimum sag in the span rope.

Formula: $\frac{W \times L}{4 \times Sag}$

Sag = 12m x 5% = 0.6m

$\frac{350kg \times 12m}{4 \times 0.6m} = \frac{4200}{2.4}$ = 1750kg (tension)