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TRAINING | CONSULTANCY | HEALTH & SAFETY



Lift Supervisor

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Fire Alarm, Tests and Evacuation



Welfare Facilities



Breaks and Refreshments



Phones



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Introduction *Donald Ritchie*

- Over 30 Experience in Management, HSE, and Machine Operator Training ranging from:
 - Director (2014)
 - Ritchies Training Centre
 - Regional Training Manager Stirling Group (Kurdistan) 2014
 - HSE Manager / TLA (Dubai) Restrata Group (Nov 2015)
 - Director / Team Leader High Access Rescue Team






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Class Introduction
Tell us a little about Yourself....
Job Role / Experience / Knowledge....

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Mutual Respect and Confidentiality.....

Why do we need to train?

To **teach** necessary skills and relevant job safety required for safe operations

To **encourage** future good practice in order to maintain and promote skills

To **create** a safe working environment and procedures within the work place

To **conform** with all Company Procedures

To **provide** greater productivity and cost saving as a direct result of training

How?

- Theory Lessons
- Discussion
- Practical Demonstrations
- Assessments



Your input is vital to a successful course

Aims of Course

- Know the importance of safe lifting operations / procedures
- Be aware with the consequences of the misuse lifting operations
- Selecting the correct type of lifting equipment
- Responsibilities of lifting team

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Legal Concerns

You and Your Employer can be subject to criminal fines and prosecution



10

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The Ultimate Aim:

Is to encourage high standards of health and safety at the work place.

The Main Aim:

To involve everyone, Management, Employees and Contractors.

Our Five Safety Golden Rules

- Reverse Park
- Wear P.P.E.
- Assess Risks
- Hold handrails
- Accept challenges

No debate - No excuses - No accidents

Deals with all safety risks, health risks in the workplace and gives protection to the public (Affected by work activities).

11

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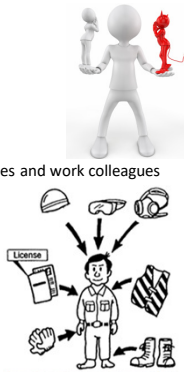
Moral Concerns

Organisations – have moral obligations to ensure that its activities are not harmful to employees and others

Individually - we have a duty to ourselves, our families and work colleagues to work in a safe manner

PPE

- Look after your PPE (HASWA 74)
- Only wear company issued PPE (Risk Assessed)
- Replace any damaged PPE (**Last Line of Defence**)



12



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Company Polices / Procedures



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- 3.Application
- 4.Strength and stability
- 5.Lifting equipment for lifting persons
- 6.Positioning and installation
- 7.Marking of lifting equipment
- 8.Organisation of lifting operations
- 9.Thorough examination and inspection
- 10.Reports and defects
- 11.Keeping of information
- 12.Exemption for the armed forces
- 13.Amendement of the Shipbuilding and Ship-repairing Regulations 1960
- 14.Amendement of the Docks Regulations 1988
- 15.Repeal of provisions of the Factories Act 1961

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Management of Operations

As with all other operation on site, Effective Management of operations should ensure Safety and Efficiency.

Management Principles

- Plan
- Resources
- Communicate
- Monitor

(Fit for Purpose)



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Assess the operation and provide such Planning, Equipment and Personnel as necessary to complete any task safely. **(Planning)**

Provide Instruction and Supervision as is necessary for the task to be undertaken safely. **(Supervising)**

Taking responsibility for the organisation and control of all operations. **(Organisation)**

Ensuring that the everyone is fully briefed on the content of the method statement / risk assessment and permits to work.

Every one has the **Authority** to stop the operation if they consider any operation is dangerous.




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HSE INFORMATION SHEET

Construction Sheet No 19

Accidents and dangerous occurrences

The main cause of accidents and dangerous occurrences involving cranes are lack of planning, training and maintenance, in particular:

- Selecting the wrong type of crane to undertake the lift.
- Incorrect positioning of the crane when carrying out the lift:
- Failing to correctly calculate the load
- Use of wrong lifting gear
- Failure of personnel to carry out the correct procedures
- Lack of proper maintenance
- Absence of properly trained personnel

Safe Systems of Work (Fit for Purpose)

All operations large or small must be controlled by establishing a Safe Systems of Work (Legal Requirement)

- Planning the operation
- Selection of correct crew and equipment
- Maintenance of equipment
- Selection of trained competent personnel
- Provision of competent supervision
- Safety of those involved or other affected by the operation
- Effective communication between all parties
- Ensure all necessary test certificates / documentation is in order
- Preventing unauthorised movement / use of equipment

19

Method Statement / Risk Assessment (Fit for Purpose)

The production of a written method statements is one of the most important duties of the Company

- It will highlight any risks and how they are to be addressed
- It explains the method of operations and ensures that suitable equipment is used
- It provides a basis for the communication (Tool Box Talk) to other members of the team

20

Reporting of Incidents (Near Miss)

The appointed person should ensure that there is an effective procedure for reporting any incidents or near misses.



This procedure should include the notification of the following:

- a) any unsafe acts
- b) incidents or accidents, however slight;
- c) shock loads, however they occur;
- d) dangerous occurrences or reportable accidents.

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Lifting Operation

Lifting Operations Must Consider

- The Foundations
- The Crane
- The Load
- The Rigging

For the Lift Plan to Work Safely



22

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Lifting Appliances (Machines)

Equipment performing the lift

"A mechanical device capable of raising or lowering a load, e.g. cranes, forklift trucks, powered hoists, manual hoists, lever hoists, etc.."



24

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Lifting Accessories

- Slings
- Shackles
- Eye-bolts
- Plate Clamps




CE Marking

CE Marking on a product is a manufacturer's declaration that the product complies with the relevant European health and safety legislation

25

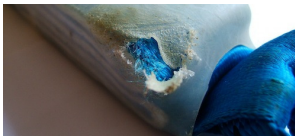
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Daily Pre-use or Post Use Inspections

Visual and functional check of all equipment to check for any Obvious signs of damage

A pre -use must be carried out every time before a piece of equipment is used and a **post use** every time, before it is returned.

26

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In Service Inspection

A more in-depth inspection than daily or weekly checks and are carried out by a competent Pearson / Fitter.

Thorough Examination: In Depth and Detailed Inspection

It involves a comprehensive, inspection into the mechanical workings or components of the equipment.

Exceptional Circumstances

- Any Concerns Regarding the Safety of Equipment
- Equipment Has Been Shock Loaded
- Long Periods Without Use

Get Equipment Retested / Certified Before Use



27

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INSPECTION, TESTING & MAINTENANCE		
S/N	Daily Inspection:	Monthly Inspection
1	Tagged Crane or Hoist	Visually inspect all critical items.
2	Control devices	Measure hooks for deformation or stretching
3	Brakes	Inspect hooks for cracks, missing or broken parts
4	Hook	Measure lifting chains for excessive stretch, twisting
5	Hook Latch	Inspect for twisted, broken or kinked cables or chains
6	Reeving	Follow any additional recommendations of the manuf.
7	Limit Switches	Check for corrosion, No water ingress, Seals intact
8	Oil Leakage	Daily check under crane
9	Unusual sound	Stop immediately
REVIEW THE MANUFACTURERS INSPECTION REQUIREMENTS!		

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Responsible Person		
Appointed Person: Plans the whole lifting operation from conception to completion (Crew, Equipment, Lift Plans, JHA's,) Crane Supervisor: person who controls the lifting operation and ensures that it is carried out safely Crane Operator: Movement of all items in a safe and controlled manner as instructed by the Banksman Banksman: Relays instructions to the crane operator during lifting activities. Slinger: Prepare loads for their lifting and release loads at their destination.		
29		

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ROLE OF THE APPOINTED PERSON		
The Appointed Person is responsible from when the crane arrives at the site, for its passage through the site, to the "setting up" position For the crane set up itself, for the lifting operation and for the crane dismantling and for access and egress from the site. For complying with all relevant Acts and Regulations, Approved Codes Of Practice and for producing the necessary Risk Assessments and Method Statements.		

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Safe Working Load (SWL)

The maximum load that Lifting Equipment can raise, lower or suspend (**When in Use**)

- the SWL can be lower than, but can never exceed, the WLL (Working Load Limit).

Working Load Limit (W.L.L)

The maximum load, determined by the manufacturer, which an item of Lifting Equipment is designed to raise, lower or suspend.

Note: Always lift the load as per SWL

31



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Types of Crane

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Truck Mounted Crane

- Crane unit on a truck chassis
- Travels on public highways
- Fitted with outriggers
- Requires good access
- Fixed or variable counterweights
- Must be used on firm level ground
- Range: 360 degree or over side and rear
- Must be used in **Blocked Duties Only**



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Rough Terrain.

- Off road
- Large balloon tyres to spread load
- Blocked and free on wheels duties
- Highly manoeuvrable
- All wheel drive and steer



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All Terrain Crane.

- Hybrid - truck and rough terrain
- Compact with variable counterweights
- most models have all axle drive and steer, therefore highly manoeuvrable
- small capacity all terrain's cranes have blocked or free on wheels duties



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Crawler Crane.

- Used on sites with high duty work cycles.
- Used on sites with poor ground bearing pressure
- Crane is transported to site in parts.
- Erection and dismantling may need auxiliary crane
- Requires large area for erection especially for long boom configurations.



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Manitowoc 31000

2100 metric tons



As with any crane the operators must follow manufactures advice for:

Rigging Crane Up and De Rigging crane

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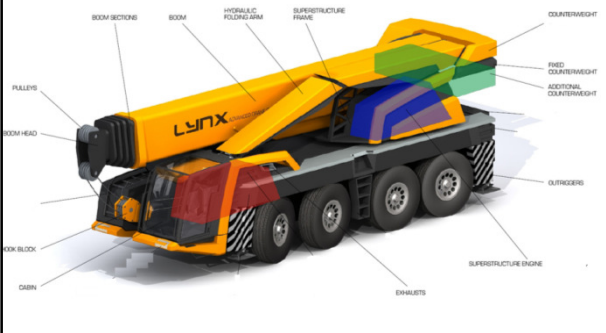

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Crane Components

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One Operators Cab (Folding arm) Driving, Operating, Raised Cab (Visibility)

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CRANE TERMINOLOGY

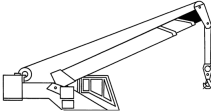
Chassis
gives the crane mobility

Slew Ring.
ability to rotate through 360 degrees

Upper-works/Superstructure.
joined to chassis via slew ring

Power Source.
diesel electric, hydraulic,
Mechanical single engine /
dual engine and power take off





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Outriggers.
increase stability base
varying beam extensions from the crane chassis

Jacks and Jack Floats.
vertical telescoping rams
enable crane to be set level
floats spread point loading

Wheels Off Ground.
Wheels must be off ground for all lifting Operations

OK for Parking at Night

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Jib/Boom.
main lifting arm

Hook Block.
pulley block attached to crane hook which is suspended with hoist rope

Falls of Rope.
mechanical advantage of reeving hoist rope between pulley blocks

Crane Capacity.
Important factors - Boom length and Radius
the longer the jib/boom or greater radius the less the capacity

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Safe Use of Cranes

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**Inspect the crane every day (before the start of each shift).
Don't operate a damaged or poorly maintained crane.**



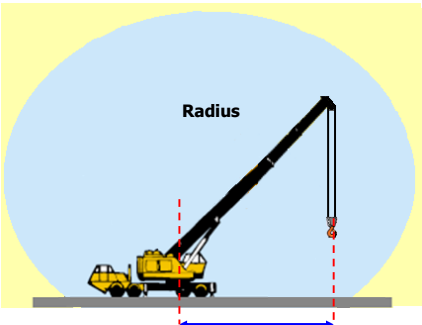
Pre – Op Checks



Running Checks

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Radius

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Jib Deflection



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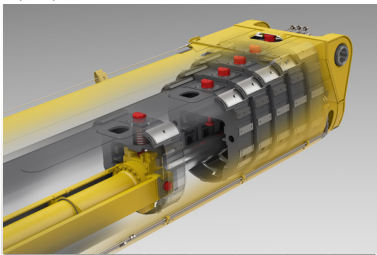
The TELEMATIK Telescoping System

It operates using just one hydraulic cylinder and an internal locking system for the individual telescoping sections.

The lifting capacity properties are excellent since the various telescopes can be extended in any sequence and independently of each other

- Boom Locking Pins
- Boom Wear Pads

Telescope: Load on?



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Y Guying

Superlift: Long boom configurations over 350t
Provides better lateral stability



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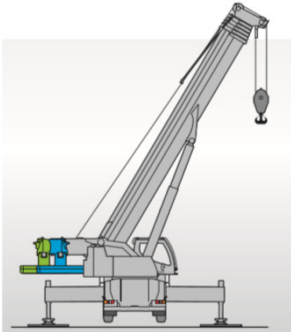
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Vario Ballast

Adjustable counterweight

Reduced: Small confined areas

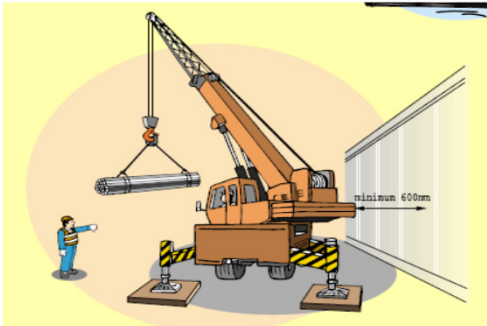
Fully Extended: Maximum capacities



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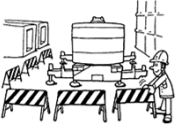
Minimum Counterweight Clearance



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When visibility is bad due to poor weather conditions stop work and do not start again until conditions have cleared

Maintain a good work site for the machine
Before you start work always check that your working area is free of people and obstructions.

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Safe Working Load (SWL)

- Never exceed SWL.
- Prevent pendulum swings.
- No dragging of loads.
- Hoist ropes must remain vertical.
- Prevent any form of side loading.

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Do not unwind so far that the hook touches the ground
Never use the main coil and the auxiliary winches at the same time.

Lower the hook sufficiently before you extend the boom. Extending the boom can put the winch into an over hoisted condition.

Switch triggers alarm in cab and cuts out movement.

Confirm the boom extension! retraction sequence.
Never use the boom to push or pull objects.

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ANTI 2 BLOCKING (A 2 B)

Can damage sheave

Can cause the wire rope to break

Can cause structural damage to the crane

Can cause the load to drop

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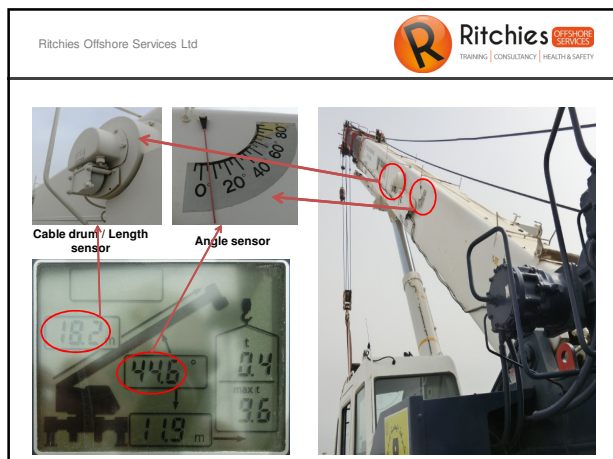
Rooster Sheave

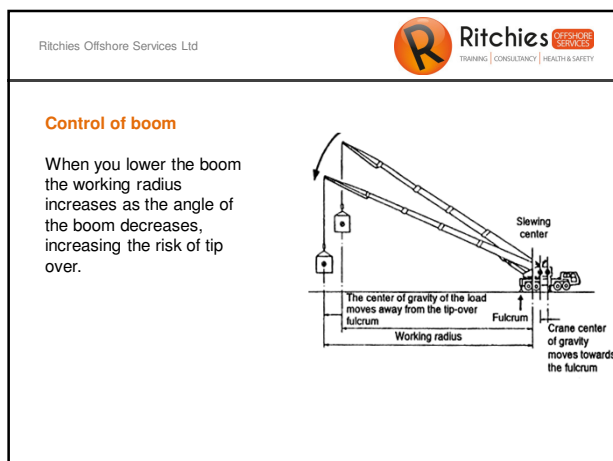
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Limiting and Indicating Devices

Load / Inductor sensor







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Eminox Spark Arrester (Chalwyn Valves)



When operating vehicles in potentially explosive atmospheres, spark arrestors are fitted for safety and they are also a legal requirement

Soot / ash from diesel engines can be heated by the combustion process, capable of igniting flammable gas or dust atmospheres

Rotating flow: Particles are reduced in size, rendering them unable to transport enough energy to ignite the explosive atmosphere.

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Crane Stability

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CONSEQUENCES OF MISUSE LIFTING OPERATIONS





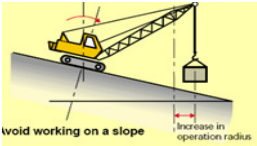
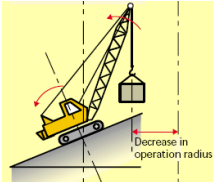

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Proximity Hazards.

Can effect stability, by not making allowances for the load once it is on the crane hook.

It is important to take due account of all factors that effect the safe system of work

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Ground Conditions

Precautions should be taken to ensure that the crane foundation is clear of any underground services or, where this is not possible, that the services are adequately protected against damage.



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Ground Conditions.

Confirm what the ground can support (site survey, "geo tech report")

Check what loadings the crane will impose, and ensure that the specified support pads are used.



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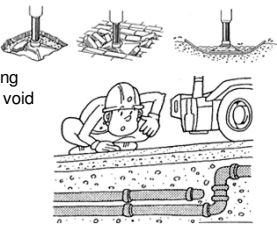

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When setting outriggers check for ground conditions, under the outrigger.
 Surfaces paved with plain asphalt
 Or with thin concrete, Bricks
 Or cobbled road surfaces

Areas where soil under the road paving
 has been eroded by water to leave a void

Road shoulders or near excavations

Set the machine on level ground with full consideration for the above points.



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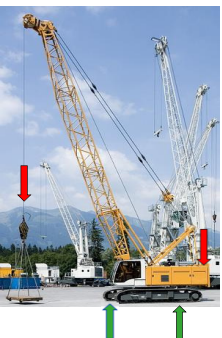

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Allowable Bearing Capacity

"Allowable Bearing Capacity of the soil at a given site is a loading intensity which is so limited that it provides an adequate factor of safety against soil rupture

It also insures that settlement due to static loading will not exceed the tolerable value."

Basic Soil Engineering



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In order to determine the correct outrigger pad size required for a crane, it will be necessary to gather some information about the ground conditions on site. It will be necessary to know: ▪ The character of the ground (i.e. Cohesive or Non Cohesive) ▪ The water conditions (Water tables) ▪ The engineering properties of the ground relevant to the design of the foundations ▪ The location of any underground hazards NOTE: If you have any doubt regarding ground conditions the Appointed Person must seek the advice from a specialist Geotechnical engineer.

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Determining Ground Conditions Site Categories Sites can be categorised to highlight the most likely potential problems that need to be considered. More attention is required to establish the strength of the ground where ground conditions are poor or where there is lack of data on the nature of the sub - soil. Greenfield Sites No previous construction activities Problem areas are: adjacent to rivers with high flood plains or on sites with high water tables.

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Determining Ground Conditions Beaches Low sand density and / or high/variable water table create difficult conditions. Filled Construction Sites (Brownfield) Unknown previous conditions, e.g. basements, poorly filled open pits, storage tanks, variable and compacted fill.

Soils - Presumed Bearing Values

Guidance to presumed bearing loads are widely available.

This is not a substitute for a proper ground investigation which must be carried out.

Non-Cohesive Soils

Dense Gravel or Dense Sand and Gravel	>61.2 t/m ²	>600 kN/m ²
Medium Dense Gravel, or Medium Dense Sand and Gravel	20.4—61.2 t/m ²	200—600 kN/m ²
Loose Gravel, or Loose Sand and Gravel	<20.4 t/m ²	<200kN/m ²
Compact Sand	>30.6 t/m ²	>300 kN/m ²
Medium Dense Sand	10.2—30.6 t/m ²	100—300 kN/m ²
Loose Sand *	10.2 t/m ²	<100 kN/m ²
* (Depends on degree of looseness)		

Soils - Presumed Bearing Values

Cohesive Soils

Very Stiff Boulder Clays and Hard Clays	>61.2 t/m ²	300—600 kN/m ²
Stiff Clays	15.3—30.6 t/m ²	150—300 kN/m ²
Firm Clay	7.6—15.3 t/m ²	75—150kN/m ²
Soft Clays and Silts	<7.6 t/m ²	<75 kN/m ²
Very Soft Clay	Not Applicable	Not Applicable
Peat	Not Applicable	Not Applicable

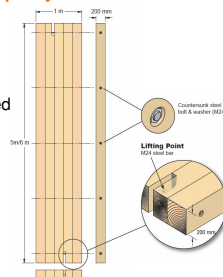
Effective Bearing Length of Crane Mats

Mat Length Based on Soil Bearing Capacity

Once the load from the crane has been calculated (outrigger load or crawler track pressure)

the required crane mat area is calculated by dividing the crane load plus the weight of the mat by the allowable ground bearing pressure.

Divide this area by the width of the mat and we have the required effective bearing length.



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Effective Bearing Length of Crane Mats

This mat length is then used to calculate bending and shear stresses in the mat

Based on the assumption of a uniform pressure equal to the crane load divided by the bearing area acting upward on the bottom of the mat



If the actual stresses are equal to or less than the allowable stresses, the mat is acceptable

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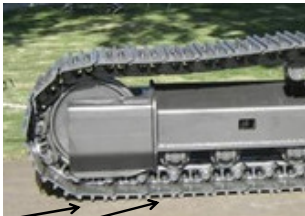
Crawler Crane / Excavator Load Bearing Pressures

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Crawler Track (Side View)



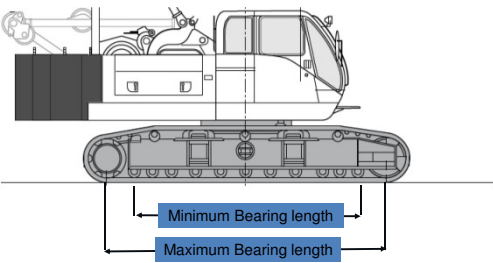
Space →

Contact →

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Bearing Length (Side View)

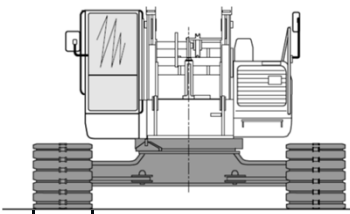


Minimum Bearing Length = 6.8m

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Bearing Length (End View)

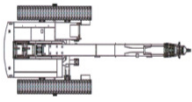


Track Plate Width = 1.2m

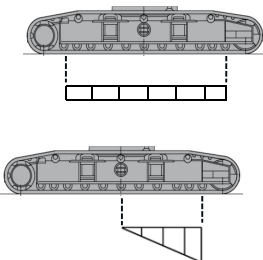
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Crawler Crane (In Line)



No Load



With Load

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Crawler Crane (Cross Track)

No Load

With Load

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Track / Outrigger Loadings Worst Case

Counterweight :	64.0te
Machinery Deck:	37.6te
Body:	21.7te
Crawler:	42.6te
Boom:	11.3te
Hook / Load:	49.8te
=	227.te

Bearing length (First – Last Track Roller) = 6.8m

Track Shoe Width 1.2m

227te

=

6.8m x 1.2m x 2 = (16.32 Area)

Average (Minimum) Bearing Pressure = 13.9te/sq/m (Crane in Line with Tracks)

Bearing Footprint Crawler Crane

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Track Bearing Pressure (Side Loaded)

Crane:	177.2te (75%)
Hook / Load:	49.8te (100%)
=	182.7te

Track Size = 6.8m

Track Shoe Width 1.2m

6.8 x 1.2 x 2 = 16.32 m²

182.7te ÷ 16.32 = 11.19t/m²

11.19 X2 = 22.38t/m² (Single Track)

22.38te/m²

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Safe Use of Outriggers

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Outrigger Remote Control

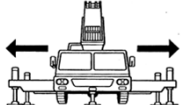



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Set up the machine using the level gauge to ensure that the body is level.

If the outriggers are not set properly the crane's Lifting capacity will be reduced and the crane may tip over.




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SAFE USE OF OUTRIGGERS

Correct **Wrong**

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OUTRIGGER LOAD BEARING AREA

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Typical Outrigger Mat Sizes & Areas

MAT SIZE (m)	MAT MATERIAL	THICKNESS (mm)	AREA (m ²)
0.76m X 0.76m	NYLON	50mm	0.58(m ²)
0.9m DIAMETER	NYLON	50mm	0.64(m ²)
1.2m DIAMETER	NYLON	50mm	1.13(m ²)
1.2m X 1.2m	ALUMINIUM	38mm	1.44(m ²)
1.5m X 1.5m	ALUMINIUM	50mm	2.25 (m ²)
2.0m X 1.25m	STEEL	200mm	2.5 (m ²)
2.4m X 1.2m	STEEL	200mm	2.88 (m ²)
2.0 X 1.5m	STEEL	250mm	3.0 (m ²)
2.0m X 2.0m	STEEL	250mm	4.0 (m ²)
2.5m X 2.5m	STEEL	250mm	6.25 (m ²)
4.0m X 1.70m	STEEL	250mm	6.8 (m ²)
3.0m X 2.50m	STEEL	250mm	7.5 (m ²)
4.5m X 1.2m	TIMBER (Ekki mat)	200mm	5.4 (m ²)

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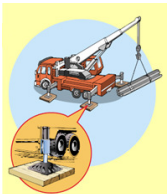
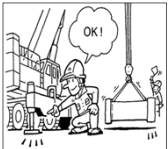

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Imposed outrigger loads.

Lift Supervisor and operator must consider the increased loadings during the placing of support mats

Operators **MUST** carry out set-up checks i.e.

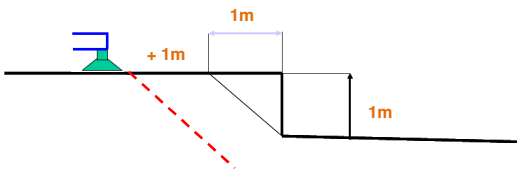
Slew through 360deg and check support bases.

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ANGLE OF REPOSE



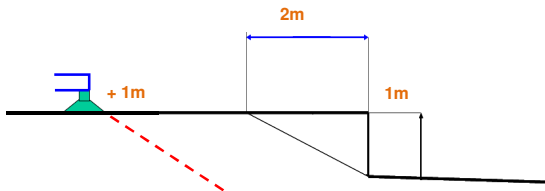
The crane must not be set up too close to slopes or trenches and depending on the type of soil, a safe distance is measured from the foot of the trench and is

Natural soil, not loose = 1 x depth of trench

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ANGLE OF REPOSE



On loose or filled soil = 2x depth of trench

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Outrigger Loadings Worst Case

It is possible when the crane is lifting a load for up to 75% of the total crane rigged weight plus all of the lifted load weight to go through any one outrigger jack when the laden boom is over it.

In order for the Appointed Person to calculate the correct area of crane structural supports for each outrigger jack,

the Allowable Bearing Pressure of the ground needs to be determined by the Employing Organisation / Client or Principal Contractor.

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Example 1

Outrigger Loading (From Ground Pressure)

Based on AP Drawings

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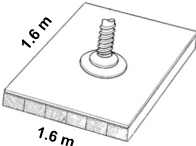
Outrigger Loading (Ground Pressure)

Weight of crane + weight of load
Ground Pressure (25t)

Weight of crane	50 tonnes
Weight of load	22 tonnes
Weight of Block / Tackle	1.5 tonnes

Crane: 50t X 0.75 (Point Load) + Load: 22t + Tackle 1.5t = 61t
 $61t / 25t \text{ (Ground Pressure)} = 2.44m^2$

$\sqrt{2.44} = 1.56$ Round up to 1.6m



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Example 2

Outrigger Loading (From Pad Size)

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Outrigger Loading (From Pad Size)

Weight of crane + weight of load
Area of Pad

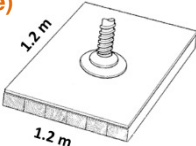
Weight of crane	50 tonnes
Weight of load	22 tonnes

Area of Outrigger Pad **1.44 m²**

$1.2 \times 1.2 = 1.44 m^2$

$72 \text{ tonnes} \div 1.44 \times 75\% \times 10$
 $= 37,500kN$

Land Rigs 50 kN (Rig Base Pad BP Oman Sites)



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Example 3

Calculate using Ground Bearing Pressures Tables

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Bearing Values BS:8004

- Crane Weight**
The maximum weight of the crane to be used 50,000kgs (worst case scenario)
- Load**
The maximum load to be lifted 22,000kgs + Hook / Tackle 1,500kgs
- Outrigger Load**
Point load = $(1+2) \times 100\% = (50,000 + 23,500) \times 1 = 73,500\text{kgs}$ or 73.5t
- Ground Type**
Ground comes in granular and cohesive types.

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Non-Cohesive Soils		
Dense Gravel or Dense Sand and Gravel	>61.2 t/m ²	>600 kN/m ²
Medium Dense Gravel, or Medium Dense Sand and Gravel	20.4—61.2 t/m ²	200—600 kN/m ²
Loose Gravel, or Loose Sand and Gravel	<20.4 t/m ²	<200 kN/m ²
Compact Sand	>30.6 t/m ²	>300 kN/m ²
Medium Dense Sand	10.2—30.6 t/m ²	100—300 kN/m ²
Loose Sand *	10.2 t/m ²	<100 kN/m ²
* (Depends on degree of looseness)		

Cohesive Soils		
Very Stiff Boulder Clays and Hard Clays	>61.2 t/m ²	300—600 kN/m ²
Stiff Clays	15.3—30.6 t/m ²	150—300 kN/m ²
Firm Clay	7.6—15.3 t/m ²	75—150 kN/m ²
Soft Clays and Silts	<7.6 t/m ²	<75 kN/m ²
Very Soft Clay	Not Applicable	Not Applicable
Peat	Not Applicable	Not Applicable

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1. Mat size

Mat size deducted from point load number 3 (in kNs) / (Soil type value 2)

$$73500 \times 9.81 = 721,035 \text{ kNs}$$

$$721.0\text{kNs} / 300\text{kN/m}^2 = 2.40 \text{ m}^2$$

$$= 1.6\text{m} \times 1.6\text{m minimum}$$

A. Soil type is compact ground (gravel 100mm in depth) covered in tar. Two outriggers will be placed here. The other two will be placed on medium dense gravel [Dense gravel has a bearing value of >600kNm² medium dense gravel <200 – 600kNm²] Area has transport trailers carrying ISO containers so a pessimistic ground bearing value of 300kNm has been selected.

Non-Cohesive Soils		
Dense Gravel or Dense Sand and Gravel	>61.2 t/m ²	>600 kN/m ²
Medium Dense Gravel, or Medium Dense Sand and Gravel	20.4–61.2 t/m ²	200–600 kN/m ²
Loose Gravel, or Loose Sand and Gravel	<20.4 t/m ²	<200 kN/m ²
Compact Sand	>30.6 t/m ²	>300 kN/m ²
Medium Dense Sand	10.2–30.6 t/m ²	100–300 kN/m ²
Loose Sand *	10.2 t/m ²	<100 kN/m ²
* (Depends on degree of looseness)		

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Example 4

Outrigger Loading (Azerbaijan)

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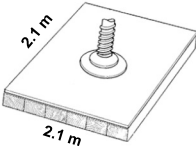
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Stage 1. Gross Load Calculation

Net Load	=	5,500	kg
+Accessories (Slings)	=	100	kg
+Hook Block	=	500	kg
Gross Load	=	6,100	kg

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Stage 2 Mat Calculation Template			
Gross weight of crane including additional ballast = 64.0 tonnes			
x 0.75 = 48.0 tonnes			
+ Gross load 6.1t (Maximum point loading) = 54.1 tonnes			
Minimum area of mat required = 5.41 m ²			
Actual area of mat to be used = 6.25 m ²			
Mat size = 2,500 mm X 2,500 mm			
or 2.5m diameter if circular			

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Actual Bearing Pressure			
Stage 3 Actual Bearing Pressure Under Selected Mat			
Resulting loading: Maximum point loading		54.1 tonnes	
Divided by the actual area of mat used		6.25 m ²	
= Resulting loading		8.7 t / m ²	
Mud, Peat, Marsh	0	t / m ²	
Cohesive Ground Soft	4	t / m ²	
Cohesive Ground Firm: This Figure to be used Unless the Exact Measurement is known (Civil Engineers Report)	10	t / m ²	
Paving, concrete Plinths, Heavy Duty Roads	50	t / m ²	
Ground Load Bearing Capability Known		t / m ²	

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Outrigger Point Loading (25t G.B.P)			
Weight of crane:	72t		
Weight of counterweight:	60t		
	132t		
Weight of load:	11.4t		
Block / Tackle:	0.7t		
Fly Jib (If Fitted)	0t		
132 x 0.75 (Point Load) + 11.4 + 0.7 = 111.1		2.1 x 2.1 = 4.41 m ²	
111.1 / 25t (G.B.P) = 4.444 m ²		2.3 x 2.3 = 5.29 m ²	
√4.444 = 2.1080		111.1 ÷ 5.29 = 21t	
Pad size 2.1m		Increase pad Size	
Outrigger Point Loading			
111.1 ÷ 4.444 = 25t			

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Calculation of Area of Circular Mat

Area of Mat = $\pi \times R^2$

$\pi = 3.14$

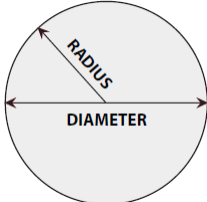
$R^2 = R \times R$

Example: Mat Diameter is 0.9m

Radius = $0.9m \div 2 = 0.45m$

$R^2 = 0.45 \times 0.45 = 0.2025$

Area of Mat is $3.14 \times 0.2025 = 0.636m^2$



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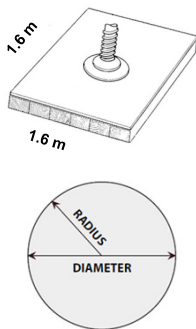
Converting Square to Round Pads

$1.6 \times 1.6 = 2.56m$

$2.56 \div 3.14 = 0.815$

$\sqrt{0.815} = .903$ (Radius)

$\times 2 = 1.8m$ (Dia)



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Rated Capacity Indicators (RCI)

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Rated Capacity Indicator.

Rated capacity indicators are fitted to the crane to comply with regulations. It has to be properly maintained and working. (Weekly / 6 Monthly Checks)

The function of the indicator is to monitor the crane under load and to warn the operator of approach to maximum safe working load

- Legal requirement
- Basic source of information
- Configurations of outriggers
- Duties of crane
- Critical boom angle
- 75% capacity for tipping/structural strength
- 100% of safe working load

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Strength and stability factors

Cranes are limited by both Structural Strength and Stability Factors

Stability means the ability of a crane to resist tipping

Structural strength the ability of a crane to resist damage




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Load Moment Indicators (LMI) or Rated Capacity Indicators (RCI)

measure and display the weight / mass of the load being lifted.

LED Display

Boom Angle / Parts of Line

Permitted Load / Boom Length

Free on Wheels Lifts

Outriggers

System Check

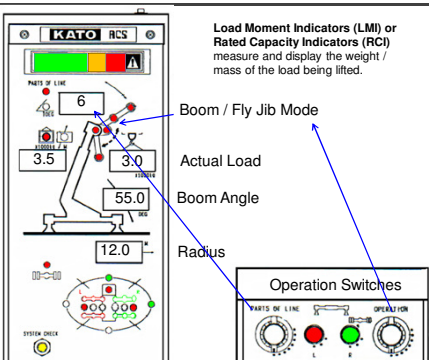
Boom / Fly Jib Mode

Actual Load

Boom Angle

Radius

Operation Switches



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RCI – Stages of Activation

Initial Warning.

Approach to safe working load is visual and takes place at approximately 90% to 97.5% **(Green)** of maximum safe working load. **(Amber)** 102.5%.



Warning of Overload.

Visual and Audible and the audible alarm is sufficiently loud enough to be heard by those persons working in the vicinity of the crane.

The overload warning is activated at 110% **(Red)** of safe working load at any radii or boom length.

112.5% RCI cuts all critical crane motions

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Load Charts



10.2m – 26.2m Boom

RATO NK-200E-V **RATED LIFTING CAPACITY TABLE (1)**
Based on BS 1577:1988 DIN 15019-2 75% of tipping loads

Crane fully extended with front jib - 300° full range
Crane fully extended without front jib - over side and rear

Working radius (m)	10.2m Boom		16.2m Boom		26.2m Boom	
	Working Radius (m)	Load (t)	Working Radius (m)	Load (t)	Working Radius (m)	Load (t)
3.3	3.3	20.00				
3.3	3.3	20.00				
4.2	4.2	17.50				
4.2	4.2	15.50				
5.2	5.2	15.50				
5.2	5.2	12.50				
5.2	5.2	10.50				
6.2	6.2	9.50				
6.2	6.2	8.50				
7.2	7.2	7.50				
7.2	7.2	6.50				
8.2	8.2	6.50				
8.2	8.2	5.50				
9.2	9.2	5.50				
9.2	9.2	4.50				
10.2	10.2	4.50				
11.2	11.2	4.10				
12.0	12.0	3.60				
13.0	13.0	3.10				
14.0	14.0	2.70				
15.0	15.0	2.30				
16.0	16.0	2.00				
17.0	17.0	1.80				
18.0	18.0	1.60				
19.0	19.0	1.40				
20.0	20.0	1.30				
21.0	21.0	1.20				
22.0	22.0	1.10				
23.0	23.0	1.00				
24.0	24.0	0.90				
25.0	25.0	0.85				
Standard hook						
Hook weight						
Part line						
Crane boom angle						

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Fly Jib



26.2 m Boom + 7.5 m Jib (Offset 5°)

RATO NK-200E-V **RATED LIFTING CAPACITY TABLE (2)**
Based on BS 1577:1988 DIN 15019-2 75% of tipping loads

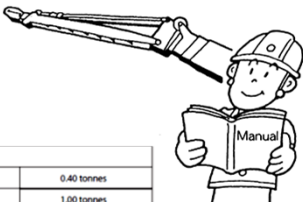
Crane fully extended with front jib - 300° full range
Crane fully extended without front jib - over side and rear

Boom angle (°)	26.2m Boom + 7.5m Jib					
	Offset 5°		Offset 15°		Offset 30°	
	Working Radius (m)	Load (t)	Working Radius (m)	Load (t)	Working Radius (m)	Load (t)
80.0	8.7	2.70	8.00	2.15	9.3	1.60
75.1	12.0	2.70	10.2	2.15	14.5	1.30
68.5	12.3	2.70	11.5	2.15	14.7	1.30
60.0	12.5	2.85	13.8	2.11	15.0	1.30
50.0	13.1	2.58	14.3	2.06	15.3	1.30
40.0	14.7	2.55	15.9	1.90	17.0	1.30
30.0	17.0	2.00	18.1	1.70	18.1	1.25
20.0	18.0	1.70	19.1	1.62	20.0	1.42
10.0	18.2	1.72	19.4	1.50	20.2	1.40
5.7	18.2	1.52	20.3	1.40	21.2	1.35
0.0	21.8	1.30	22.8	1.30	25.4	0.97
-10.0	23.8	0.70	24.5	0.76	25.1	0.74
-20.0	25.9	0.50	26.3	0.57	26.7	0.55
Standard hook						
Hook weight						
Part line						
Crane boom angle						

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Fly jib operations the rated lifting capacity is determined on the basis of the boom angle, not the working radius.



Fly Jib Reductions

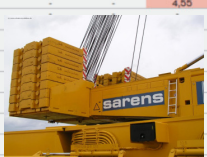
Folding Fly Jib		
9.0/16.0m	stowed	0.40 tonnes
9.0m	erected	1.00 tonnes
16.0m	erected	1.50 tonnes

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12 t 3.5 m' 360° 9.8 m/s EN 13000

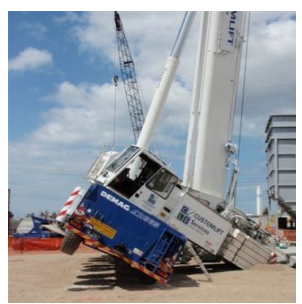
	10.3 m	14.0 m	17.7 m	21.3 m	25.0 m	28.7 m	32.4 m
3	41.90	-	-	-	-	-	-
3.5	37.45	-	-	-	-	-	3.5
4	30.70	29.05	27.50	-	-	-	4
4.5	25.95	24.60	23.55	-	-	-	4.5
5	22.35	21.20	20.35	20.00	14.50	-	5
6	17.20	16.60	15.70	15.95	13.30	9.60	6
7	13.85	14.05	12.55	12.85	12.80	8.50	6.00
8	11.30	11.70	10.15	10.55	10.65	8.00	5.70
9	-	9.90	9.00	8.85	9.05	7.50	5.40
10	-	8.45	8.20	7.40	7.70	7.00	5.00
11	-	7.30	7.50	6.35	6.65	6.65	4.70
12	-	6.45	6.45	5.50	5.70	5.85	4.50
13	-	-	5.70	4.75	5.05	5.15	4.30
14	-	-	5.15	4.30	4.30	4.50	4.00
15	-	-	4.55	4.00	3.80	4.00	3.80
16	-	-	-	3.70	3.35	3.50	3.50
17	-	-	-	3.40	2.85	3.15	3.25
18	-	-	-	3.10	2.55	2.75	2.85
19	-	-	-	2.90	2.25	2.40	2.60
20	-	-	-	-	2.00	2.15	2.30
21	-	-	-	-	1.90	1.90	2.05
22	-	-	-	-	1.70	1.85	1.80
23	-	-	-	-	1.60	1.45	1.60
24	-	-	-	-	-	1.25	1.45
25	-	-	-	-	-	1.05	1.25
26	-	-	-	-	-	0.90	1.05
27	-	-	-	-	-	-	0.85
28	-	-	-	-	-	-	0.75
29	-	-	-	-	-	-	0.55
30	-	-	-	-	-	-	0.50



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Counter Weights




Fixed Counterweight

Additional Counterweight

Slew locking pin **Not** engaged
Weight of ballast rotated crane
when transporting

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Crane Utilisation

Gross load not recommended to exceed 80% of the SWL of the crane configuration selected

Note: Must not exceed 90% of the SWL

Crane Utilisation

Gross load x 100 Divided by the SWL @ radius worked =

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	10.3 m	14.0 m	17.7 m	21.3 m	25.0 m	28.7 m	32.4 m
3	41.90	-	-	-	-	-	-
3.5	37.45	-	-	-	-	-	3.5
4	30.70	29.05	27.50	-	-	-	4
4.5	25.95	24.60	23.55	-	-	-	4.5
5	22.55	21.20	20.35	20.00	14.50	-	5
6	17.20	16.60	15.70	15.85	13.30	9.60	6
7	13.85	14.05	12.55	12.85	12.80	8.50	7
8	11.30	11.70	10.15	10.55	10.65	8.00	8
9	-	9.90	9.00	8.85	9.05	7.50	9
10	-	8.45	8.20	7.40	7.70	7.00	10
11	-	7.30	7.50	6.35	6.65	6.00	11
12	-	6.45	6.45	5.50	5.70	5.85	12
13	-	-	5.70	4.75	5.05	4.95	13
14	-	-	5.15	4.30	4.30	4.50	14

Crane Configuration – Radius: 12m – Boom length: 32.4m (Crane can lift 4.5 tons)

Crane Utilisation

Load 4t x 100 ÷ 4.5 = 88.8% Crane Utilization to high (Complex Lift)

You would need to Reduce Boom Length or Reduce Crane Radius

Load 4t (@10m) x 100 ÷ 5t = 80.0% Crane Utilization Good (Routine Lift)

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RADIUS: Straight Line Lifts

All Operators must fully understand Where & How to position their crane safely

To many accidents are caused by the operator not positioning the crane correctly

Lift: You have to position a load centred on the roof of a building

The easiest lift you can do is a straight line lift (from point A to point B)

Stage 1: Position crane (centre of slew ring) on the X directly in front of the drop point X B Note: Do not position the crane too close or too far away from building (Safe distance)

Step 2: Find centre point of building and pace distance back to centre of slew ring (in metres)

Step 3: You can now check cranes load charts to see if you can lift the load at that radius

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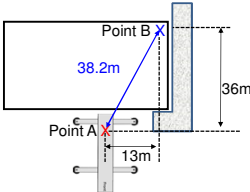
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RADIUS: Angled Lifts

Angled lifts need more planning

Lift: You have to position a load on the corner of a building

No lifting within shaded area



Stage 1: We need to measure from B to A X then from A X to X B

Step 2: We now have 2 known distances 36 and 13

Step 3: If we times $36 \times 36 = 1296$ and times $13 \times 13 = 169$. Add both numbers together $1296 + 169 = 1465$ and square root $\sqrt{1465} = 38.2$

Radius from point A – B is 38.2 metres

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Basic / Intermediate / Complex Routine / Non Routine / Engineered Lifting Operations

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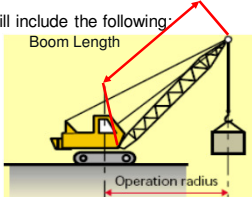
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BASIC LIFTS (Routine)

Where the loads to be lifted is of established weight and there are no known hazards or obstructions within the area of the operation

The duties of the person in control will include the following:
the selection of the crane based on:

- SWL of Load.
- Maximum Boom Length.
- Maximum Radius.
- Maximum Height of Lift



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Check when loads have to be lifted over an extended period of time, or with repetitive lifts that no changes are required.

The person appointed controlling a simple lifting operation should be aware of when they have reached their limit of experience

At that point they must seek appropriate help



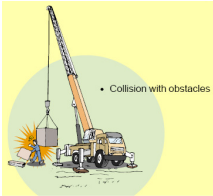
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Intermediate Lift (Standard / Non Routine)

Where the load to be lifted is of established weight or possibly not known accurately.

There are hazards to be considered within the working area.



Investigate all hazards in the work area. These may be from surrounding buildings or structures or over ground or underground services

liaise with any other person or authority as required to overcome any hazard for a safe system of work

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COMPLEX LIFTING (Engineered)

Where the lifting operation is to take place at a location with exceptional hazards
Gas / Chemical Plants, (Man Riders)

Safe system of work requires two or more cranes to be used to lift a single load

Planning must given greater attention than for more straight forward lifting operations



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COMPLEX LIFTING (Engineered) If the safe system of work requires two or more cranes to be used to lift a single load, lift supervisors and ground crew should ensure: A written method statement is drawn up outlining the steps to be followed to ensure compliance with the safe system of work. The method statement is given, understood and followed by those involved This is in addition to the briefing (tool box talks) (No other Personnel on the project has the authority to approve plans). Crane operators involved in lifting operation should be aware of when he/she has reached the limit of experience and knowledge

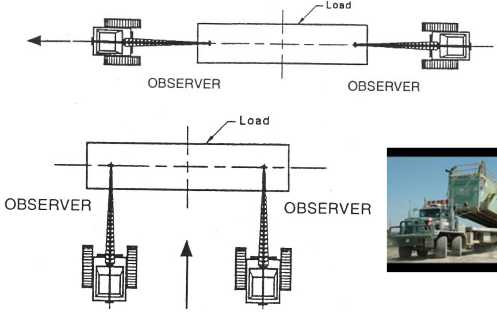
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TANDEM LIFTS You should have an restriction on tandem lifts. ▪ The only tandem lifting should be engineered through the office. ▪ Avoid slewing operations. ▪ Crane jibs must be kept parallel ▪ Work with two cranes of the same model. ▪ Set machines which have ample capacity for the job. ▪ Appoint one signaller for the entire operation. ▪ As a rule control the cranes by single lever operations and avoid compound lever operations. ▪ The dangers in tandem lifts are the cranes are going to side load each other

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TANDEM LIFTS When all the factors cannot be accurately evaluated, appropriate down-rating should be applied to all the cranes involved. The down-rating might have to be 20 % or more.

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TANDEM LIFTS




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TANDEM LIFTS

Tandem lifts are dangerous

They can be done safely if they are planned and every one involved is trained.

IF IN ANY DOUBT GET HELP FROM YOUR OFFICE OR SUPERVISOR



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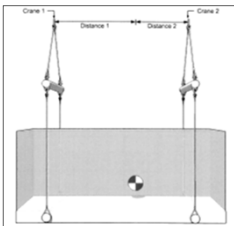
TANDEM LIFTS

Crane 1

$$(\text{Load weight} \times \text{Distance 2}) \div (\text{Distance 1} + \text{Distance 2})$$
(Heavy End)

Crane 2

$$(\text{Load weight} \times \text{Distance 1}) \div (\text{Distance 1} + \text{Distance 2})$$



Load 30t
 Distance Crane 1: 20m
 Distance Crane 2: 15m

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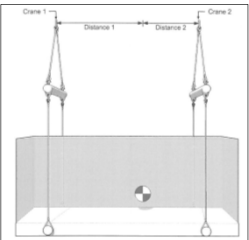
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TANDEM LIFTS

Crane 1
(Load weight X Distance 2) ÷ (Distance 1 + Distance 2)

$$\frac{30 \times 15}{15 + 20} = \frac{450}{35} = 12.86$$

Crane 1: 12.86 x 1.2 (Safety Factor) = 15.43t



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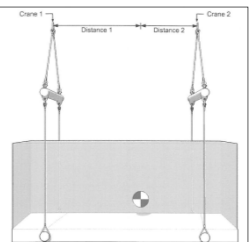
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TANDEM LIFTS

Crane 2
(Load weight X Distance 1) ÷ (Distance 1 + Distance 2)

$$\frac{30 \times 20}{15 + 20} = \frac{600}{35} = 17.14t$$

Crane 2: 17.14 x 1.2 (Safety Factor) = 20.57t



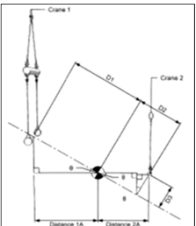
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Topping & Tailing Lifts

Crane 1
(Load weight X Distance 2A) ÷ (Distance 1A + Distance 2A)

Crane 2
(Load weight X Distance 1A) ÷ (Distance 1A + Distance 2A)



Load 30t
D1A: 20m
D2A: 15m
D3: 1m

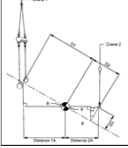
Topping & Tailing Lifts

Crane 1 Sling Distance **Crane 2 Sling Distance**

Distance 1A + @ 30° Distance 2A + @ 30°

$20 \times \cos 30^\circ$
 20×0.866
 $= 17.32\text{m}$

$(15 \times 0.866) + (D3 \times \sin 30^\circ)$
 $12.99 + 1 \times 0.5$
 $= 13.49\text{m}$



Loading Crane 1 (Load weight X Distance 2A) ÷ (Distance 1A + Distance 2A)

$(30\text{t} \times 13.49) \div (17.32 + 13.49)$
 $= 13.14\text{t}$

Loading Crane 2 (Load weight X Distance 1A) ÷ (Distance 1A + Distance 2A)

$(30\text{t} \times 17.32) \div (17.32 + 13.49)$
 $= 16.86\text{t}$

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Topping & Tailing Lifts

Loadings on Crane 1: @ 30° (Cos = 0.866)

$= 13.14\text{t}$

Loadings on Crane 2: 30°

$= 16.86\text{t}$

Loadings on Crane 1: @ 60° (Cos = 0.5)

$= 13.6\text{t}$

Loadings on Crane 2: 60°

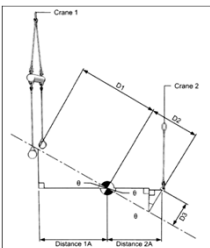
$= 16.3\text{t}$

Loadings on Crane 1: @ 90° (Cos = 0)

$= 30\text{t}$

Loadings on Crane 2: 90°

$= 0\text{t}$



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DISMANTLING OPERATIONS

The safe system of work should include steps to ensure all loads are free from adhesion, steel wedges, jacking equipment may be needed to break the suction.

There will be a final inspection of the load by the Crane Supervisor before the lift commences.

Lifting loads in mid-air should be avoided if possible. It is necessary to handle a load by attaching the crane then cutting free, the Appointed Person should ensure that a 100% uplift has been added to the estimated weight when selecting the craneage.

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Hoisting Over Live Facilities :

Hazards *	Controls *
✓ Live facilities (process plant or equipment) ✓ Equipment, protected or not, ✓ Equipment having any single or combination as (hazardous, pressurized, energized or containing strategic "fluid") Example of Hazards: ✓ Pipes ✓ Vessels containing hydrocarbons ✓ Electric cables ✓ Equipment cooling water supplies Note: ✓ Generally, Lifting operations over live facilities should be avoided at all times. ✓ Only in exceptional circumstances will this restriction be lifted. ✓ But strict procedures should be followed and there should be additional controls in place.	* Further safety precautions to be considered* ✓ Additional authorization from the manager of the asset. ✓ Shutting down, isolating, depressurizing and purging the live process plant, equipment or other facilities. ✓ Selecting higher rated L&G equipment, so there is no need to exceed 75% of the capacity. ✓ The use of static backup safety rigging, such as slings hooked up parallel with the hoist to sustain the load in the event of a hoist brake failure. ✓ Have an emergency plan in place. ✓ Having an emergency crew standing by. ✓ Having direct communications with the control room. ✓ Being ready to shut down.

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LIFT PLAN DEVELOPMENT

POST LIFT REVIEW

After the Lift Review, Inspect and Update



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Personnel Transfer Carriers

The Reflex Marine "FROG"



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Man Riding Carriers

Man riding carriers should only be used when the particular circumstances make it **essential**

- Transfer personnel by less hazardous means (MEWP)

Duty holders and operators need to have clear written risk assessments and procedures which cover all aspects of personnel transfer operations, (including effective communication).

Only approved lifting equipment, which has been marked as suitable for man riding or suitable for personnel transfer should be used.



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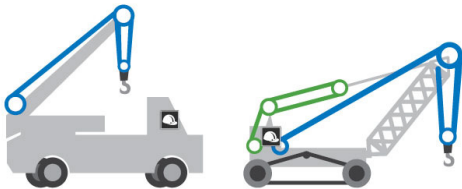


Hoist System

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Example 1



Example 2



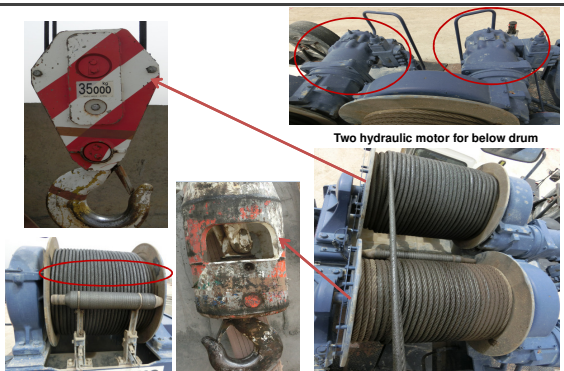
Example 3



Example 4

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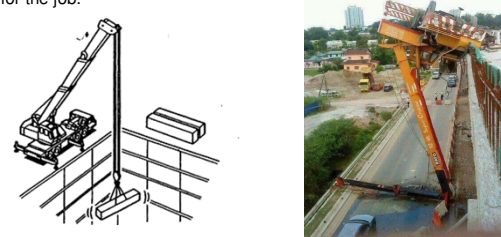


Two hydraulic motor for below drum

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Mobile Cranes **Ritchies** OFFSHORE SERVICES
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Crane operation on sites with underground areas
Choose a number of parts of line with ample capacity for the job.



Choose outrigger placement positions with particular care.
Be particularly careful in all aspects of the operations

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Ram's Horn Hook

Master links must be used for single point lifts



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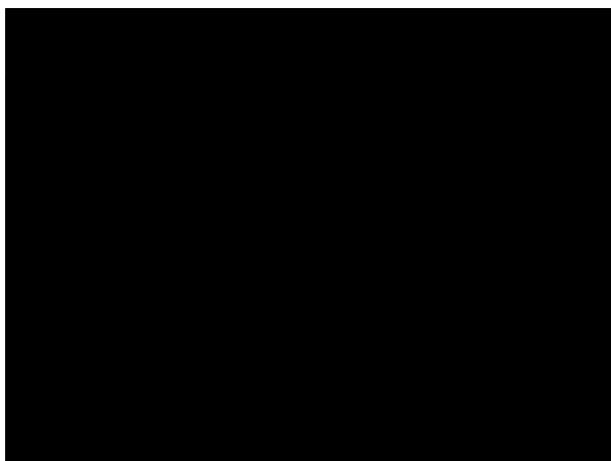
Synthetic Rope

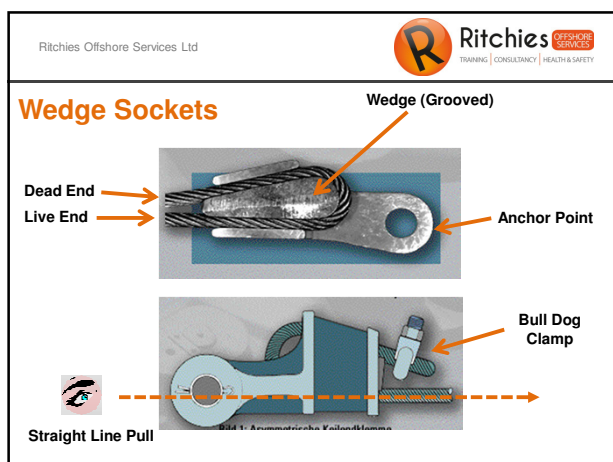
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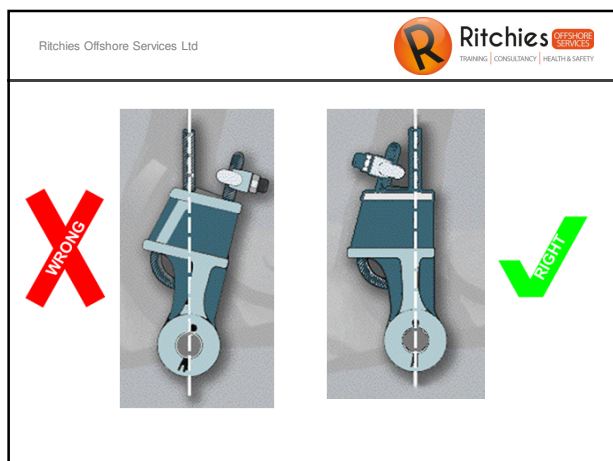
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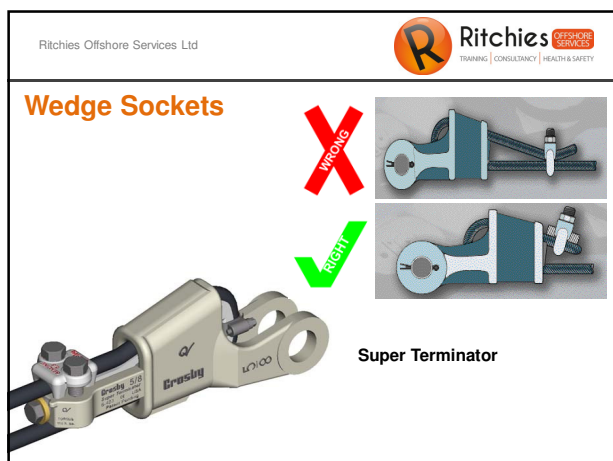
Spooling and Reeving

Left Lay - Left Hand		Right Lay - Right Hand	
Underwind Left to Right Use Left Lay Rope	Overwind Right to Left Use Left Lay Rope	Underwind Right to Left Use Right Lay Rope	Overwind Left to Right Use Right Lay Rope
Underwind Fasten on Left	Overwind Fasten on Right	Underwind Fasten on Right	Overwind Fasten on Left

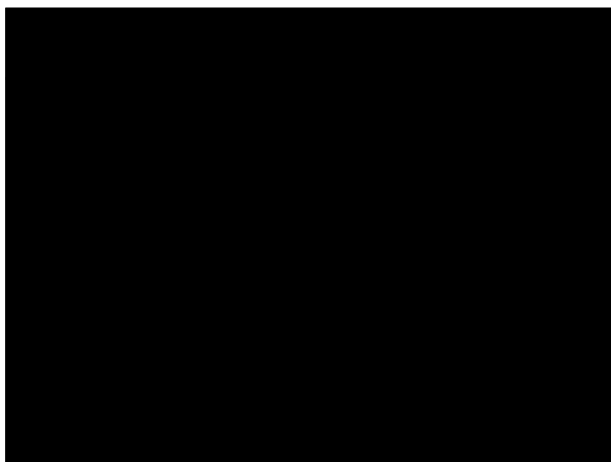












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Twists (Hook Block)

The diagram illustrates the process of correcting a twist in a hoist rope. It shows three stages: 1. A rope with a twist and a question mark. 2. The rope being untwisted. 3. The rope being re-twisted in the opposite direction to the original twist. Labels include 'n' part line' and '(Number of twisting X all turns)'.

Should a twist in the hoist rope occur, remove hoist rope anchor point and twist the anchor point in the opposite direction to the twist in the rope the same number of turns as were originally in the hoist rope. Attach hoist anchor point and check again for twisting. Repeat procedure if necessary.

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Factor of Safety

**Mobile Crane Hoist
Rope 4.5:1 – 6:1**



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FALLS OF ROPE

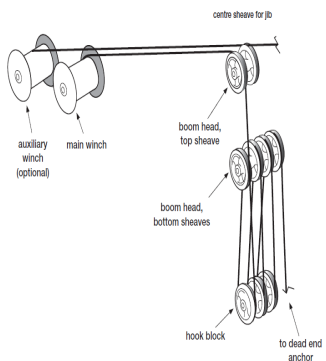
$\frac{25}{9}$	$25 / 9 = 2.7$	$7 \times 2.7 = 18.9 \text{ ton}$	
$\frac{70}{12}$	$70 / 12 = 5.8$	$10 \times 5.8 = 58.0 \text{ ton}$	
$\frac{21}{7}$	$21 / 7 = 3.0$	$4 \times 3.0 = 12.0 \text{ ton}$	



**To work out maximum weight per fall of rope
divide maximum capacity of the crane to
maximum falls of rope**

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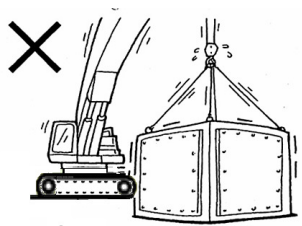

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Choose a hook and parts of line suitable for the mass of the load from the rated lifting capacity table.



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INSPECTION, TESTING & MAINTENANCE

Hook Check for

- Damage,
- Cracks
- Nicks or twist
- Gouges
- Deformity of the throat opening
- Wear on saddle or load bearing point
- Refer to the manual furnished by the original manufacturer of the crane or hoist.






Hook Latch

Check that hook latch, if provided, is not missing and that it operates properly.





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Proximity Hazards

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Weather Conditions – Wind

Refer to manufacturers instructions

Mobile Cranes: 9.8 m/s or 7.0 m/s (man riding work)
Crawler Cranes: 14 m/s

The speed of a gust is the average value of the wind speed measured for a duration of **3 seconds**. The gust speed is higher than the average wind speed, which is measured over a period of 10 minutes.

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Beaufort Scale

Maximum →

Beaufort number	Wind Speed (mph)	Seaman's term	Effects on Land
0	Under 1	Calm	Calm; smoke rises vertically.
1	1-3	Light Air	Smoke drift indicates wind direction; vanes do not move.
2	4-7	Light Breeze	Wind felt on face; leaves rustle; vanes begin to move.
3	8-12	Gentle Breeze	Leaves, small twigs in constant motion; light flags extended.
4	13-18	Moderate Breeze	Dust, leaves and loose paper raised up; small branches move.
5	19-24	Fresh Breeze	Small trees begin to sway.
6	25-31	Strong Breeze	Large branches of trees in motion; whistling heard in wires.
7	32-38	Moderate Gale	Whole trees in motion; resistance felt in walking against the wind.
8	39-46	Fresh Gale	Twigs and small branches broken off trees.
9	47-54	Strong Gale	Slight structural damage occurs; slate blown from roofs.
10	55-63	Whole Gale	Seldom experienced on land; trees broken; structural damage occurs.
11	64-72	Storm	Very rarely experienced on land; usually with widespread damage.
12	73 or higher	Hurricane Force	Violence and destruction.

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Thunderstorms

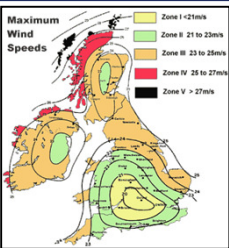


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**Resistance Coefficient
(Wind Drag on Loads)**



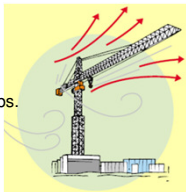
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Wind on Suspended Loads

Wind can have a significant effect on suspended loads

- Increase in the load radius or side loadings on jibs.
- The aerodynamic drag on the load
- The area and weight of the load.



Mobile cranes are designed with a standard drag factor of 1.2 and a wind area/weight of 1.2 m²/tonne.

This means that certain types of loads will produce higher side loads on the crane than it is designed to take.

Load	Drag Factor c_w
Standard values from EN13000	1.2
12m Container Cabin	1.55
System Shutter Panel 3m high x 1.9m wide	1.4
Wind Turbine Rotor	1.5 to 1.8

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Power Lines

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Recommended Safe Distances

You must not allow any part of your equipment to enter the **EXCLUSION ZONE**

Voltage	Exclusion Zone
275KV or 400KV	7m
132KV	6m
11KV and 33KV	3m
LV 230/400V	1m

Electricity can Arc over large distances

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PROXIMITY HAZARDS

you can receive a shock even if the crane does not actually touch the cables.

Fully Extended Jib Length + 9m

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PROXIMITY HAZARDS

Keep a safe distance between the machine and the power cables.

Fully Extended Jib Length + 15m

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Goal Posts

6m

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Bunny Hop Minimum 15 mts

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PROXIMITY HAZARDS

Electricity GS6

Structures

Other cranes

Stacked goods

Public access areas

Highways - relevant authority

Railways - relevant authority

Rivers - relevant authority

Services

Airfields


Stirling Group
www.stirling-group.com



Communication

What is it?

Relaying messages by Verbal Hand, Radio

Correct signals are pre-determined at the Tool-Box talk before the task begins.



Signals should be clear and not confuse the operator or other people in the area

Mobile Crane

 STOP	 STOP
 HOIST THE LOAD	 HOIST THE LOAD
 EXTEND BOOM	 RETRACT BOOM
 EXTEND BOOM	 RETRACT BOOM

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Stop

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Emergency Stop

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Hoist

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Hoist Slowly

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Lower

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Slew Left

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Slew Right

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Travel Too Me

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Travel Away From Me

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Jib Up

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Jib Down

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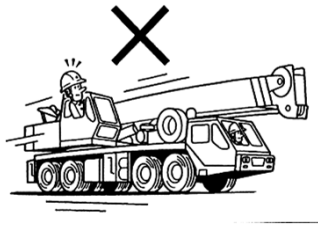


Operations Cease

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While driving you are subject to the Road Traffic Regulations.
Any offence committed could lead to a fine, penalty points or disqualification.



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Know the area in which you are working.
Familiarize yourself with work site obstructions and other potential hazards.
Use caution when in the vicinity of overhanging banks or edges.



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Stay alert when operating



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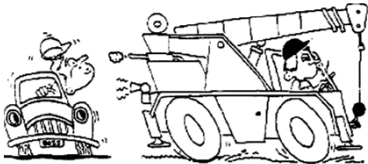

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Check load limits of bridges,
dock plates, manhole covers etc.



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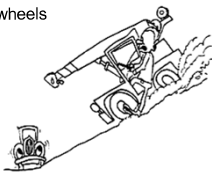
Never reverse on site without the assistance of a banksman

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When parking on slopes chock the wheels

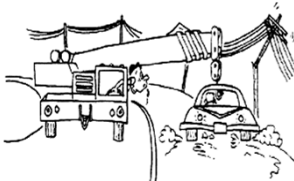


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Think



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Drive carefully

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WHAT IS THE MOST IMPORTANT ACTION THAT THE APPOINTED PERSON MUST HAVE THE AUTHORITY AND BE PREPARED TO DO STOP THE JOB

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Any Questions



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Load Configuration and Weight Calculation

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There are some load considerations affecting the choice of lifting gear for each lifting operation:

- Weight of the load
- Position of centre of gravity (CoG) of the load

Weight of the load can be established in the following ways:

- Weight is marked on the load
- Weight is indicated on documentation (e.g. shipping documents)
- Weight is indicated on drawings
- Weight can be identified using scale/load cell
- Weight can be estimated by a competent person

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We will look at how to estimate various types of load configuration and their weight and what kind of information is required

In order to calculate it properly we need to know **density of materials**

Please note that the density may vary depending on water content (some material may be saturated with water), contamination, decomposition etc

Therefore we can only **estimate** it – never assume that it will be precise calculation

There is a table of Densities of Materials on the next slide recommended by BS 7121-3:2000

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Densities of Materials
(BS 7121-3:2000)

Material	Density kg/m ³
Aluminium	2700
Brass	8500
Brick	2100
Copper	8800
Concrete	2400
Earth	1600
Iron – Steel	7700
Lead	11200
Oil	800
Water	1000
Wood	350 to 1000 (soft / hard)

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In order to estimate the weight of the load first of all we need to determine its volume

There are various forms of load can be encountered within the lifting industry

Basic forms – easy to calculate the volume

Complex forms – need to be carefully calculated

Following formulae can be used for volume determining

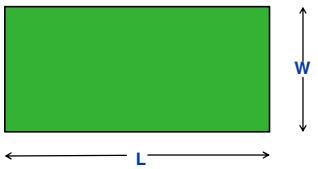
NOTE: Always ensure that all measuring units are the same, i.e. all dimensions are in meters

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Basic Shapes

■ Area

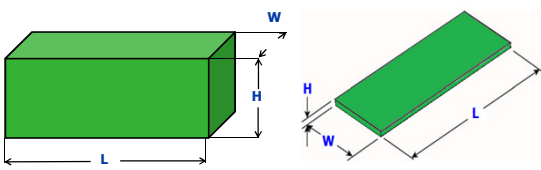


To get a squared area we need to multiply its Length by the Width, i.e.
 $S = L \times W$

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Rectangular Prism (Cuboid)

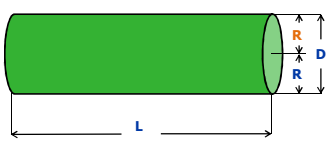


To get the volume of a rectangular prism (cuboid) we need to multiply its Length by the Width and by the Height, i.e.
 $V = L \times W \times H$

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Solid Cylinder



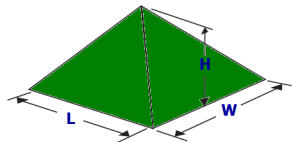
To get the volume of a solid cylinder we need to multiply the number π (Pi) by cylinder's squared Radius and by its Length, i.e.
 $V = \pi \times R^2 \times L$

Note:
 π is a mathematical constant (never changes) and equals to 3.14

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Rectangular Base Pyramid



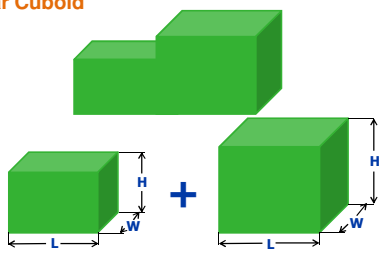
To get the volume of a rectangular base pyramid we need to multiply the area of the base by the Height and divide by 3, i.e.

$$V = \frac{1}{3} \times L \times W \times H$$

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Irregular Cuboid

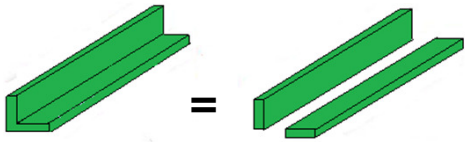


To get the volume of an irregular cuboid we need to cut this object into rectangular prisms (cuboids) and then calculate the volume of each separately and just add the results at the end.

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Angle Beam

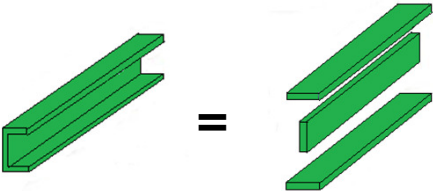


The calculation process is the same – cut it into sections and calculate each separately with adding outcomes at the end.

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Channel Beam

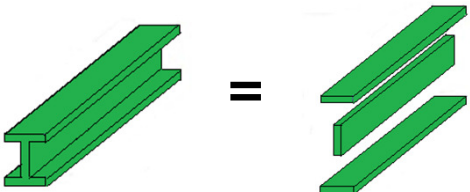


The calculation process is still the same – cut it into sections and calculate each separately with adding outcomes at the end.

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I (or H) Beam

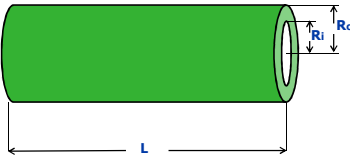


The calculation process is still the same – cut it into sections and calculate each separately with adding outcomes at the end.

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Hollow Tube (pipe)



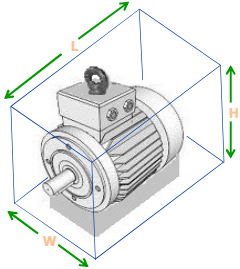
To get the volume of a hollow tube we need to multiply the number π (Pi) by a difference of squared Radii (inner from outer) and by its Length, i.e.

$$V = \pi \times (R_o^2 - R_i^2) \times L$$

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Rough calculation of motor's volume can be done as shown on sketch

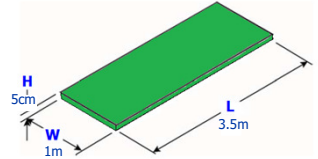


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Calculation Exercises

Calculate the approximate weight of the steel plate with given dimensions

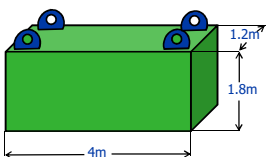


5cm = 0.05m
 $V = 3.5 \times 1 \times 0.05 = 0.175 \text{ m}^3$
 Plate weight = $0.175 \times 7700 = 1347.5 \text{ kg} = 1.35 \text{ te}$

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Calculate the approximate weight of the concrete block with given dimensions



$V = 4\text{m} \times 1.2\text{m} \times 1.8\text{m} = 8.64 \text{ m}^3$
 Block weight = $8.64 \text{ m}^3 \times 2400 \text{ kg/m}^3 = 20,736 \text{ kg} = 20.74 \text{ te}$

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Calculate the approximate weight of the **brass** cylinder with given dimensions

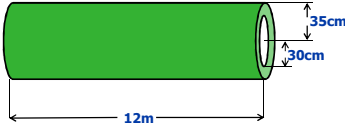


25cm = 0.25m
 $V = 3.14 \times 0.0625 \times 10 = 1.9625 \text{ m}^3$
 Cylinder weight = $1.9625 \text{ m}^3 \times 8500 \text{ kg/m}^3 = 16,681.25 \text{ kg}$
 = 16.69 te

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Calculate the approximate weight of the **aluminum** pipe with given dimensions

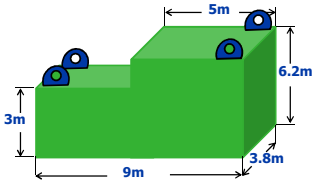


35cm = 0.35m and 30cm = 0.3m
 $V = 3.14 \times (0.1225 - 0.09) \times 12 = 1.2246 \text{ m}^3$
 Pipe weight = $1.2246 \text{ m}^3 \times 2700 \text{ kg/m}^3 = 3306.42 \text{ kg} = 3.31 \text{ te}$

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Calculate the approximate weight of this irregular cuboid made up of **soft wood** with given dimensions



This figure is made from two cuboids with dimensions:

4m x 3.8m x 3m and 5m x 3.8m x 6.2m
 Volume of first cuboid = $4 \times 3.8 \times 3 = 45.6 \text{ m}^3$
 Volume of second cuboid = $5 \times 3.8 \times 6.2 = 117.8 \text{ m}^3$
 Total volume of both cuboids = $45.6 \text{ m}^3 + 117.8 \text{ m}^3 = 163.4 \text{ m}^3$
 Wooden cuboid weight = $163.4 \text{ m}^3 \times 350 \text{ kg/m}^3 = 57,190 \text{ kg} = 57.19 \text{ te}$

Centre of Gravity (CoG) – is the point about which all parts of the load (body) exactly balanced against each other

To ensure safety of the lift the hook of lifting appliance should be positioned above the CoG

Estimation for basic shapes is straight forward, e.g. the CoG of a straight pipe can be found just by measuring a midpoint in each direction

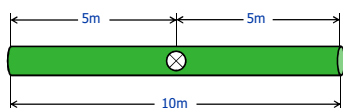
For complex shapes usually CoG of subdivided parts is estimated and then combined CoG is found

In any case the determined CoG should be marked in some way, e.g. sticky tape, marker, chalk etc

On following slides we will have a look on some examples of CoG estimation

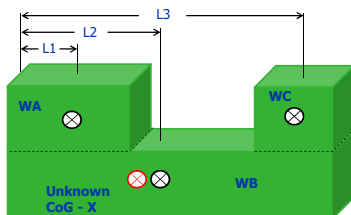
Just measure the midpoint from each end

Always ensure that the load is equally balanced



Below is an example:

- ✓ Divide the whole figure into separate cuboids
- ✓ Define CoG of each separate cuboid and estimate their weight
- ✓ Measure the distance from one end of the whole figure to each separate CoG



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To determine the unknown CoG – X use the following formula:

$$(WA+WB+WC) \times Z = L1 \times WA + L2 \times WB + L3 \times WC$$

or

$$(2+5+1) \times Z = 1 \times 2 + 5 \times 2.5 + 1 \times 4 \text{ following } 8Z = 18.5$$

$$Z = 18.5 / 8 \text{ following } Z = 2.3$$

Same process should be done for all other planes to find out CoG's precise position

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There is another method of CoG calculation

After breaking the whole figure into separate sections determine their CoGs

After making a triangle by connecting all CoGs the combined CoG will be somewhere within this triangle

Let see how it can be estimated on next slides

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We need to find a combined CoG between two separate sections

The combined CoG will be closer to heavier part, therefore:

$$WB / (WB + WA) = 8000 / (8000 + 2000) = 0.8 = 80\%$$

The same should be done with another section and already found combined CoG

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The combined CoG will still be closer to heavier part, therefore:

$$(WA+WB) / ((WA + WB)+WC) = 10000 / (10000 + 2000) = 0.83 = 83\%$$

When more sections involved the same process should be conducted until all sections covered and main CoG is found

This can be marked on the load by chalk or marker

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Tension in each leg =

At 0° Vertical = 4 Te in each Leg
At 90° Angle = 5.6 Te in each leg
At 120° Angle = 8 Te in each leg

At 151° Angle = 16 Te in each leg
At 171° Angle = 48 Te in each leg

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0°	SWL=	SWL of one sling x 2
30°	SWL=	SWL of one sling x 2 x 0.966
60°	SWL=	SWL of one sling x 2 x 0.866
90°	SWL=	SWL of one sling x 2 x 0.707
120°	SWL=	SWL of one sling x 2 x 0.5
0°	SWL=	SWL of one sling x 2
30°	SWL=	SWL of one sling x 1.93
60°	SWL=	SWL of one sling x 1.73
90°	SWL=	SWL of one sling x 1.414
120°	SWL=	SWL of one sling only

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Recommended Maximum Included Angle

10 Te

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90° Max between any 2 adjacent legs

SWL 3t

SWL 3t

?T

Max Lift =
S.W.L. of one sling x 0.707 x 3
= 3t x 0.707 x 3 = 6.3t

90° Max between any 2 diagonally opposite legs

SWL 3t

SWL 3t

?T

Max Lift =
S.W.L. of one sling x 0.707 x 3
= 3t x 0.707 x 3 = 6.3t

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When the weight is equally distributed between lifting points, the tension will be the same for each sling if they used at the same angle.

5te

5te

10 te

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When the weight is not evenly distributed between lifting points, the slings and fittings will not have the same tension.

Leg 2 is closer to the COG and therefore has the more tension.

Leg 1 = $5 \times 3 / (3 + 7) = 1.5 \text{ te}$

Leg 2 = $5 \times 7 / (3 + 7) = 3.5 \text{ te}$

COG 5te

3m 7m

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If load should be lifted using two single leg slings under the angle, this method could be used to calculate tension on each leg.

Tension1 Load x N2 x L1 / H x (N1 + N2)

Tension2 Load x N1 x L2 / H x (N1 + N2)

N1 N2

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When length (L) and height (H) are known you can calculate the tension on equipment using the angle factor

Vertical Angle	Length Factor	L/H
60 deg	1.15	2
50 deg	1.31	1.55
45 deg	1.41	1.4
40 deg	1.55	1.3
35 deg	1.74	1.21
30 deg	2	1.16

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The maximum recommended included angle is 90°

This angle can be approximately estimated if sling length and distance between lifting points are known

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Most slinging method calculations are based on triangle principle

Any triangle can be subdivided into separate (smaller) triangles and calculated to find out the side needed

Pythagorean Theorem (right triangle)

Cathetus – are always shorter sides

Hypotenuse – is always the longest side

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Pythagorean Theorem

If you know two of the lengths of a right triangle you can always find the third one

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

$$c^2 - b^2 = a^2$$

$$c^2 - a^2 = b^2$$

$$c = \sqrt{a^2 + b^2}$$

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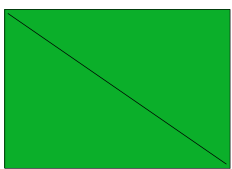

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To calculate the length of the sling multiply distance between lifting points to the angle factor.



In order to calculate total slinging height always take into account all equipment used, e.g. Shackles, master link etc

To calculate the sling length for 4 legged sling, multiply distance between diagonal lifting points to the angle factor.

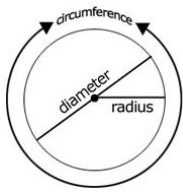


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Some slinging method calculations are based on circumference length (for slinging round loads)

If you know the diameter of your load you can calculate the circumference length using the following formula:



$L = 2\pi R \text{ or } L = \pi D$
