07 Lifting with Cranes

SEACAMEL

Lifting is an essential part of the work we do. The various types of lifting will be discussed and you will learn how to select a crane suitable for the job.

You will also learn:

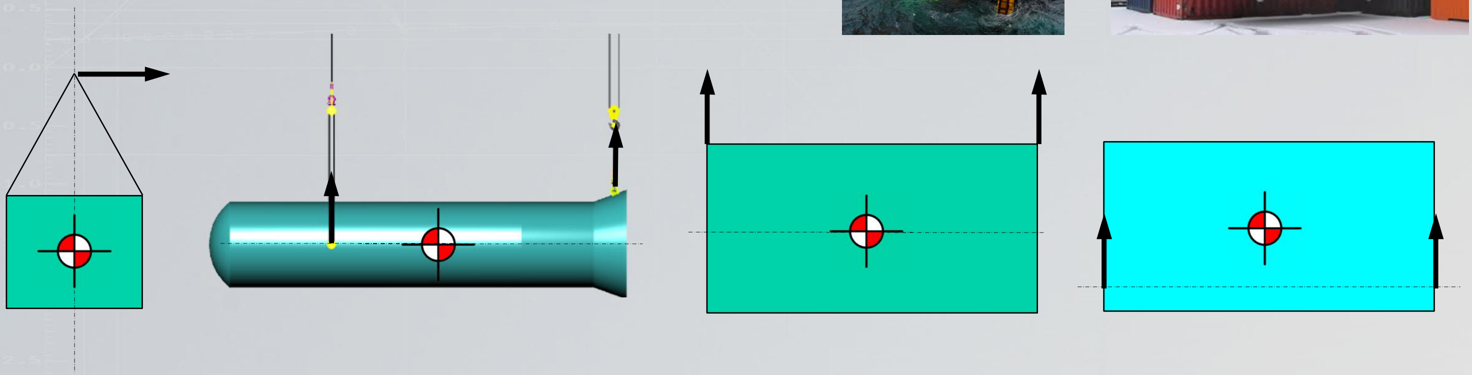
– how to select your equipment.
– about the stability of a load,
– how to design a lifting plan,
– the use of spreader bars and,
– how to organize a lift.

Module Summary

SEACAMEL

Lifting of Loads

DIFFERENCES IN LIFTING
- Horizontal movement
- Move from Horizontal into Vertical position
  - Often done with more then one crane
- Lifting points above the CoG
- Lifting points below the CoG



How to select your crane(s)?

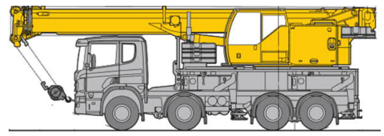
SEACAMEL

Many types of cranes are available and each type has its own characteristics. The selection for what crane to select depends on the type of job.

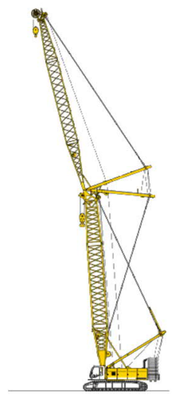
Selection criteria to be considered for the selection include:

- characteristics of the load(s) like masses, dimensions, cog, location of lifting points or internal strength. Include the weight of the hook, spreaders, slings etc.
- Required hook height
- Flexibility of the boom (telescope cranes)
- operational speeds, radii, heights of lifts and areas of movement;
- Speed (number and frequency lifting operations;
- Temporarily or permanently installed crane;
- Soil conditions and other environmental conditions restrictions ;
- Space available for crane access, erection, travelling, operation and dismantling;
- Entering and leaving the work site
- counterweight when swinging.

Comparison; Crawler versus Tyre

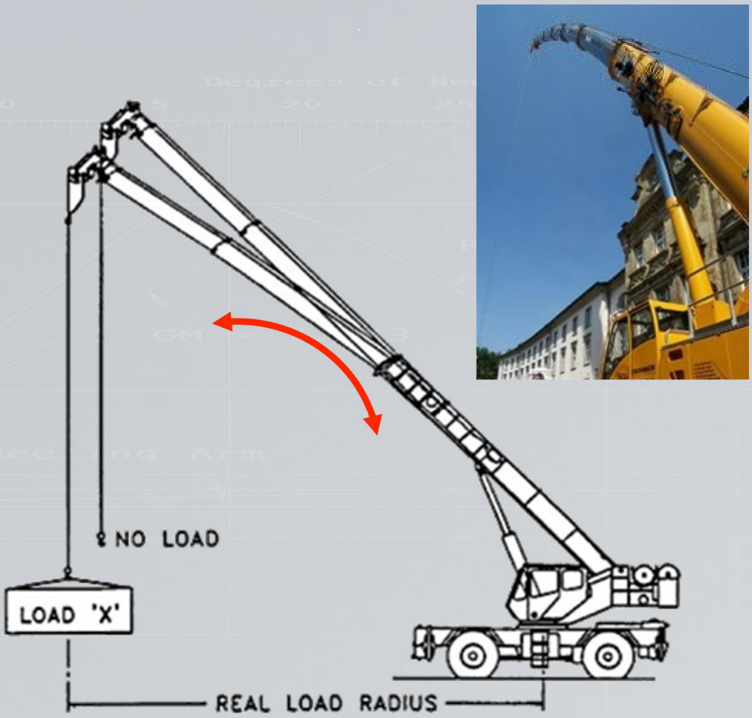
	 CRAWLER CRANE	 CRANE ON TYRES
STABILITY	**High Stability**	Outriggers required
TRAVEL SPEED	Low (max 1.5 km/h)	**High (up to 90 km/h)**
BEARING	**Large bearing surface**	Small bearing surface
SET UP	Slow Disassembled for transport	**Fast** **Big crane needs partial assembly**
OTHER	**Can travel with load**	**Can be driven on public roads**

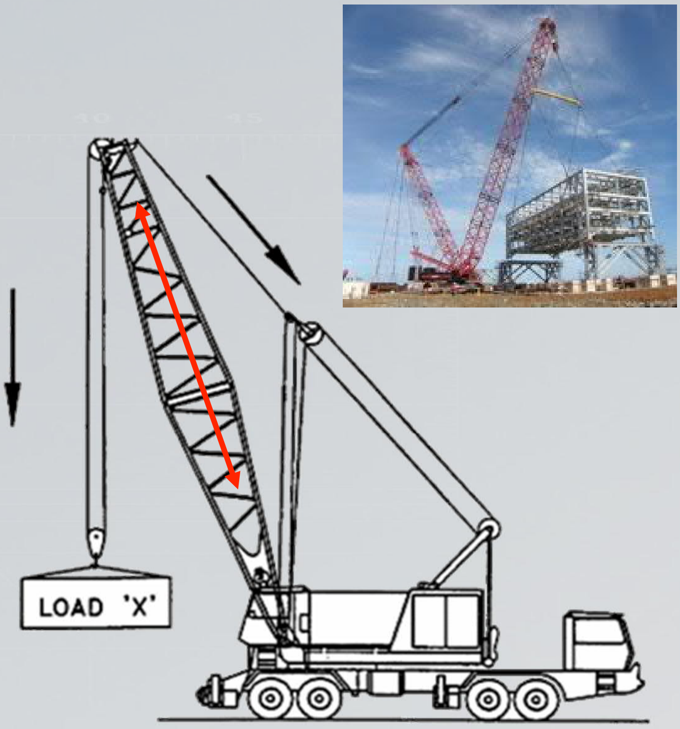
Comparison; Telescopic versus Lattice (1)

	 BOX (TELESCOPIC) BOOM	 LATTICE BOOM
CONSTRUCTION	Tube sections Heavy construction	Lattice (High tensile steel) Lighter construction
ASSEMBLY	**Fast**	Slow
TRANSPORT	**Easy road transport**	Complex road transport
EXTENSIONS	**Hydraulic extension**	By sections (3, 6, 9 or 12 m)
BOOM LENGTH	Fly jibs for longer reaches	**Very long**
LOADS SIZES	Medium to heavy loads	**Heavy loads**

Comparison; Telescopic versus Lattice (2)

SEACAMEL

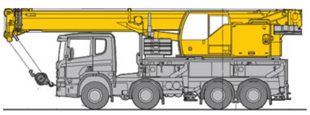




1. The boom of a telescopic crane is based on bending forces
2. The boom of a lattice boom crane is based on compression forces

Pros and cons of the various crane types

SEACAMEL

	 **Mobile Hydraulic Crane**	 **RT (Rough Terrain) Hydraulic Crane**	 **Crawler Hydraulic Crane**	 **Lattice Crawler Crane**
TRANSPORT	Driven on public roads	Not allowed on public road but easy transport	Not allowed on public road but easy transport	Heavy transport
ASSEMBLY	Fast Counterweights transported separately	Fast No assembly	Fast No assembly	Slow
CAPACITY	Up to 900 t	Up to 100 t	Up to 100 t	Up to 3,000 t
MANOEUVRABILITY	Limited	High	Low	Low Can move with load
BOOM LENGTH	Telescopic + fly jib	Telescopic + fly jib	Telescopic	Very long (up to 245 m) Various combinations
STABILITY	Need outriggers	Need outriggers	High	Very High
TRAVEL SPEED	Fast (up to 90 km/h)	Fast (up to 35 km/h)	Fast (up to 35 km/h)	Slow (up to 1.5 km/h)
HOIST WINCHES	1 or 2	1	1	8

Lift versus Heavy duty

Cranes look similar from the outside but are really different inside.

Comparison; Lift versus Heavy duty

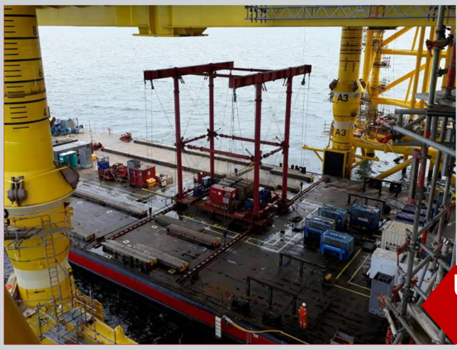
	LIFT CRANE Liebherr LR 1130	**HEAVY DUTY CRANE** Liebherr HS 885 HD
MAX DUTY CYCLES	**+/- 100,000**	**> 1,000,000**
MAX LIFTING CAPACITY	137,2 t @ 4.0 m	120,0 t @ 3,8 m
LINE PULL	12-15 t	20-30 t
ENGINE POWER	240 kW	400-605 kW
ROPE DIAMETER	26 mm	30-34-36 mm
ROPE SPEED	0-136 m/min	0-85, 0-69, 0-55 m/min
TOTAL WEIGHT	138,5 t	106,8 t
COUNTERWEIGHT	65,5 t	32,5 t
GROUND BEARING PRESSURE	1.03 kg/cm²	0.98 kg/cm²
MAX MAIN BOOM LENGTH	80 m	74 m
6 M BOOM SECTION WEIGHT	1,040 kg	1,240 kg
MAIN BODY	Strong / **NO fatigue**	Very Robust / **fatigue**

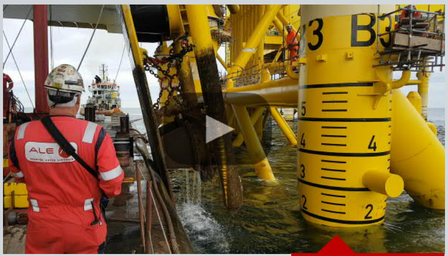
FROM THE SITE. Crane selected for Dolwin gamma

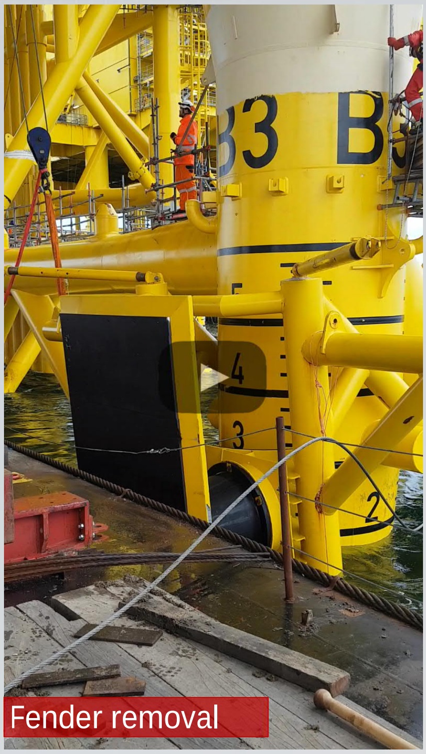
SEACAMEL

For the float-over of the Dolwin gamma topside, fenders were installed to the jacket legs. Once the float-over was completed, the fenders of about 25 tonne each had to be removed.

The fender removal was done with a second (smaller barge) on which a project dedicated crane was installed.







Rated Crane capacity and Load moment

SEACAMEL

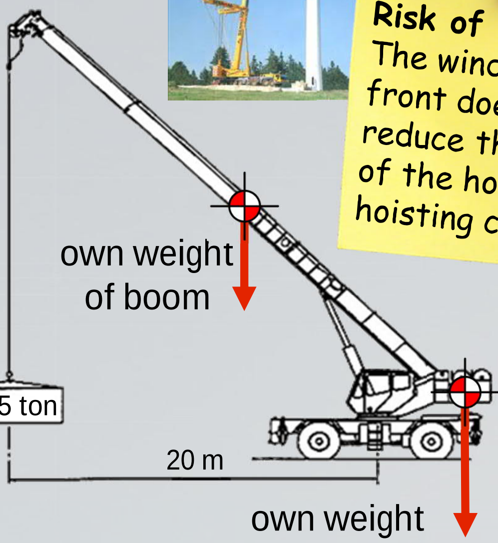
Rated capacity:	Maximum permitted load that can be lifted by the crane under conditions specified by the manufacturer.
Load Moment:	Radius x capacity.

For example. A crane that has a lift capacity of 3 tons at 10 m radius has a load moment of 3 x 10 m = 30 ton meter

With this knowledge we can quickly estimate the crane, needed to lift a load of 1,5 tons at 20 m radius

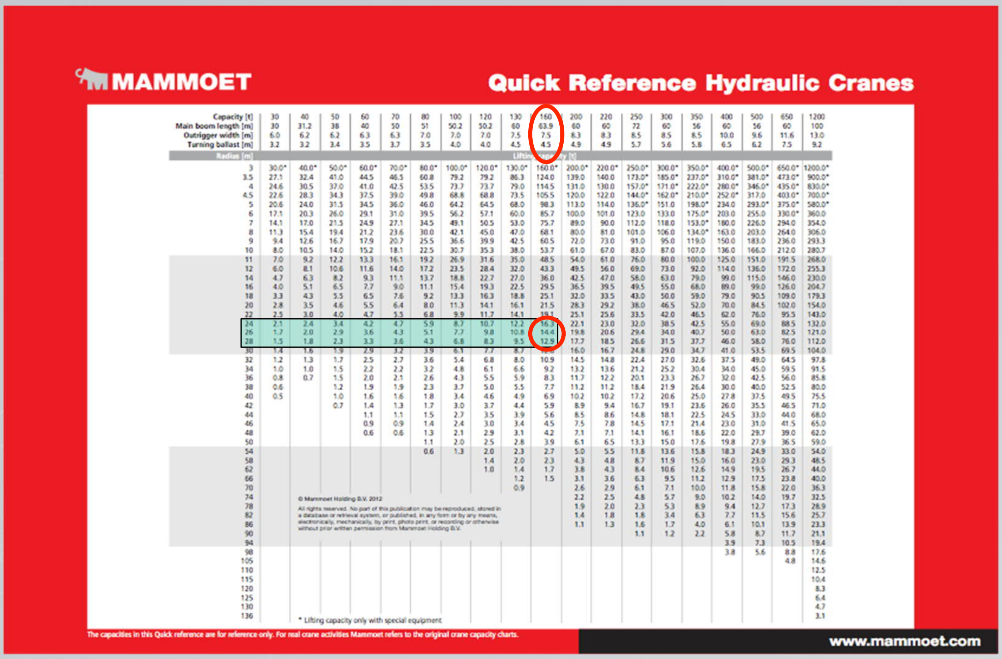
1. Be aware that this is just a rule of thumb and not accurate at all. The theoretical load moment needed is 1,5 x 20 = 30 ton meter. Always consult the capacity chart of the crane.
2. This means we need at least a crane that can lift 10 tons at 3 m radius, which normally would be a 10 tons crane, but this is not correct!
3. We have not taken into account, the own weight of the boom and this significantly decreases the load moment!
4. The crane that can actually do the job could well be approx. 30-70% bigger. With the quick reference capacity chart, you will get an estimate of the crane needed

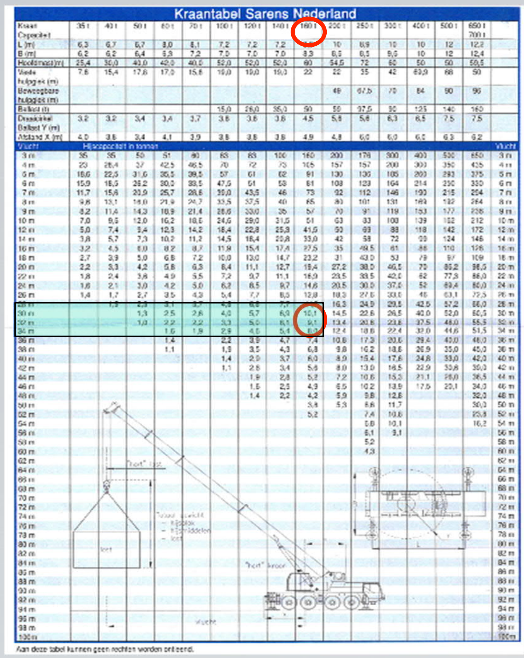
Risk of accident! The wind from the front does not reduce the loading of the hook, hoisting cable



NOTE: For the final lift plan always use the actual lifting capacity chart of the crane!

Quick Reference capacity Chart for Hydraulic cranes

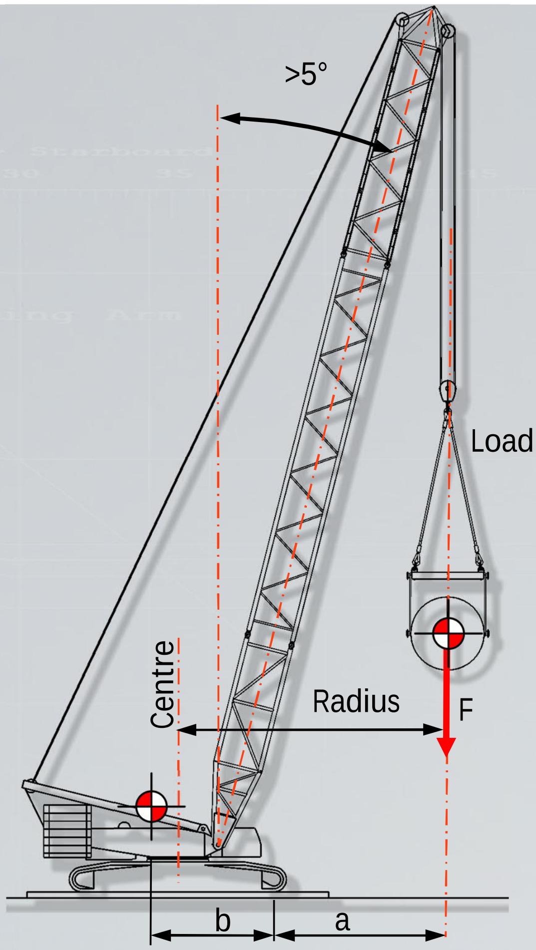


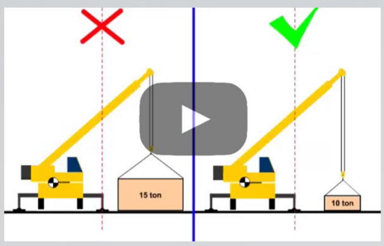


1. With these rough Lift capacity charts one can quickly establish what crane type is needed for a certain load at a certain radius
2. Be careful, these are only average values.
3. Always consult the actual lift capacity chart of the crane before making the lift.

The Stability criteria of a crane

1. The load moment of a crane is load (ton) x radius (m) measured to the center of the crane and is defined in Ton meter.
2. The tipping moment of a crane is the moment of the load around the tipping line. (A x (Load)
3. The stabilizing moment is the moment of the weight of the fixed parts of the crane around tipping line (B x total crane weight)
4. Many standards are struggling with how to address this issue in their standards. The margin of stability is specific for the various types of crane mountings. As guidance for cranes with outriggers: The Capacity of a lift crane is based on 75% of the tipping moment. In other words, the tipping moment must be at least: 1/0,75 = 1,33 x as big as the stabilizing load moment.
   Check the applicable standard
5. With an unloaded crane the angle between the vertical line through the tipping line and the line through the CoG must be at least 5°



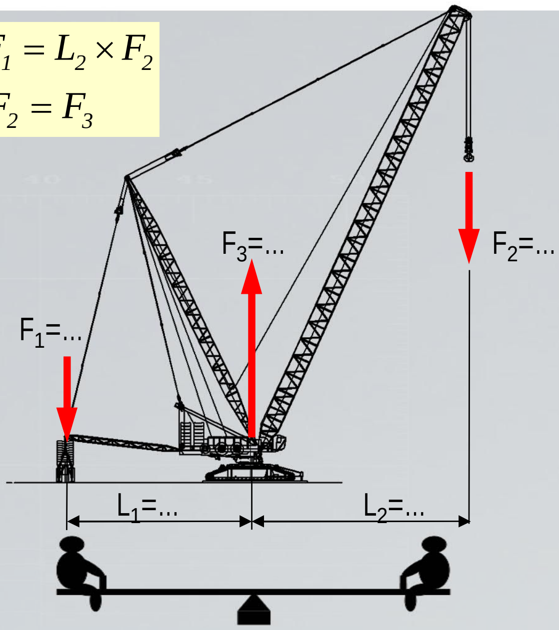


Super lift

Various definitions are used:

- Lifting with a crane rated at 1000-Ton Capacity or higher
- Any lift that presents a risk of catastrophic damage to human life or the facility
- Lifting with a crane equipped with capacity enhancing attachments. like an SL counterweight. A weight often connected to the superstructure by a telescoping rod which extends essentially horizontally

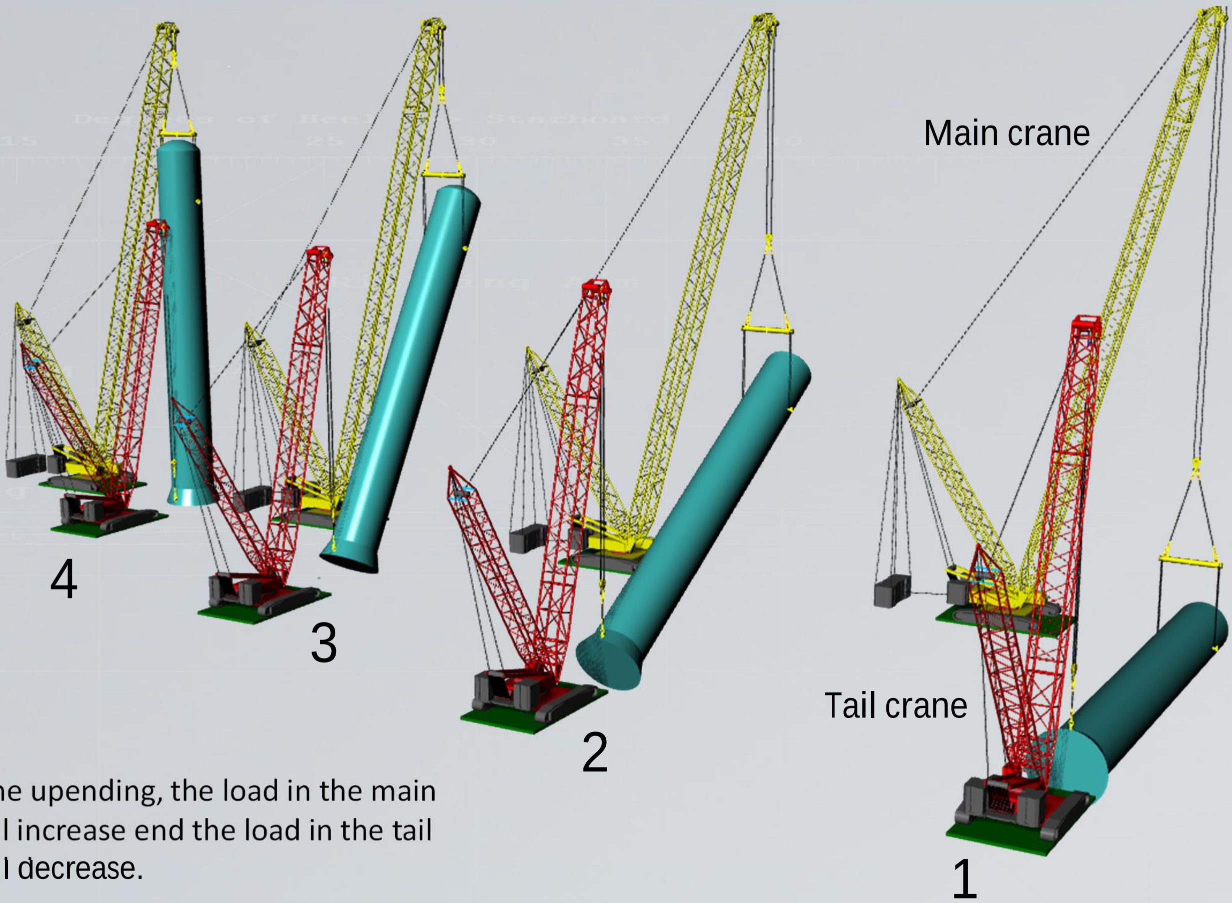
$$L_1 \times F_1 = L_2 \times F_2$$
$$F_1 + F_2 = F_3$$



Soil Analysis

The allowable ground bearing capacity has to be investigated and confirmed by an experienced soils engineering firm.

Upending a vessel with 2 cranes, one crane moving



During the upending, the load in the main crane will increase end the load in the tail crane will decrease.

Upending a vessel with 3 cranes

SEACAMEL

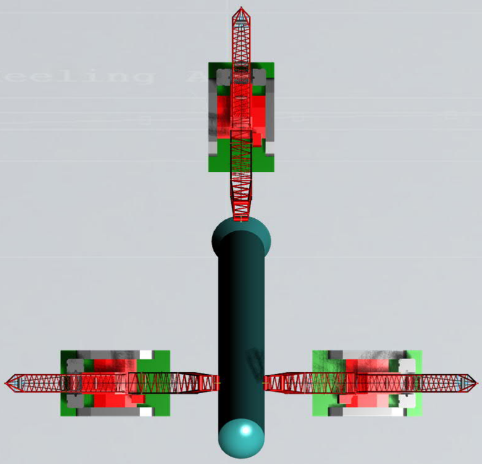
In stead of 1 big crane with a spreader bar, 2 smaller cranes can be used.

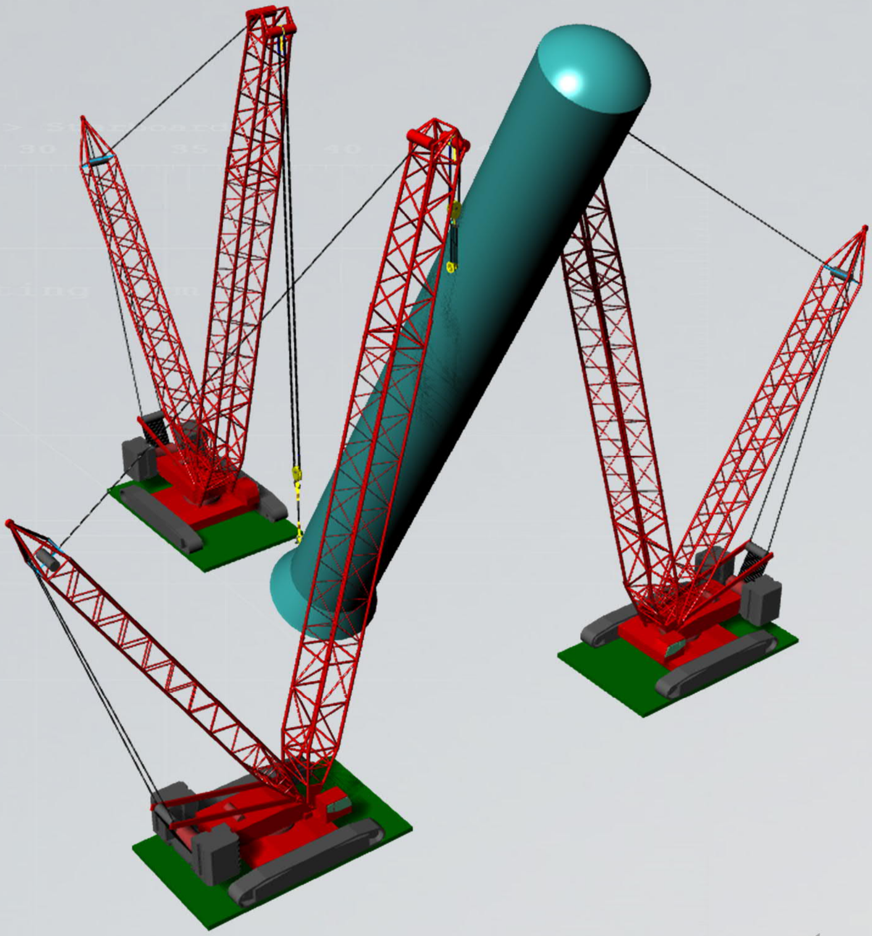
Advantage:

- The big lead crane is replaced by 2 smaller cranes.

Disadvantage:

- More space required.



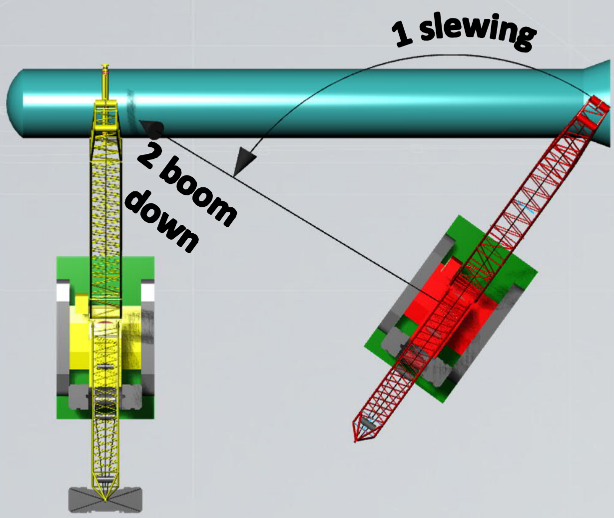


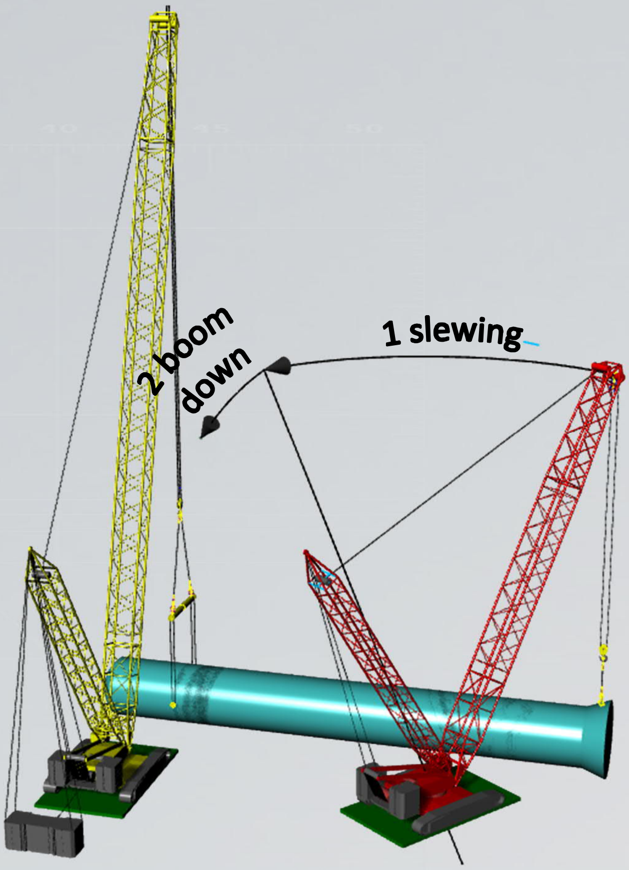
Upending a vessel while slewing the tail crane

SEACAMEL

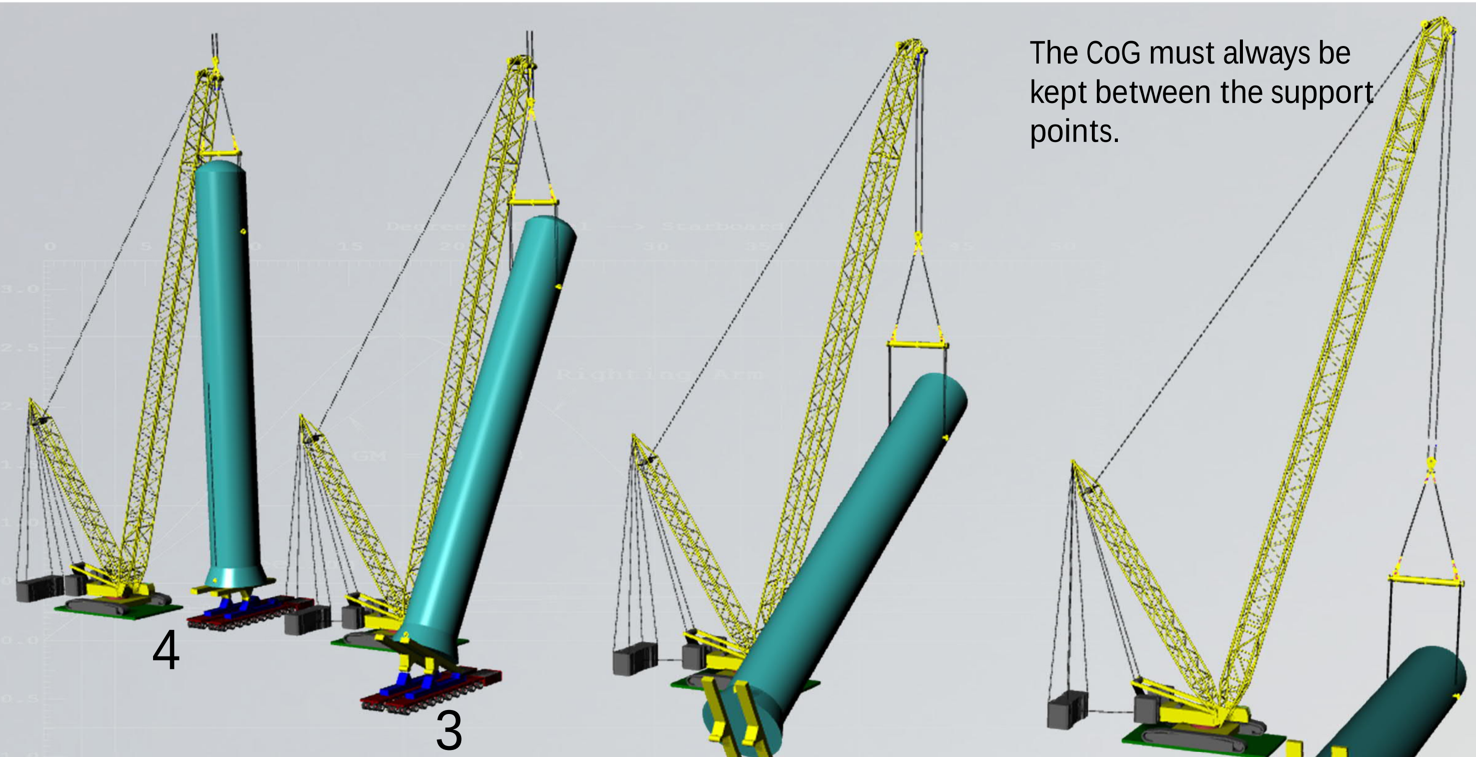
Variations can be made by slewing both the lead cranes and the tail crane.

During the first phase (1), load on the tail crane will reduce. This allows the crane to luff the boom down in the second phase (2).

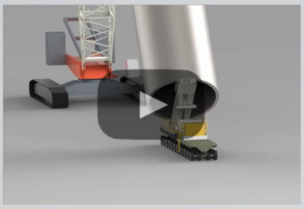




Upending a vessel using a tailing frame



The CoG must always be kept between the support points.



Upending using a lift System


Lift System with Crawler Crane


Strand Jack with Trailer


Lift System with Trailer


Lift System with Cross Slide


Gantry with a strand jack a tailing gantry

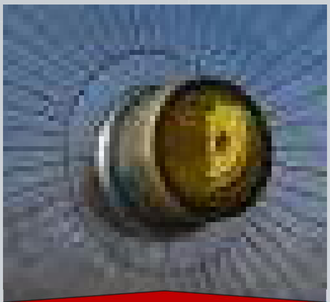
In combination with cranes, alternative lifting methods can be used.

Any combination is possible.

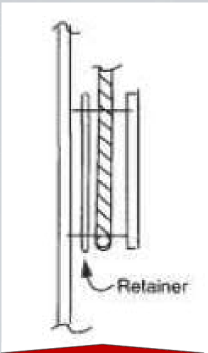
Lifting points

Both pad-eyes and trunnions can be used for lifting.

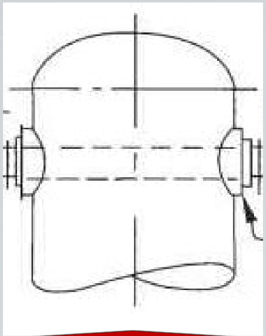
Trunnions can take in general bigger loads then pad eyes.



Top lug



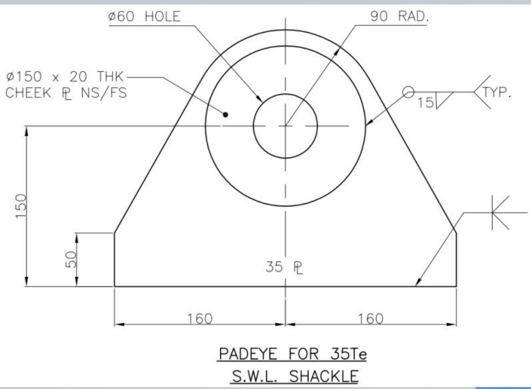
Trunnion

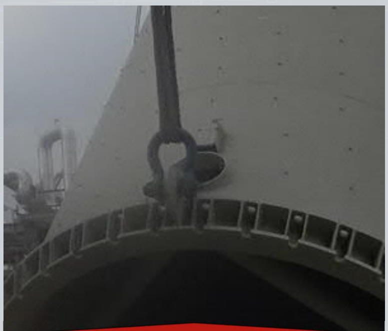


Insertion of lifting pipe

Welded lifting plates

Tailing lugs



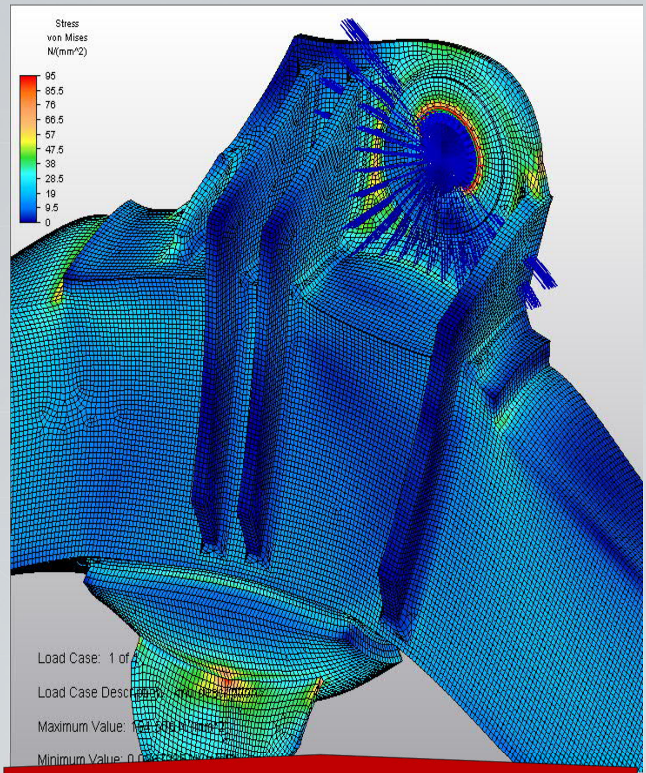


Tailing lug welded to skirt

Tailing frame bolted to the skirt

Tailing lugs

Tailing lug bolted to the bottom flange



Thoroughly checked using FEA

The equation of moment equilibrium for dual crane operations.

When the CoG of a Load which is not spaced at equal distances from the crane hooks, we can calculate the load in each crane with the moment equation as shown below:

Looking from F_1

$$L_1 \times G = L_2 \times F_2 \qquad \Rightarrow F_2 = \frac{G \times L_1}{L_2}$$

Looking from F_2

$$F_1 \times L_2 = G \times (L_2 - L_1) \qquad \Rightarrow F_1 = \frac{G \times (L_2 - L_1)}{L_2}$$

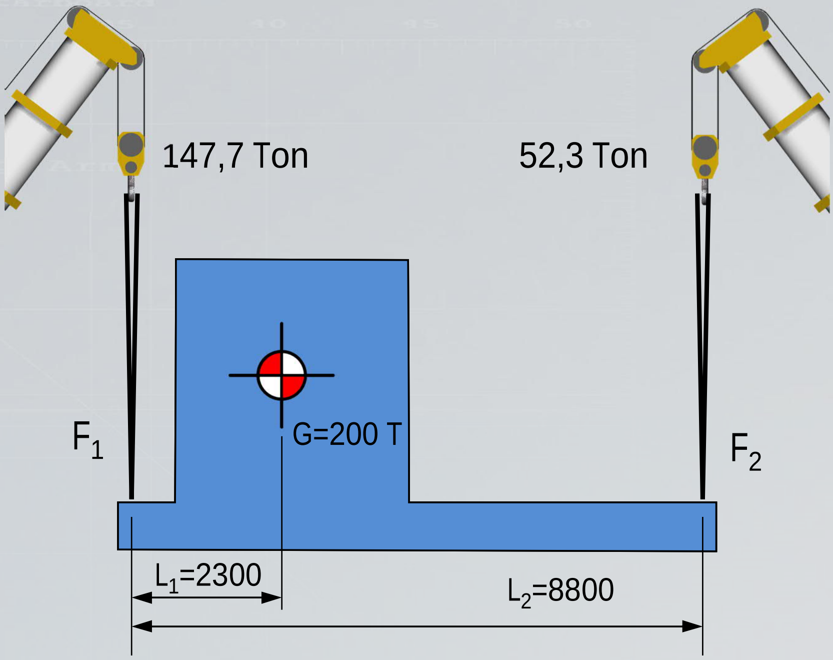
Or easier

$$F_1 = G - F_2$$

What is the load in S1 and S2?

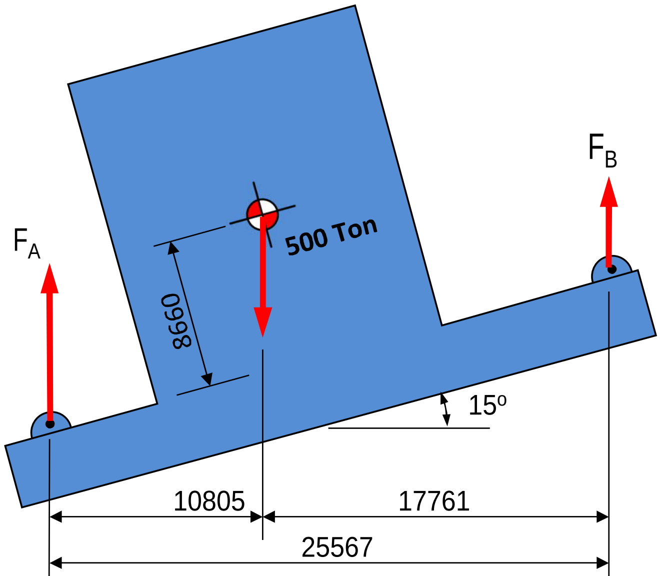
$$F_1 = \frac{200 \times (8.8 - 2.3)}{8.8} = 147.7 ton$$

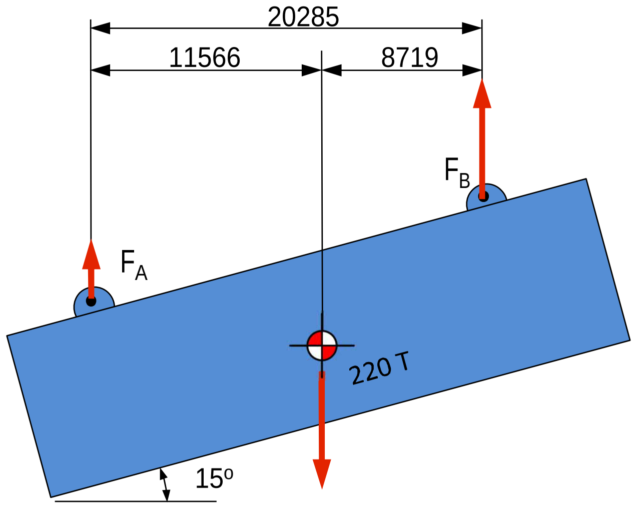
$$F_2 = \frac{200 \times 2.3}{8.8} = 52.3 ton$$



1. When we lift a load with two cranes and do not lift at equal speed, the load in each crane can vary significantly. This strongly depends on the height of the CoG above or below the lift points.
2. Depending on where the CoG is located, the load difference will increase (when the CoG is higher above lift points) or decrease (when the CoG lower is below the lift points)

#Q11: What will happen when A is lowered?





#Q12: What is the load in F_A and F_B?

1. F_A = 16.220/29.540x500 = 274.54 ton
2. F_B = 13.320/29.540x500 = 225.46 ton

What is the load in F_A and F_B?

1. F_A = 8.719/20.285x220 = 94.56 ton
2. F_B = 11.566/20.285x220 = 125.44 ton

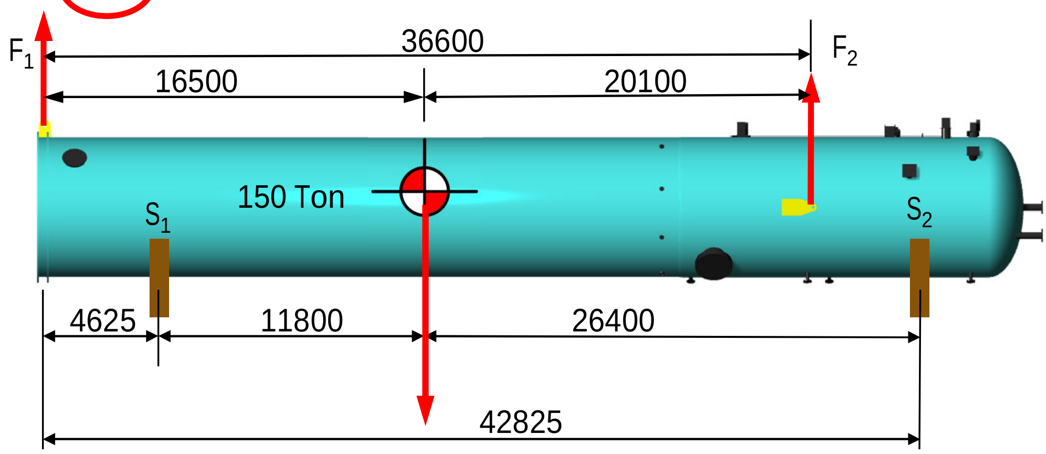
Location of CoG in relation to the lift and support points

#Q13: Calculate the load for the following situations. The saddles are attached to the column.

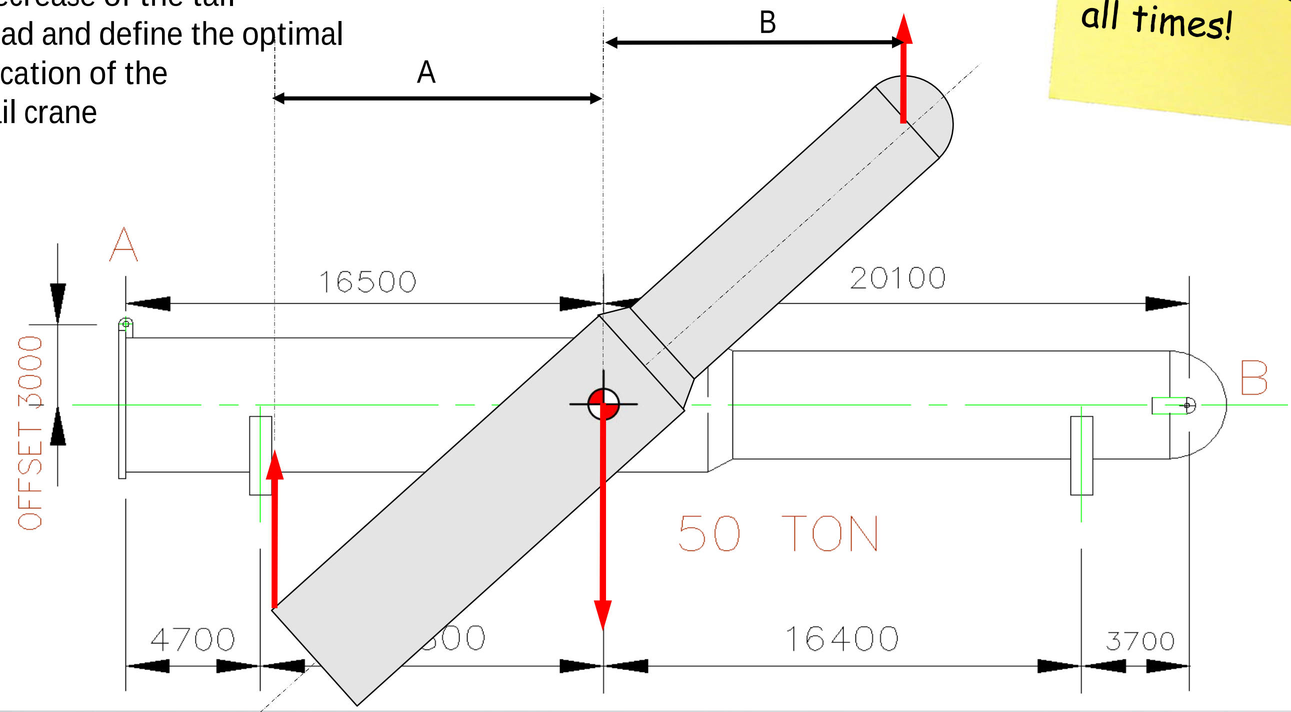
1. Calculate the load in the lift points F_1 and F_2 (lifted by both cranes)
2. Also calculate the loads in transport saddles S_1 and S_2 (both cranes are released)
3. What is the load on saddle S_2 when and crane 1 when crane 2 lifts and saddle S_1 in the air?
4. What is the load on saddle S_1 when and crane 2 when crane 2 lifts and saddle S_2 in the air?

1. Load in F_1 = 150x 20.1 /36.6 = 82.38 Ton
   Load in F_2 = 150-82.38 = 67.62 Ton
2. Load in S_1 = 150x 26.4 /38.2 = 103.66 Ton
   Load in S_2 = 150-87.23 = 46.34 Ton
3. Load in S_2 = 150x16.5/42.825 = 57.78 Ton
   Load in F1 = 150-42.825 = 107.17 Ton
4. Load in S_1 = 150x20.1/(36.7-4.625) = 94.00 Ton
   Load in F_2 = 150-94.51 = 56.00 Ton

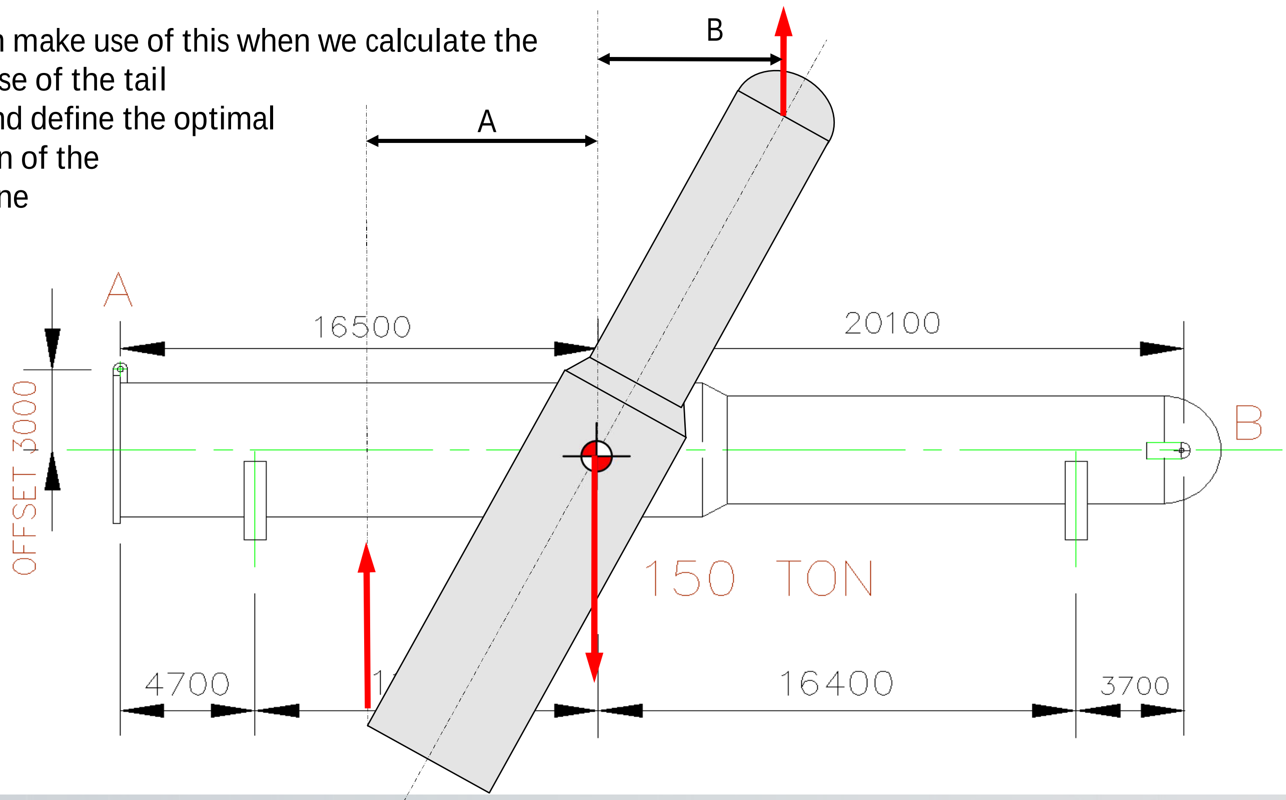
NOTE:
When lift points and support points are not at the same pos. to the CoG, be aware of load differences !!!



1. Due to the offset of the tail lift point of the load, the tail load gradually decreases when the load reaches its vertical position
2. We can make use of this when we calculate the decrease of the tail load and define the optimal location of the tail crane

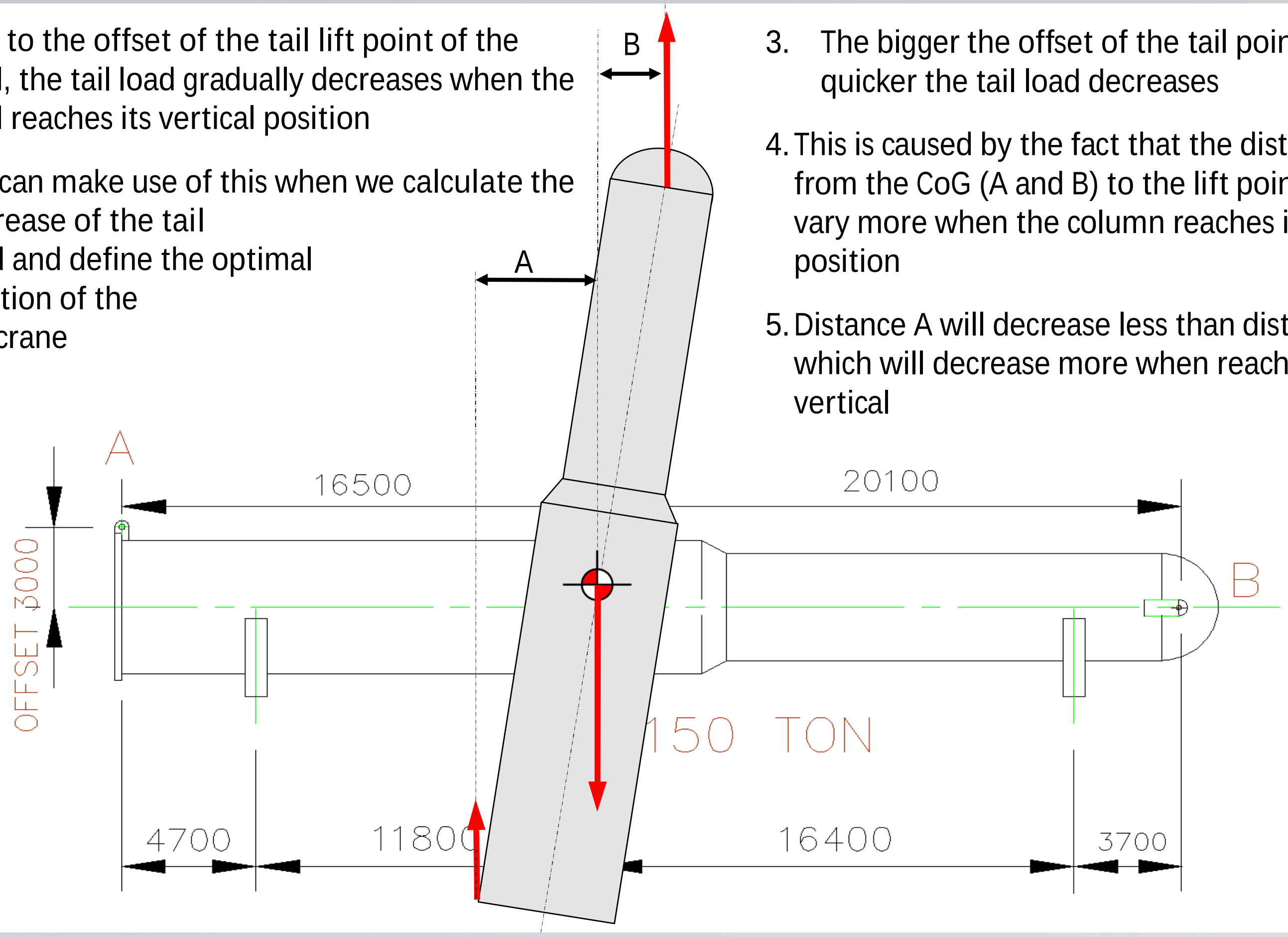


1. Due to the offset of the tail lift point of the load, the tail load gradually decreases when the load reaches its vertical position
2. We can make use of this when we calculate the decrease of the tail load and define the optimal location of the tail crane
3. When the offset is bigger, the tail load decreases faster



Tail crane and distribution of load between tail crane and main lift crane (3)

1. Due to the offset of the tail lift point of the load, the tail load gradually decreases when the load reaches its vertical position
2. We can make use of this when we calculate the decrease of the tail load and define the optimal location of the tail crane
3. The bigger the offset of the tail point is, the quicker the tail load decreases
4. This is caused by the fact that the distances from the CoG (A and B) to the lift points will vary more when the column reaches its vertical position
5. Distance A will decrease less than distance B which will decrease more when reaching the vertical



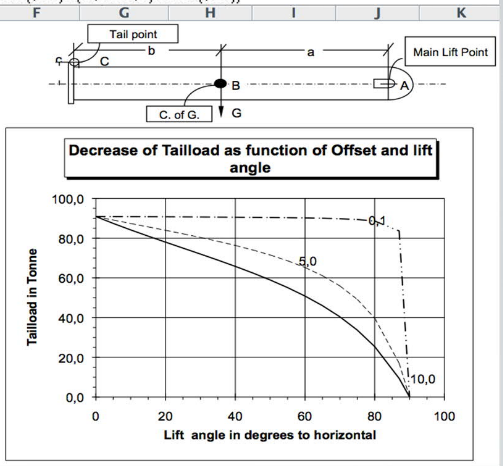
Tail crane and distribution of load between tail crane and main lift crane (4)

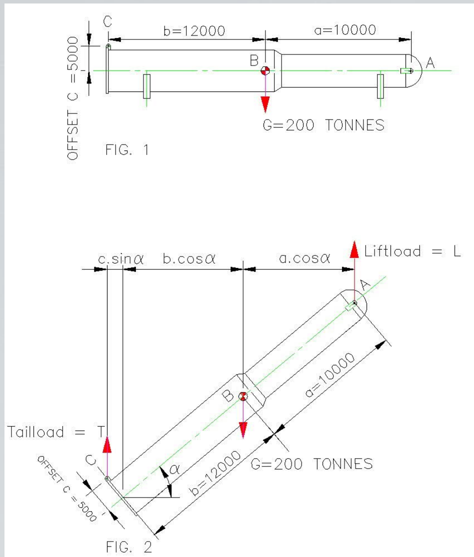
This change of tail load can be calculated by means of an Excel spread sheet at a certain offset

- The formula to calculate the force in the tail crane at C is done by calculating the load in C and A by using the moment equation.
- Moment equation:
- Load in C = a/(a+b) * 200 = 10000/22000 * 200 = 90.91 ton;
- Load in A= b/(a+b) * 200 = 12000/22000 * 200 =109.09 ton (in horizontal position)
- or when the column is being erected and changes from horizontal into vertical position, the perpendicular distances to the CoG changes into: b = b.cos+c.sinα and a = a.cosα
- or in formula: Load in C = 200 * (a.cosα)/ (b.cosα + c.sinα + a.cosα) = 200 * (a.cosα)/(c.sinα+ (b+a) * cosα)
  As in the excel sheet the Formula is: the load in C = C$5 * (cos($B8)/(C$4 * sin($B8)+(C$3+C$2) * Cos($B8))

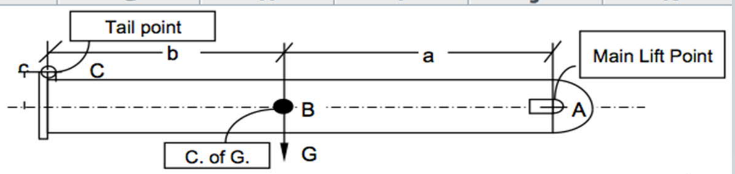
C8 = =C$5*C$2*COS($B8)/(C$4*SIN($B8)+(C$3+C$2)*COS($B8))

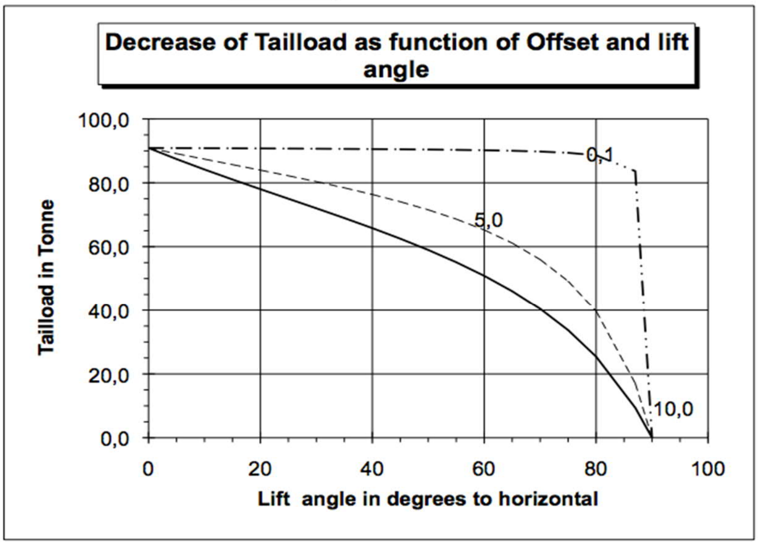
	A	C	D	E
1		(m)	(m)	(m)
2	Dist. a from A to B =	10,0	10,0	10,0
3	Dist. b from B to C =	12,0	12,0	12,0
4	Offset c =	10,0	0,1	5,0
5	Weight G in Tonne=	200,0	200,0	200,0
6	Angle to Horizon in Degrees	Tailload in Tonne		
7		Graph 1	Graph 2	Graph 3
8	0	90,9	90,9	90,9
9	5	87,4	90,9	89,1
10	10	84,2	90,8	87,4
11	15	81,0	90,8	85,7
12	20	78,0	90,8	84,0
13	25	75,0	90,7	82,2
14	30	72,0	90,7	80,4
15	35	69,0	90,6	78,4
16	40	65,8	90,6	76,3
17	45	62,5	90,5	74,1
18	50	59,0	90,4	71,5
19	55	55,1	90,3	68,6
20	60	50,9	90,2	65,2
21	65	46,0	90,0	61,1
22	70	40,4	89,8	56,0
23	75	33,7	89,4	49,2
24	80	25,4	88,6	39,7
25	87	9,4	83,7	17,0
26	90	0,0	0,0	0,0
27				





	A	C	D	E
1		(m)	(m)	(m)
2	Dist. a from A to B =	10,0	10,0	10,0
3	Dist. b from B to C =	12,0	12,0	12,0
4	Offset c =	10,0	0,1	5,0
5	Weight G in Tonne=	200,0	200,0	200,0
6	Angle to Horizon in Degrees		Tailload in Tonne	
7		Graph 1	Graph 2	Graph 3
8	0	90,9	90,9	90,9
9	5	87,4	90,9	89,1
10	10	84,2	90,8	87,4
11	15	81,0	90,8	85,7
12	20	78,0	90,8	84,0
13	25	75,0	90,7	82,2
14	30	72,0	90,7	80,4
15	35	69,0	90,6	78,4
16	40	65,8	90,6	76,3
17	45	62,5	90,5	74,1
18	50	59,0	90,4	71,5
19	55	55,1	90,3	68,6
20	60	50,9	90,2	65,2
21	65	46,0	90,0	61,1
22	70	40,4	89,8	56,0
23	75	33,7	89,4	49,2
24	80	25,4	88,6	39,7
25	87	9,4	83,7	17,0
26	90	0,0	0,0	0,0
27				





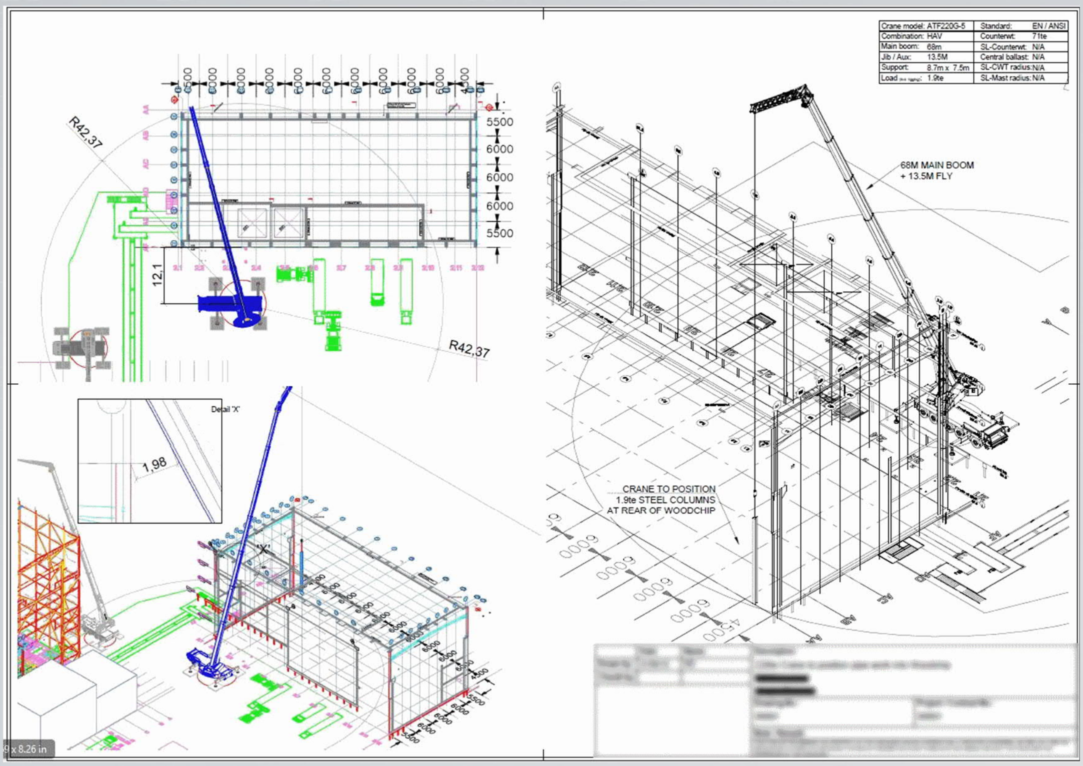
Do we need a Lift Plan?

YES, no exceptions.

Why we make a lift plan:

- Feasibility study
- Work plan
- Capture information
- Basis of TRA / RA / Permits
- Communication to parties involved

Is this a proper lift plan?



What should be in the lifting plan.

1. Classifications of Lift
   - Routine Lifts / Non-Routine Lifts
2. Applicable rules and legislation
3. Roles & Responsibilities
   - Directors, Operation Managers, Project Managers, Supervisors, Operators, Riggers, Signalmen
4. Description of Load to be Lifted.
   - Details of load to be lifted
   - Load Crucial Information. (protrusion)
   - Weight(s) and CoG's including lifting gear
   - Centre of Gravity (CG) of the load
5. Crane Selection
   - Details of the Crane
   - Bearing Capacity
   - Used Crane Capacity
6. Ground and Surrounding Conditions.
   - Ground & Outriggers
   - Access & Lifting Location
   - Clearances
7. Crane(s) Set-up & Lifting Study
   1. Boom Height & Angle
   2. Pick Up & Place Down Radius
8. Rigging Plan (Drawings)
   1. Weights and CoG's
   2. Lifting Lugs/Pad-Eyes
   3. Type of Rigging and Lifting Capacity
   4. Sling Angles/lengths/SWL
   5. Shackles/Beams/Links/SWL
9. Method Statement (procedure)
10. Operational Requirements and **limitation**
11. Customer Provision
12. Weather Conditions
    1. Wind, waves, visibility
13. Communications
14. Risk assessment
15. Checklist
16. Mobilization and demobilization,
17. Rigging and De-Rigging

Type of lifts

We distinguish 2 types of lifts. This to be decided by the competent person.

– Routine lift and

– non-routine lift (or engineered lift)

The routine lift.

Generally, these are lifts that are carried out on a regular basis that require no detailed engineering planning and which have been previously subject to a generic risk assessment and can be done with a generic lift-plan

– Repetitive nature (at least once every 4 weeks)

– Users of the equipment are trained in its use and aware of its limitations

– Significant elements involved are assessed as unlikely to change

– The identified Competent Personnel can execute it in its entirety

– The personnel involved are familiar with the Risk Assessment and the Lifting Plan

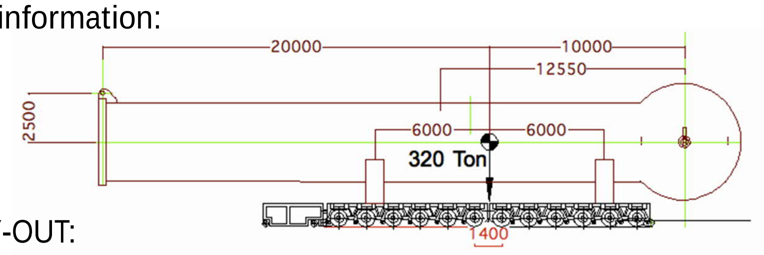
– Lifting Plan is verified as the current issue and has been reviewed

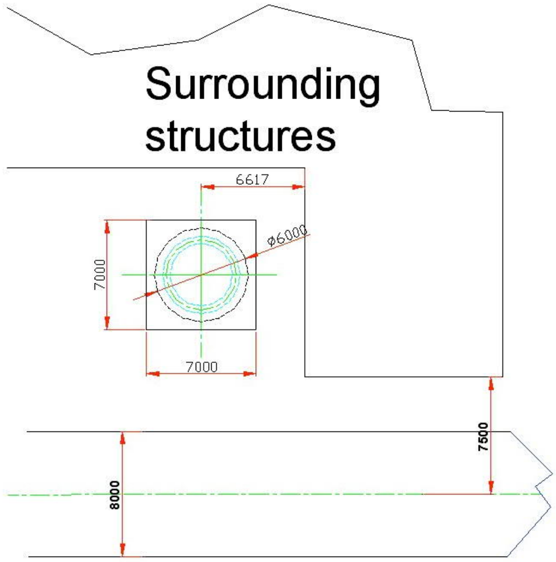
Non-routine lift are all other lifts. A modified lift plan can sometimes be used but often a new lift-plan is to be made for an engineered lift.

Setting up of a Lift Plan

SEACAMEL

1. To set up a proper lift plan one needs following information:
   – Details of the loads to be lifted
   – Drawings or details of the job site
   – Obstacles on the job site
2. Before a lift plan will be made THINK OF the LAY-OUT:
   – Logo in the right hand bottom corner
   – Side- and Top view in case possible on one and the same sheet
   – Which scale are you going to use
   – Where is the lift information placed
   – Use if possible a Computer Aided Design, i.e. Autocad drawing program or special lifting software.
3. A LIFT PLAN should be made so that the lift supervisor, who has to do the job, can easily find all relevant information to execute the project safely.



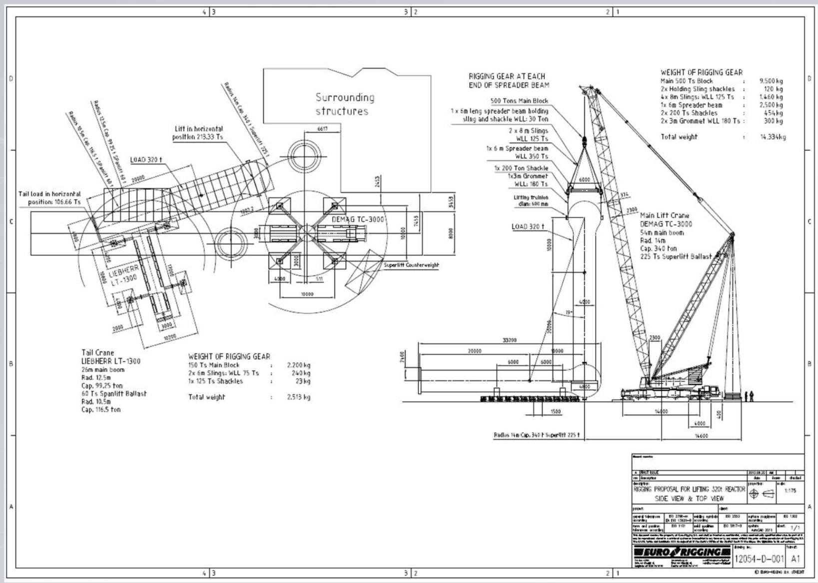


Drawing of a lift plan for the erection of a reactor

SEACAMEL

The following information must be stated in the drawing:

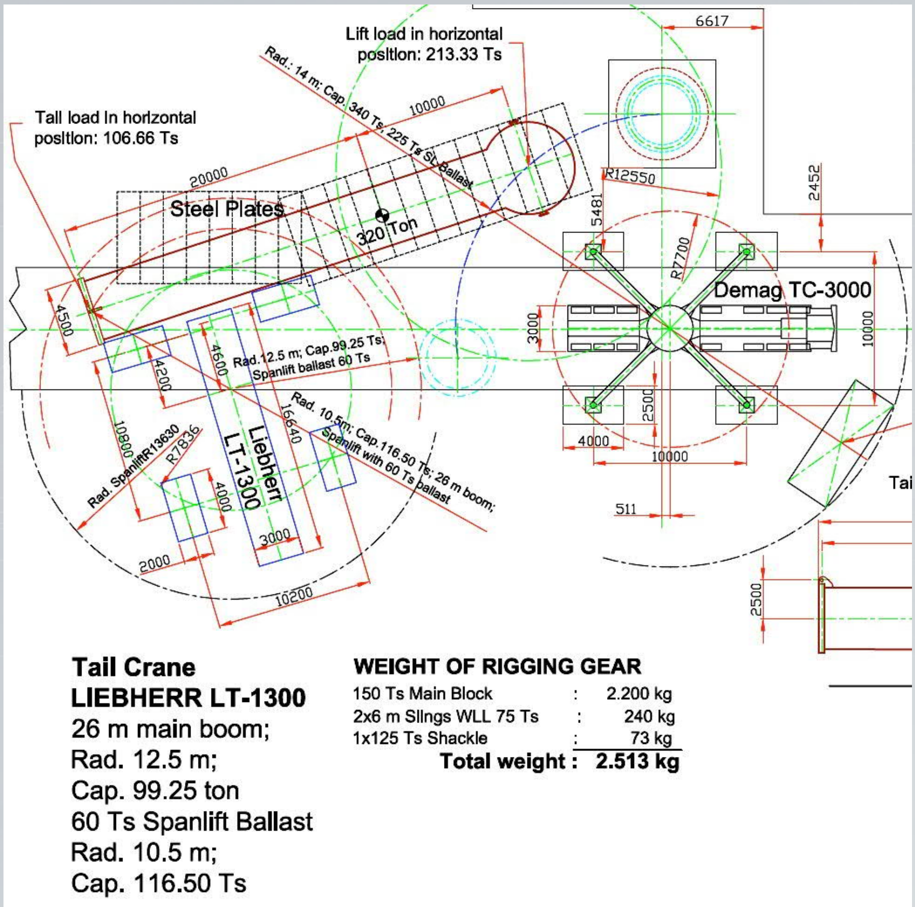
1. Radius and lift capacity at which the cranes are picking up the load.
   This also applies for the tail crane
2. This also applies for the setting down position
3. Outrigger base or footprint (Crawler crane) of cranes
4. Radius of the counter weight
5. Position of each crane in relation to the foundation
6. Type and outfitting of the used cranes (Super lift, span lift or fly-jib)
7. Offset of the top sheave, jib length and jib width
8. Centre lines of load, foundations, cranes etc.
9. Dimensions and locations of possible obstacles

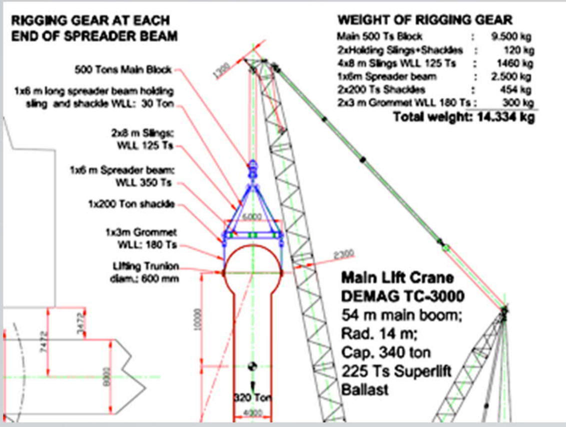


10. Dimensions and details of load spreading mats
11. Clearance between jib and load
12. Used lifting gear, such as but not limited to slings, shackles, lift beams, spreaders etc.
13. Job site requirements, such as mats, compacted areas, steel plates etc.
14. If applicable check wind loads

Drawing of a lift plan for the erection of a reactor (details)

SEACAMEL

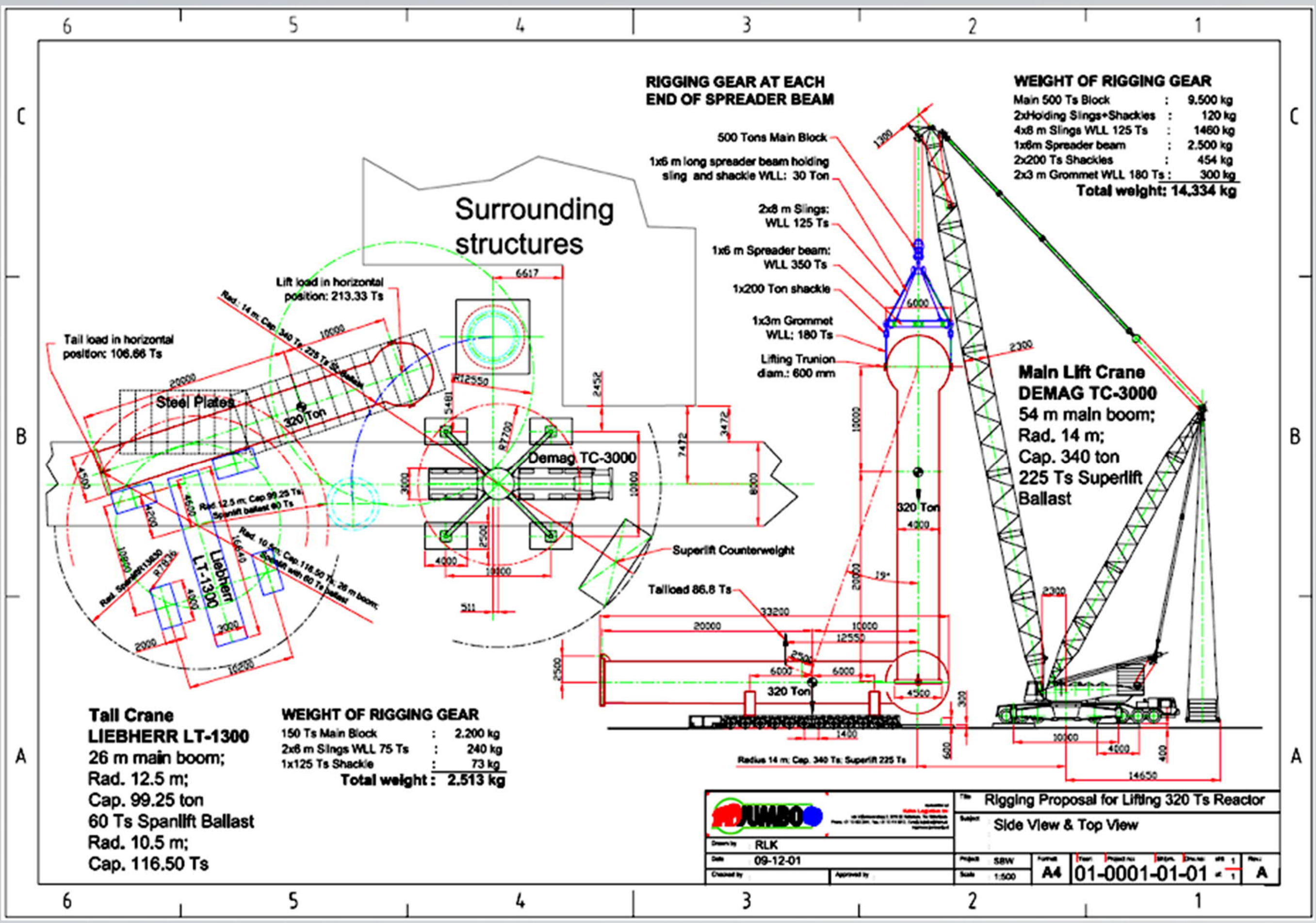




NOTE:
If wind load is relevant, a proper wind load calculation must be part of the lift plan

Drawing of a lift plan for the erection of a reactor

SEACAMEL



Show what is needed, not what you can.

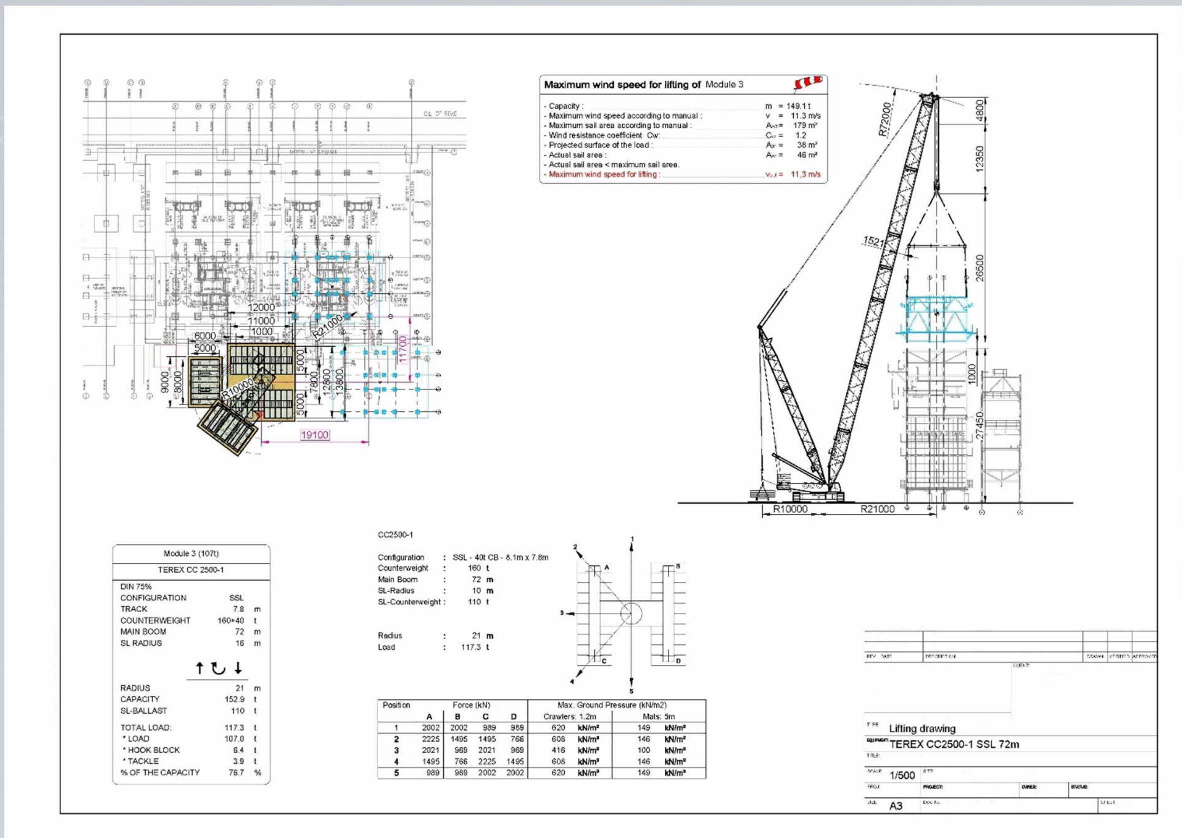
SEACAMEL

More details do not make a plan more clear.

They distract the reader from what is important.

Making a simple drawing takes more time.

"the expert reveals himself in simplicity"

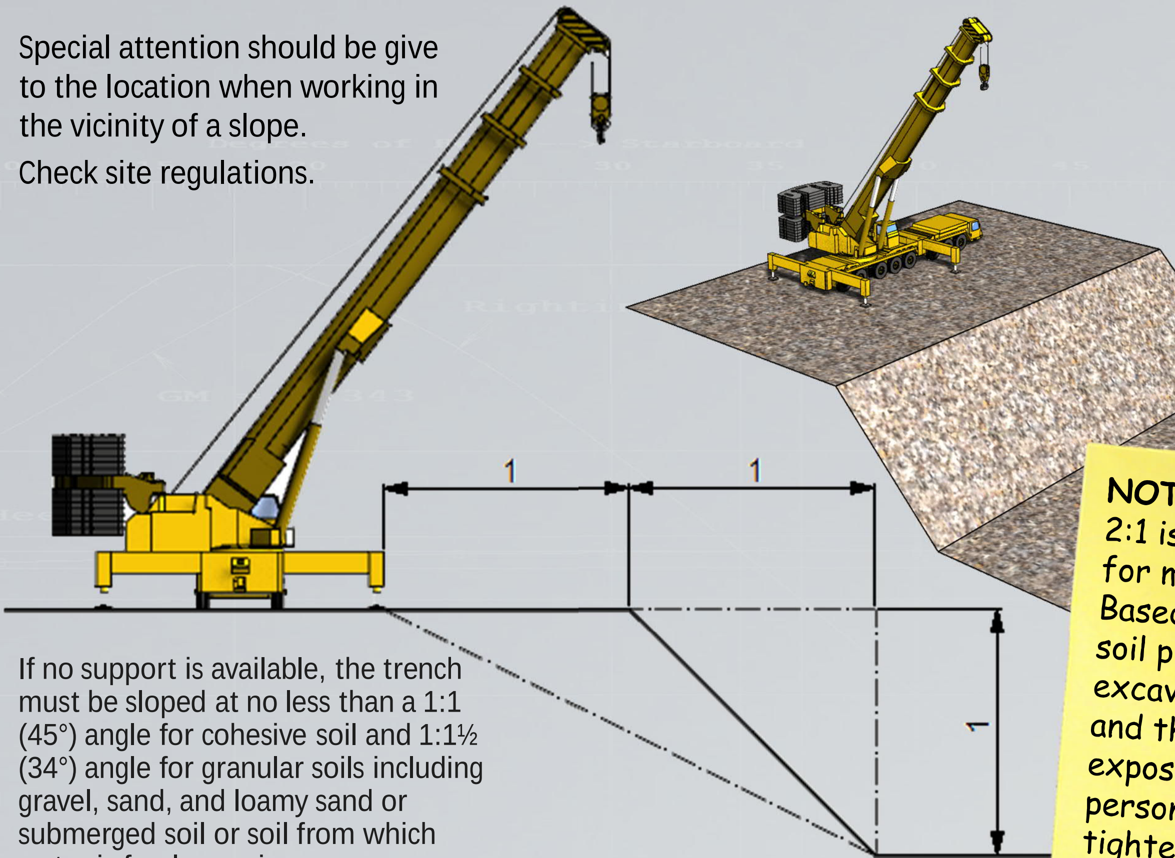


Working in the vicinity of a slope.

SEACAMEL

Special attention should be give to the location when working in the vicinity of a slope.

Check site regulations.



If no support is available, the trench must be sloped at no less than a 1:1 (45°) angle for cohesive soil and 1:1½ (34°) angle for granular soils including gravel, sand, and loamy sand or submerged soil or soil from which water is freely seeping.
https://www.osha.gov

NOTE:
2:1 is a safe slope angle for manned entry.
Based on analysis of the soil properties, the excavation performance and the environmental exposure a competent person may come to tighter limits

Lift data sheet (Singapore)

SEACAMEL

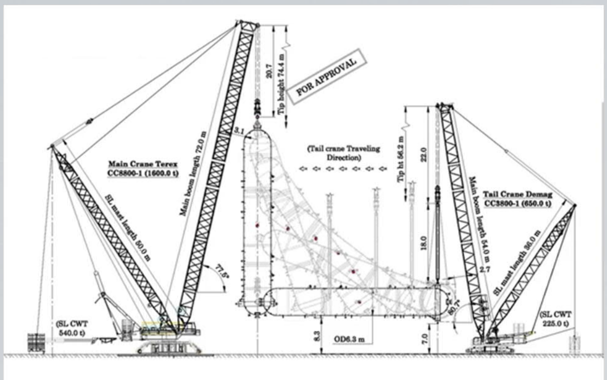
1. General			
Project			
Location of lifting operation			
Contractor carrying out the lifting operation		Date/ time of lifting operation	
		Validity period of lifting operation	
2. Details of the Loads			
Description of load/s			
Overall dimensions	2. Details of the Load/s		
Weight of load	Kg / tonne	☐ Known weight	☐ Estimated weight
Centre of gravity	☐ Obvious	☐ Estimated	☐ Determined by drawing
3. Details of the Lifting Equipment/ Lifting Gears			
Type of lifting equipment			
Maximum SWL as certified on the LM cert		Date of last certification	
Max boom / Jib length	m	Fly jib / offset	
Intended load radius	Distance between the load and the crane	SWL at this radius	
Type of lifting gears	Slings / webbing / chains / shackles / spreader beam / receptacle		
Combined weight of the lifting gears	Kg / tonne	Certification of lifting gears	☐ Yes ☐ No
4. Means of Communications			
Can the operator see the loading and unloading point for the load from his position?			
☐ Yes	☐ No		
What are the means of communication between the lifting crew?			
☐ Standard hand signals	☐ Radio	☐ Others	
5. Personnel Involved In Lifting Operation			
Position	Name	Qualification/ Experience	
Site Supervisor			
Lifting Supervisor			
Crane Operator/ Lifting Equipment Operator			
Rigger			
Signalman			
Others (please state)			

6. Physical and Environmental Consideration (please include any details in the space provided)		
Ground conditions	Is the ground made safe (e.g., placing steel plate)?	o Yes o No
	Are the outriggers evenly extended?	☐ Yes ☐ No
Obstacles	Are there any overhead obstacles such as power lines?	☐ Yes ☐ No
	Are there nearby buildings or structure, equipment or stacked materials that may obstruct lifting operation from being carried out safely	☐ Yes ☐ No
Lighting	Is the lighting condition adequate?	☐ Yes ☐ No
Demarcation	Has the zone of operation been barricaded (with warning signs and barriers) to prevent unauthorized access?	☐ Yes ☐ No
Environment	Do not proceed with the lifting operation under the following circumstances:	
	☐ Strong winds that may sway the suspended load.	
	☐ Strong winds that may sway the suspended load.	
	☐ Other circumstances (please specify).	
7. Sequence / Special Precautions	**8. Sketch of the Zone of Operation:**	
	(It is recommended that you include the initial location of the load, the final location and path of the load. It is also important to indicate any obstructions or equipment that may obstruct the lifting operation).	
Applied by: Name:	Signature:	Date: Time:
Prepared by: Name:	Signature:	Date: Time:
Assessed by: Name:	Signature:	Date: Time:
Approved by: Name:	Signature:	Date: Time:

https://www.tal.sg/wshc/-/media/TAL/Wshc/Resources/Publications/Codes-of-Practice/Files/Code_of_Practice_Safe_Lifting_Operations_Revised_2014.pdf

Video: Lifting of 950Tons reactor

SEACAMEL



Source: https://www.integrated-me.com

Organizing the lift

Resp. Person

Responsible Person
overall responsibility for work activities.
(project manager, (offshore) construction manager, Master, base manager or project engineer.)

The competent person (Appointed person / (person in charge) is designated by their company as having the required level of competency to plan and supervise the specific lifting operation.
Can be same person as ‘Lifting supervisor’, (engineer, master, officer, foreman rigger, (assistant) offshore manager.)

- The responsible person has the overall responsibility for the work
- The lift is prepared by the competent person.
- A lifting team exist minimum out of 3 persons . They have the competence and experience to perform the job and an equal responsibility to ensure that the lift is carried out safely.

Lifting team

Lift supervisor

Lifting supervisor, supervises the lift and the lifting team

Load handler/Rigger Banksman / slinger / signalman.

Crane driver
- Ensures the crane is fully operational;
- He understands the procedure;
- He has a full view and/or radio contact with the Banksman and the transfer area;
- He stops the work when not confident

Lift planning process

Responsible Person

The Responsible Person can delegated task. Responsibilities can not be delegated!!!

Responsible Person.
Identifies need for lifting operation.

The competent person to plan the lift

Routine Lift
- Carry out risk assessment (Generic)
- Lift plan (Generic)

Non-Routine Lift
- Carry out risk assessment (New or modified)
- Lift plan (New or modified) / Lift plan (New)
- Technical review by competent person

Appoint team appropriate for the lift

Toolbox talk. Review risk assessment and lift plan, include all personnel involved in the lift

Perform lifting operation with appropriate supervision

Post-job debrief and lessons learned

Toolbox talk for the Lifting team

The 10 Golden Rules for Lifting a load

SEACAMEL

1. Communicate. Inform all personnel about the planned lift operation and check the communication equipment
2. Lifting Gear. Always check the lifting gear before lifting, if it is applied in the correct way and not damaged.
3. Location of personnel. Make sure all personnel is standing in the right place and cannot be hit by the load.
4. Stability. Check that the crane is set-up correctly and that the outriggers cannot give away.
5. Super lift. Check the location of the Super lift ballast and that there are no obstacles which interfere during slewing and setting down of the load.

Super lift with counter weight on SPMT's

6. Condition of the load. Make sure all lashings of the load are released from the transport mode and that the lift points are in a good condition, located in the right position and not damaged.
7. PPE = Personnel Protection Equipment. During work always use the right PPE, such as but not limited to: safety helmet, safety goggles, safety boots, gloves etc.
8. Release the brakes. When lifting a load from a trailer, release the brakes of the trailer in case this can be done safely.
9. Mooring lines. When lifting a load from a floating body (i.e. barge of vessel) make sure there is sufficient slack in the mooring lines to allow the vessel to adjust itself under the load.
10. Verticality of the lifting tackle. When lifting: Gradually tighten the lift tackle and make sure that the jib head is always precisely above the CoG of the load. Check this from different angles and adjust this when the jib is bending.

Checklist for lifting (Subsea 7)

SEACAMEL

For the lift supervisor.

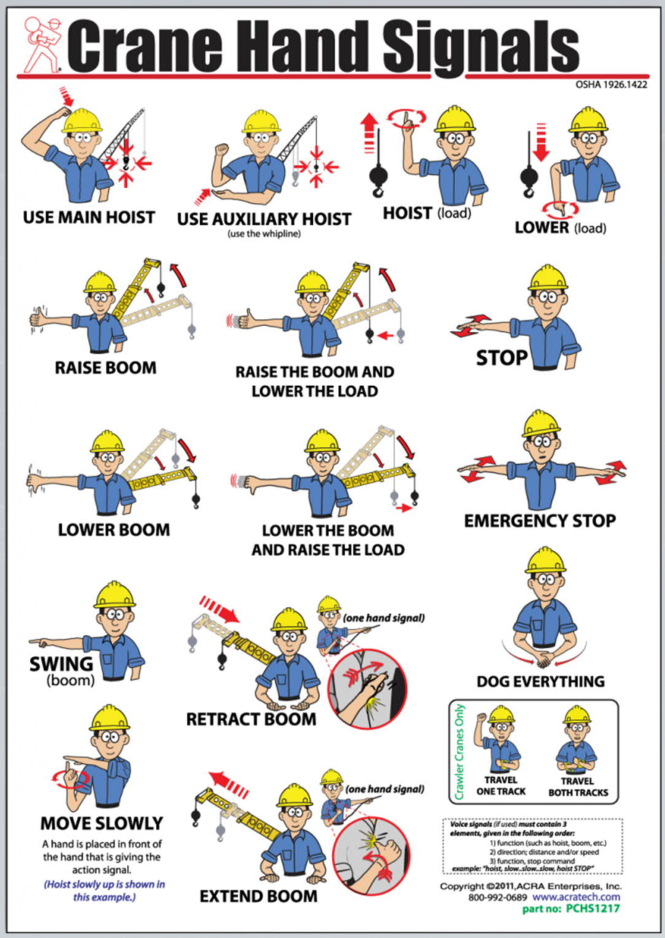
- ❑Is there a new or existing lifting plan that is suitable for the operation
- ❑Has a risk assessment been undertaken by a competent person and the risks managed through the control measures of the lifting plan
- ❑Is the equipment selected fit for purpose, certified for use, and identified in the plan?
- ❑Do the personnel selected to undertake the lift job have the correct level of experience and knowledge?
- ❑Have the steps of the lift plan been communicated and understood by all personnel involved?
- ❑Has there been a toolbox talk
- ❑Have all potentially affected parties bee informed of the lifting activities
- ❑What could go wrong? Has the information fed into the risk assessment and lift plan.
- ❑Are there contingency measures?

For everybody involved.

- ❑Is there a risk assessment, lift plan and authorization/PTW for the operation and do they fully cover the actual task(s) to be conducted?
- ❑If there is a generic lift plan for a routine lift, are there any changes for this lift compared to the generic plan?
- ❑Have you considered the weight, CoG, wind, visibility, load path, vessel motions, tag lines and communications?
- ❑Are the steps in the lift plan and individual responsibilities clearly understood by all those affected and/or involved.
- ❑Are personnel in the vicinity aware of the lift?
- ❑Is adequate supervision present and is it clear who will be in control of the lifting operation?
- ❑Have the necessary pre-lift inspections and preparations been carried out?
- ❑Has the lift been checked for loose items?
- ❑Has the lifting equipment been checked, is it certified, is it fit for purpose and appropriate for use?
- ❑Have you reviewed all the safety measures from the lifting plan?

Mobile Crane Hand Signals

SEACAMEL



Wallet-sized cards can be ordered everywhere and illustrate the correct crane hand signals as required by OSHA and ANSI/ASME when directing the operation of overhead cranes. These ones were taken from http://www.acratech.com

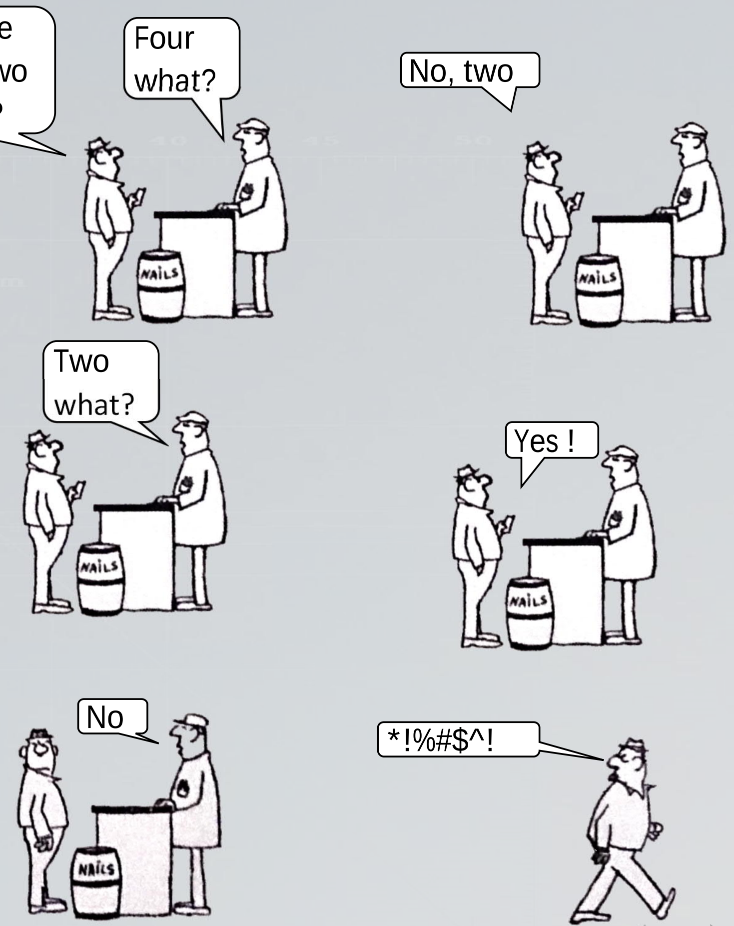
However, there are no universally agreed set of hand signals.

Most important is to make sure the rigging crew is aware of the hand signals you all have agreed to.

Radio Communication

SEACAMEL

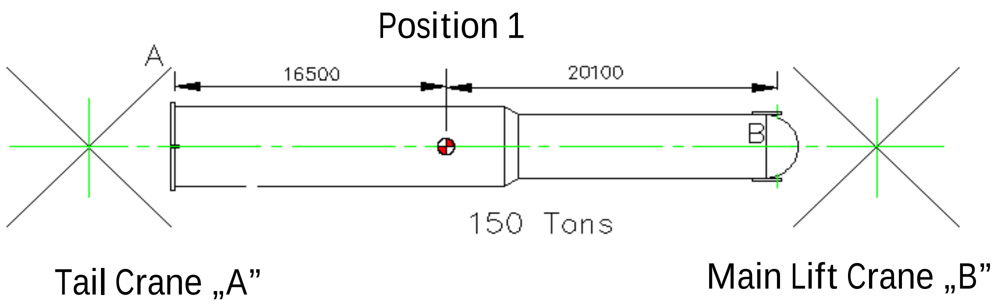
- Who has the lead
- Have a pre job talk
- Introduce yourself
- Give short instructions
- Use clear reference points
- No coffee talk
- acknowledge the receipt
- If you do not comprehend the message, do not confirm it. Use
  - "SAY AGAIN"
  - "REPEAT",
  - "STAND BY"



Lifting of a Load with 2 cranes (position of Cranes) (1)

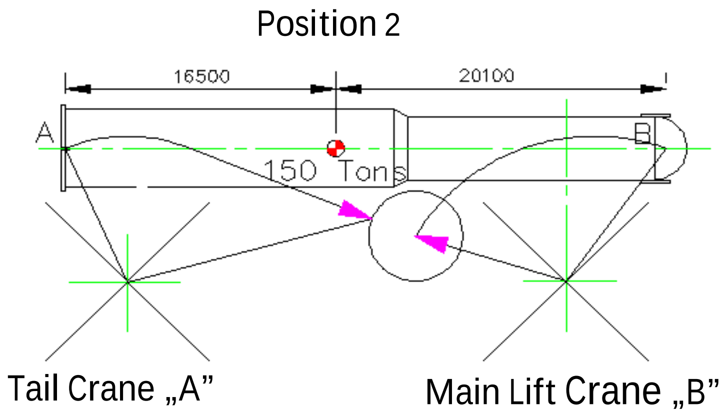
SEACAMEL

1. Select the right position of each crane



2. By placing both cranes next to the column, a smaller tail crane can be selected

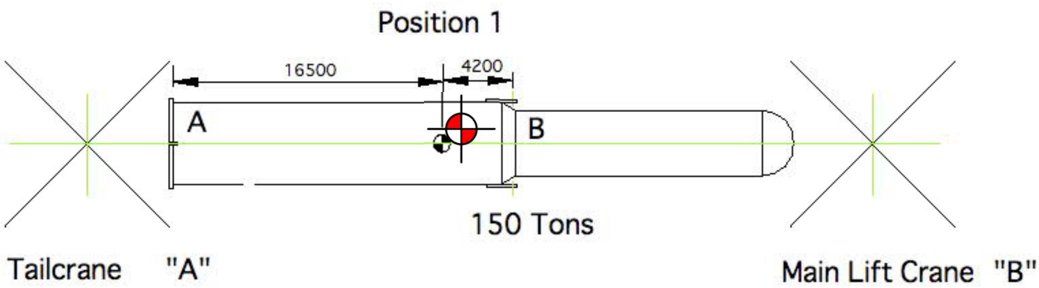
3. Make use of the decrease of tail loac (at a certain offset) when reaching the vertical position



Lifting of a Load with 2 cranes (position of Cranes) (2)

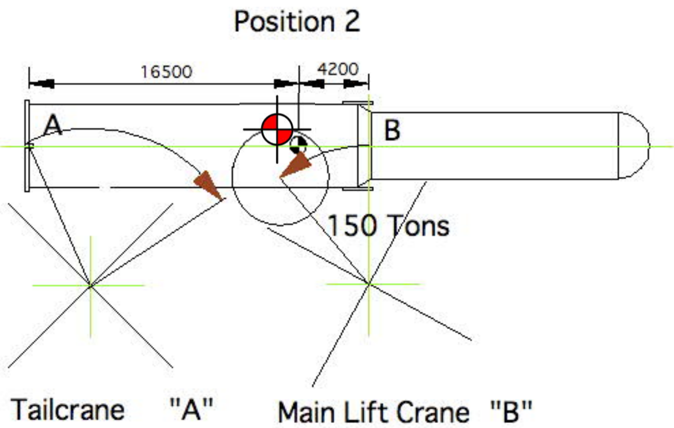
SEACAMEL

1. Now the lift points are placed at the diameter decrease of the column and the main lift crane B will be loaded more at the start of the lift

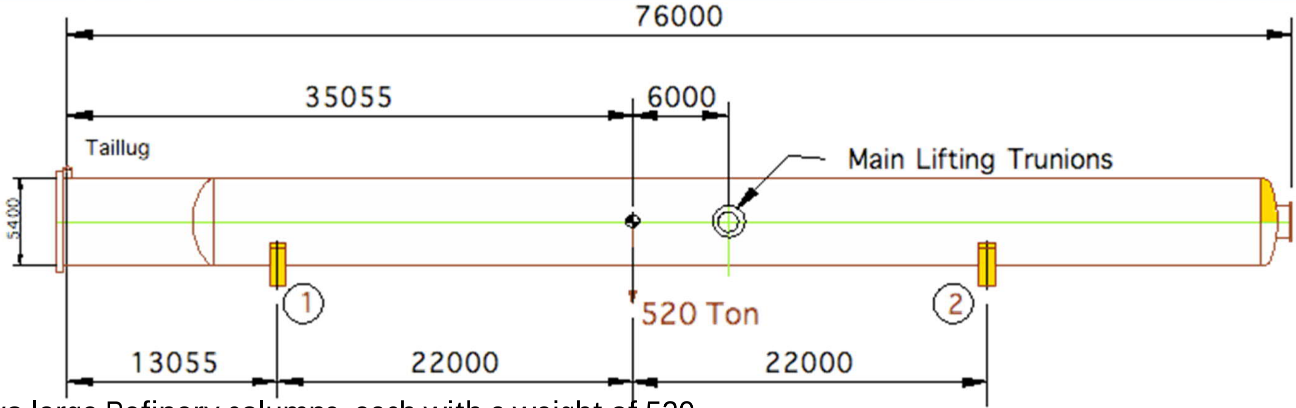


2. Position 1 is not a good position as we are far from the lift points, which requires larger cranes

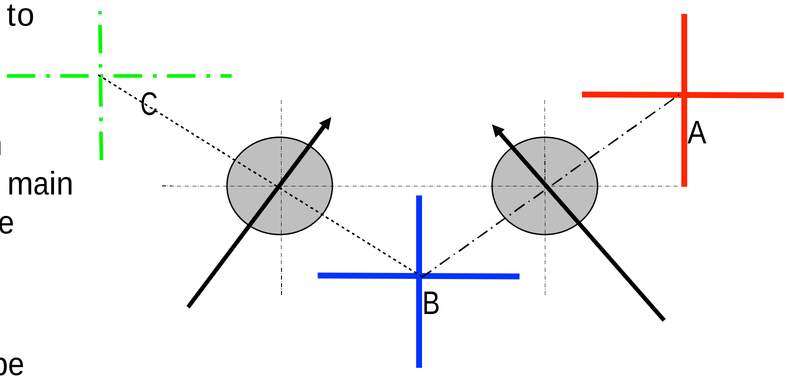
3. A much better location is Position 2



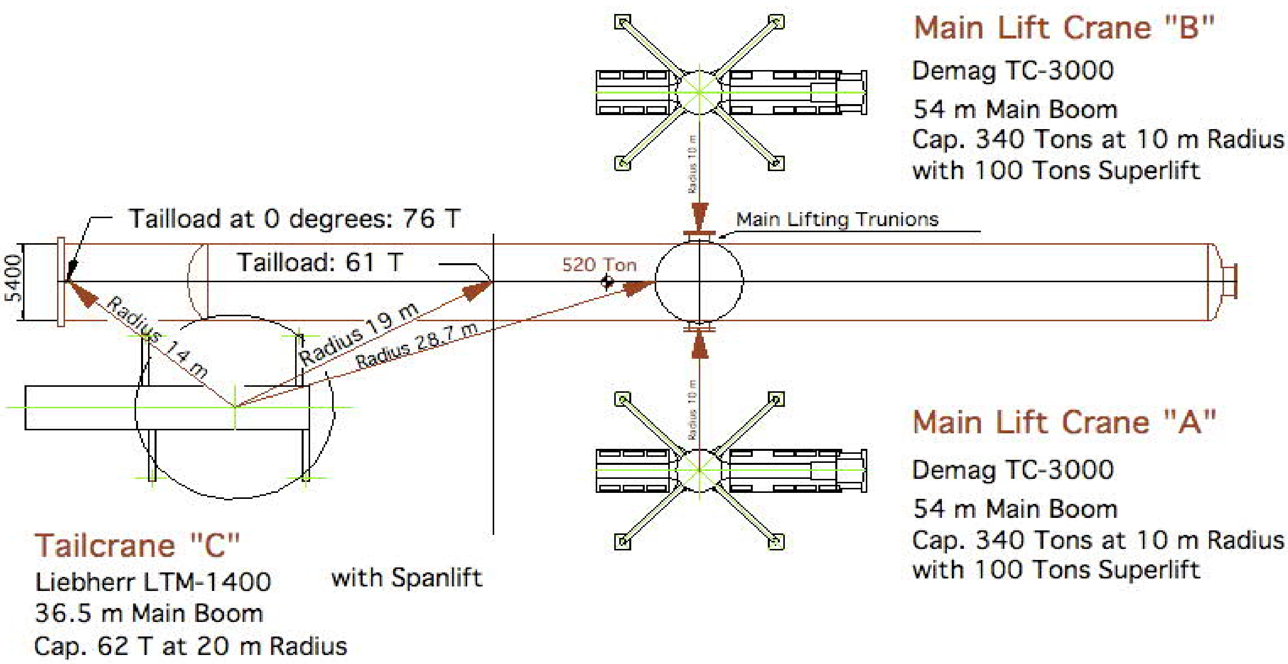
The lifting of two large columns with 3 cranes (1)



1. Two large Refinery columns, each with a weight of 520 tons must be erected into vertical position onto foundations which are situated on ground level next to each other.
2. By selecting the right location of lifting bollards in relation to the COG, we can erect both columns with relative small cranes. Two Demag TC-3000 cranes as main lift cranes and one Demag CC-2000 as tail crane were used
3. Both foundations are approx. 20 m apart
4. Crane B is set up in a fixed position and crane A will be relocated to the location C after erection of the first column



The lifting of two large columns with 3 cranes (2)



1. By selecting the position of lifting bollards close to the CoG, one can limit the tail load to approx. 76 ton
2. We could even tail this column in with a 400 Tons Telescopic crane
3. For practical reasons we selected a crawler crane at the end

The lifting of two large columns with 3 cranes (3)

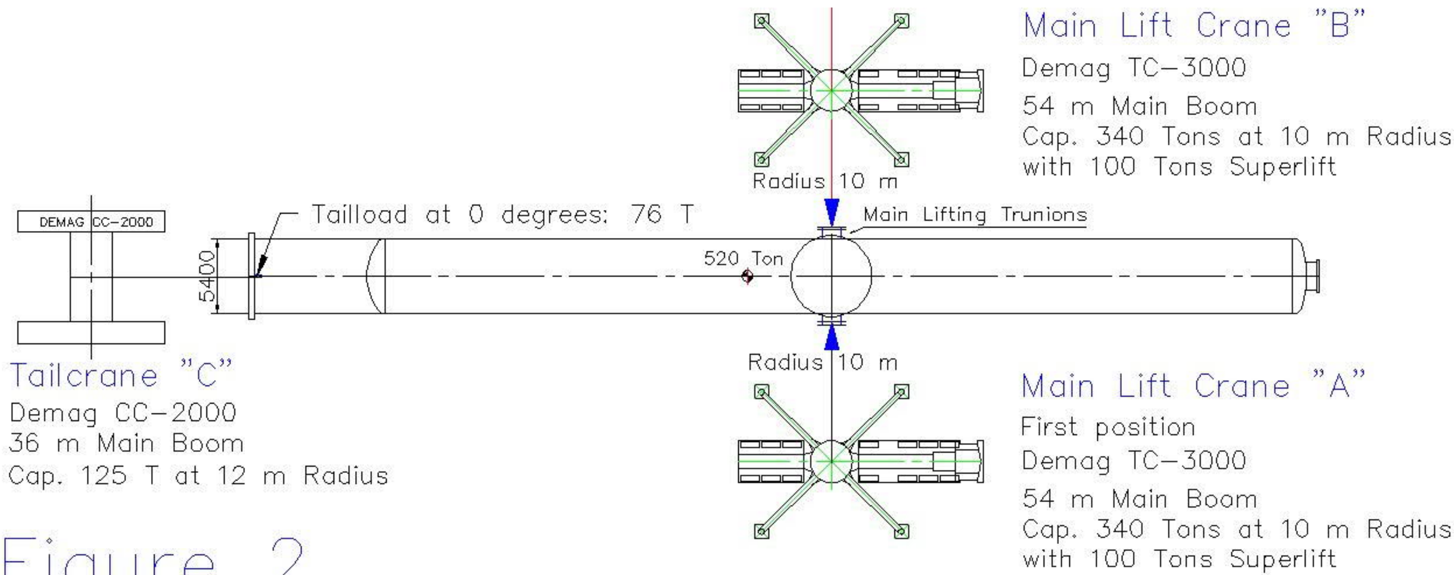
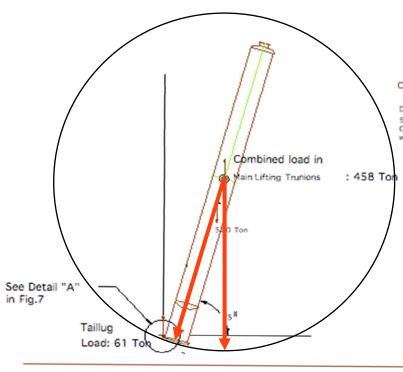


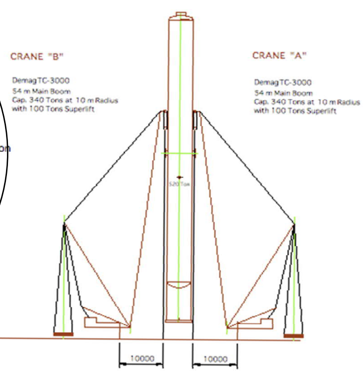
Figure 2

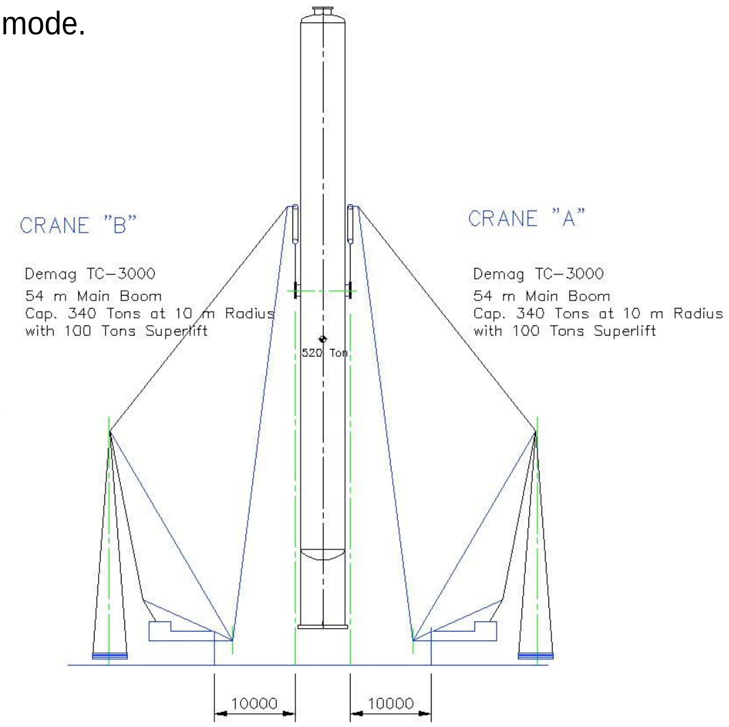
1. The Demag CC-2000 (300 tons crawler crane) only needs to keep a max. load of 76 ton off the ground

The lifting of two large columns with 3 cranes (4)

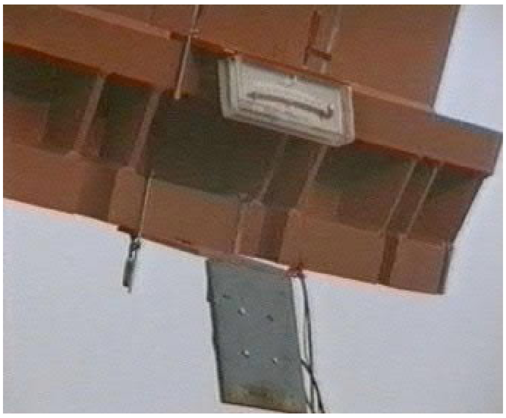
1. The lifting bollards protruded ca. 700 mm outside the shell of the column, hereby enabling the column to swing in between both jib heads when reaching the vertical
2. To monitor the load in each crane accurately, an inclinometer was installed at the skirt end of the column in a swiveling mode.

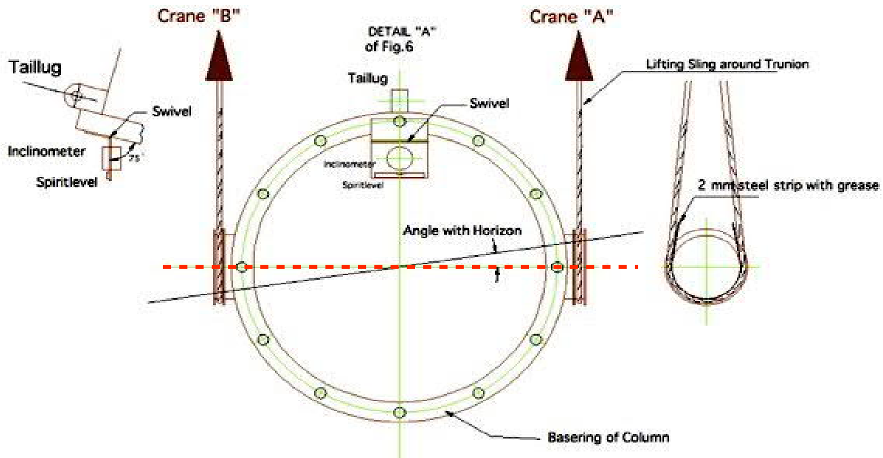






The Inclino meter

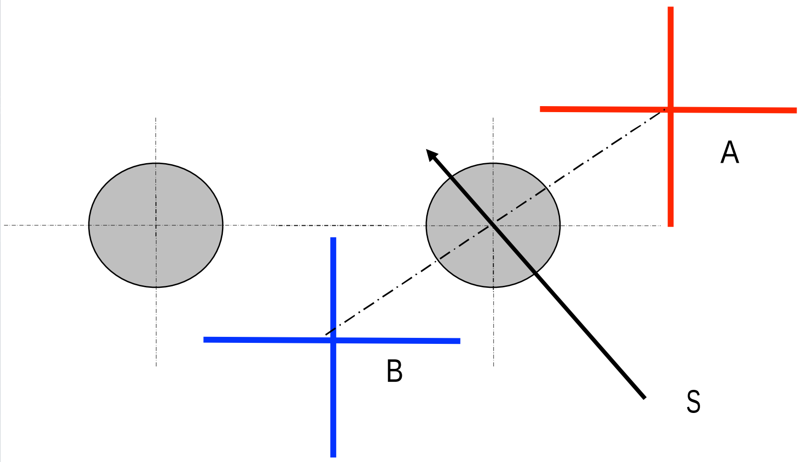




1. With an inclinometer one accurately measures the angle between both lifting bollards with the horizon.
2. The inclinometer is fixed with some clamps to the skirt ring
3. Before start lifting, the inclinometer must be calibrated. Ensure that both lift bollards are set at an horizontal level (we check this with a level instrument by slightly lifting with either crane) and set the inclinometer to zero
4. As back-up a standard bubble spirit level is used, which is also suspended in a swiveling mode.

The lifting of two large columns with 3 cranes (1)

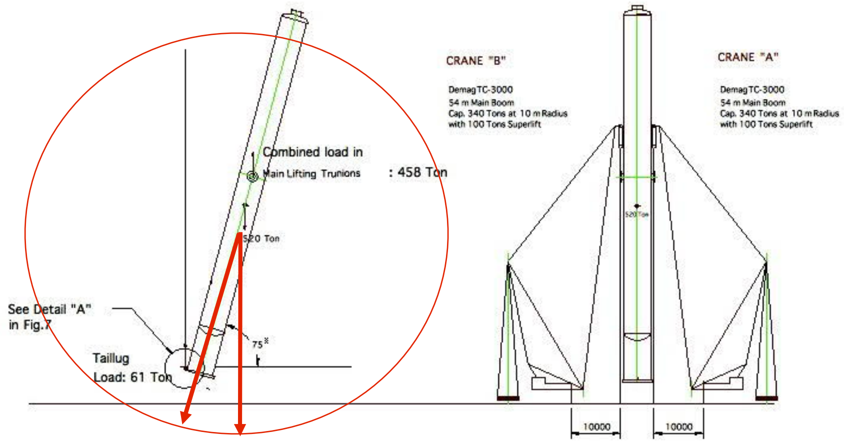
1. We lift with a constant speed (e.g. 50% of max. speed) with crane B
2. With crane A we control the lift, i.o.w. depending on the angle of the inclinometer we know whether we should lift faster or to slower with crane A
3. The tail crane (S) does nothing more then just keep the column off the ground at the skirt end and follow the erection path.



The lifting of two large columns with 3 cranes (2)

SEACAMEL

1. By setting both cranes in slightly inclined pulling mode, we will keep both jib heads free from the column's shell.
2. On the tail crane use enough boom length and a long tail sling, in order to limit horizontal forces due to inaccuracy of keeping the tackle vertical during tailing



3. When the column has almost reached 80^o , lift the column high enough so that the tail crane can lower the column and will swing in between both jib heads without lifting anymore with both main lift cranes

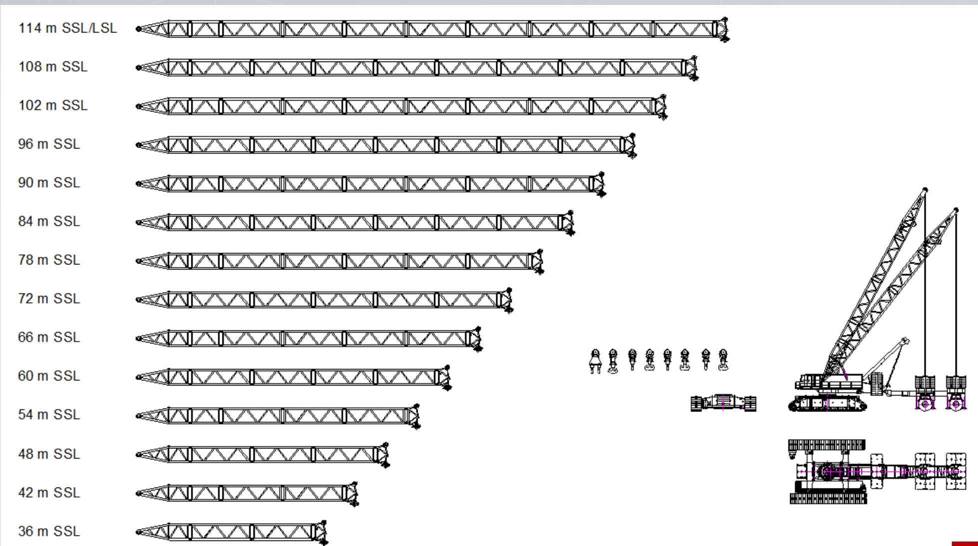
Lifting a 480 tons heavy column with 3 cranes

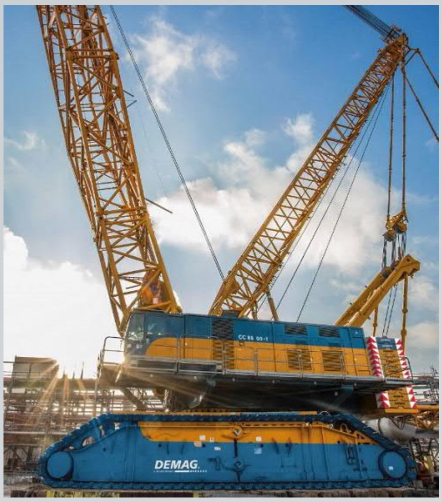
Drawing the lifting plan using CAD blocks.

SEACAMEL

The first impression most clients have of their vendors is the paperwork they receive.

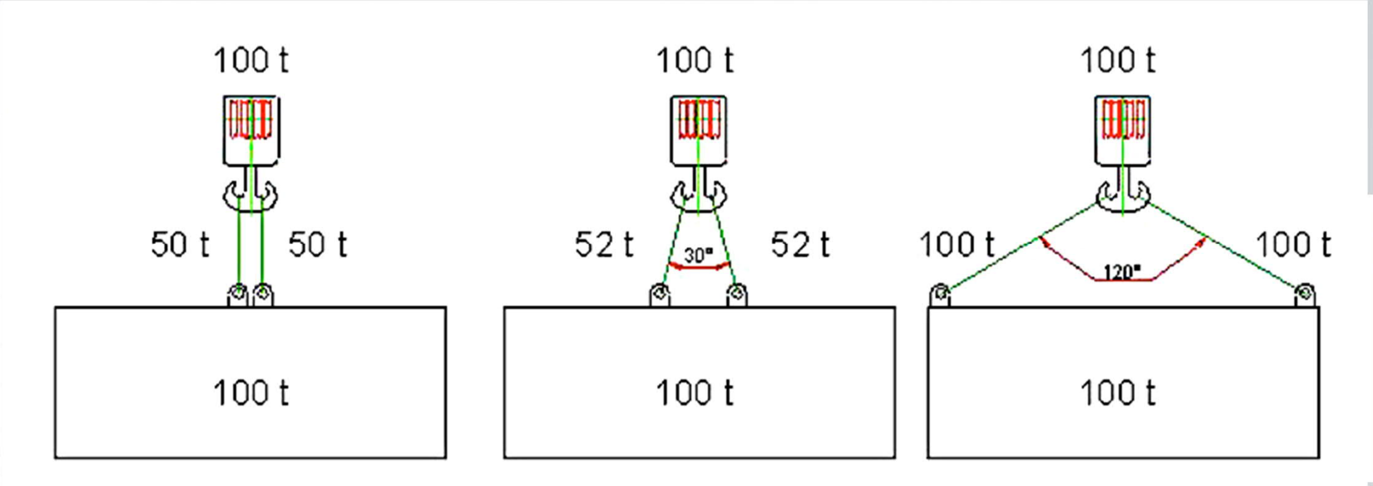
With the right set-up, a professional lift plan can be completed in minutes by using CAD blocks to compose your crane setup.





Do not forget and underestimate the effect of bending!

Sling plan and forces in lifting slings



NOTE: With a load (G) in a crane we must include everything i.e. lift block, lifting slings, shackles, lifting beams, spreaders and auxiliary frames etc.

1. Most cranes can be equipped with a variety of lift blocks
2. This does not apply to ship's canes, where the weight of the lift block is included in the net lifting capacity of the crane. Shackles, slings, lifting beams etc. must be added to the load, as with mobile cranes

Calculate the forces in slings

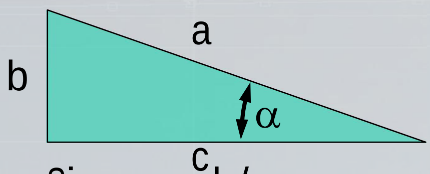
Question:

1. Calculate the forces in S_1 and S_2
2. Calculate the forces in F_{1H} and F_{2H}

Answer: $F_{1_V} = F_{2_V} = 50t$

$$S_1 = S_2 = \frac{50t}{\cos 20°} = 53.21t$$

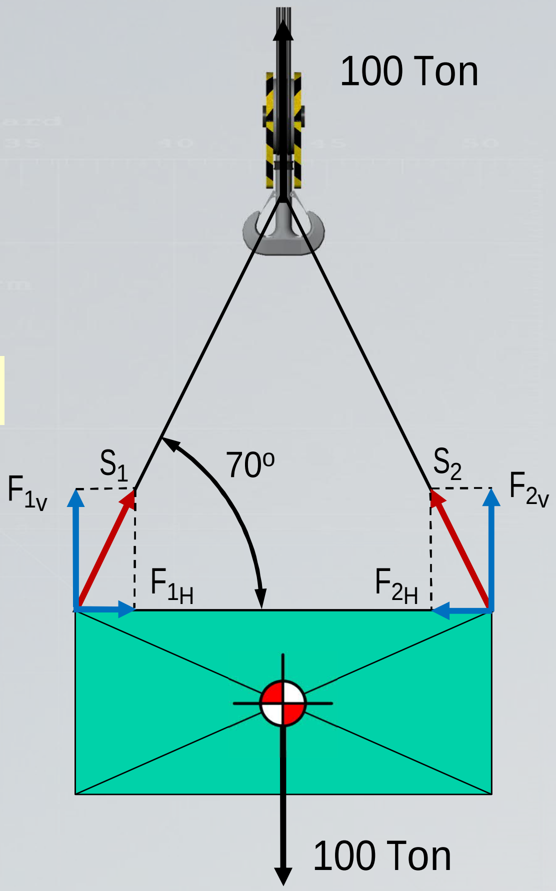
$$F_{1_H} = F_{2_H} = 50t \times \tan 20° = 18.19t$$



Sin α = b/a

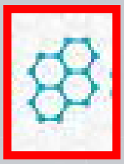
Cos α = c/a

Tan α = b/c



Define the forces in each sling and spreader beam.

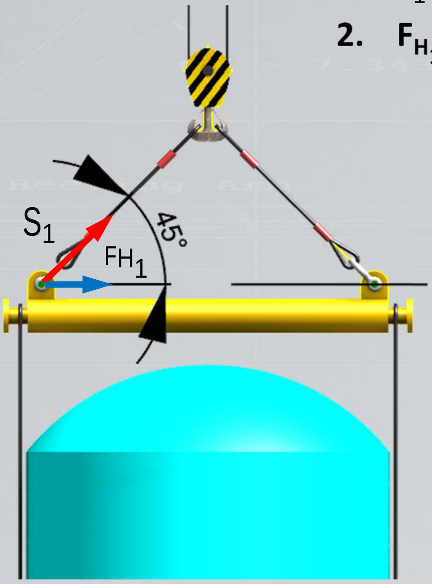
SEACAMEL

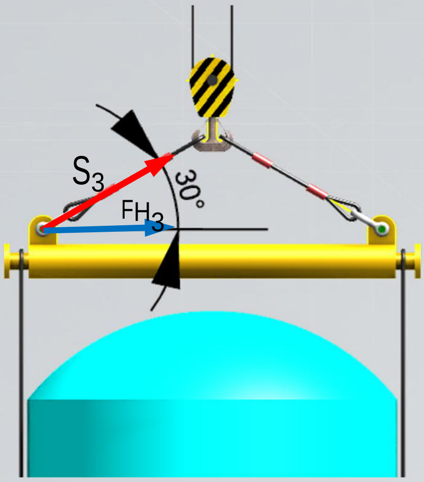


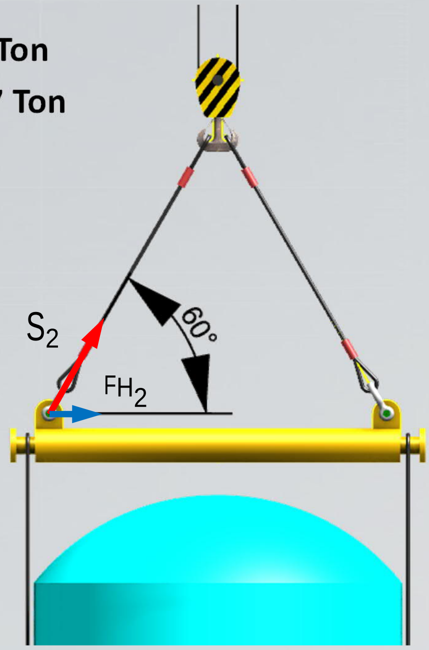
1. #Q14:Caluating sling and compressions forces. The weight of the column is 100t
2. Calculate the forces in slings S_1, S_2 and S_3
3. Calculate the pressure forces F_{H_1}, F_{H_2} en F_{H_3}

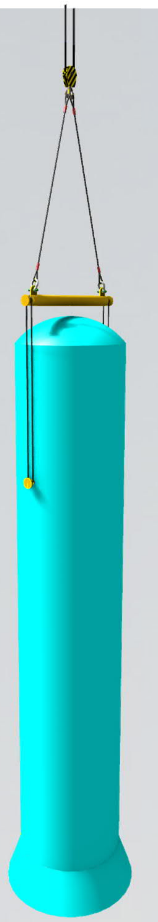
Answer:

1. S_1 = 71 Ton; S_2 = 58 Ton; S_3 = 100 **Ton**
2. **F_{H_1}** = 50 ton; F_{H_2} = 29 ton, F_{H_3} = 87 **Ton**



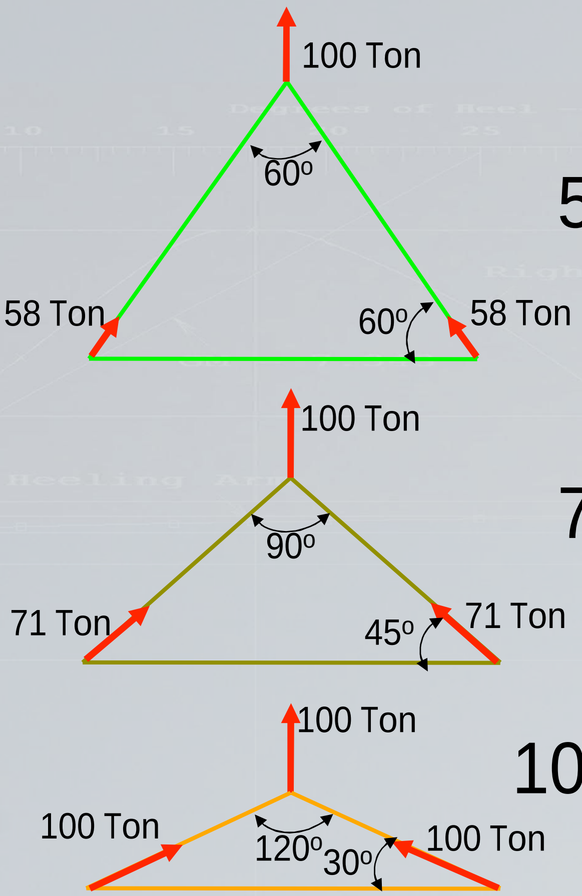






Sling plan and forces in lifting slings (2)

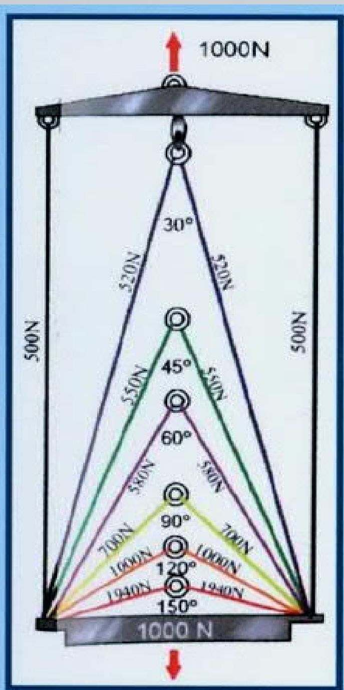
SEACAMEL



58%

71%

100%



Load per sling at different top angles

The bigger the spread the more pain!

Calculate the forces in the spreader beam

SEACAMEL

Calculate the forces in S_1 , S_2 , S_2 and S_4.

Calculate the forces D_1 en D_2

Answer:

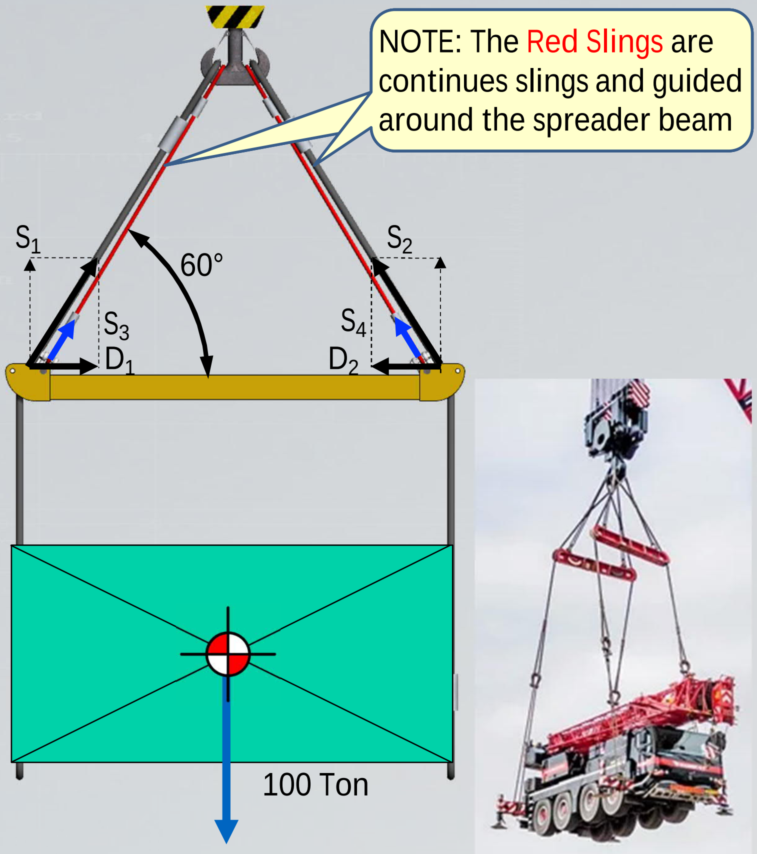
- The forces in S_1 and S_2 are 50 ton each, as the slings are only spread by the spreader beam and not connected to it with shackles.
- In case the slings $S_1 = S_2$ were connected to the spreader beam, the forces in each sling would be:

$$S_1 = S_2 = \frac{50\,mTon}{\cos 30°} = 57.73\ mTon$$

- So the force in the spreader supporting sling is now S_3 =7.73 ton, as the main lift slings in our case were not connected to the spreader but spread only. (own weight of spreader ignored)
- The force D_1 and D_2

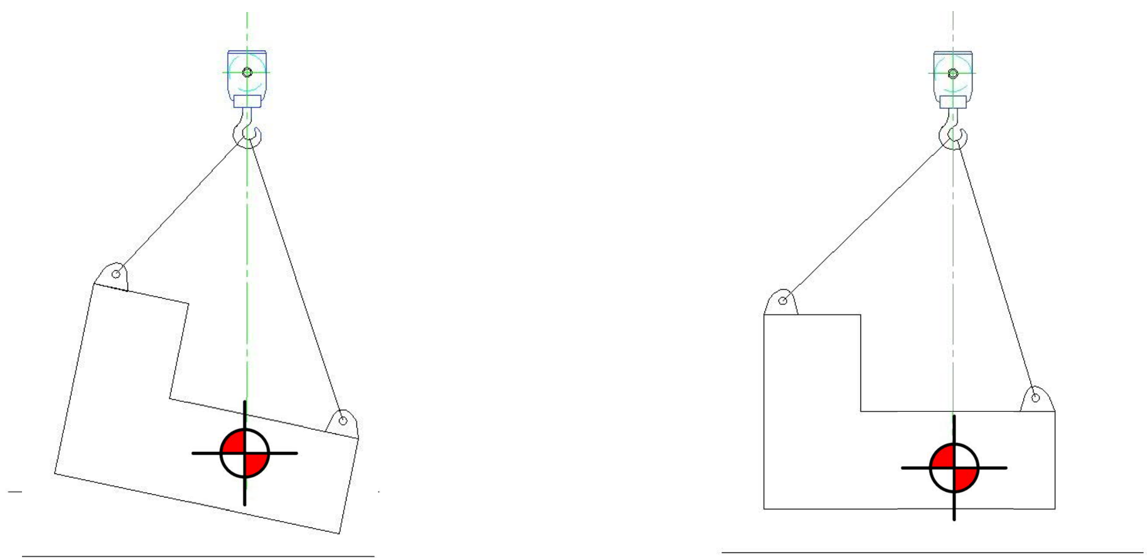
$$D_1 = D_2 = 50\,mTon \times \tan 30° = 28.86\ mTon$$

NOTE: own weight of spreader is hereby ignored



The CoG is always suspended straight under the hook

SEACAMEL



When lifting a freely suspended load, the CoG of the load will always be on the vertical line through the hook block

Forces in slings of unequal lengths

1. One can calculate the forces in slings of unequal lengths with the formulas:

$$S_1 = \frac{F_x \cdot \sin \beta_2}{\sin(180 - \beta_1 - \beta_2)}$$

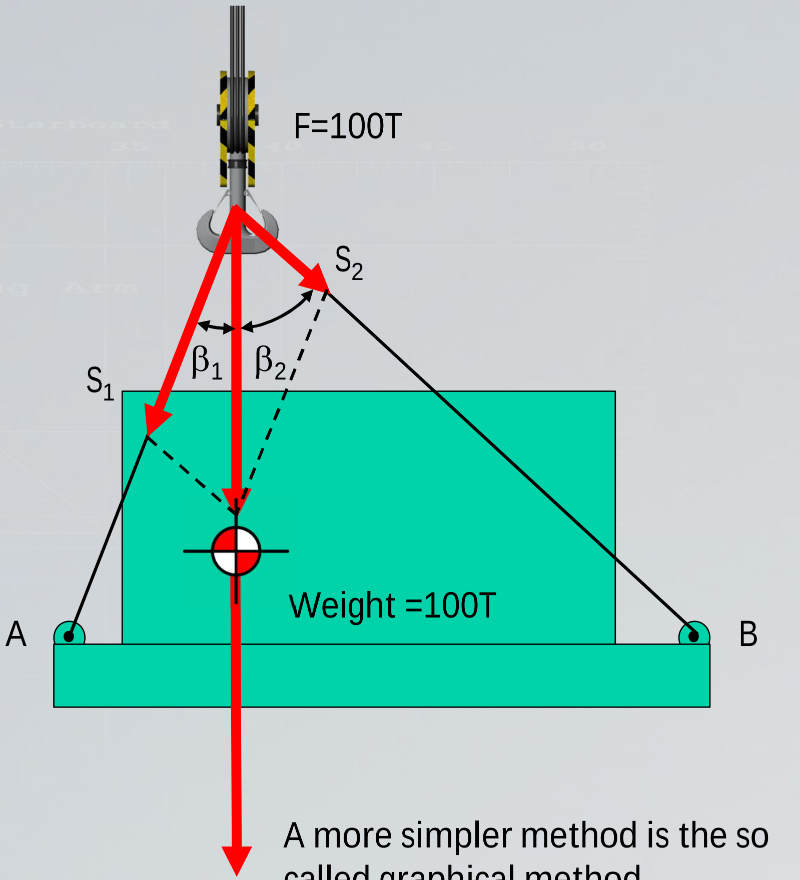
or

$$S_2 = \frac{F_x \cdot \sin \beta_1}{\sin(180 - \beta_1 - \beta_2)}$$

2. An example:
   $\beta_1 = 25°$and $\beta_2 = 45°$

$$S_1 = \frac{100mT \cdot \sin 45°}{\sin(180° - 25° - 45°)} = 70.71mT$$

$$S_2 = \frac{100mT \cdot \sin 25°}{\sin(180° - 25° - 45°)} = 42.26mT$$

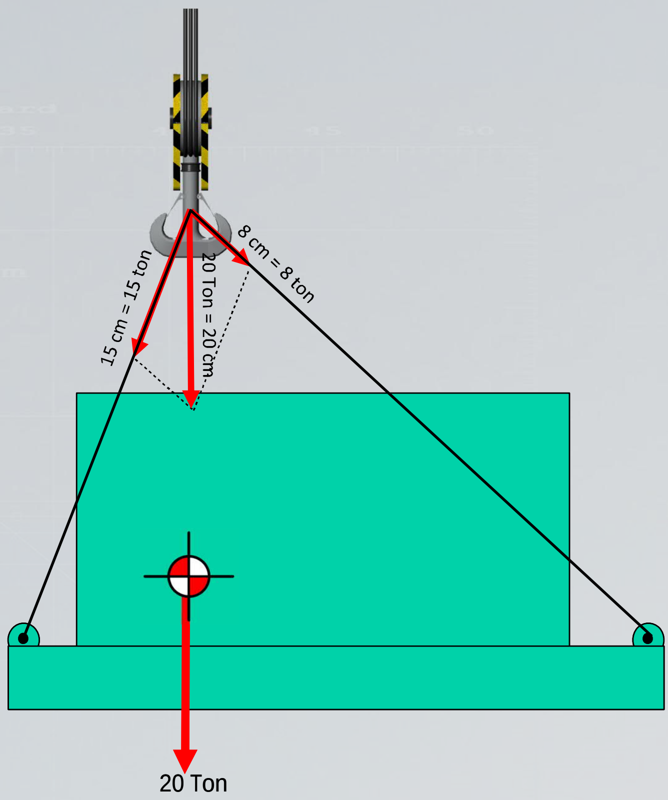


A more simpler method is the so called graphical method

Define the sling length and force with the graphical method

Example:

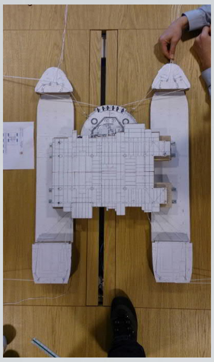
1. Position the hook on the vertical line through the CoG and draw the slings from the lift points to one point in the hook
2. Draw the force diagram on scale starting at the top of the lift slings
3. Use e.g. a scale of 1:100, so that 1 cm = 1 Ton
4. First draw 20 cm straight down, this represents the weight of 20 Ton
5. Then from the point of that force one completes a parallelogram and can draw the other forces
6. By measuring these forces, and use the scale factor, one can define the magnitude of each force.



Play time!

Lifting a train
- 2 small spreader beams
- 1 large spreader beam
- Slings

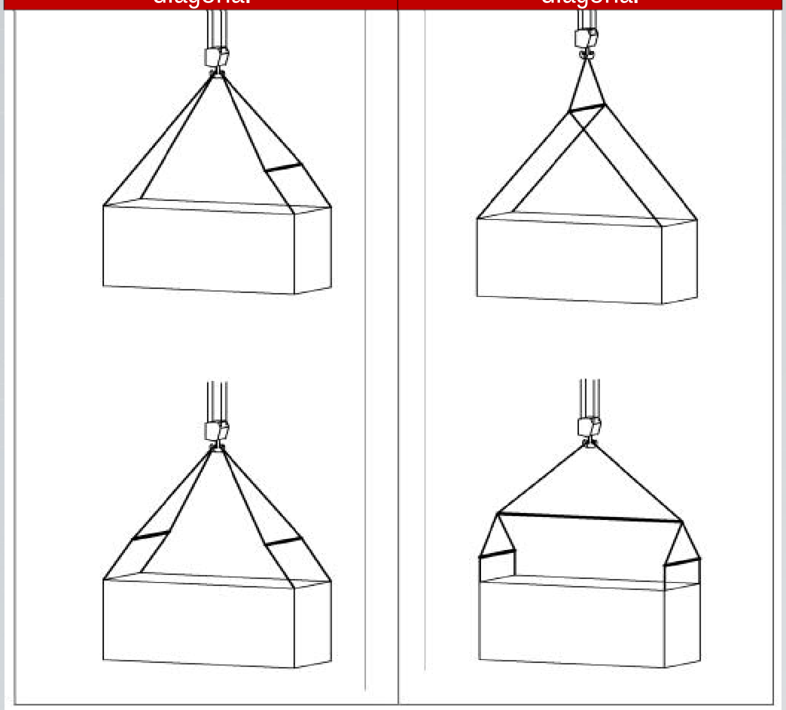
The crane has a limited hook height!
Sling angles about 45°.



Spreader beam configurations

Due to inaccuracies in sling lengths, not all slings get the same load

Floating spreader bar systems	
60% distribution to any diagonal	55% distribution to any diagonal

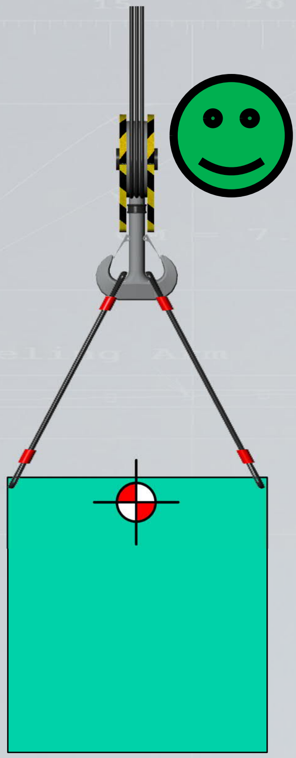


HMC-SC201-single crane lift systems-rev3.

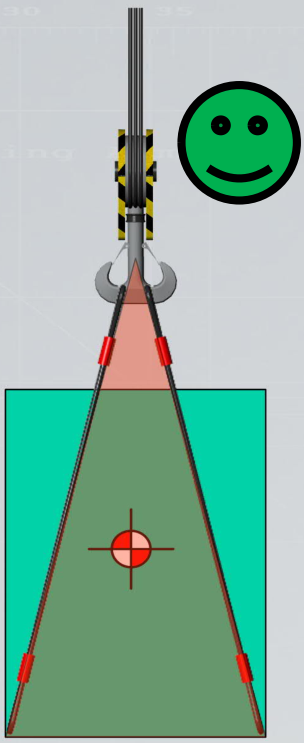
The Stability of a load to be lifted (1)

SEACAMEL

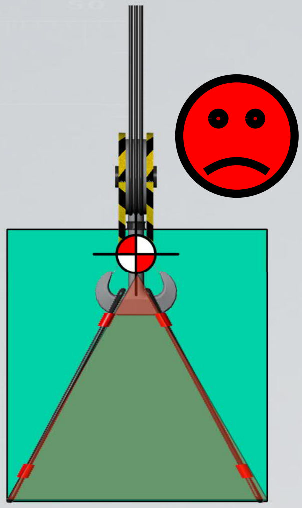
1. A load with lifting points above the CoG is always a stable load

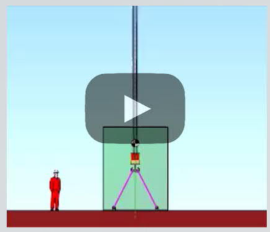


2. The load is stable when the CoG is inside the lift triangle



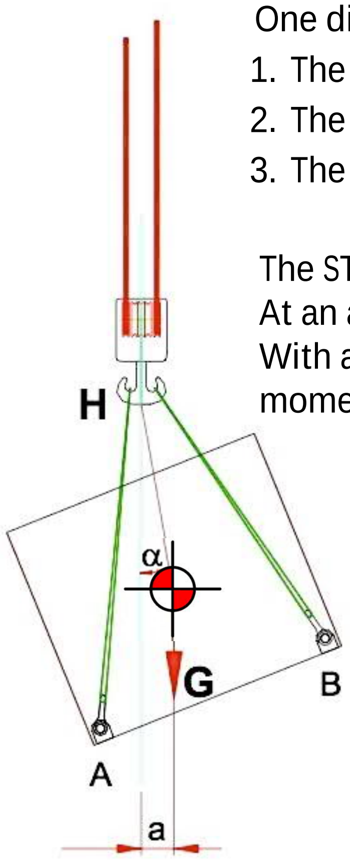
3. The load is unstable when the CoG is outside the lift triangle





The Stability of a load to be lifted (2)

SEACAMEL



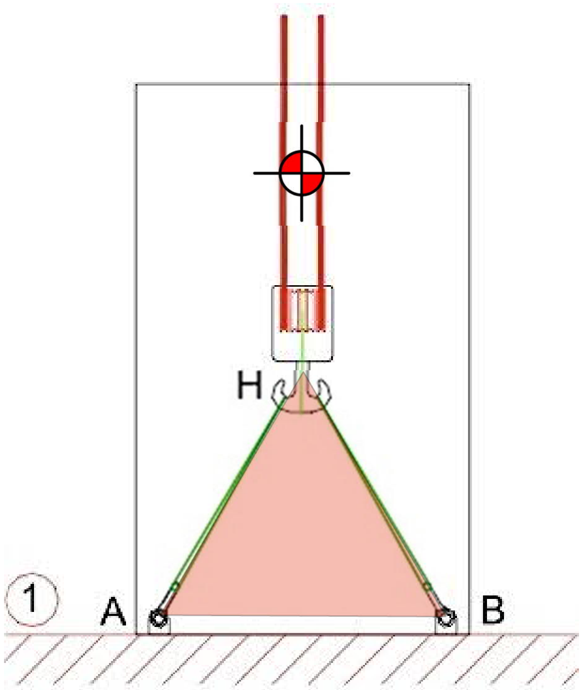
One differentiates:

1. The initial stability
2. The stability moment
3. The stability range

The STABIL.MOM.
At an angle α is G x a
With a disturbing
moment from outside

1. The load is unstable when the CoG is outside the lifting triangle

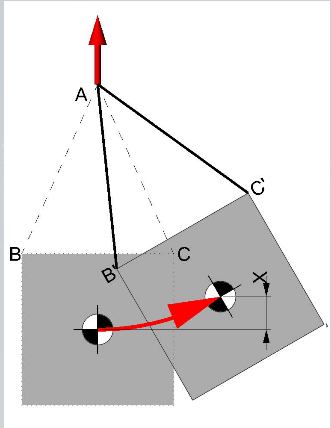
2. WATCH OUT when the lift points are at the underside of the load below the CoG



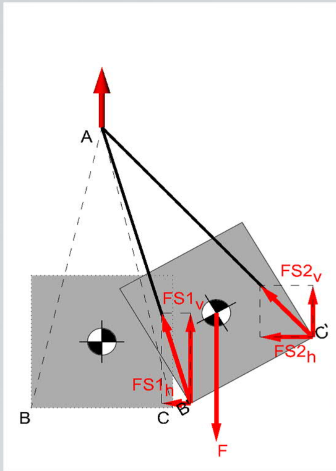
COG inside the triangle

We can draw the force in the lifting slings AB and AC as vectors for a rotated condition. These vectors we can decompose into a vertical and a horizontal component. For the sling AB, these components are

$FS1_v$

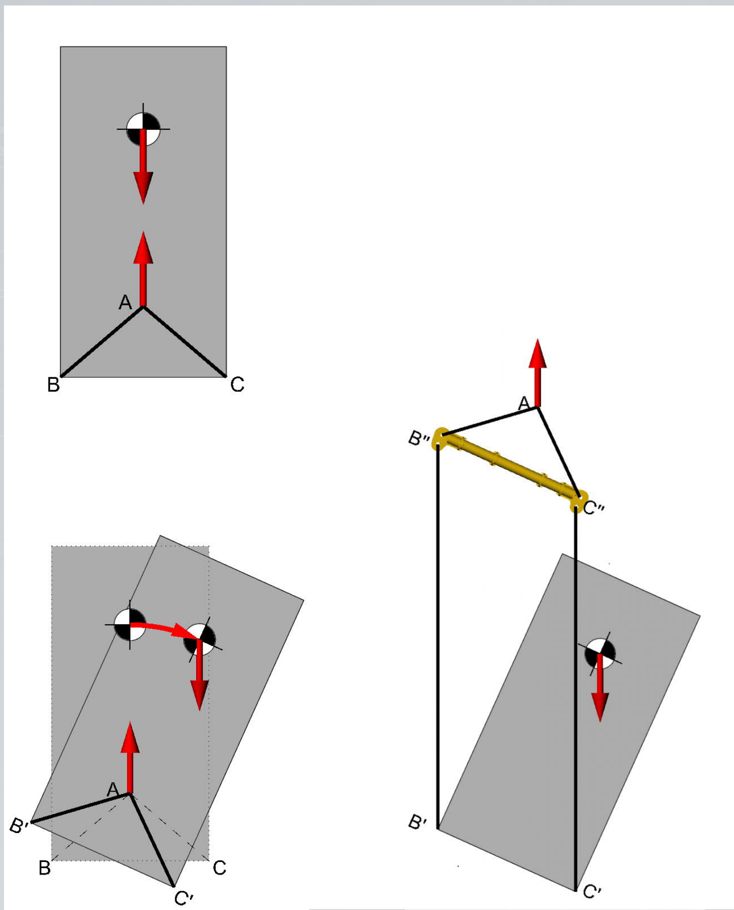


We can draw the force in the lifting slings AB and AC as vectors for a rotated condition. These vectors we can decompose into a vertical and a horizontal component. For the sling AB, these components are $FS1_h$ and $FS1_v$, and for the sling AC, these components are $FS2_h$ and $FS2_v$.



COG outside the triangle

We draw an object again with the hook in A and the lift points in B and C. The difference is that the cog is not the lifting triangle ABC, but outside the triangle. The consequence is that when we now rotate the arrangement around the hook A, the cog moves downward. When an object can move downwards without being restrained, it will go down. Initially, the force vectors are at the same line of action, but you only need a little push (wind) to start the rotation and the overturning moment is created, and it increases rapidly.



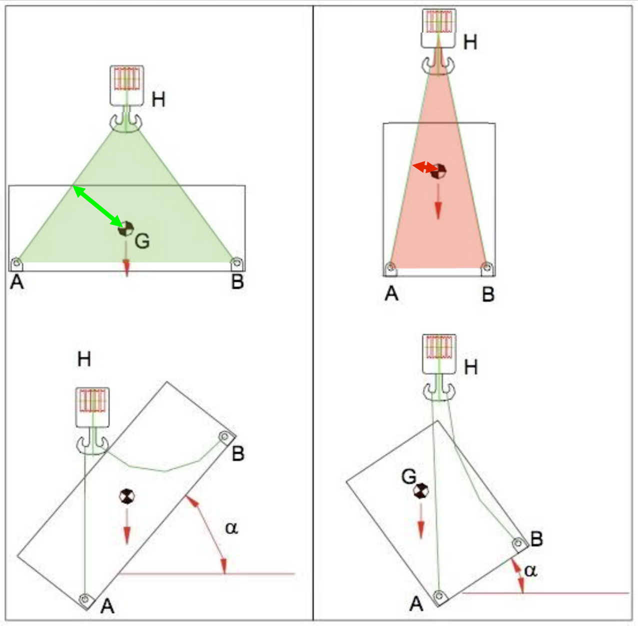
The Stability Range

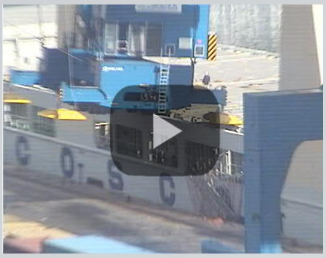
SEACAMEL

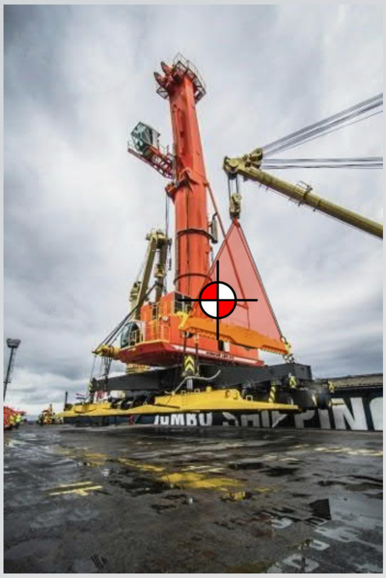
Large stability range

Small Stability range

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







The Stability Moment of the load to be lifted (1)

SEACAMEL

The stability moment can be calculated as below:

Stab.mom:

$$M_{st} = G \times h \sin\alpha - G \times v \sin\alpha$$
$$= G \times (h - v) \sin\alpha$$

(this is valid up to angle β)

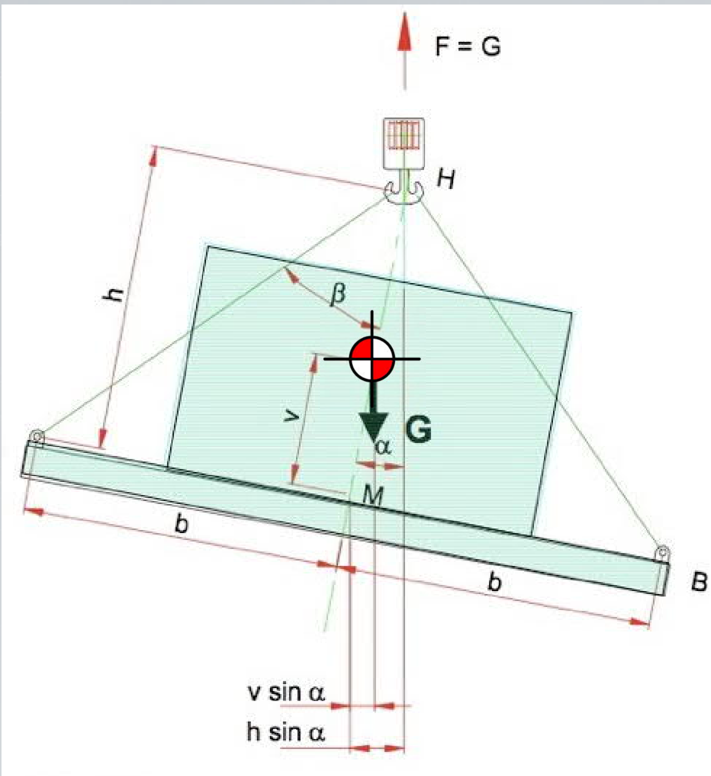
Conclusion:

The stability moment is positive and so is the initial stability in case : h > v

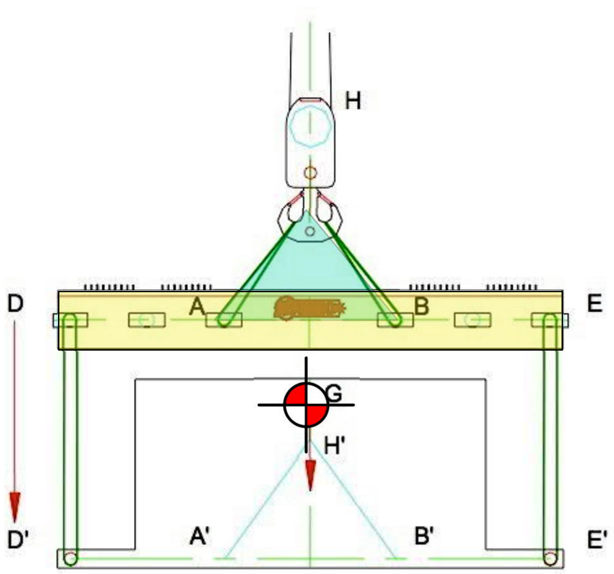
or i.o.w. in case the CoG of the load remains within the lift triangle AHB.

For angles > **β** :

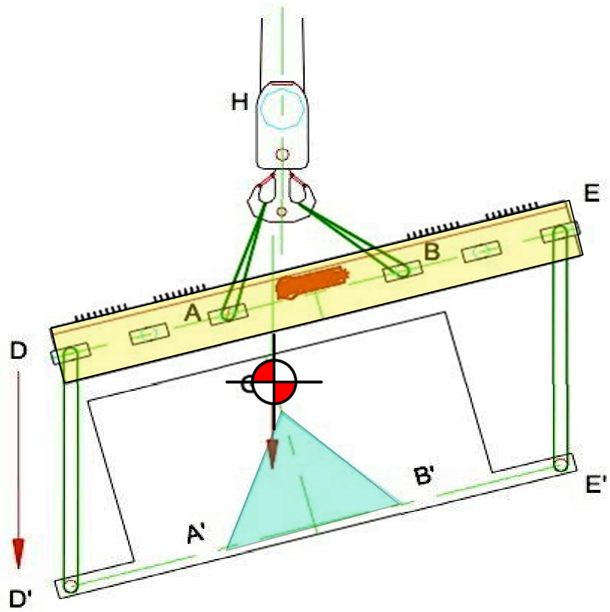
$$M_{st} = G \times b \cos\alpha - G \times v \sin\alpha$$
$$= G \times (b \cos\alpha - v \sin\alpha)$$



SEACAMEL



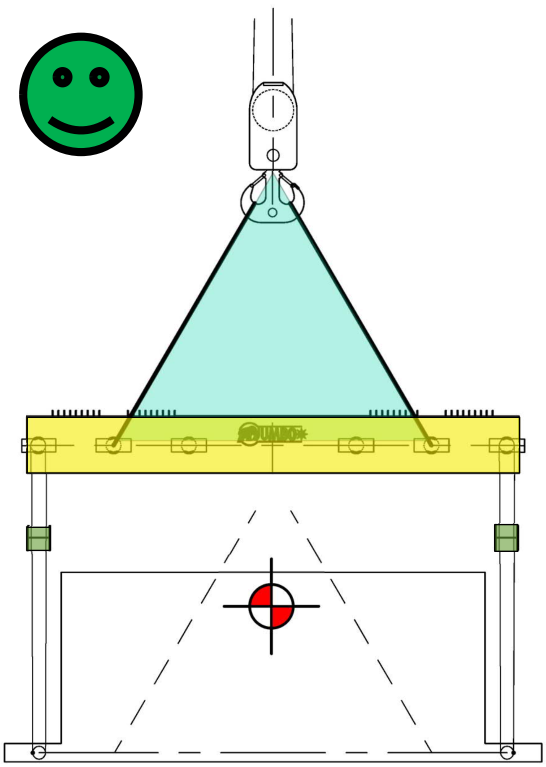
1. This load is unstable as the projected lift triangle is below the CoG



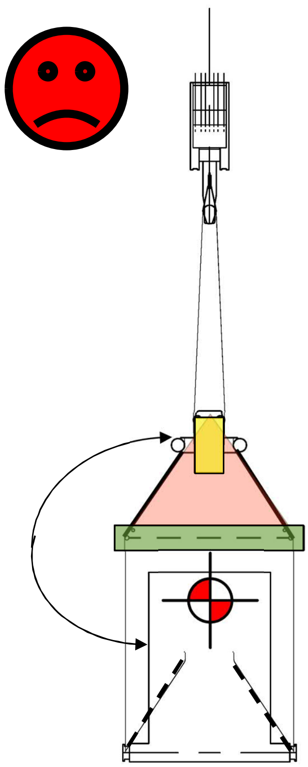
2. The load will tip over

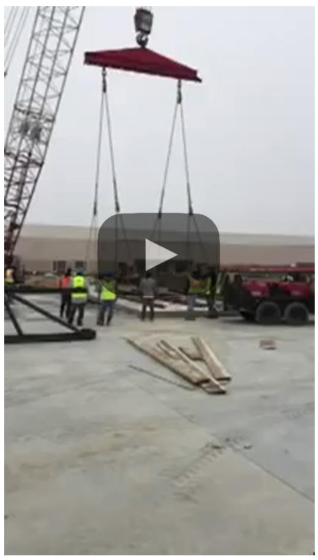
SEACAMEL

In this plane the load IS stable



In this plane the load IS NOT stable

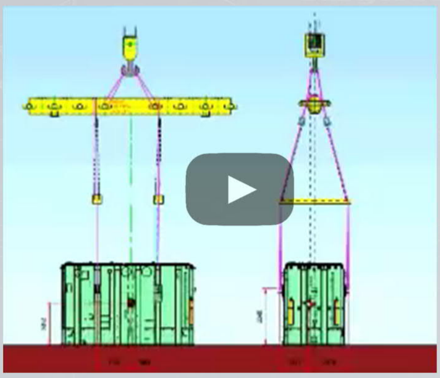




How to rig a Trafo to a Lifting Beam

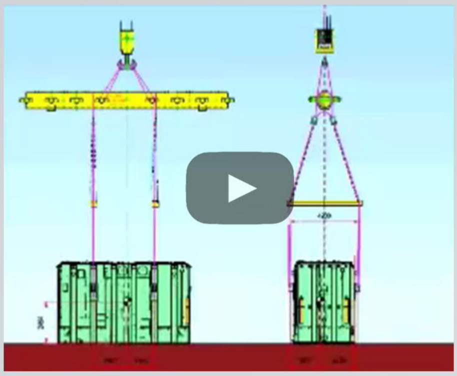
When lifting the load, the CoG of the load will shift directly under the load

If the rigging is applied as single slings going over the lift beam, they could slip as shown below



When lifting the load the CoG of the load will shift directly under the hook

Now the rigging is made up of individual slings and cannot slip

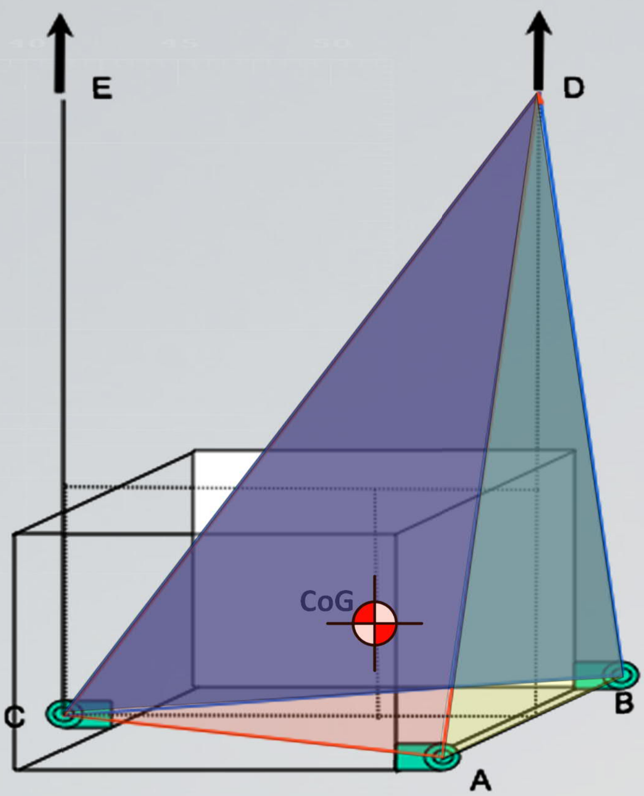


The Stability of the load with 3 lift points below CoG

1. In case a load is lifted by two cranes E and D from 3 lift points at the bottom of the load as shown at right, than the lifting slings must be so long that the CoG of the load is enclosed by the red and blue planes (ACD and BCD).
2. The perpendicular distance to these planes is a measure for the stability of the load (the larger the distance, the bigger the stability).
3. In these kind of cases, it is very important to know the exact location of the CoG. The two lift points A and B at the right side should be closer to the CoG then the single lift point C at the left side.

Lifting a 2400 Tons Drill Tower with 2 Floating Cranes

Asymmetric suspension

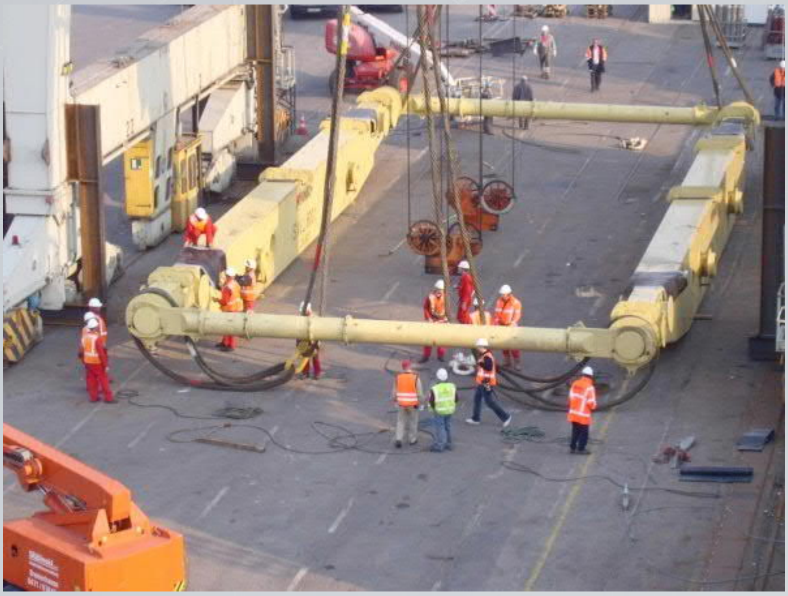


Lifting if a container crane

SEACAMEL

To lift the container crane, a special lifting frame was made.

Can you indentify the lifting triangle?



Examples of Stability of the Load

SEACAMEL

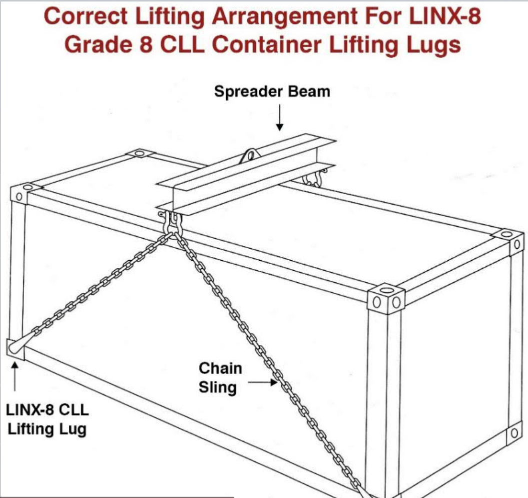
Dangerous type of lift beams, when lifting a load from bottom lift points

Stability of the load is never at risk when lifting from lift points above the CoG

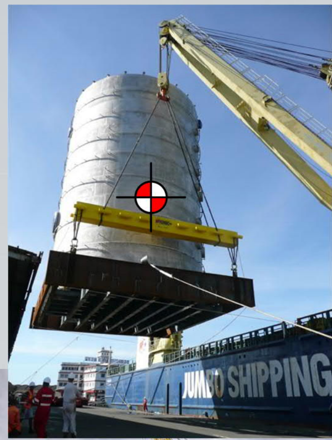
Stability of the load is never at risk when lifting from lift points above the CoG

The Stability of the load to be lifted, okay or not?

SEACAMEL



Found on internet



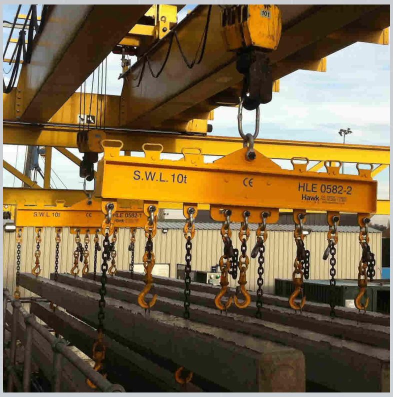
The CoG can be outside the physical structure

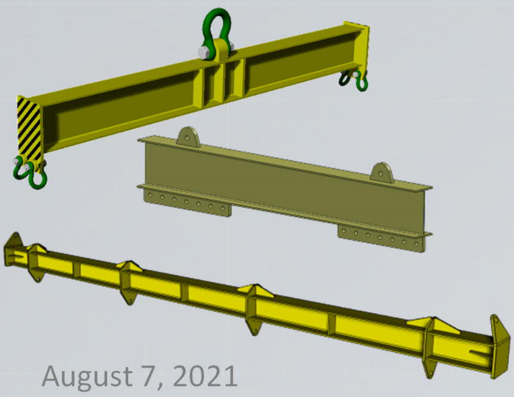
Lifting beams versus and Spreader beams

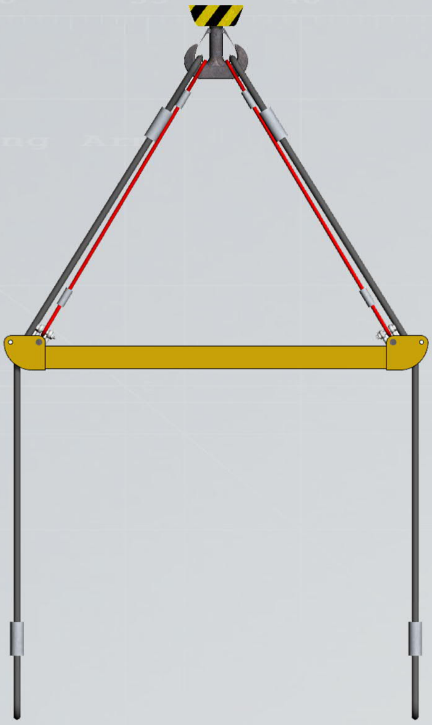
SEACAMEL

Lifting beams

BENDING

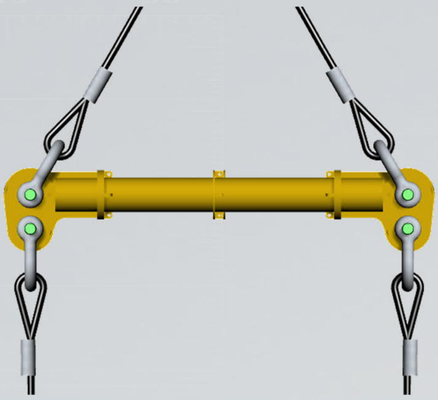




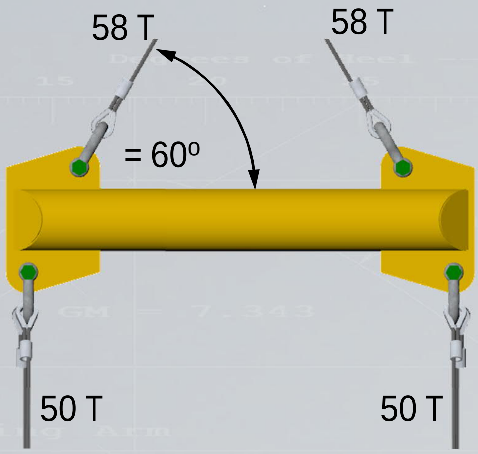


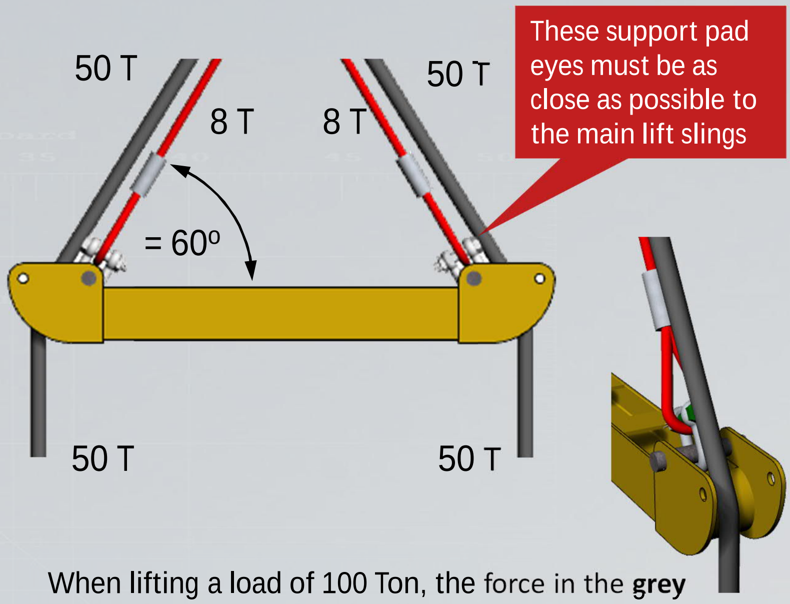
Spreaders

COMPRESSION



2 types of spreader beams





When lifting a load of 100 Ton, the force in the vertical slings below the spreader will be 50 T

Due to the angle with the horizon, the force in the diagonal slings at:
x = 60º will be 58 T

In a lift beam the forces go through the lift points

When lifting a load of 100 Ton, the force in the **grey** sling above and below the spreader beam remain the same, as it is one continuous sling.

Due to the angle with the horizon, you would expect a higher force in the sling above the spreader beam. This extra force component is now absorbed by the red slings (At x = 60º, the force in the blue sling will be 8 T;

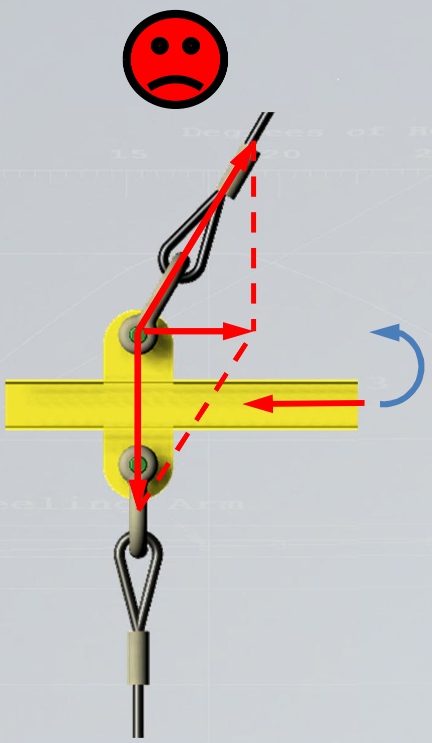
The spreader the beam is only loaded by compression.

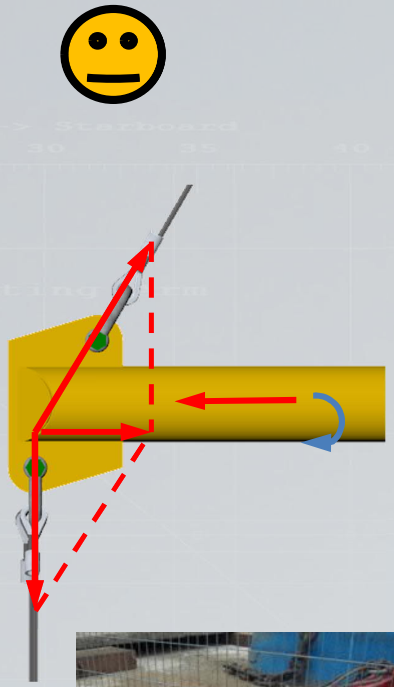
Spreader beam

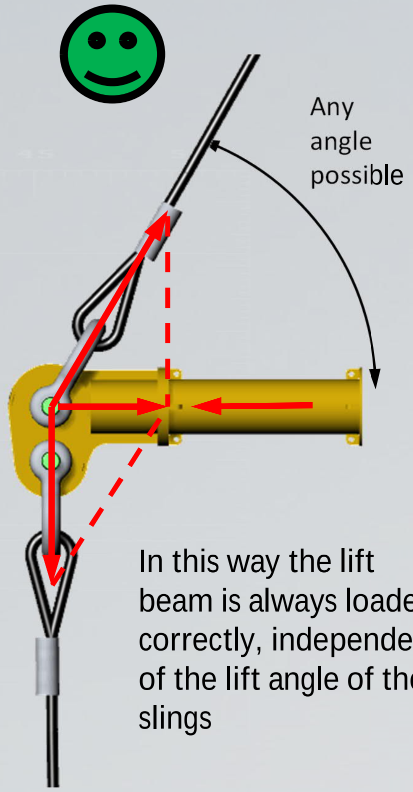
Example of lifting a 250 mt casing on the deck of a semi submersible heavy lift vessel. As the condition of the pad eyes was unclear, they were cut off and new ones were welded.

Various spreader beam designs (1)

SEACAMEL







In this way the lift beam is always loaded correctly, independent of the lift angle of the slings

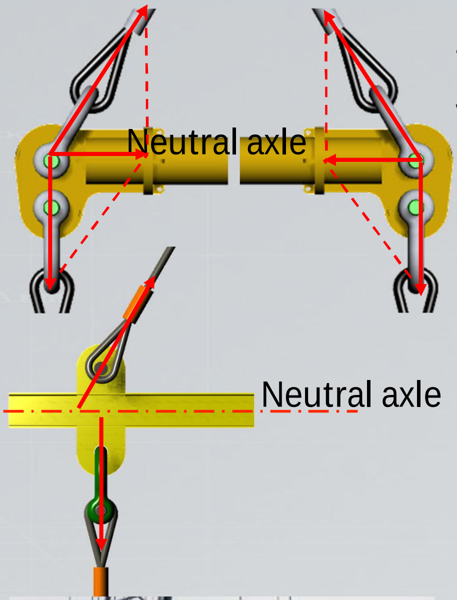
An extra bending moment could cause buckling of the lift beam

Adjustable spreader beam

Various spreader beam designs (2)

SEACAMEL

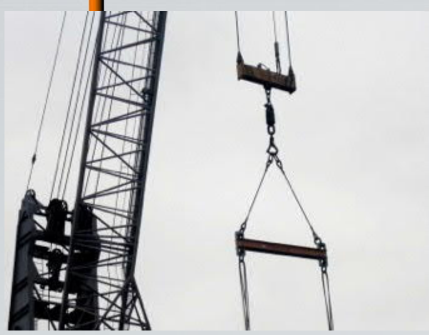
1. When a lift beam is designed correctly, it will only be loaded with compression forces
2. This is only correct when the lines of action of forces cross each other in the so-called neutral axle of the lift beam
3. In case this is not so, a bending moment will be added to the compression force as well
4. Due to a relatively small bending moment the lift beam could buckle.
5. Before use, always check the design criteria of the lift beam on following points:
6. The max. allowable tension in the lift points
7. The allowable angle under which the lift slings lead from the lift beam to the hook
8. The max. allowable compression force in the lift beam itself.



This lift beam is outfitted with swivel eyes, which turn in the neutral axle of the lift beam.

Wrong design

NOTE:
The load vectors do not intersect at the neutral axis of the beam. This causes a bending moment in the beam.



Use of various Lifting beams

SEACAMEL

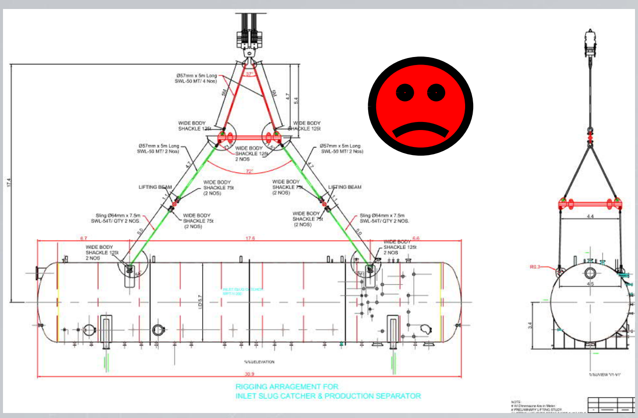
1. This lift beam are subject to bending

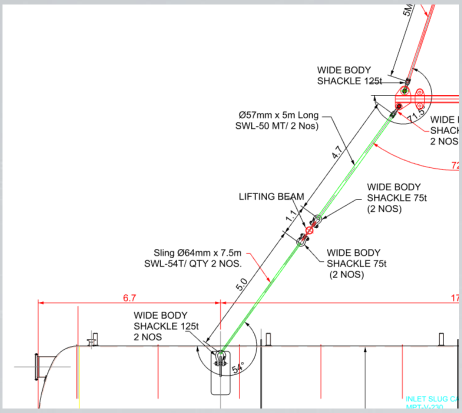
A combination of 2 Lift beams to accommodate 3 lift points

This universal lift beam can be used in various applications: single crane lift or dual crane lift for long loads as well as concentrated loads

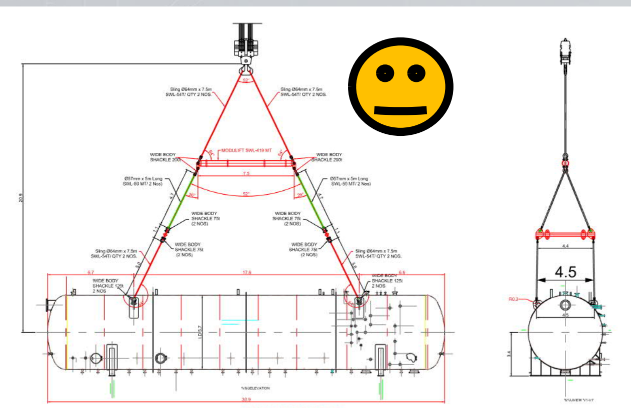
Rigging arrangement

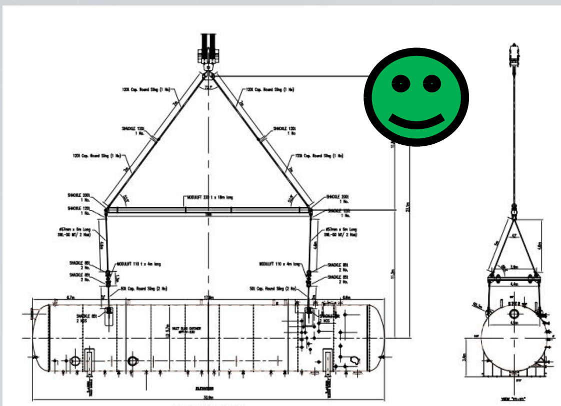
SEACAMEL





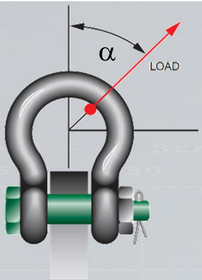
All details are in the drawing but is it good?
This spreader bar left makes it worse.

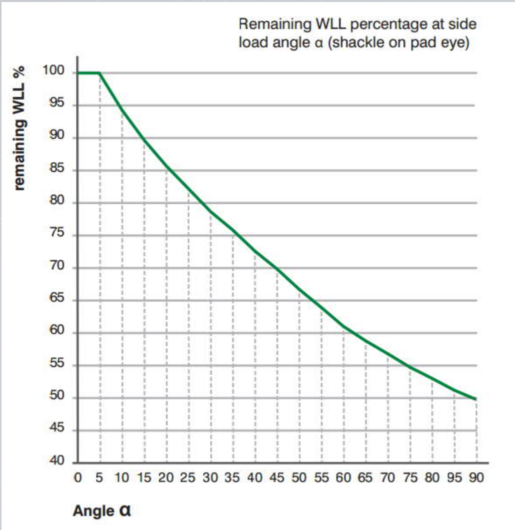




Use of shackles and pad-eyes

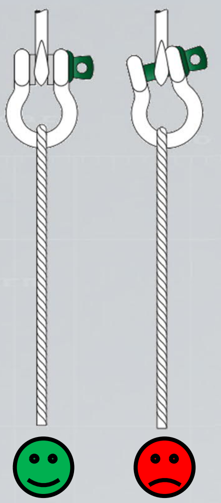
Side loads should be avoided, as the products are not designed for this purpose. If side loads cannot be avoided, the WLL of the shackle must be reduced:



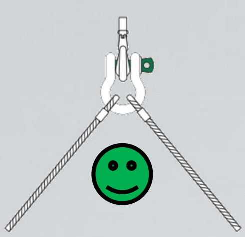


This graph is valid for all Green Pin® shackles, except P-6033 (Sling shackles)

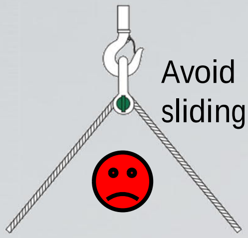
http://www.vanbeest.nl



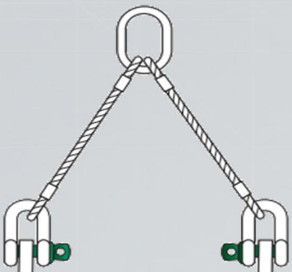
The pin goes through the eye.



Avoid sliding



Only allowed with reduced load

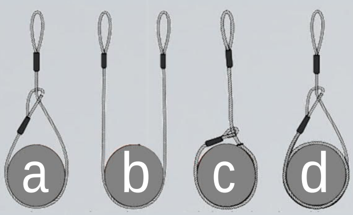


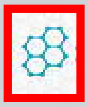
52% FAILED The Basic Rigging Quiz?

1. When installing a shackle pin into a screw pin shackle, you first hand tighten the pin and then:
   a) Leave the pin hand tight
   b) Back the pin off one quarter tern
   c) Back the pin off one half tern
   d) Back the pin off one whole tern

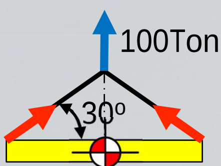
2. What sling material shall not be used when acid conditions are present?
   a) Nylon
   a) Chain
   b) Wire rope
   c) Polypropylene

3. For improved load security, which hitch would be best?
   a) Single wrap choker hitch
   b) Single wrap basket hitch
   c) Chocker hitch with eye pulled down
   d) Double wrap choker hitch

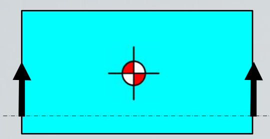




4. What is the stress per sling leg when 2 slings are placed under a 30 degree horizontal sling angle for a 100 ton lift?
   a) 50 ton
   b) 75 ton
   c) 100 to
   d) 200 ton



5. What can happen if you attach the slings to a point below the centre of gravity of the load?
   a) You gain mechanical advantage
   b) The load is well balanced
   c) The load may topple
   d) The load sits down in the slings bridle



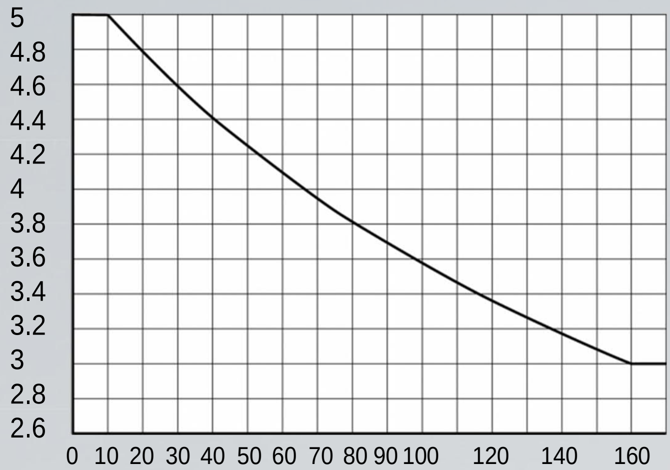
http://www.cranetech.com/blog/rigging-quiz

Work factors (Safety Factor)

SEACAMEL

1. For lifting grommets and Slings the WLL or SWL the is Min. Break load divided by a factor of Safety
   For cranes with:
   SWL < 10 t, SF = 5
   SWL > 160 t, SF = 3

   Code for Lifting Appliances in a Marine Environment(CLAME; Lloyd Register)
   The SWL should never be < 3
2. For Polyester lifting slings a safety factor of 7 applies in relation to the min. Break load (In the USA : 5)
3. Lifting beams and spreaders from 10-160 ton WLL need to be tested after fabrication with a test load of 10 -100% extra according to the following formula:
   L_{test} = 1.04 x WLL + 9.6   Spreaders with a WLL<10 ton need a proof load of 200%
   (AS 4991 - 2004: Lifting Devices)
4. Shackles and turnbuckles are all being tested with a factor 2 after fabrication.
5. The min. breaking strength is in most cases 4-6 times the SWL.
   Well known fabricators like "Greenpin" and "Crosby" do not use the standard safety factors



Rope safety factor versus crane SWL
Lloyds Register Code for Lifting Appliances in a Marine Environment 2016, Figure 4.2.13

OS-H205_2014-04 Nominal safety factor

SEACAMEL

LRFD approach. Not a factor on the MBL but on the "loads"

$$\gamma_{sf} = \gamma_f \gamma_c \gamma_r \gamma_w \gamma_m \gamma_{tw}$$
$$\gamma_{sf} = 2.3 \gamma_r \gamma_w \gamma_{tw}$$

γ_{sf}: Nominal safety factor for slings.

γ_f: Load factor (=1.3)

γ_c: Consequence factor. 1.3 for lifting points and equipment
(1.3 for Lifting equipment not subjected to load testing (e.g. spreader frames or beams, plate shackles).
1.15 for Main elements supporting the lift point
1.0 Other elements of lifted object)

γ_r: Resulting reduction factor due to splicing or bending.

γ_w: Wear factor (=1 - 1.1)

γ_m: Material factor (=1.5 for steel)

γ_{tw}: Twist reduction factor.

γ_s: Reduction factor due to the end termination. (Hand spliced according to EN 13411-2: γ_s = 1.25

γ_b: Reduction factor due to bending
= $1/(1-0.5/(D/d)^{0.5})$ for steel
=1 sometimes for fiber ropes

Multiplication of all RED values = Total 3.5

Certification (Europe).

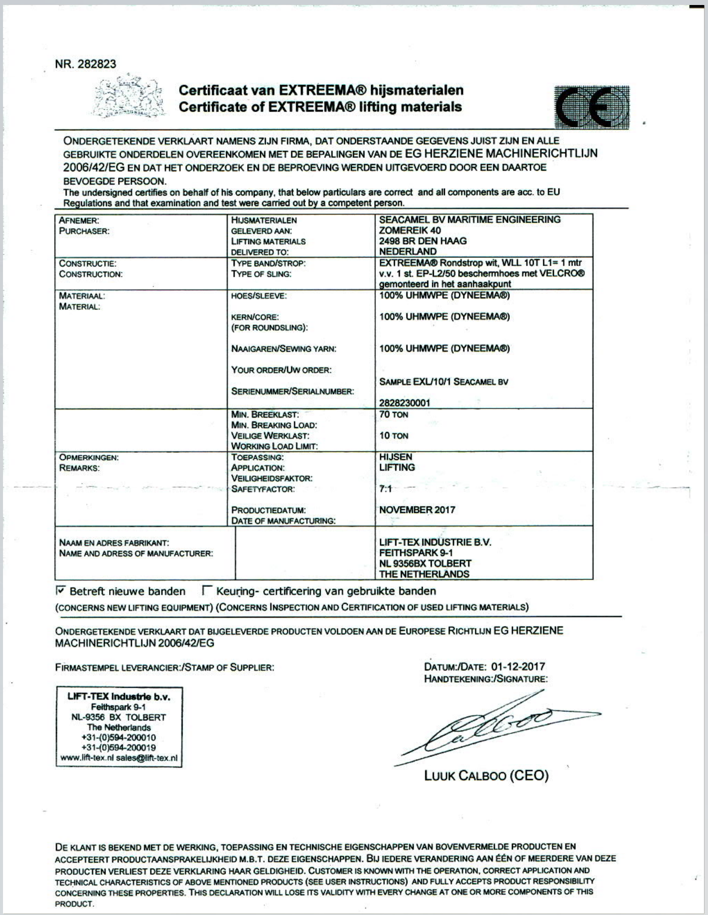
The European CE marking applies to products related to health, safety and environment and which are placed in the market or put into service in the European Economic Area. All lifting equipment must have CE marking. The equipment must have a certificate and use should be clear. The certificate should show at least:

- Application
- Capacity
- date of manufacturing or last certification
- Details of manufacturer or certification company
- serial number

The end user is responsible to manage their own equipment.

This can be simplified by giving each item its own unique ID and certificate for ease of tracking, maintenance, inspections etc. (RFID: Radio Frequency Identification)

The IMO colour indicates the year of inspection.			
Brown	2016	2022	2028
Blue	2017	2023	2029
Yellow	2018	2024	2030
Red	2019	2025	2031
Black	2020	2026	2032
Green	2021	2027	etc



NR. 282823

Certificaat van EXTREEMA® hijsmaterialen
Certificate of EXTREEMA® lifting materials

ONDERGETEKENDE VERKLAART NAMENS ZIJN FIRMA, DAT ONDERSTAANDE GEGEVENS JUIST ZIJN EN ALLE GEBRUIKTE ONDERDELEN OVEREENKOMEN MET DE BEPALINGEN VAN DE EG HERZIENE MACHINERICHTLIJN 2006/42/EG EN DAT HET ONDERZOEK EN DE BEPROEVING WERDEN UITGEVOERD DOOR EEN DAARTOE BEVOEGDE PERSOON.
The undersigned certifies on behalf of his company, that below particulars are correct and all components are acc. to EU Regulations and that examination and test were carried out by a competent person.

AFNEMER: PURCHASER:	HIJSMATERIALEN GELEVERD AAN: LIFTING MATERIALS DELIVERED TO:	SEACAMEL BV MARITIME ENGINEERING ZOMEREIK 40 2498 BR DEN HAAG NEDERLAND
CONSTRUCTIE: CONSTRUCTION:	TYPE BAND/STROP: TYPE OF SLING:	EXTREEMA® Rondstrop wit, WLL 10T L1= 1 mtr v.v. 1 st. EP-L2/50 beschermhoes met VELCRO® gemonteerd in het aanhaakpunt
MATERIAAL: MATERIAL:	HOES/SLEEVE:	100% UHMWPE (DYNEEMA®)
	KERN/CORE: (FOR ROUNDSLING):	100% UHMWPE (DYNEEMA®)
	NAAIGAREN/SEWING YARN:	100% UHMWPE (DYNEEMA®)
	YOUR ORDER/UW ORDER:	SAMPLE EXL/10/1 SEACAMEL BV
	SERIENUMMER/SERIALNUMBER:	2828230001
	MIN. BREEKLAST: MIN. BREAKING LOAD:	70 TON
	VEILIGE WERKLAST: WORKING LOAD LIMIT:	10 TON
OPMERKINGEN: REMARKS:	TOEPASSING: APPLICATION:	HIJSEN LIFTING
	VEILIGHEIDSFAKTOR: SAFETYFACTOR:	7:1
	PRODUCTIEDATUM: DATE OF MANUFACTURING:	NOVEMBER 2017
NAAM EN ADRES FABRIKANT: NAME AND ADRESS OF MANUFACTURER:		LIFT-TEX INDUSTRIE B.V. FEITHSPARK 9-1 NL 9356BX TOLBERT THE NETHERLANDS

☑ Betreft nieuwe banden ☐ Keuring- certificering van gebruikte banden
(CONCERNS NEW LIFTING EQUIPMENT) (CONCERNS INSPECTION AND CERTIFICATION OF USED LIFTING MATERIALS)

ONDERGETEKENDE VERKLAART DAT BIJGELEVERDE PRODUCTEN VOLDOEN AAN DE EUROPESE RICHTLIJN EG HERZIENE MACHINERICHTLIJN 2006/42/EG

FIRMASTEMPEL LEVERANCIER:/STAMP OF SUPPLIER:

LIFT-TEX Industrie b.v.
Feithspark 9-1
NL-9356 BX TOLBERT
The Netherlands
+31-(0)594-200010
+31-(0)594-200019
www.lift-tex.nl sales@lift-tex.nl

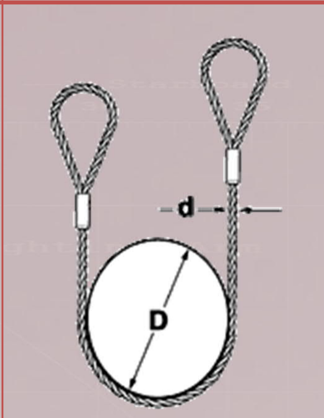
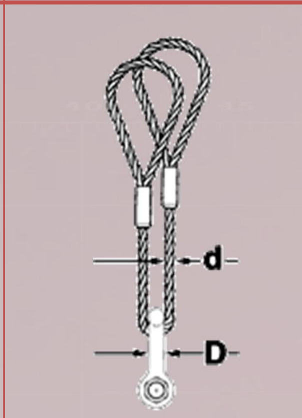
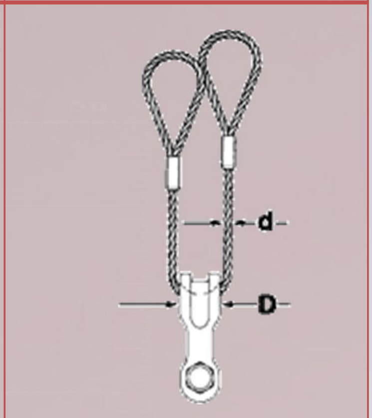
DATUM:/DATE: 01-12-2017
HANDTEKENING:/SIGNATURE:

LUUK CALBOO (CEO)

DE KLANT IS BEKEND MET DE WERKING, TOEPASSING EN TECHNISCHE EIGENSCHAPPEN VAN BOVENVERMELDE PRODUCTEN EN ACCEPTEERT PRODUCTAANSPRAKELIJKHEID M.B.T. DEZE EIGENSCHAPPEN. BIJ IEDERE VERANDERING AAN ÉÉN OF MEERDERE VAN DEZE PRODUCTEN VERLIEST DEZE VERKLARING HAAR GELDIGHEID. CUSTOMER IS KNOWN WITH THE OPERATION, CORRECT APPLICATION AND TECHNICAL CHARACTERISTICS OF ABOVE MENTIONED PRODUCTS (SEE USER INSTRUCTIONS) AND FULLY ACCEPTS PRODUCT RESPONSIBILITY CONCERNING THESE PROPERTIES. THIS DECLARATION WILL LOSE ITS VALIDITY WITH EVERY CHANGE AT ONE OR MORE COMPONENTS OF THIS PRODUCT.

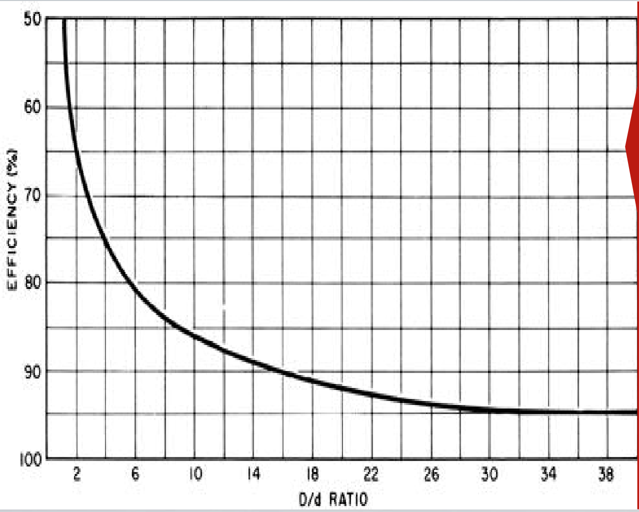
http://www.lift-tex.nl/

Sling capacities in various applications

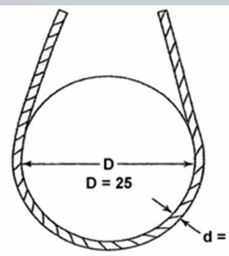
max. 100 Ts	max. 100 Ts	max. 200 Ts	max. 120 Ts	max. 150 Ts
				
Eye Length must NOT be smaller than twice the object (e.g. a hook) diameter	If the shackle or object has 2 times the diameter of a 6 strand wire rope sling (D/d 1:1) the basket sling capacity must be reduced by 50%	If the object with a 6-strand wire rope sling in a basket hitch is at least 25 x larger than the sling diameter (D/d 25:1) the basket capacity need not to be adjusted	If the shackle or object has 2 times the diameter of a 6 strand wire rope sling (D/d 2:1) the basket sling capacity must be reduced by 40%	It is better to uses a larger shackle or Wide Body shackle type. If the shackle or object has at least 5 x the sling diameter (D/d 5:1) the basket sling capacity must still be reduced by 25%

Safety factors of slings and grommets are all in relation to the Minimum Break Load (MBL).
The Minimum Break Load is the calculated break load of a wire rope. SWL= WLL = MBL / Safety factor

http://unirope.com



Strength Efficiency Compared to Catalog Strength in %

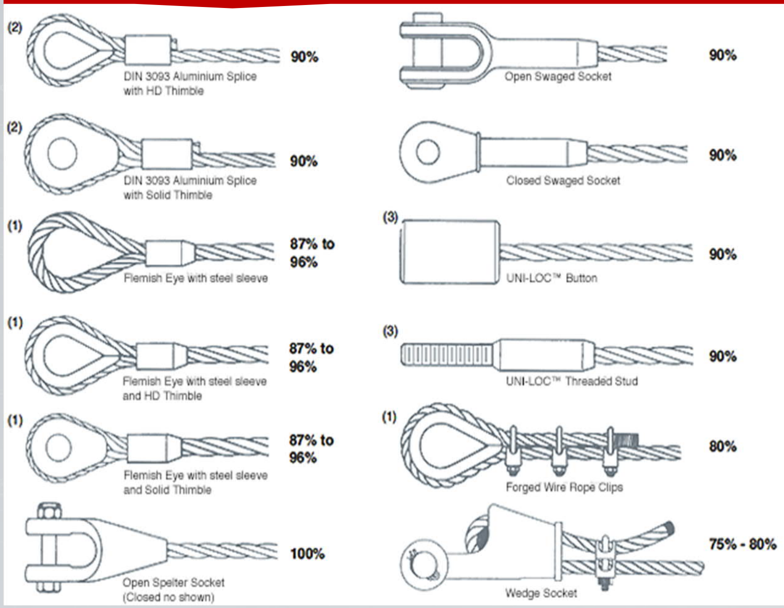


GENERAL NOTE: When D is 25 times the component rope diameter (d), the D/d ratio is expressed as 25/1.

Determining D/d ratio

[Occupational Safety and Health Administration]

End terminations

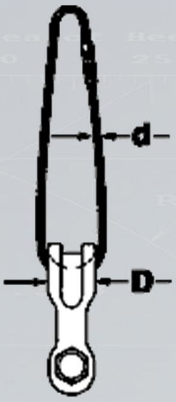


Tønsberg Link (Mooring)

max. 200 Ton

Use large enough hooks and large diameter shackles to avoid crushing and kinking of the sling

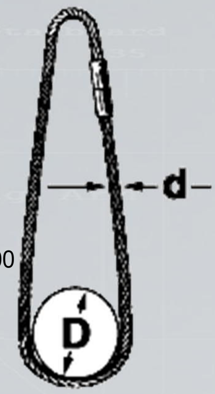
max. 100 Ton



If possible use Wide Body shackles. They increase the D/d ratio and you gain sling strength.

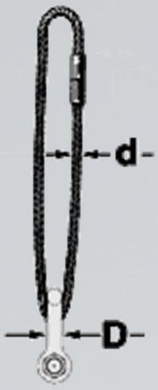
< 100 ton depending on angle and D/d ratio

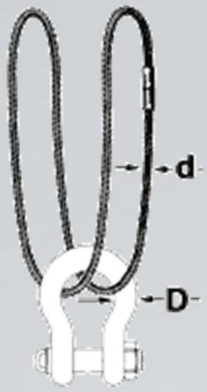
max. 100 Ton



Proper D/d ratio for the sling capacity. If the sling is too short you may have to adjust the capacity because of sling angle.

< 200 ton depending on the D/d ratio





Small diameter shackles reduce the sling strength and, most likely, that small diameter shackle also has insufficient capacity for that job. Shackle or not, objects to be lifted and all hook up points MUST at least ensure a D/d ratio of 5:1

http://unirope.com

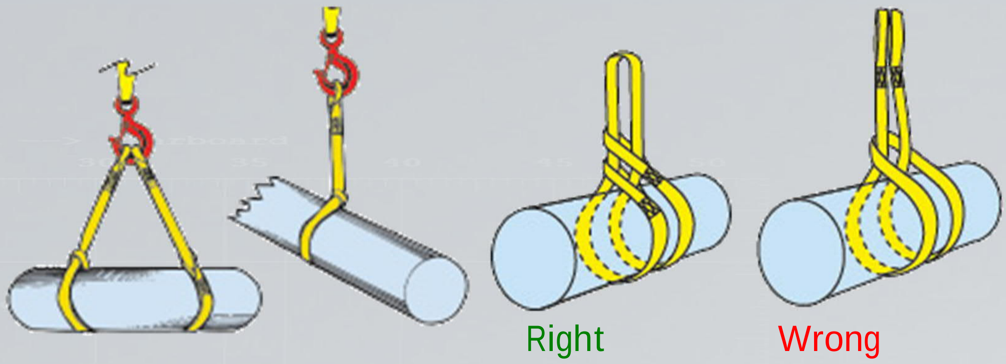
Safety factors of slings and grommets are all in relation to the Minimum Break Load (MBL).
The Minimum Break Load is the calculated break load of a wire rope. SWL = WWL = MBL / Safety factor

Check with manufacturer. Values also depend on capacity and type of the wire!

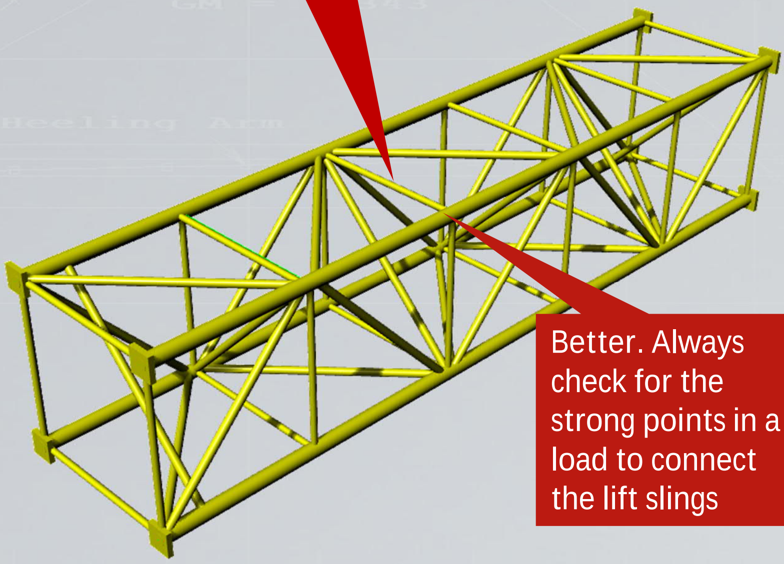
Applying (round-) slings to a load

SEACAMEL

Always apply use the strong points of a structure.



Wrong. This bracing can easily be overloaded and will bend



Better. Always check for the strong points in a load to connect the lift slings

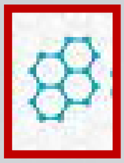
Offshore Grommet made of 300 mm diam. wire rope

Calculate the loads in this example

SEACAMEL

Question:

1. What is the max. load which we can lift with the tip of a crow bar when we push at one end with 80 kg?



A. 320 kg

B. 2000 kg

C. 200 kg

D. 500 kg

Answer :

$$\frac{80\ kg \times 1\,m}{0{,}04\ m} = 2000\ \text{kg}$$

Lifting with more than 2 cranes

Construction of the Gina Krog jacket for Statoil 2015