

# Guidelines for the safe use of taglines



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### 1 Introduction

Freely suspended loads are subject to dynamic and wind forces that can cause them to swing or rotate (wind vane) during lifting.

These tendencies need to be managed and controlled.

To mitigate these risks, it is a requirement that persons conducting a lifting operation are in control of the payload at all times ensuring that it does not make unintended and uncontrolled movements.

### 2 Definition of a tagline

A tagline is a rope of suitable strength, construction and length attached with an appropriate recognised bend or hitch to a load during a lifting operation to allow a rigger to control swinging and/or rotation of a suspended load during lifting or positioning.

Multiple taglines may be required to exercise full control.

Taglines are otherwise known as a guide line, guide rope, end line, strap line, or pay off line, depending on which part of the world you are in but the most common term for the use of this piece of rope is “tagline”.

### 3 Purpose of a tagline

Taglines are used to:

- ✓ oppose uncontrolled rotation of a freely suspended load as it is lifted and/or manoeuvred/relocated under the influence of forces such as wind acting on it
- ✓ alter the rotational attitude of a suspended load as it is guided along a path or to position it in a particular attitude
- ✓ assist controlling swinging induced in lifting
- ✓ avoid the need for persons to put their hands directly on a load to control it where that would pose a hazard, allowing safe distance between them and the load

Taglines are not to be used to:

- ✓ pull a load out of its natural suspended line inducing in-haul or out-haul of the load lines
- ✓ hold a load against wind forces trying to push it out of line
- ✓ contribute to supporting the load

### 4 Types of taglines

Ropes used for taglines should be manufactured from suitable soft fibres, i.e. non rotating synthetic or natural fibres that don't present the manual handling hazards of wire rope.

Preferably they should be of a 100% polyester braid on braid (braided core covered with braided cover) rope.

Using a regular rope of polypropylene, nylon or sisal has some inherent problems when used as tagline:

1. They tend to wrap around objects
2. They get caught in pinch points
3. The bottoms fray and are then knotted to stop the fraying causing the line to catch
4. They get slick when worn, wet or dirty with grease

Taglines of choice can also be semi-stiff or coated so as not to easily tangle and be in single lengths (continuous without joins).

The end of the rope shall be secured against fraying, but knots shall not be used at the free end of the rope.

Good practice is the use of taglines that are specifically designed for the application as tagline such as:

- ✓ Dynamica tagline, which are manufactured with high- strength Dyneema fibres, which are lighter and easier to handle than steel Dynamica taglines are over braided with polyester cover to avoid abrasion of the main rope
- ✓ The Dynlce Helix taglines are tangle resistant as it is designed with a rigid core & stiff over brading to prevent any turning on itself and wrapping around objects. They have an additional factor which is the spiral effect, which will dramatically increase grip in wet & slippery conditions and do not catch on pinch points, as there are no knots or areas to snag
- ✓ Also retractable safety taglines are available from Tagattach

## 5 Why would a load want to rotate

There are a couple of reasons why a load may rotate on the hook as it is lifted and manoeuvred.

- ✓ The main reason why a load would rotate as it is lifted is the action of wind forces. Unless a load has the same area to the wind regardless of rotation (e.g. a vertical cylinder), it will want to rotate in a wind to present its least area to the wind (principle of a weather vane). So for instance a vertical, cylindrical, chemical vessel may show little or no tendency to rotate in a wind, whereas a long flat-sided steel beam of the same area may show a pronounced tendency to rotate at the same wind speed. Understanding this is a key factor in deciding whether or not taglines are required to control rotation.
- ✓ Secondly, the load lines may tend to spin up some as the load is lifted. Using taglines, the load can be held static allowing the spin-up to shake out at the bearing in the hook block.



*Not liable to rotate much.*



*Quite liable to "vane" in the wind*

## 6 Wind speed, wind pressure and forces induced

The magnitude of the forces and rotational effects acting on a load when that load is subject to the wind is often not well understood; underestimation can cause big problems. So, time to look at some theory.

When a static object is subjected to a flowing stream of air, pressure is created acting on that object.

Pressure is given by the formulae:

$P=0.613V_s^2$  N/m<sup>2</sup> (or Pa); equivalent to  $P=0.0625V_s^2$  kg/m<sup>2</sup>, where  $V_s$  is in m/s, or

$P=0.0473V_s^2$  N/m<sup>2</sup> (or Pa); equivalent to  $P=0.00482V_s^2$  kg/m<sup>2</sup>, where  $V_s$  is in km/hr

*Note that the pressure is directly proportional to the square of the wind speed e.g. twice the wind speed, four times the pressure.*

Wind pressure acting on the projected area of the object gives rise to a force acting on the object.

The Wind Force  $F$  is given by the formula:

$F = P \times A \times C_f$ , where  $P$  is the wind pressure,  $A$  the projected area and  $C_f$ , a shape factor or drag coefficient.

*Note that the shape of the object also affects the magnitude of the force.*

Typically  $C_f = 1.2$  for long round pipes,  $0.8$  for short round pipes,  $2.0$  for long flat plates or  $1.4$  for short flat plates.

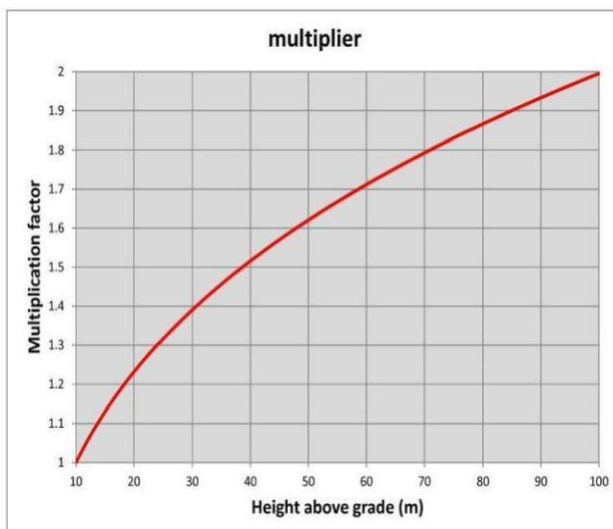
Wind speed is often referred to using the Beaufort scale on a scale of 0 - 12. e.g. Beaufort 6 is a strong breeze that would sway large branches and equates to 25-31mph or 40-50km/hr or 11-14m/s.

*Note that these wind speeds are quoted at a standard 10m (33') above grade.*

## 7 Where is the wind force measured

The wind speed that you are actually interested in is, of course, the wind speed that is actually blowing on the suspended load; that wind speed can be a lot different to the wind speed at ground level. Wind speeds are quoted (by say a weather station) by convention at 10m (33') above grade;

*Note that wind speed increases logarithmically with height according to a curve similar to the following.*



What that curve actually looks like depends on whether it is stable, neutral or unstable air, whether over water or land, whether the site is disturbed by human habitation and so on.

In this instance, the wind speed at 100m (330') is twice that at 10m (33'). (This means of course that the pressure is four times that at 10m). So you need to be aware of this!

For lifting purposes, the wind speed indicated by the anemometer mounted on the boom head should be used as that is what is actually happening at height.

## 8 Why would a load want to swing

A load typically takes to swinging when the wind is gusting or when moving a load with the crane. Once started, it can be difficult to stop.

Ideally you want to prevent swinging starting or at least limit its amplitude before it gets out of hand. If an unrestrained suspended load is subjected to a sustained lateral wind force, it moves sideways inducing an out-of-plumb angle in the suspension. Forces balance when the lateral (horizontal) component of the tension in the suspension equals the wind force and the load will reach equilibrium at a slight out-of-plumb so long as the wind continues to act in a constant manner.

### Example:

If for instance a 3m x 3m cladding panel is lifted in a 9m/s breeze (with its face to the wind), assuming a shape factor of 1, there will be a 5kg/m<sup>2</sup> pressure acting on 9m<sup>2</sup> = 45kg of “force” acting on the panel. If the panel weighs 450kg, the load will move horizontally approximately 1/10th of the suspension height until the forces balance. If you have a suspension length of about 15m say, the load will therefore move 1.5m or so sideways. If the wind drops, it will tend to return back to plumb and swinging will be induced.

## 9 Why would a load want to swing - inertia

When you move a load with a crane, the crane moves forwards (say) but the load initially stays where it is (inertia) until accelerated by the horizontal component of the tension in the (now) slightly inclined suspension. If the crane suddenly stops moving, the load’s momentum keeps it moving and it will swing like a pendulum until it eventually comes to rest. To minimize this, an operator should gently accelerate and decelerate the crane so the load keeps up with the crane without swinging wildly.

Note: There is a natural frequency to the swing (which is independent of weight and is related to the suspension length). If you are really unlucky wind gusting can reinforce this natural swing ever increasing the amplitude of the swinging (how much the load moves between extremes).

You can see from this that light loads with large sail areas can be particularly problematic.

**The take-away is don’t lift light loads with large sail areas in high winds;** if loads start to swing, attempt to damp down the movement; if that is problematic, possibly turn the load to rotate to present its least area to the wind, wait until it stops swinging, then turn it back and try again with improved control

## 10 When to use taglines and when not to

**OSHA 29CFR 1926.953(d)** requires taglines on any load “where hazards to employees exist” in order to keep the loads under control.

**LOLER:** “Appropriate measures should be taken to prevent a freely suspended load from moving in an uncontrolled manner where the risks justify it. Taglines may be necessary to stop the load swinging (example overhead crane).”

**BS 7121:** “If one or more hand-lines/taglines are required to give more control of the load, the appointed person should designate persons to handle the lines.”

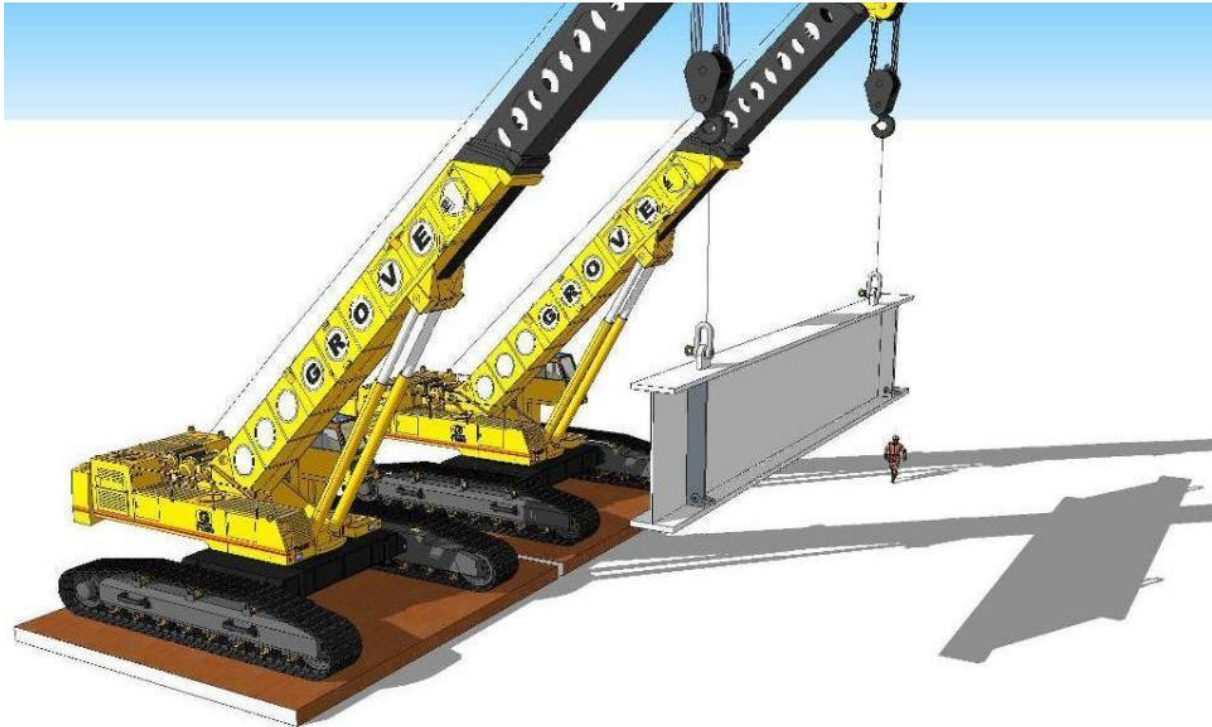
i.e. A common theme is that where taglines are required to control a load they must be used.

On the other hand where they are not required to control a load, they are not required to be used.

It is recommend that they are used unless they would serve no useful purpose and could potentially create a snagging hazard. How many taglines you would need, where they should be located and what their purpose is needs to be evaluated as part of the lift planning exercise and should come out of the risk assessment. Taglines may for instance not be required to stop rotation but may be required to receive, steady and finally position the load, keeping people at a distance.

***Taglines should be used unless they would serve no purpose and could create a hazard!***

Loads suspended from two or more lifting devices (tandem lifts) will not freely rotate in the wind but may swing a little. Trying to use taglines to rotate a load suspended from two cranes is a bad idea.



*This tandem lift will not need to be controlled against rotation but taglines may be required to control swinging of the suspended load!*

## 11 Manual Load Control – hands on the load

There may be instances when it is necessary for one or more persons to put hands on the load to, for instance, fine align a vessel over its holding down bolts. Trying to do this with taglines could prove impossible.

- Never reach above shoulder height to access a load
- Place hands on the surface and never in the or on the end of a load
- Maintain an arm's length away from the load
- Walk the load down, reaching down moves you closer to the load
- Dynamic effects on the load (wind, pendulum actions & swinging) will put you at risk
- Never place any part of your body in between a load and another object (pinch point)
- Make sure that good communication is always maintained especially when hands are on the load.



*Keep toes, fingers etc well away from pinch points; lowering is only to be initiated on the command of the person-in-charge on confirmation all is clear*

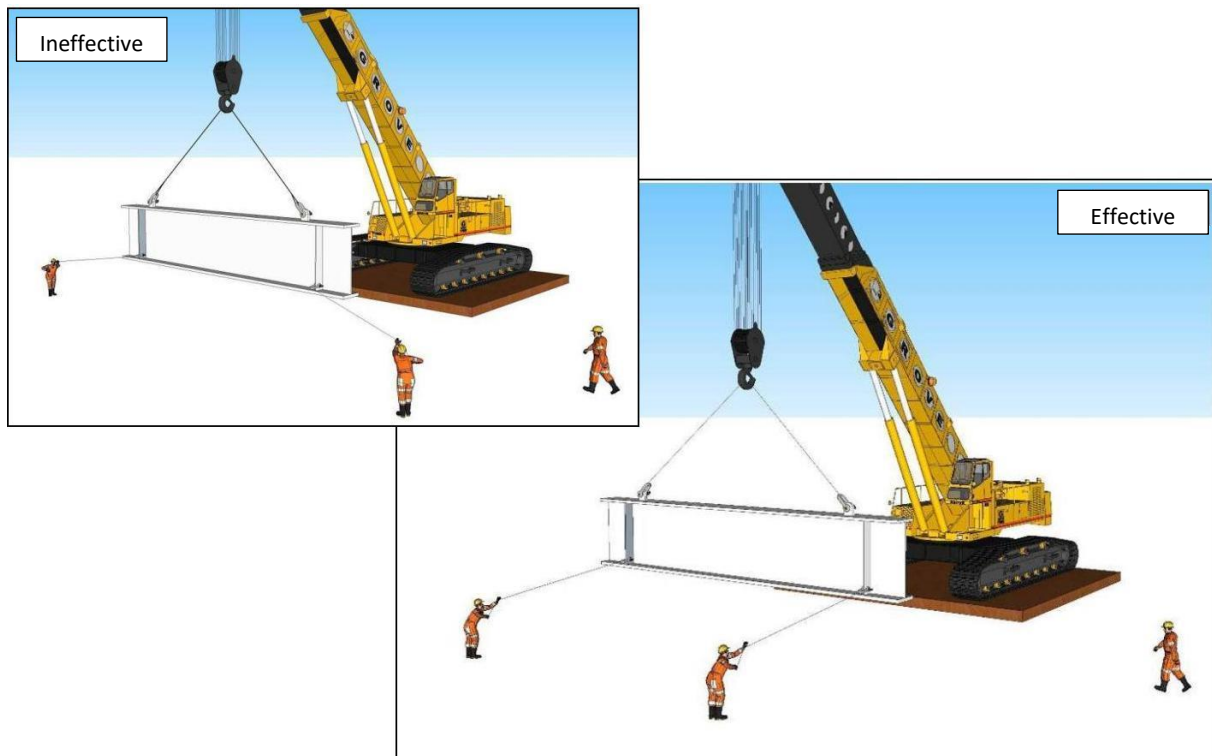
## 12 How much can I pull

How much force can one person pull? The Ergonomics Center reckons a man can be expected to be able to pull (horizontally) a sustained force of between 34-41kg, with the rope at elbow height and allowed free position.

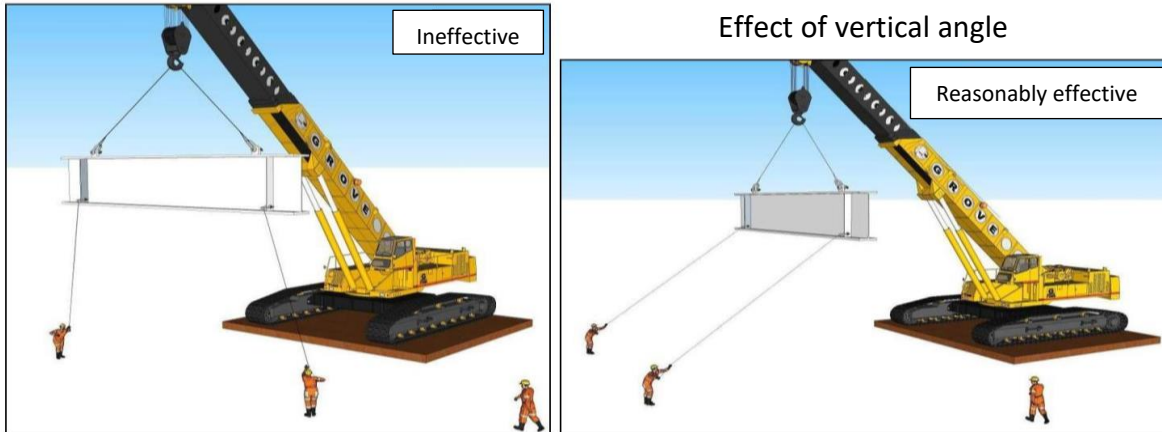
Note that the surface on which the person is standing can affect this. You can imagine that even with two or more taglines on the load, you won't be able to do a lot to directly oppose wind forces on larger loads in even modest winds but you may well be able to prevent the load rotating on the hook. As a rule of thumb, a man might pull a maximum of about 45% of his weight and sustain a pull of about 35% of his weight. This is a bit subjective but gives some measure to work from. If your boots cannot get a good grip on the ground the figures could be a lot less!

## 13 Factors affecting the effectiveness of the “pull”

- ✓ Pull to be as effective as possible
- ✓ Make the moment arm as great as possible
- ✓ Imagine (in plain view), a line from the crane hook to the point of attachment of the tagline, aim for a 90 degree angle to that line



- ✓ Pull is most effective when the tagline is near horizontal
- ✓ Pull is most effective when the tagline is near horizontal
- ✓ At 45 degrees to the horizontal, the pull is only 71% effective
- ✓ Note that as the angle to the horizontal increases, you are pulling down on the load
- ✓ If nearing vertical with the tagline, the pull is all vertical and contributes nothing to rotating (or preventing rotation of) the load
- ✓ When lifting to height, you may start in control of the load but get progressively less able to control it as the lift progresses



## 14 Rotational effects acting on a load

If the wind pressure is uniform on the load, the wind force can be considered to act through the centre of area of the load as presented to the wind.

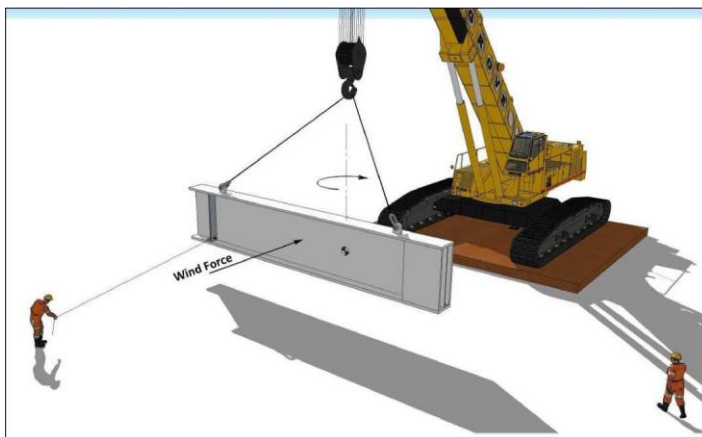
The axis of rotation of a singly suspended load is centred on the crane's hook block bearing and that will naturally lie over the C of G. If the centre of area lies on the same line then the wind force has nominally no rotational effect and the tagline forces are nominal.

A load whose centre of area lies to one side of the C of G will have wind forces acting to one side of the axis causing a rotation. To hold that load static against the wind can require considerable force.

***Do not under estimate this!***

## 15 Assessing forces and rotational effects acting on a load

Wind forces act horizontally on the load and may cause a rotation if the centre of area lies to one side of the axis of rotation



Example:

Consider a plate girder 3m deep x 18m long. It has thick plates at one end forming a node.

The C of G of the girder is 6m from one end i.e. 3m off centre.

The centre of area is at mid length.

Lateral wind forces thus act 3m offset from the line of suspension (centre of rotation).

Let's consider lifting in a 15.3m/s wind (measured at boom head).

The wind pressure ( $\text{kg/m}^2$ ) is given by  $P=0.0625V^2$  (where V is mph). At 15.3m/s, the pressure is about  $14.6\text{kg/m}^2$ . With a projected area of  $54\text{m}^2$  (assuming shape factor = 1), the wind "force" (at 15.3m/s) =  $14.6 \times 54 = 788\text{kg}$ . The moment =  $788 \times 3 = 2364\text{kg.m}$

If a single tagline is used at the 6m end (and it is in tension) and it is pulling horizontally at 90deg to the plate girder, the moment arm is 6m and the tension =  $2364/6 = 394\text{kg}$ . This is way too much for one person to control. If the wind speed is reduced to say 9m/s, the rotation becomes approximately  $818\text{kg.m}$ . If two taglines are used, one at either end, both resisting rotation in the same direction, the required force each has to provide is about 45kg, which might just about be achievable. Given that the shape factor is likely greater than 1, and you may not have a perfect 90 degree purchase on the



load and the tagline may be inclined vertically, it would be advisable to have two persons on either line. Note also that you may not be guaranteed that the load will always want to turn in the same direction particularly if you have to slew (swing) the crane or that you will not need to correct an over-correction. So it may be necessary to provide 4 taglines, 2 rotating clockwise, and two counter-clockwise (each with two persons on them).

## 16 Other considerations

- 1) Guiding a load in a dead calm only requires overcoming the resistance of the bearing. Forces will be small
- 2) Once a heavy load is moving it has inertia and can take a lot of stopping
- 3) Wind speed increases with height
- 4) Wind funnelling can occur around structures, e.g. concrete cooling towers. This can cause localized zones of high wind velocities.

## 17 When to lift and when not to lift

As can be seen from the preceding there are a number of factors that come into play when lifting that affect the ability to control the load, they include:

- ✓ Prevailing (and predicted) wind speed at the height of the lift when conducting the lift
- ✓ Possible wind funnelling effects, exposure when clear of structures
- ✓ Possible gusting
- ✓ Size of load, shape of load, weight of load
- ✓ How close to capacity the crane is
- ✓ Criticality of clearances between the load and the crane, structures, lines etc
- ✓ Whether it is a single crane or a tandem crane lift
- ✓ Ability to locate taglines and tagline handlers to maintain adequate “purchase” on the load during lifting, i.e. maintain effectiveness of taglines
- ✓ A limiting wind speed in the crane manual doesn’t necessarily mean it’s safe to lift a particular load at that wind speed
- ✓ Some capacity charts are based on a particular limiting wind speed and sail area
- ✓ Other charts simply require “operator judgment to be exercised”
- ✓ If a load cannot be safely controlled it should not be lifted. That judgment is going to fall on the crane operator ultimately and is necessarily somewhat subjective; it must be respected.

## 18 Plan your tagline use

**How many taglines are required?**

- ✓ All you can achieve with a single tagline is to resist movement of a load away from you (or pull it towards you)
- ✓ It is not acceptable to dart across from one side of the load to the other with a tagline to correct an over-correction
- ✓ **Remember: you cannot push on a load with a tagline!** If you have to push, push poles may be used
- ✓ Generally two lines will be required to adequately control a load against rotation. To control swinging, both will have to apply load.

Remember that if attempting to control a long load at height with the tagline at a steep angle to the horizontal, the force you apply to a tagline has a horizontal component (that you want), and a vertical component (that you don’t want) that is trying to drag down the end of the load to which it is attached. Using two taglines may help balance that.

There are instances as noted above (particularly on large long loads) where 4 taglines may be required allowing control of swinging in both directions and allowing two persons to control rotation in either direction. Good communication is required in such cases! Also note that when erecting steel generally only one tagline is used to receive the steel then orientate as needed. The tagline is usually put on the numbered end of the piece so that the connectors know which end of the steel goes where

During steel erection the practice of Xmas-treeing steel presents other hazards. A good practice is to bring the bottom piece of steel in at waist to shoulder height of the personnel and then move into place. This prevents the load from having to be lowered over the top of the personnel.

In cases where this is not feasible allowing the personnel to move out of the way then lower the load to the required height then the personnel move in and place the steel in place is another option. This practice requires well trained personnel who are experienced in steel erection (crane operators, ironworkers and supervision).

## 19 Where to attach a tagline

Taglines should be attached:

- 1) As close to the end of the load as feasible for ease of control as explained earlier; also for ease of retrieval when accepting a load
  - 2) To the rigging assembly when setting loads with complex rigging arrangements at heights for control of the rigging assembly back to the ground. Shorter taglines may be needed for the personnel at heights to take over the control of the load once near the setting point. This would also be advantageous when setting loads over power lines ([this would need to be planned carefully](#)).
- ✓ At the corners of loads with large sail areas and pieces of equipment that may require more than two taglines
  - ✓ To a lug, nozzle, structural member or other substantial and solid member capable of taking a significant force without being deformed or damaged or moving

Taglines should not be attached to:

- ✓ the rigging supporting the load (unless that is the only option and is assessed to be safe to do so)
- ✓ door handles, valves or items of equipment
- ✓ where they could slip off as the operation proceeds

## 20 How to attach taglines to the load

- 1) Use of a bowline or mechanical hook to a fixed point

Attachment point to be:

- ✓ Structural and sufficiently substantial for the forces envisaged
  - ✓ Secure such that the tagline will not slip and come off in use or the attachment point move relative to the load
  - ✓ Not likely to be damaged by this use
  - ✓ Not likely to significantly damage the tagline
- 2) Use of a clove hitch ( without and with a stopper knot)
  - 3) Use of a choked loop (with a tied bowline, a braided eye and a mechanical hook)
  - 4) Connected to the rigging assembly or the rigging assembly and the load for control by personnel at heights

## 21 How long should the tagline be

You first need to decide what control is required:

- ✓ Is it required only during uplift and receipt?
- ✓ Is control required throughout the entire operation?
- ✓ Will control have to be handed off to (say) height during a lifting operation?
- ✓ Will I have to let go of the tagline(s) at some point? If so, will they be a hazard?

The lines need to be:

- ✓ Long enough to keep your body parts out of harm's way
- ✓ Long enough to reach the load from where it will be to where the handler has to stand (with some reserve) considering the load height
- ✓ Long enough so that the handler can be positioned so that the angle of the tagline to the horizontal does not get so steep that control becomes impossible as the lift proceeds
- ✓ Not so long as to create a snagging hazard

There should always be a clear line from the handler to the point of attachment so that the tagline does not have to pass over or under or around parts of the load as the operation proceeds.

## 22 Where to stand when using taglines

As noted earlier, taglines are most effective if their line of action forms a 90 degree angle (in plan view) to an imaginary line from the C of G to the attachment point. Tagline handlers should aim to position themselves as close to that as possible, consistent with being in sight of each other. As a load is turned (rotated), this angle will depart from 90 degrees and the pull becomes less effective. It may be necessary for handlers to relocate to regain better "purchase" on the load.

## 23 Moving with a load

As much of lifting involves relocating a load either by hoisting, swinging, booming out, crawling or some combination thereof, tagline use needs to reflect this.

- ✓ Persons handling taglines will either need to move with the load and/or be able to pay out the tagline.
- ✓ Note extent of correctional rotation required between start and finish and plan for it.
- ✓ Plan for guiding the load between obstructions.
- ✓ Plan a clear foot path for handlers.
- ✓ If duplicate taglines are required, plan hand over of control

## 24 Lowering down shafts

When lowering loads down shafts it may only be possible to effectively control rotation at the shaft opening before lowering and on receipt at the bottom. Rotational control may not be possible down the entire shaft and the risks that may or may not pose should be considered.

Taglines may need to be released at the top and retrieved at the shaft bottom. The potential for snagging of the taglines needs to be addressed.

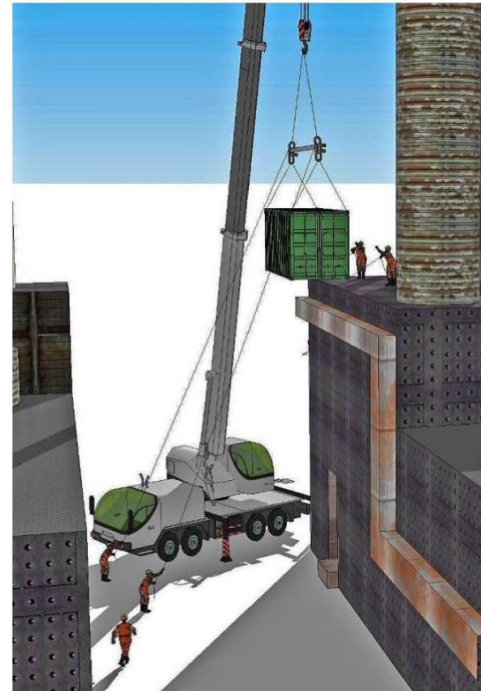
Points to consider in preparing a tagline plan for lowering down a shaft:

- ✓ What rotational / swing control or adjustment of attitude is required from uplift to shaft opening?
- ✓ How many tag lines are required?
- ✓ How long do they need to be?
- ✓ Where can handlers stand?
- ✓ How critical is rotational control as the load enters and is lowered down the shaft? Can that be controlled if required?

- ✓ At what point should taglines be released (if that is necessary)? Will they cause a snagging hazard?
- ✓ Are taglines required for receipt at the shaft bottom? How many, how long, how are they safely retrieved?
- ✓ Hand-over and signalling protocols.

## 25 Lifting to height

- ✓ Loads may suddenly be subject to wind when clear of surroundings
- ✓ As the lift progresses the increasing vertical angle may render the control ineffective
- ✓ Loads lifted high onto structures may require a two sets of taglines (long and short), a protocol for transfer of load control must be established
- ✓ The potential for taglines to snag on the surroundings when lifting / lowering / manipulating the load must be addressed and managed.



## 26 Receiving a load

If persons receiving a load need to retrieve a suspended tagline from the load they are receiving, a boat hook or similar should be used to avoid having to get close to or under the load

## 27 Key tagline considerations

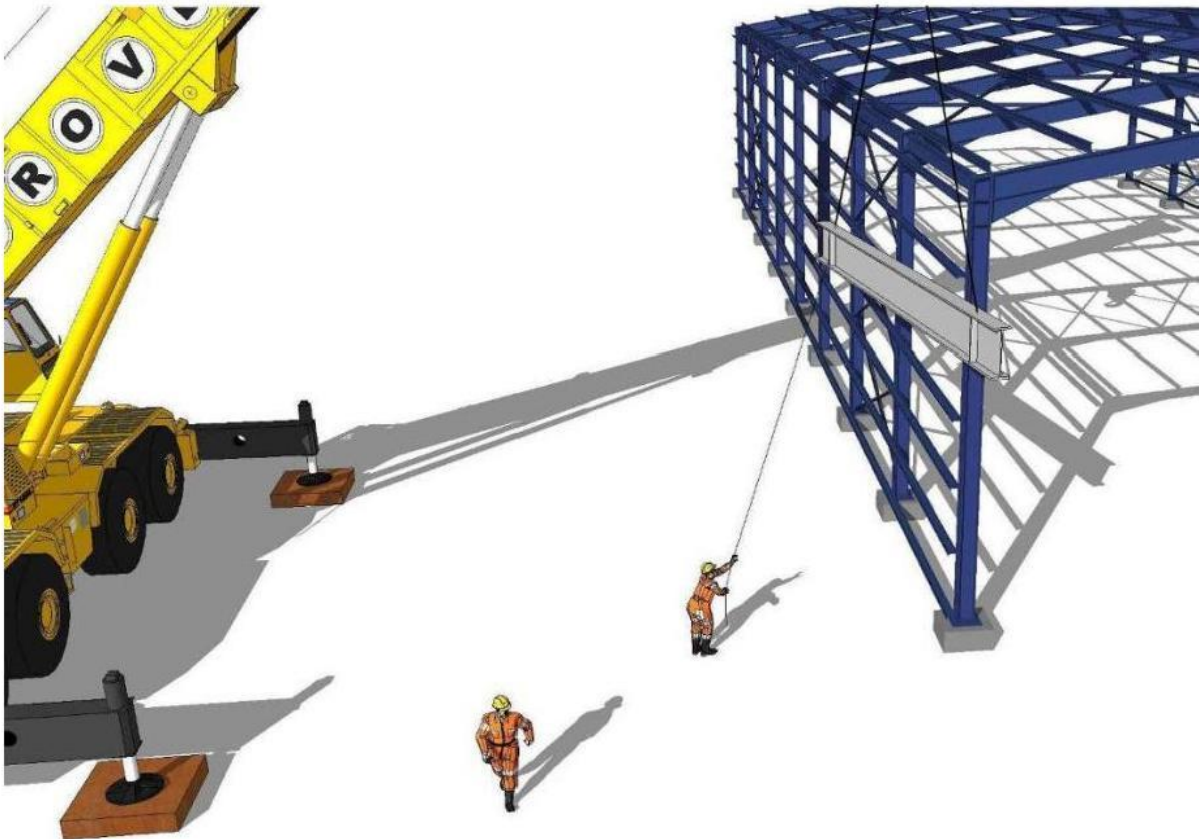
- ✓ Type of load
  - Small Short loads (beams & straight run pipe)
  - Long Light Loads (rebar or bundles of small bore pipe)
  - Large Light Loads (sheet steel, form panels & or wall panels)
  - Large Heavy Loads (compressors, lube oil skids & or generators)
- ✓ Loads at Heights (steel erection, setting equipment in or on structures & or wind turbine work)
- ✓ Wind Conditions (shape of load)
- ✓ Travel Path (clear or congested)
- ✓ Orientation to Boom (will it need to be turned during lift)
- ✓ Hand Off to Other Personnel (at height or in excavation)
- ✓ Power Lines (going over or working close to)
- ✓ Number of Personnel Needed (their lines of sight to operator and each other)
- ✓ No knots in the body or on the tail end of taglines
- ✓ Mechanical Assistance (capstan hoist) required?

## 28 Tagline safety

- ✓ Use taglines to control loads when their use is practical and will not create additional hazards
- ✓ Always use a rope intended and recommended for tagline use
- ✓ Use a tagline that has the appropriate length
- ✓ Wear gloves when handling the tagline
- ✓ After securing the load with taglines, stay clear of the load and well forward of the load
- ✓ Never wrap the tagline around an arm or leg in an attempt to stop a load's swing
- ✓ Keep the "spare" end of the tagline tidy so as not to be a tripping or snagging hazard and to allow unimpeded "paying out" as required
- ✓ Do not tie knots in the tagline
- ✓ Assess the path of the lift and remove any obstructions prior to commencing the lift
- ✓ If it's necessary to guide the load, stay well away from the wheels or tracks of the crane
- ✓ When guiding load, remain clearly visible to the crane operator at all
- ✓ Ensure the lifting area is barricaded off and appropriate tags are affixed informing other workers of the operations
- ✓ Never step into a loop in a tagline
- ✓ Never place yourself between an immovable object and a load that is not firmly on the ground
- ✓ Do not position yourself where you could be trapped as the operation proceeds
- ✓ If you must, you should release the tagline to avoid becoming trapped or pinched
- ✓ Be very aware of power lines in the proximity of the lifting operation. Even synthetic slings can conduct an electrical charge if damp.

## 29 Exercises

Is this load under control? What thoughts do you have regarding this set-up?



**Disclaimer**

This guideline should be considered as best practice for the subjects addressed, though is not exhaustive for all possible work activities related to the installation and use of taglines. Use the content provided herein, experience and the conditions as presented by the load, the personnel, the work environment and the load handling equipment when determining the best placement and use of taglines and above all: always comply with applicable legislation, rules and regulations.