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PROCEDURE FOR MAKING TANDEM CRANE LIFTS IN THE USA

A two crane or tandem crane lift is where two cranes are used to support a load where their hooks are attached directly to an equalizer beam or to the load by slings or lugs. Up ending a vertical vessel using two cranes on the top end and a tailing crane of the bottom end would still be considered a two-crane lift.

There are two ways to make a two crane lift, equalized and unequalized.

Equalized lift:

One way a lift can be equalized is where the load is supported by a link and pin at the center of an equalizer beam and both crane hooks are connected to either end of the equalizer beam with links and pins. For the beam to be a true equalizer beam, the three pins must all be on the same centerline. If they are, each crane will maintain it's designed share of the load through out the lift. If the holes or pick points are not all on the same level, then the beam is not a true equalizer beam and as the beam becomes out of level during the lift, one crane will receive more load than the other. Therefore, some beams are more equal than others.

For a lift that is equalized, the load to each crane is kept at 90% or less of the lifting capacity chart of each crane. Extreme care must be used to ensure that a predetermined out of levelness of the beam is not exceeded during the lift. The maximum out of levelness of the beam is determined by the angle of the beam where there is a physical interference between the beam and one of the links. It is recommend that the out of levelness be determined with a 5:1 safety factor, ie, if there is an interference between a link and the beam when the crane hooks are out of level from each other by say 5 feet, then the level of the beam should be kept so that the crane hooks are not out of level by more than one foot during the lift.

Another way where a lift could be considered equalized is where the load to be lifted is very long, (like a horizontal drum or bullet), and the lift cranes are hooked near each end where a foot of difference in elevation between crane hooks will only throw about 0.5% of load to the high hook. Lifting by lugs on top of the load will throw more load per foot to the high hook than if the bullet was lifted using basket hitches where the rotation point is down close to the centerline of the bullet.

In most cases, an equalized tandem lift would be allowed in an operating unit with the same restrictions as for a one-crane lift. That is, the lift would be classified as a critical lift, i.e., the load would have to be known within .5%, the soil loads would have to be well below the allowable soil loading (probably the cranes would have to be on mats or piles), no swinging or booming of the cranes would be allowed, the cranes would have to be extremely level and working below the Manufactures recommended wind speed, etc.

Un-equalized lift:

An un-equalized lift is where two cranes are hooked directly to the load and any out of levelness of the hooks causes a large increase in load to one crane. An example of an unequalized lift is where two cranes are up ending a vertical column and the hook for each crane is hooked directly to a lift lug on each side of the column. Depending on the location of the CG, a foot of elevation between hooks can throw a large percentage of the load to one crane or the other.

If the lift is unequalized, then each crane must be derated down to 75% of the lifting chart for the boom length and radius being used. Extreme care must be used to ensure that a predetermined out of levelness of the crane hooks is not exceeded during the lift. As with equalized lifts, it is recommend that the out of levelness be determined with a 5:1 safety factor. For example, the maximum out of levelness between hooks should be calculated where the first crane reaches its 75% of capacity. Then divide this vertical out of levelness by 5. The result should be used during the lift.

The above refers to engineered lifts. It would probably be a good idea to derate the cranes even further for field designed lifts.

Main factors for controlling an equalized two crane lift where no swinging or booming is allowed:

CONFIGURATION OF THE TWO LIFT CRANES:

It is recommended that both lift cranes be the same model and be configured with the same length of boom.

LAYOUT OF THE CRANES ON THE LIFT PADS:

It is recommended that the cranes not be facing directly toward each other for the lift. They should be positioned approximately 15° off-center from a baseline that runs thru the lifting lugs and the center of the foundation. The following procedure can be used in the layout of the cranes and the lift pads. For the purpose of this discussion, assume that the head of the vessel is pointing north and it will be laid out in the initial pick position (IPP) with the lifting lug(s) over the centerline of the foundation and the vessel itself on a south radial from the foundation. The IPP is when the vessel is in the horizontal.

1. Have the surveyors lay out a north-south line on the ground that starts at the centerline of the foundation and continues south along the centerline of the vessel, as it will be when it is in the IPP.
2. Lay out an east-west line that will intersect the north-south line at the centerline of the foundation and the lift point(s) on the vessel, ie, thru both lifting lugs or a flange lug.
3. On the east-west line, measure off the distance from the centerline of the foundation to the pick point of each crane as determined by the lift points on the equalizer beam. Mark both of these points on the foundation or ground and label them west crane and east crane.
4. Lay out a centerline for the west crane along a 285-degree radial starting at its pick point. Lay out a centerline for the east crane on a 75-degree radial from its pick point.
5. Lay out the operating radii for the two cranes from their pick points to their center of rotations as determined by the crane studies. Mark the centerline of rotations for both cranes. This will place both lift cranes 15 degrees north of the east-west line.

   In my experience, it doesn't matter if both cranes are position north or south of the east-west line. The important factor is controlling the tail crane so that all three hoist lines are kept plumb during the upending. This way, the vessel won't be pushing the lift crane hooks into their respective booms if the cranes are setting north of the line or pushing the hooks away from their booms so their radii is increased if the cranes are setting south of the line.
6. In most cases, the crane tracks or the truck crane carriers can be oriented to suite the field.

MAINTAINING THE OPERATING RADII, the draw down:

Once the crane hooks are up in the air, it is pretty hard to visually tell if they are over the original pick points. There are several ways to make sure that the cranes are working at their planned radii. The following methods are for one crane but apply to both cranes.

1. With the crane in place on the lift pad and the hook centered over the pick point, make a match mark on the boom stops that can be spotted from the ground. During the lift, assign someone to monitoring the match marks to ensure that the boom angle has not changed. This is fairly accurate, but it must be remembered that some rotation of the crane itself might occur due to settlement under the crane mats. This would increase the radius of the crane.
2. A more precise way would be to monitor the boom tip with a transit. Set up the transit perpendicular to the boom tip and monitor the tip for draw down during the lift. The signalman would have the operator boom up as necessary to maintain the planned radius.

MONITORING SIDE LOADING OF THE BOOM:

Side loading of the boom occurs when the load block is not hanging directly under the boom tip. When the hook is not connected to a load, it acts like a large plumb bob and is very useful in checking the level of the crane in a side ways direction. If the crane is level side ways, the load block should hang in the center of the boom as viewed along the longitudinal centerline of the

crane. When the hook is connected to a load, it is not free to hang free as a plumb bob. The following steps should be taken to ensure that the boom is not side loaded.

1. With the crane hooked up to the vessel in the IPP; make a match mark on the turntable or the Rotec bearing. Assign someone to monitor the match mark to ensure that the crane does not swing during the lift.
2. Assign someone to look thru the boom and monitor the position of the load block during the lift. The load block should stay pretty much in the center of the boom. If the boom is solid, ie on a hydraulic crane, the spotter should look on both sides of the boom to make sure the load block stays within the envelope of the boom. If the load block is forced out of the envelope of the boom, then side loading is occurring. The lift should be stopped until the load block is brought back into place under the boom tip.

MONITORING THE LEVEL OF THE EQUALIZER BEAM:

Determining the amount that the hooks can be out of level with each other during the lift is the easy part. Monitoring the actual out of levelness during the lift is more difficult. The level of the equalizer beam can be determined in one of two ways, using tapes or a transit. Using an inclinometer is probably the best way, but it is rather expensive to purchase. The transit method is probably the second best way due to the fact that only one person is involved and the tapes tend to whip around a bit due to the wind.

1. An inclinometer usually has a magnetic base that will clamp directly to the top of the equalizer beam. It has a scale marked off in increments of degrees in two directions and a built in potentiometer. A hand held receiver that can either be connected to the inclinometer by a cord or by remote also has a potentiometer in it so that the degees the equalizer beam is out of level is displayed. The person monitoring the inclinometer can read the amount of degrees the equalizer beam is out of level.

2. A transit can be used to monitor the out of levelness of the equalizer beam. Before the lift, attach a vertical scale to each end of the equalizer beam at the lift pins. The scales should be free to hang like plumb bobs from the pins. The scales should be marked off in inches or centimeters with zero at the center of the pins. The length of the scales should be the maximum out of levelness value plus 12" (30 cm).

   The transit should be located perpendicular to the equalizer beam and far enough away to maintain a 2:1 slope. During the lift, the surveyor would keep his horizontal stadia cross hair centered on the lowest lift pin. He could then determine the amount the beam is out of level by reading the scale on the high lift pin.

3. The tape method involves hooking a long tape to each end of the equalizer beam. The tapes are then run down vertically and around pins located at ground level. They are then run horizontally out from under the lift a safe distance to a monitoring station. When the cranes are hooked up to the vessel in the IPP and the hoist lines are snugged up with the beam level, a reading for each tape would be taken at the monitoring stations. The distance to the monitoring stations would be adjusted as required to ensure that both tapes

are reading the same. During the lift, the difference in the readings should never be more than the out of level tolerance.

END OF PROCEDURE