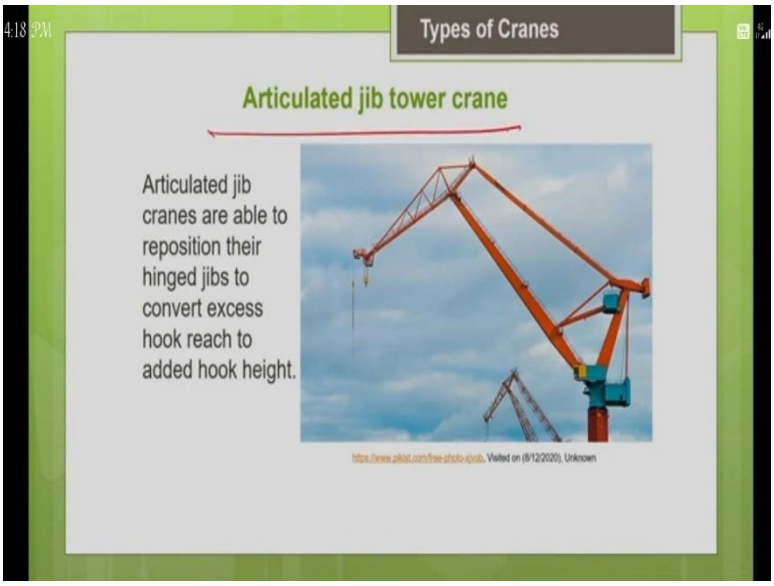
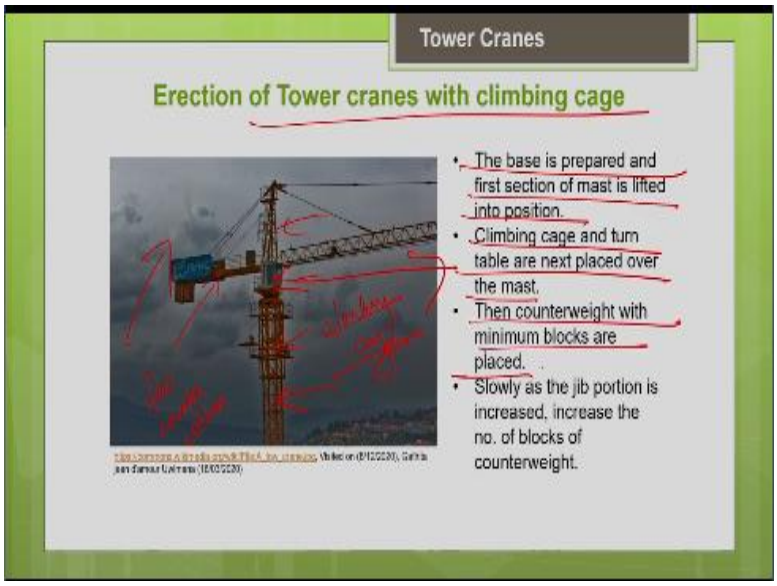


There is another type of jib apart from the horizontal boom, luffing boom. You also have this articulated jib tower crane. You can see the picture. See, these articulated jib cranes are able to reposition their hinged jibs to convert the excess hook ridge to added hook height that means so, you can reposition the jib in such a way that. So, whenever you do not need excess horizontal reach, you can convert the horizontal reach into vertical height.

You can convert it into hook height. You can make the adjustments accordingly. You can just reposition the hinge. So, that the excess horizontal reach can be converted into vertical height. The excess horizontal reach can be converted into vertical height so, according to your requirement but these are also very costlier cranes articulated jibs.

(Refer Slide Time: 24:10)



Now, let us see how the erection of the tower crane is done with climbing cage. In modern tower cranes, we have this climbing cage facility which facilitates the self erection process of the crane. So, basically, what you have to do is first, you have to prepare the foundation for the tower cream that is very important. You have to prepare a heavy foundation for the tower crane according to the requirement, put heavy reinforcement and then both the tower sections to the foundation after construction of the first few sections of the tower crane.

Now, what you do is, you erect your turntable or this slewing ring, operator cap and the tower top. For all these things, we need the support of another mobile crane. With the help of another mobile crane, you erect the turntable, climbing cage, this is your climbing cage, climbing cage with the hydraulic jack system. You will be seeing a hydraulic cylinder here which helps the lifting.

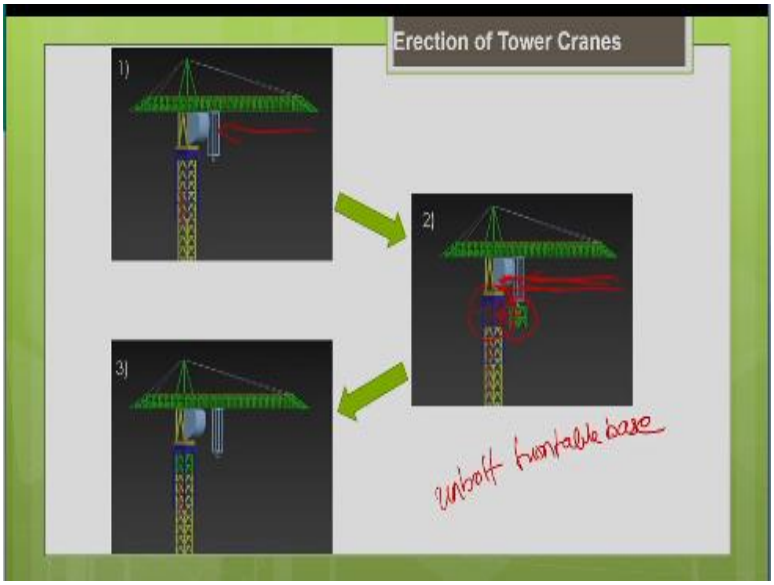
So, the first, you put the foundation few sections of the tower mask you erected, bolted to the foundation then erect your climbing cage, your turntable or the slewing ring and the operator cap. And the tower top, you erect it. Then now, you put the counter jib with few counterweights. First, you put few counterweights, then slowly increase the jib portion.

As you increase the jib portion sections, you can increase the number of blocks here; number of counterweight blocks. Now, when this is done, till this, you need the support of another mobile

crane. After this, you can do the erection process yourself with the climbing cage help without the help of another crane. So, that is the advantage of the climbing cage. So, let me summarize.

So, basically first what we do is; the base is prepared with the proper foundation and the first section of the mask is lifted into position with the help of another mobile crane. Climbing cage and the turntable are takes place over the mast. Then the counterweight, there is a counter jib with the minimum blocks are placed, then slowly increase the jib portion and correspondingly increase the number of blocks of counterweight in the counter jib also.

(Refer Slide Time: 26:41)



Once this is done, then you can do the self-erection of the tower crane. So, how to do that? First, what you do is, you have to introduce a new section to increase the height of the tower crane with the help of trolling action. You know the trolling rate. There is a trolley here in the main jib. By the trolling action so, you can bring the, you see, here you can see, this is a new section.

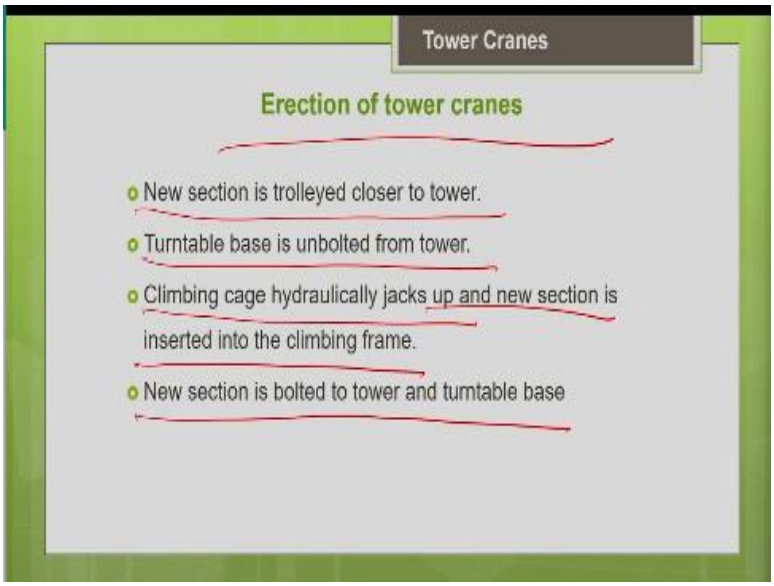
The new section is brought closer to the tower with the help of the trolling action. Now, what you do is unbolt your turntable base, unbolt your turntable base, unbolt it and lift it with the hydraulic jack in the climbing cage. This blue colour one is your climbing cage. So, this has a hydraulic cylinder, hydraulic jack system, you can see here. So, now, you unbolt the turntable and lift it with a hydraulic jack. So, that you can create the space to introduce a new section.

You are going to create a space below the turntable. So, that you can introduce a new section below the turntable. Now, once the space is created, now, you introduce a section into this space into this climbing cage. Now, you bolt the new section to the turntable as well as to the remaining portion of the tower. So, that is how the new section is now connected. So, like this, you can keep on adding the sections.

Every time, you have to do the trolling action and bring the new section near the tower and lift the turntable, unbolt the turntable, lift the turntable with the hydraulic jack, then introduce a new section, then again bolt it. Like this, you can keep on adding the section for the erection of the tower crane. This is called as a self erecting procedure. Similarly, if you want to dismantle it, you do the entire thing in the reverse order.

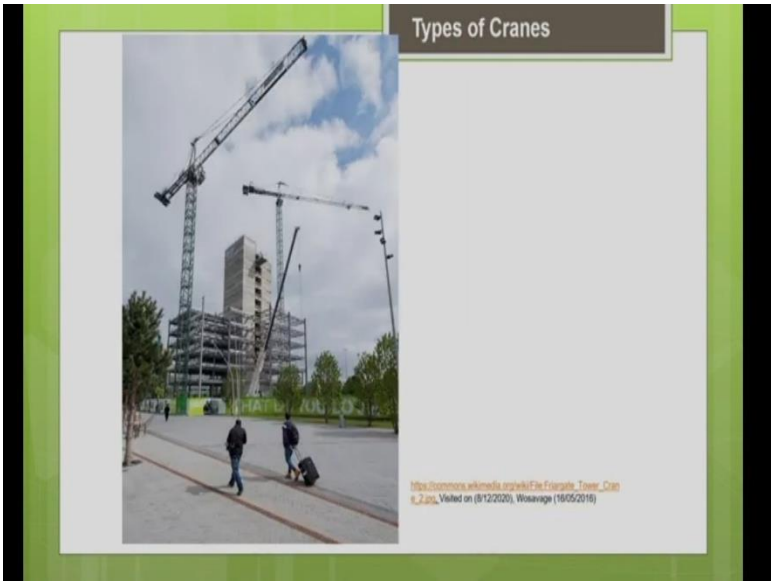
So, you can remove the section one by one with the tower crane. After the desired height is reached with the help of another mobile crane, you can remove the jib and the counter jib portion. That is how they dismantle it with the climbing cage. So, with the climbing cage, the process is relatively easier and the time consumption is also less. We do not need the support of another mobile crane for the entire process of erection. Only for the initial stage, we need the support of the mobile crane.

(Refer Slide Time: 29:10)



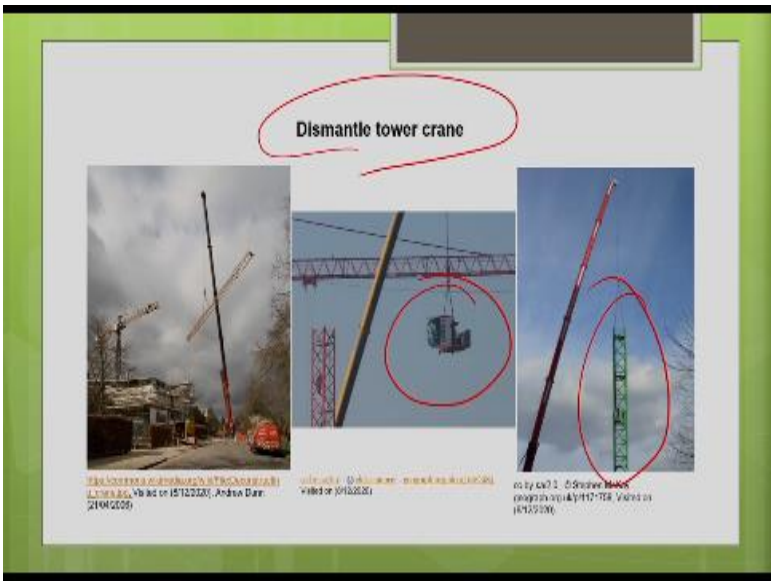
So, let me summarize what we discussed here for the erection of tower crane with the climbing cage. So, first, you bring the new section, it is trolleyed closer to the tower. Now, the turntable base is unbolted from the tower. Climbing cage hydraulically jacks up and a new section is inserted into the climbing frame. The new section is bolted to the tower and the turntable base. So, every time, you introduce a new section below the turntable base that is how you can increase the height of the tower crane.

(Refer Slide Time: 29:44)



So, always for the erection of tower crane, you can see the mobile cranes are always standing nearby. It will help in the erection of the tower crane.

(Refer Slide Time: 29:55)



So, dismantling procedure of tower crane, say, if it is going to be climbing cage, it is going to be easy. If there is no climbing cage, we need the support of another mobile crane for the entire process. Say, first, you have to remove the trolley part you have to remove the trolley. So, after removing the trolley, you remove the counterweights. You remove the counterweights then you remove the jib. So, then you remove the counter jibs.

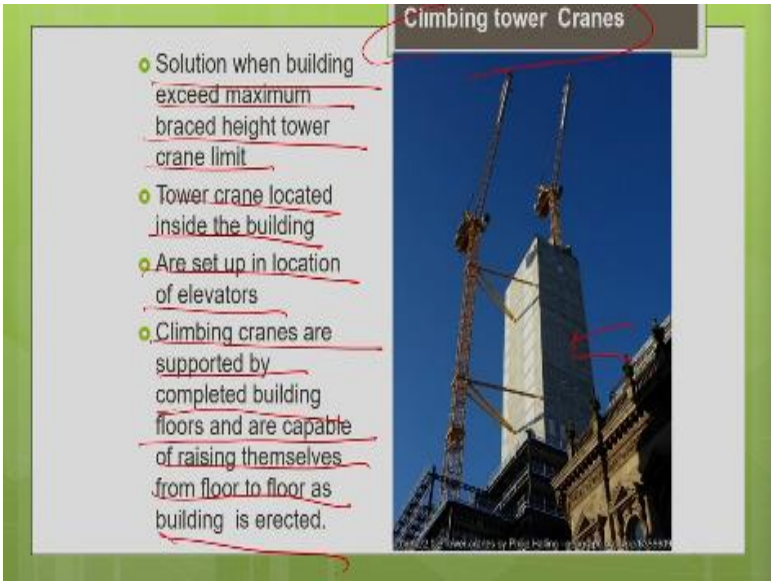
So, after that, you remove the operator cap and the tower top and the turntable, remove that portion. So, turntable with the operator cap and the tower top will be removed. So, after that, we remove all the sections one by one with the help of another mobile crane. So, this is how the normal dismantling procedure of the tower crane goes. You need the support of another mobile crane for the entire procedure if you do not have the climbing cage.

(Refer Slide Time: 31:03)

So, another important thing, you need to know that is the maximum free standing tower crane height permissible is 60 to 120 meter. So, beyond 120 meters, the tower crane should take the help from the structure. You should properly brace it to the nearby structure to transfer the overturning movement to the structure from the stability point of view. So, after 120 meters, definitely should provide the lateral bracing. The crane must be tied to the structure and the construction.

So, even with brazing, you cannot go beyond 300 meters; maximum brace height possible is only 300 meters. Beyond 300 meter even with brazing, it is not allowed from the stability point of view.

(Refer Slide Time: 31:53)



Say, for example, you need a tower crane for a structure which is greater than 300 meters. So, in that case, what is the option available? There are certain special cranes called as climbing tower cranes which can grow along with the structure. These grains are generally shorter but it will grow along with the structure. So, basically, what this climbing tower grains will do is; it will take the support from the actual structure which you are going to construct.

We usually provide it in the opening of the lift or the elevator. So, in that location, you can place this tower crane. Initially to start with, it will take this support or the base from the foundation of the structure, actual foundation of a building. From the foundation of the building, it will take its base. Then as few floors are completed, then what you do is, you detach this tower crane from the foundation of the structure and then on to the desired flow level, you should shift it and attach it with the special collars to that particular floor.

So, that is why when you design this particular structure itself, you should know that it has to support the crane also and then load from the crane also that has to be taken into the structural design of the structure. So, as the structure grows, you keep on shifting the tower crane. You detach it from the particular floor and attach it to a new floor with a special collar arrangement and this is possible with a hydraulic jack system.

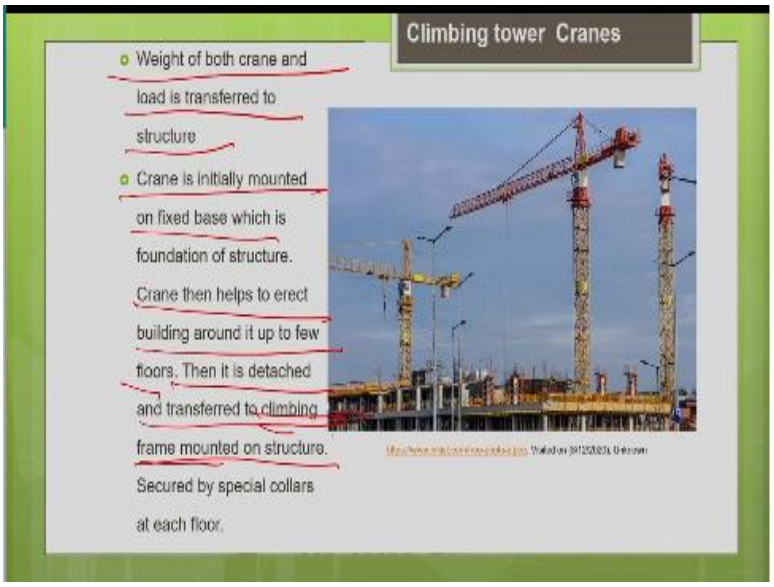
So, that is how it keeps on growing and finally, it will stand at the top of the tower. Now, either you can leave it as such for the maintenance purpose or you can remove it. If you want to remove it, what you can do is; if you have a mobile crane which can reach this particular height, then with the help of the mobile crane, you can remove it or if you do not have the mobile crane which can reach this height, then what you do?

You have to construct a simple derrick on the roof top. That derrick can be constructed with the help of already existing climbing tower crane. So, now, with the help of derrick after the construction of derrick, you can dismantle this crane. This dismantles the climbing tower crane. Then after dismantling the climbing tower crane, you can dismantle the derrick also and then both the things can be transferred either to the lift or through even in certain cases, they even take the help of a helicopter to transfer the components.

So, depending upon the requirements, you can remove the components of the crane from the structure. So, let me summarize what we discussed just now. The solution when building height exceeds the maximum braced height tower limit is your climbing tower crane. This tower crane is located inside the building. Mostly it is set up in the location of elevators or the lift. So, that you can use that for the construction of the lift.

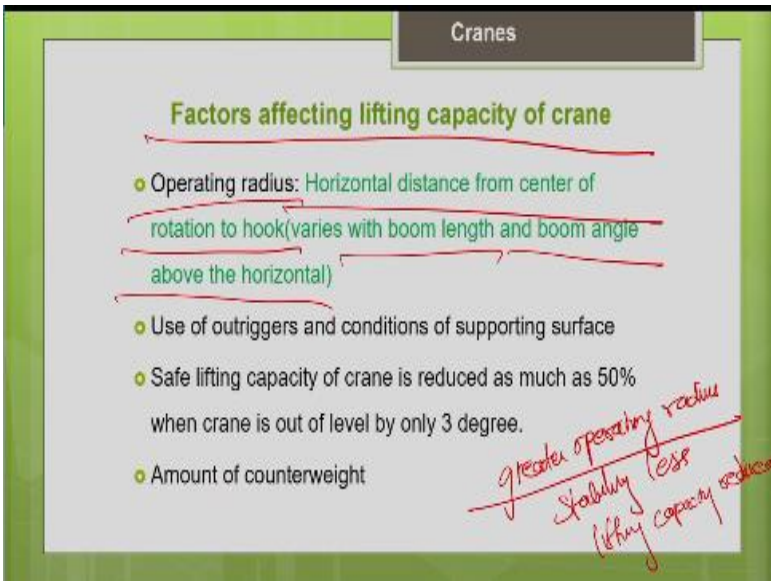
Climbing cranes are supported by the completed building floors and they are capable of raising themselves from floor to floor as the building is erected. That is why I told you, this crane will grow along with the structure.

(Refer Slide Time: 35:02)



Weight of both the crane and the load, the crane is transferred to the structure. So, the crane is initially mounted on the fixed base which is the foundation of your structure. Crane then helps to erect the building around it up to few floors. So, after the completion of the floors, the crane will be detached from the foundation and then it will be transferred to the climbing frame mounted on the structure. So, you can keep shifting the crane from floor to floor as needed with the help of the climbing frame as we discussed earlier with hydraulic jack system. So, to every floor, you can secure it with special collars at each floor.

(Refer Slide Time: 35:45)



So far, we have discussed about the different types of tower cranes on the basis of method of slewing, top slewing, bottom slewing and on the basis of the type of boom, horizontal boom, luffing boom and articulated jib and special tower cranes like climbing tower cranes particularly for very tall structures. All these things are discussed. Now, let us move on to the next topic, what are the factors what are the affects the lifting capacity.

Generally, for any crane, what are the list of factors which affects the lifting capacity of the crane. So, what is the operating radius? As you know, operating radius is nothing but your distance from the centre rotation, centre of axis of rotation of the crane to the hook point that is here. That horizontal distance is called as the operating radius. So, that is going to vary with your boom length. Greater the boom length, operating radius will be more.

It depends upon the boom angle also. So, if you are going to have a luffing boom so, your boom angle is going to determine your operating radius. So, as I told you earlier, at greater operating radius and we have even seen the load radius diagram for the mobile cranes as well as for the tower cranes. So, we have seen that greater operating radius, your stability of the crane is less at greater operating radius. As the load lane moves away from the centre of the crane, the stability gets reduced.

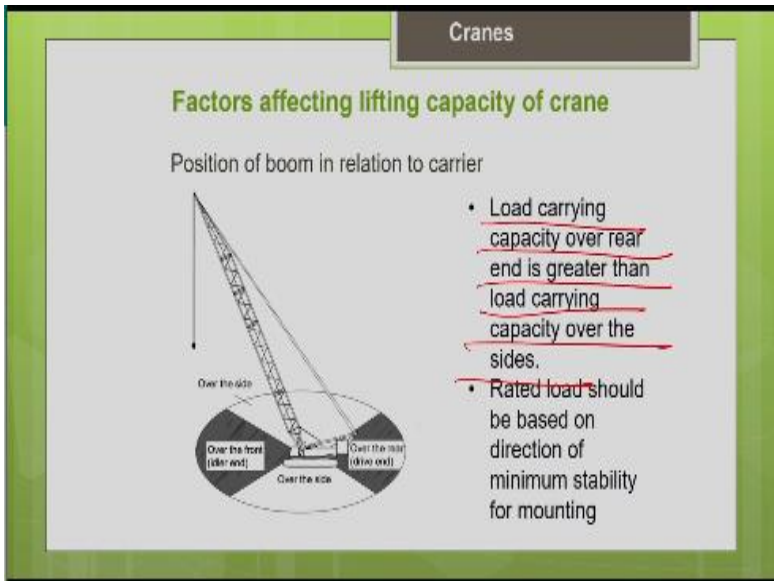
So, the lifting capacity gets reduced. This, you should always keep in mind. At greater operating radius, lifting capacity is less because the stability is less. At lesser operating radius, you can see that stability is more; lifting capacity is more and use of outriggers, if it is going to be a tire mounted crane. If you do not use outriggers, your stability is affected. So, lifting capacity is reduced and the condition of the supporting surface, your surface should be level.

You have to level the surface. The soil bearing capacity should be good. Otherwise, your lifting capacity will get reduced. It will affect the safety of your crane. I have even shown you a picture the crane toppled over because of the poor or weak soil. So, safe lifting capacity of the crane is reduced as much as 50% when the crane is out of level by only 3 degree. When the level of the surface is gets reduced by 3 degree, you can see that the lifting capacity of the crane is reduced as much as 50%.

So, the amount of counterweights what you are going to use that is also going to decide the lifting capacity of the crane because that is only going to resist your overturning movement and apart from this, you should also consider the structural frame capacity. Every crane has its own structural limitations. Beyond that it is not possible to load the crane because other than the tipping failure, there is also structural failure. Your boom can break down.

Your boom can totally collapse. So, that can also happen if you overload the crane. So, the structural strength of the crane should also be considered when you consider the lifting capacity of the crane.

(Refer Slide Time: 38:38)

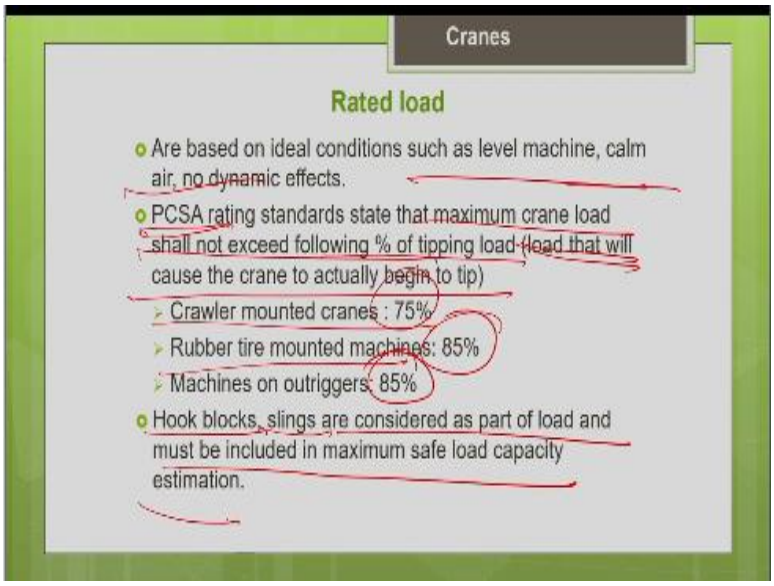


Another important thing is, as the boom of the crane rotates so you can see that the lifting capacity possible varies. You can divide it into four quadrants. You can see in this picture. When the boom is in the front end or the boom can be in the rear end or boom can be to the right side or left side so, boom can be in the side of the carrier or boom can be in the front end with respect to the carrier or boom can be the rear end with respect to the carrier.

So, based on the studies, it is found that when the boom is in the rear end, when the bomb is in the rear end, the stability of the crane is more. It all depends upon the position of the centre of gravity of your system. As a boom shifts, the centre of the gravity of the system also gets shifted. So, when it is in the rear end, the crane is in the more stable position because of the centre of gravity location.

In that case, you can see that the lifting capacity will be more when compared to the sides. Load carrying capacity over the rear end is greater than the low carrying capacity over the sides. It all depends upon the position of the centre of gravity of the system and generally when the manufacturer gives you the load rating, they consider the direction of the minimum stability for mounting. So, we have to consider the minimum stability for mounting and accordingly only, they will do the rating.

(Refer Slide Time: 39:55)



So, the rated load as I told you, the crane rating, the load rating is done based on ideal conditions assuming that the machine is level; the surface is level; the air is calm; the wind speed is not high; there are no dynamic effects. Based on this assumption only, rating is given. If your conditions are going to be different, so, the lifting capacity must be reduced accordingly. So, as I told you in the earlier lecture, there is an organization called PCSA Power Crane Shovel Association.

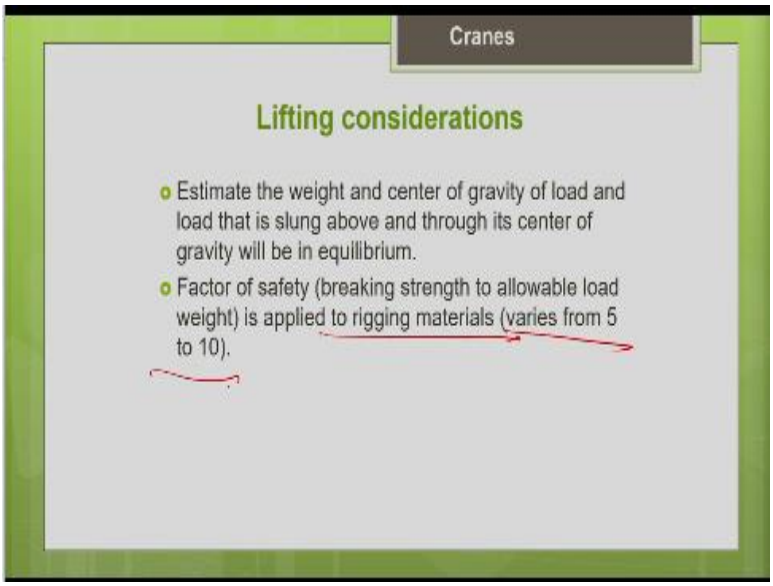
So, this organization is common for both shovels and the crane. Both are treated as the same family only cranes and shovels. So, cranes have development of standards and guidelines for the cranes and shovel. So, according to the guidelines of PCSA, you should know that the maximum crane load shall not exceed following percentage of tipping load. Tipping load is nothing but the load that will cause the crane to actually begin to tip that is what is tipping load.

We have already discussed about tipping load in the earlier lectures. You can recollect that. So, for crawler mounted, depending upon the mounting, the safety margin is decided. For crawler mounted cranes so, you should never exceed; the load shall not exceed 75% of the tipping load. For rubber tire mounted cranes, the load should not exceed 85% of the tipping load and for the machine outriggers 85% of the tipping load.

So, when you estimate the lifting capacity of the crane, you have to also consider the hook blocks and the slings also as a part of the weight. So, when you estimate the lifting capacity of the crane,

the weight of the hook block, the weight of the sling and all the accessories what you use for lifting, everything should be considered as a part of the load and must be included in the maximum safe load capacity estimation.

(Refer Slide Time: 41:40)



So, another important thing is; when you do the rigging of the load so, it is better to find the centre of gravity of the load and rig it at that point. So, that the load will be in a stable equilibrium from the safety perspective. This is another guideline and many times, you can see that some accidents happen even because of the rigging failure. So, that is why even the rigging materials according to the standards, you should have a good factor of safety ranging from 5 to 10 to avoid accidents due to rigging failure.

So, the factor of safety recommended for the rigging material is from 5 to 10. So, estimate the weight of the load, centre of gravity of the load and the load that is slung above and through its centre of gravity will be in equilibrium that you should always keep in mind. Rig it at its centre of gravity.

(Refer Slide Time: 42:28)