And what is this u? u is nothing but distance from the center of your boom of the crane to the fulcrum point that is your tipping axis that is a u distance between the center of your broom to the tipping axis that is your u. Now, how to find X? X is nothing but the distance between the load line and the tipping axis that is your X, distance between the load line and the tipping axis that is it X. How to find X?

$$X = R - F$$

You can see here, R is your operating radius that is the distance between the load line and the center of axis of rotation; from the earth subtract the fulcrum distance that will give you X. Now, let us determine the safe working load on the crane.

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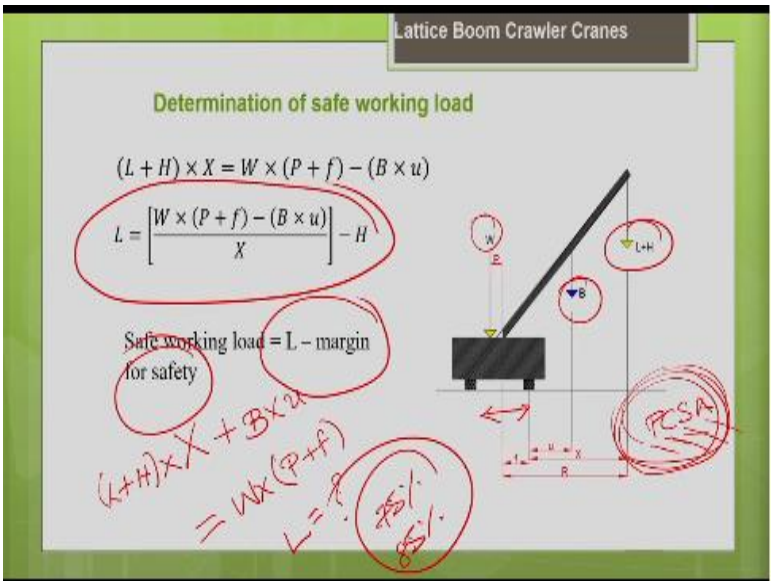

So, you balance both the moments now; equate both the moments. One is the overturning moment. Other one is just stabilizing moment. So, what is contributing to the overturning moment?

$$(L + H) \times X = W \times (P + f) – (B \times u)$$

u is nothing but the distance between the center of the boom to the tipping axis. So, what is your stabilizing moment or the resisting moment? That is contributed by a self weight of the crane along with the counterweight excluding the weight of boom that is nothing but your W. W into your P plus f that gives you the distance from the tipping axis. So, W into P plus f. You equate this.

Now, you simplify and you can get L. L is determine as shown here. You simplify this equation and find L. So, this L will give you the working load, permissible working load. Apart from this, you have to deduct some margin for safety. How will you determine that margin for safety? So, there are some guidelines given in the literature. Say, for example, there are different types of organizations which does the crane rating which prepares the standards related to the crane and gives the guidelines for the crane rating.

So, one such organization is your PCSA, Power Crane Shovel Association. Your shovel and crane, everything is considered together. They belong to the same family; power crane shovel association. So, this is given a separate guideline for the rating. Say, if your crane is going to be crawler mounted, in that case, you should not go beyond 75 percentage of the tipping load. If your crane is going to be truck mounted, tire mounted, you should not go beyond 85 percentage of the tipping load. Such safety margins or guidelines are given.

So, you can take into account those safety margins and determine the safe working load but the basic, the base value L, you have to determine by equating these 2 moments, overturning moments of the stabilizing movement.

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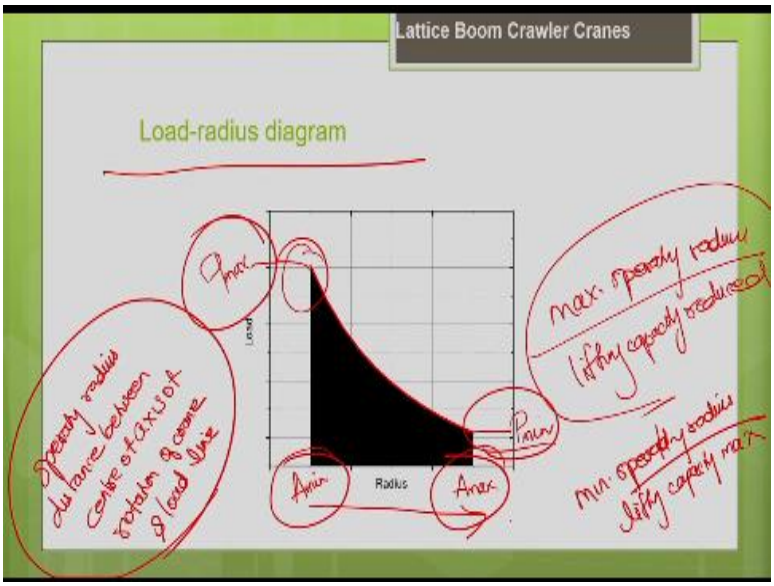

So, after determining the load L, you can plot this load radius diagram as shown in this picture, you can see. As the radius increases as the operating radius increases, so, what is happening to the

lifting capacity? Here, the lifting capacity is maximum. Here, the lifting capacity is minimum. So, here, you can see the operating radius is maximum; here the operating radius is minimum.

So, you can see that when the operating radius is minimum, lifting capacity is maximum. When the operating radius is maximum, lifting capacity is minimum that is what I discussed earlier also. So, when your load line is far away from the center of the crane that means at the maximum operating radius, when the load line is far away from the center of the crane, your center of gravity of the system will be shifted outside. So, that will affect the stability of your system.

As the crane becomes relatively unstable at maximum operating radius, your lifting capacity gets reduced. So, everything depends upon the center of gravity of the system. As you change the angle of inclination of your boom, your center of gravity of the system will change. The points get shifted. So, the load line is very closer to the crane center, when the load lane is closer to the crane center, center of axis of rotation, now, you can see that the crane will be in more stable position. So, that means that minimum operating radius, your lifting capacity will be maximum.

Hope, you know what is operating radius. Operating radius is nothing but distance between center of axis of rotation of crane and the load line. So, as your operating radius changes, you can see your lifting capacity of the crane also changes. At minimum operating radius, I can have the maximum capacity because the crane is in more stable position as a load line is near to the center of the crane.

As a load line goes far away from the center of the crane and due to the shifting of the center of gravity of the system, the stability gets affected and also, your current lifting capacitor gets reduced that is what this picture says.

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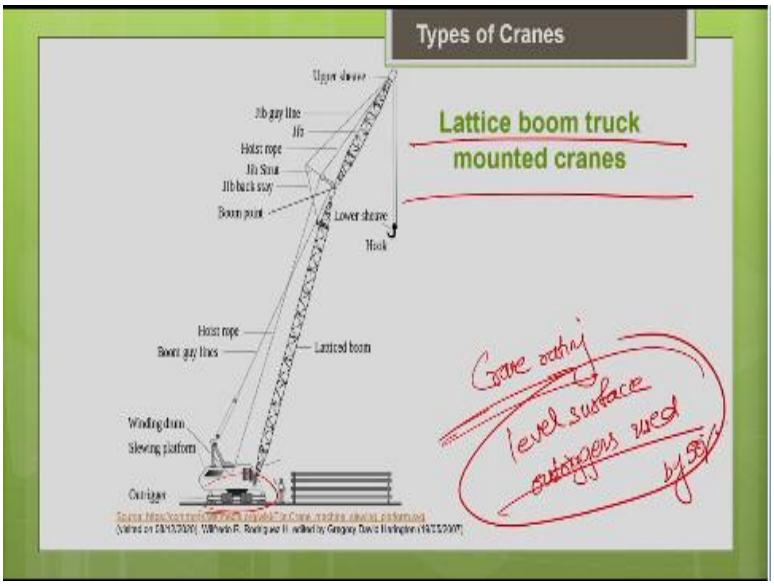

Now, let us look into the next type of the crane that is nothing but your lattice boom truck mounted crane. Instead of crawler mounting, here you have truck mounted. It is wheel mounted crane, tire mounted crane. So, what will be the basic advantage? Its mobility will be very good. You can have a better speed, higher speed than when compared to the track mounted crane. But obviously, crawler mounted, track mounted will give you a very high lifting capacity when compared to the truck mounted crane.

So, one more important thing, you have to note here is since, it is going to be tire mounted. To enhance the stability of the crane particularly during the lifting operation, you have to use these outriggers. You can see the outriggers. They are kind of beams, horizontal beams which are extended laterally. So, there are a pair of outriggers, one in the front and other in the rear end. You extend both the outriggers completely during the lifting operation and to lift the tires off the ground; lift the tires off the ground.

The load will be transferred through the outriggers to the ground. So, that will ensure the stability of your crane. If the crane is stable only, you can have the better lifting capacity. So, that is why only particularly for the tire mounted crane, you have to definitely use the outriggers. The crane rating which the manufacturer does, he assumes that your crane is placed on a level surface and if it is going to be tire mounted, you are supposed to use outriggers.

Based upon this assumption only, the manufacturer would have given you the rating or the maximum lifting capacity. So, if you are not going to use outriggers, in that case, you have to know that your lifting capacity must be appropriately reduced. You have to, you may have to even reduce lifting capacity by 50 percentage if you are not going to use your outriggers. So, the crane rating given by the manufacturer is applicable only if you use outriggers and when you use it on a level surface.

Even if the surface where the crane space is not level, even a small undulation in the level will result in reduction of lifting capacity. All those things, we should consider while checking the lifting capacity. We should not blindly go with the manufacturer rating because manufacturer rating is based on certain assumptions that the surface is this level; there are no dynamic effects; the wind speed is normal.

So, based on those assumptions only, they have given you the lifting capacity. But, when the situations are going to be more dynamic, you have to apply certain guidelines and then you have to adjust the lifting capacity accordingly.

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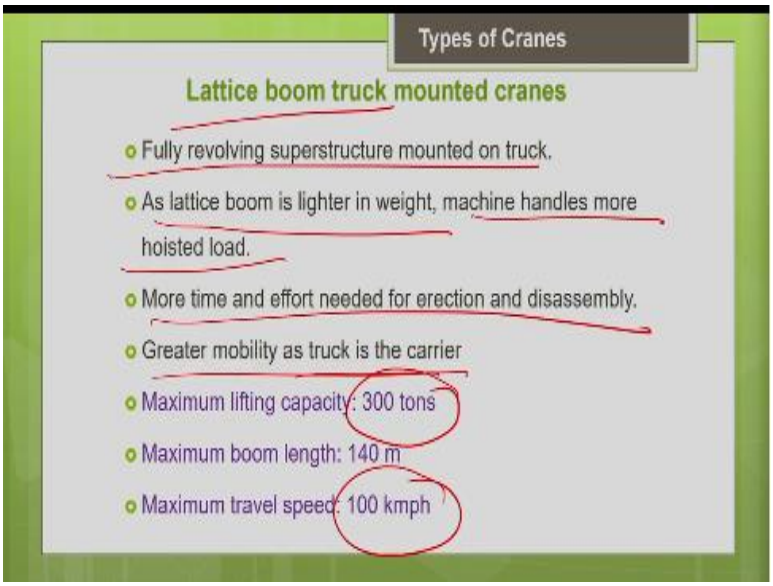

So, basically the lattice boom truck mounted crane as the revolving superstructure mounted on truck. Here also, since it is lattice boom, we get the advantage. Boom is lighter in weight. So, the machine can handle more hoisted load. The demerit is, the erection and dismantling take more

time. It cannot be taken on public highways. You have to erect it and dismantle at the project site. But, the advantage is greater mobility because it is tire mounted as truck is a carrier.

So, you can have a better travel speed of 100 kilometer per hour but one thing I have to notice the lifting capacity is reduced because it is truck mounted. You can note down the values.

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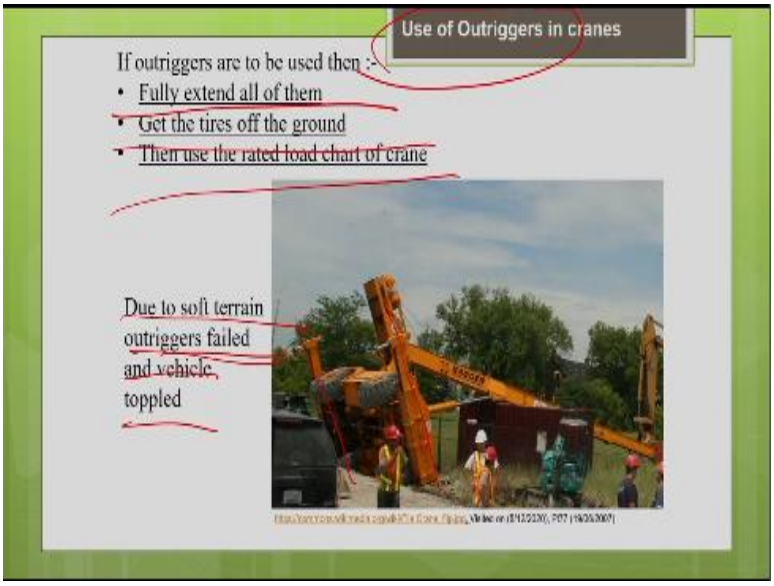

As I told you, use of outriggers is very important when you go for tire mounted cranes that is very important for the stability of your crane. So, without outriggers, you cannot get your desired lifting capacity. So, you can see this picture where the crane is toppled so, because of the poor soil conditions. So, before planning the use of crane, you have to check for the soil conditions.

If the soil is a poor bearing capacity, then in that case, you have to put some proper steel mat or timber mat to ensure the stability of your crane. So, if you do not use a proper steel mat or timber mat, in that case what happens? Your machine will topple over like this due to the soft terrain. Even when you use outriggers also, the outriggers have failed. The crane is not stable. So, you can clearly see the outriggers in this picture, pair up of outriggers.

So, you have to fully extend it and the load should be transferred only through the outriggers to the ground when you do the lifting operation. Fully extend, the outriggers get the tires off the ground, then only use the rated load chart of the crane. The load chart given by the manufacturer

is applicable only when you fully extend the outriggers. Otherwise, you have to reduce lifting capacity by even 50%.

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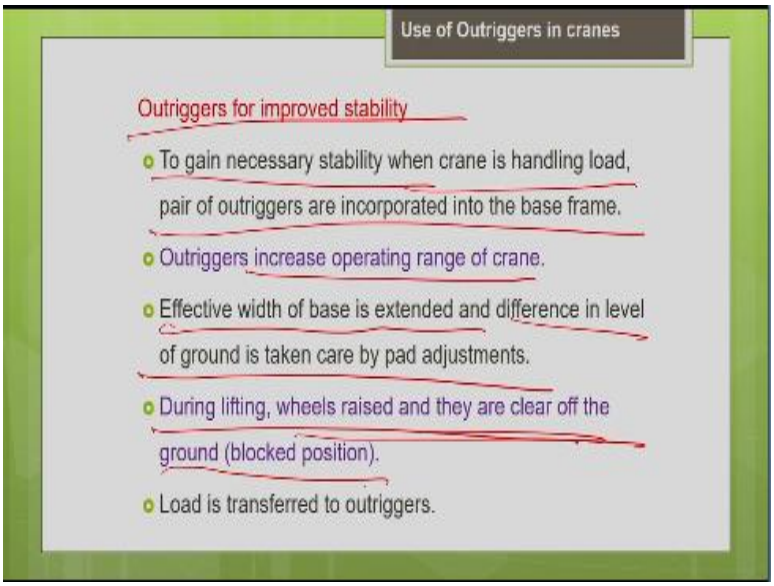

So, let us see what is the main purpose of going off for outriggers. So, outrigger is mainly intended for improved stability of your crane. To gain necessary stability when the crane is handling the load, pair of outriggers are incorporated into the base frame. They increase the operating range of the crane. They widen the base area. So, that you can have a better lifting capacity.

The effective width of the base is extended by using outriggers and also there is possibility to do the adjustment if there are some undulations in the level of the ground by adjusting the outriggers, I can also do the height adjustment and I can do the leveling to certain extent. Difference in the level of the ground is taken care by pad adjustments to certain extent. During lifting, you have to raise the wheels and clear of the ground position that is called as blocked location.

During lifting, the wheels should be lifted off the ground and the load should be transferred only through the outriggers to the ground. So, that you can have the rated lifting capacity as given by the manufacturer.

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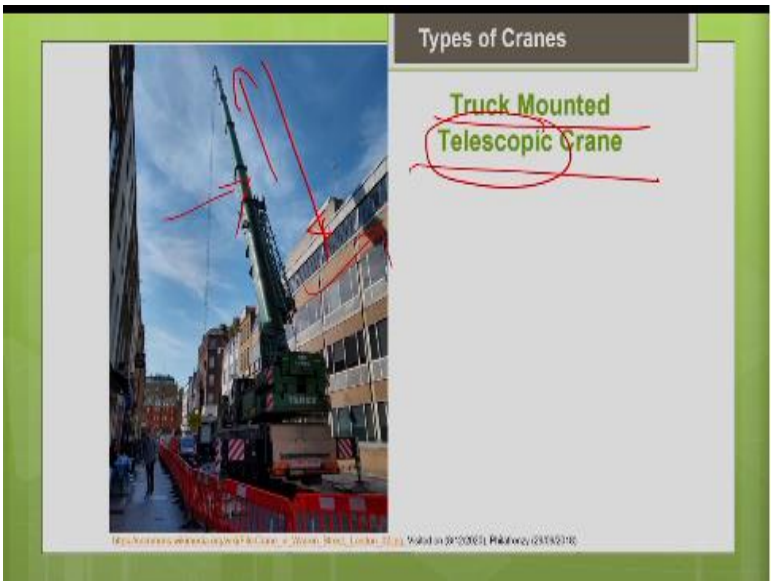

So, we have discussed about the lattice boom crawler crane, lattice boom truck mounted crane. Now, we are going to see telescopic boom cranes, truck mounted telescopic boom crane. So, as the name indicates just like a telescope, you can extend the length of the boom or retract the length of the boom. Just this is the boom. You can see, this is a telescopic boom. You can extend the length of the boom or retract the length of the boom depending upon your working range requirement.

So, the main advantage of the crane is; you can easily take it on the public highways. So, mobilization is very easy. Mobilization causes minimum and erection and dismantling time, I mean the setup cost will be; is going to be less because the setup time needed is very much less for this telescopic truck mounted crane. So, if you need a crane only for few hours of couple of days in the project site, this is the right equipment of choice because its mobilization is easy and the erection is also easy. Setup is easy.

But, what would be the disadvantage, demerits? It is a solid boom, telescopic boom. So, lifting capacity the crane gets reduced that thing you have to note and another thing is, this crane is generally costlier. Telescopic boom cranes are costlier as its solid booms, they are heavier booms when compared to lattice boom cranes.

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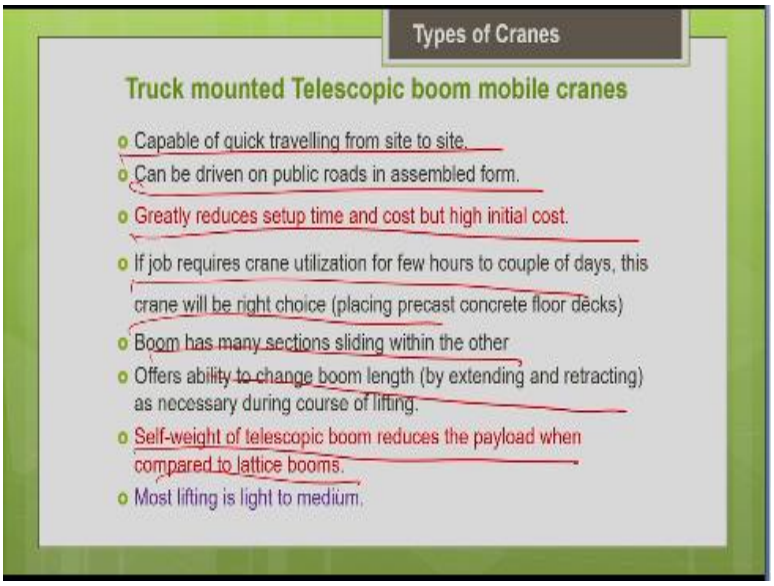

So, now, let me summarize. The truck mounted telescopic boom, mobile crane, they are capable of quick traveling from side to side. Mobilization is very easy; can be driven on public roads in assembled form. It greatly reduces the setup time and cost but high initial cost that you have to note it. So, if job requires crane utilization for few hours to couple of days, this crane will be the right choice.

Say, for example, when to just place a concrete floor, precast concrete floor decks on a particular floor, in that case, you may not wait for a longer duration. So, this crane will be of right choice provided the crane has a sufficient vertical reach. So, just like a telescope, it has many sections sliding within the other. So, you can either change the boom length by extending or retracting.

So, the self weight of the telescopic boom reduces the payload that is one demerit when compared to the lattice boom. So, generally we recommend the screen for light to medium lifting; not for heavy lifting. For heavy lifting, we always go for lattice boom crawler mounted crane. So, that only is suitable for heavy lifting.

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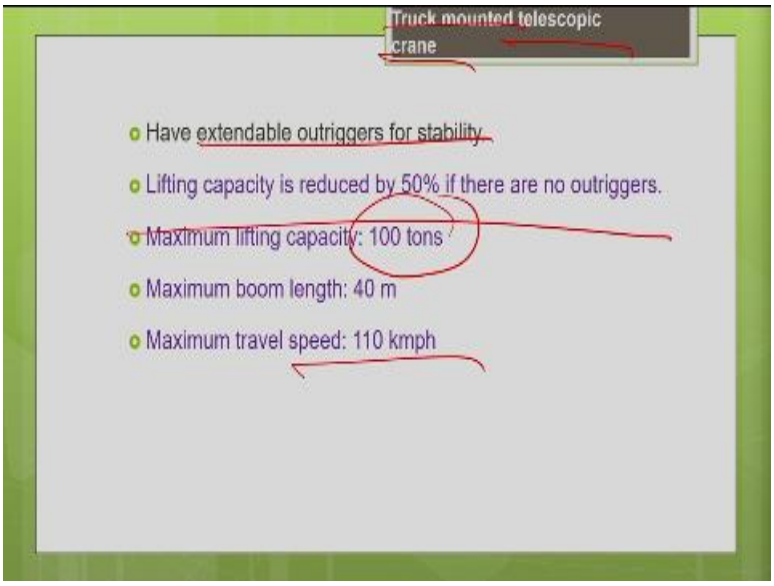

Since, it is truck mounted or tire mounted obviously, we have to go for outriggers for stability. You know the purpose of outriggers. So, those 2 beams should be extended laterally and that will transfer the load to the ground. If you do not use outriggers, lifting capacity will be reduced by 50% that you have to take into account. So, here, you can see lifting capacity with the truck mounted crane is only 100 tons and particularly with telescopic crane, the maximum lifting capacity is getting reduced. You can see that. I can have a very high travel speed because it is truck mounted.

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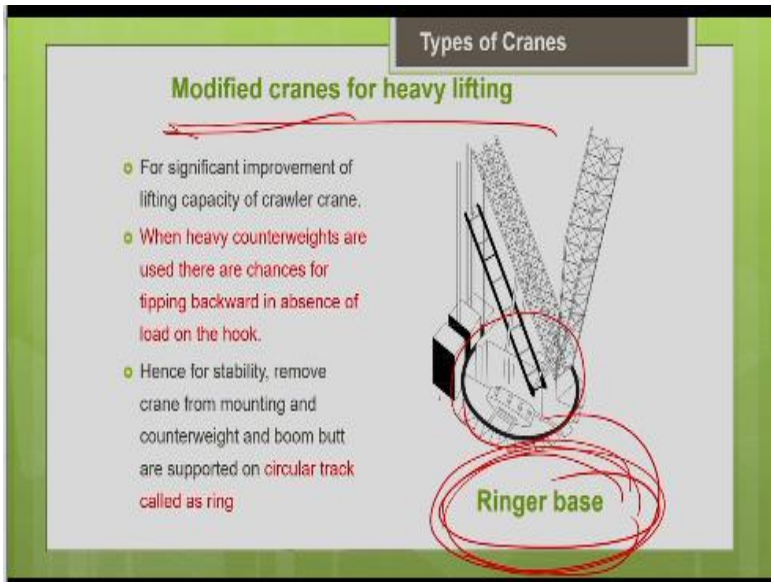

So, another important type of crane is modified cranes particularly for heavy lifting applications. Say for example, if I need a lifting capacity of 1000 tons, 2000 tons, these are very rare cases,

exceptional cases, in those cases, now we go for this kind of modified cranes. So, why do we need these modified cranes? So, we discussed about the tipping of crane in the beginning.

So, when we discussed about the stability of the crane, we discussed about the tipping. So, there, we discussed about the forward tipping. So, there are also chances that your crane can tip in the backward direction. When that can happen, say for example, for a very heavy lifting crane where you put very heavy counterweights, when the crane is in the unloaded condition, when it is not lifting any load, when it is in the unloaded condition, there are chances that due to the heavy counterweight, the crane can tip in the backward direction that is called as stripping backward.

So, to prevent that tipping backward, particularly for heavy lifting cranes, we can go for modified cranes like this. Instead of conventional mounting like a crawler mounting or truck mounting, you can go for mounting called as ringer base. You have a broader ringer base. You mount everything on that. So, this one will give you a better stability and prevent tipping of the crane in the backward direction even when the crane is in unloaded condition.

So, that is the main advantage of the ringer base cranes. This is called as ringer base mounting for heavy lifting cranes. So, earlier ringer base were stationary only but nowadays due to advancement in technology even this ringer base cranes can be made mobile that means your crane can lift its base crawl to a new location and then settle down and do the lifting operation.

So, even that the possibility is now available due to the advancement in technology even the ringer based cranes are made mobile nowadays. These are special type of cranes for very heavy lifting operations. So, let me summarize what we discussed. For significant improvement of lifting capacity of the crawler crane, we have to go for this modification. When heavy counter weights are used, there are chances for tipping backward in the absence of load on the hook.

So, we are always concerned about tipping in the forward direction. Now, tipping in the backward direction can also happen when more counterweights are there and there is no load in the crane. To protect the crane from that, hence for the stability, remove the crane from the conventional

mounting, crawler mounting or truck mounting and put everything on the circular track called the ring.

Let us call the ringer base. This will enhance the stability of your crane and facilitate you to have a greater lifting capacity without tipping in the backward direction. So, we have come to the end of this lecture. So, let me summarize what we have discussed so far. So, we have discussed some of the important types of mobile crane like your lattice boom crawler crane, lattice boom truck mounted crane and telescopic boom crane. So, we can see that every crane is economical only for a particular situation.

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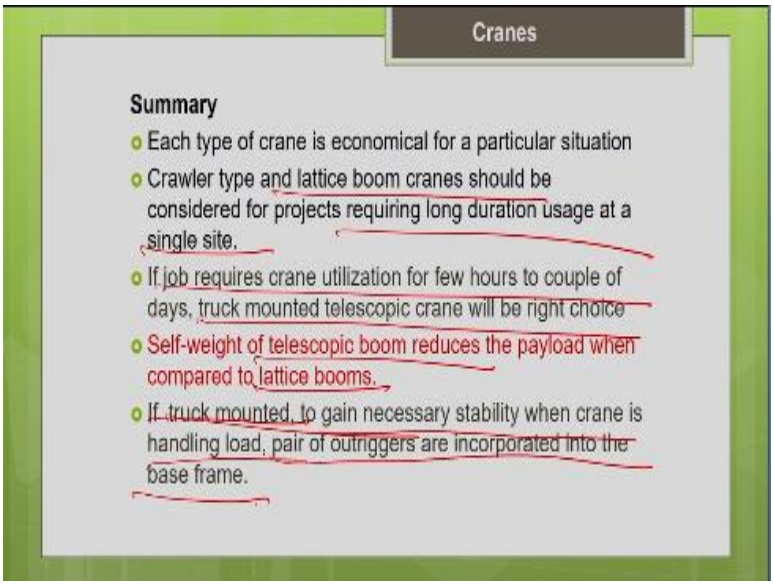

So, the lattice boom crane, it will be economical provided you need the crane for a longer duration of the single project site. In that case, it will be economical. If you need it just for a few hours, it will not be economical because its mobilization cost, erection-dismantling cost is going to be higher. So, if you need it for a longer duration, go for the choice of lattice boom cranes and crawler type cranes.

If the job requires crane utilization only for few hours to couple of days, truck mounted telescopic crane will be the right choice because it can be easily mobilized to the site and its setup time will be very less but one thing to be noted, the telescopic boom crane has its limitation on maximum lifting capacity because boom is heavier solid boom. So, when compared to lattice booms, there is

a restriction on the maximum lifting capacity. So, and one more important thing to be noted is, if that crane is going to be tire mounted that is truck mounted, you should make sure that the outriggers are properly used. So, many of the crane accidents occurs because you do not use outriggers properly. So, if the outriggers are not used properly, it will affect the stability of the crane and lifting capacity of the crane. So, if truck mounted, to gain the necessary stability, when the crane is handling the load, a pair of outriggers are incorporated into the base frame, extend it completely, lift the wheel, off the ground and transfer the load to the ground through the outriggers only that will enhance the stability and the lifting capacity of your crane.

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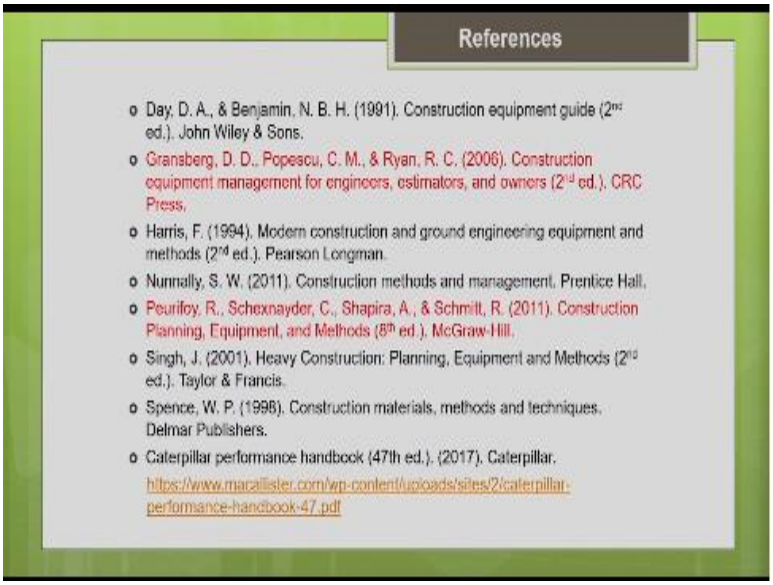

So, these are the references which are referred for this lecture. So, in the part 2 lecture, in the next lecture, I will be discussing about the tower cranes. So, what are all the different types of tower cranes, merits and demerits? And how to do the erection and dismantling of the the tower cranes? And what are the factors which affects the lifting capacity of the crane? So, these are the important things which will be discussed in the next lecture. Thank you.