It should be properly protected for the severe weather conditions and you should start the curing of concrete as early as possible in aggressive conditions to protect the concrete from the cracking of concrete. And another important factor which will affect the selection machine particularly the crane selection is a wind velocity. So, the lifting capacity of your crane will depend upon your wind velocity in places where the wind velocity is going to be very high, the lifting capacity will be significantly reduced.

So, how much a crane is going to lift it depends upon the speed of the wind prevailing there. So, there are some standard guidelines, which help you to make the selection of the capacity of the crane depending upon the wind speed. So, you can go through those guidelines. So, basically the wind speed is very high say more than 50 kilometer per hour or more than 55 kilometer per hour you have to stop the crane operation.

So, it is not safe to operate the crane when the wind velocity is very high, because so many crane accidents that happen when we try to operate the crane at high wind velocity it will result in entire toppling of your crane. So, one thing you have to keep in mind is your wind speed will decide your selection of your crane capacity in places where the wind speed is likely to be high you have to select the crane with a larger capacity so that you can counteract the wind speed. Now let us say what is the effect of the rainfall on the selection of the machine?

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So, in some places you can see that for most of the months there will be continuous heavy rainfall. So in those places obviously the terrain will be very poor like it will be having the poor underfoot conditions with a very high rolling resistance the terrain will be very muddy. So, as

I said earlier in those cases, we have to select the machine with the proper mounting and with the better horsepower capacity so that it can overcome the rolling resistance in the poor underfoot conditions.

So, the same thing it will apply for the snowy terrain also in snowy terrain, we can see that the traction for the rubber tire mounted machine will be very poor. So, in that case, we have to go for the crawler type mounted machines, crawler mounted machines, so that it will have better traction. So, the underfoot conditions influences the selection of the mounting of the machine as well as the selection of the horsepower capacity of the machine. So that it can overcome the rolling resistance and it will be able to do the job productively. So, the next important factor is the power source.

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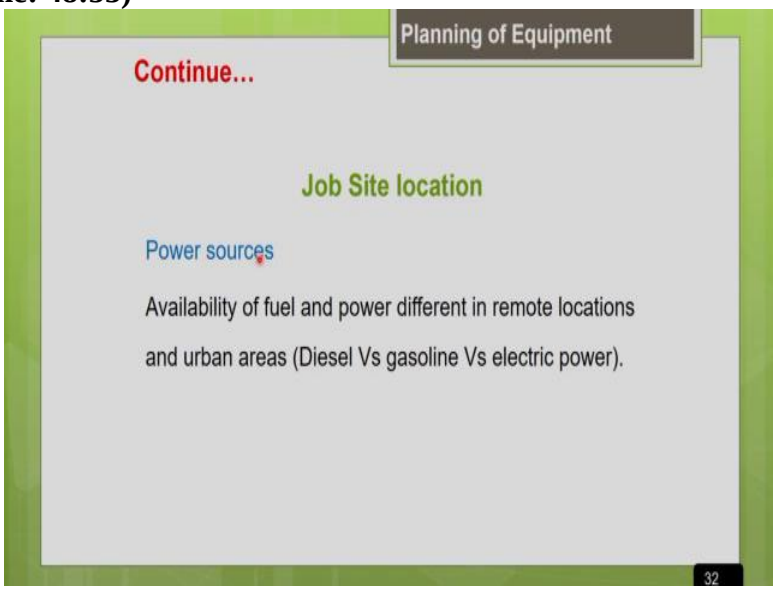

So far we have discussed about how the job site conditions and the job site location how it influences the selection of the machine. So, now we move on to the next factor affecting the selection or machine that is the power source availability. So, the machines which we use at the construction site may be either operated with diesel as a fuel or it may be the gasoline operated or it may be based on electrical power operated.

So whatever may be the mode of source of fuel. So, first we have to check whether that particular fuel availability is possible in the job site location, because availability of fuel and the power are different in remote locations and urban areas. So, the fuel availability may be easier in the urban areas when compared to remote locations. So, if your job site is located in

a remote location, we have to first check for the availability of the particular fuel needed for the machine.

So, there are always provision to store huge quantities of the fuel required for the equipment, but still, we have to make sure that the since the project is going to happen for a longer duration, so, it is convenient to select an equipment for the particular equipment, the fuel should be available in the particular site location. So, it is always advisable to select equipment on such a basis of the fuel required for the machine is available in the site location.

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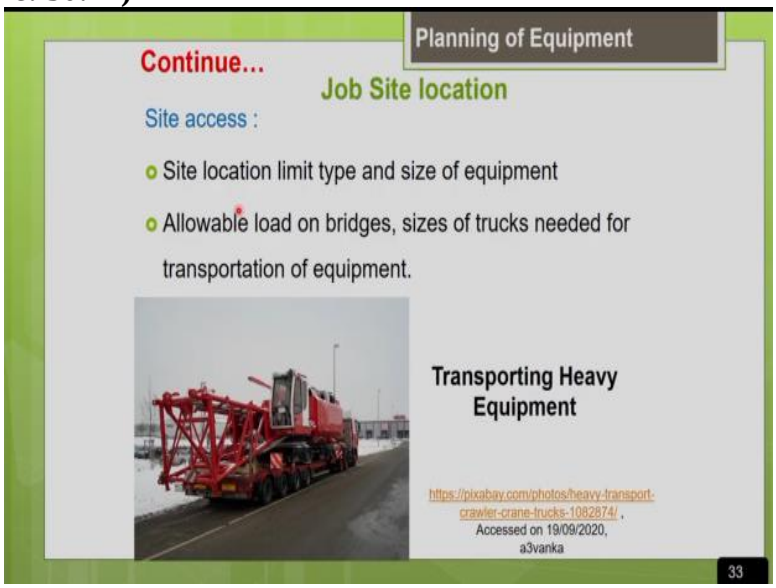

So, the next is about the influence of the site access, on the equipment and the selection. So, many cases you can see if the project site is in a very remote place, it will be really challenging to mobilize the equipment to the particular site. So, the site location will limit the type and the size of the equipment. So, if you have to mobilize a heavy equipment to a very remote site, we have to check whether there are availability of the proper access routes or the haul routes to mobilize equipment to the particular remote site.

And also we have to check on what is the allowable load on the bridges, all these things need to be checked before deciding that particular equipment for the particular site location. Because if it is going to be heavy end equipment like say for example a very big crane, you may need so many trailers on to the transport one particular equipment to the project site. So, generally when we go for a very bigger equipment, heavy equipment.

Obviously, we will get the benefit of higher productivity, but the mobilization costs will also go up. So we have to work out the economics before selecting the heavy equipment because it is associated mobilization costs will be definitely higher. So, as I discussed, just know, you have to look into the site location, wherever the access roads to the site is proper for the mobilization of your machine to that particular site, then accordingly only we have to make a selection of the machine for that particular site location.

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So then here we can see a picture here a trailer is the transporting heavy equipment to the project site.

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So far, we discussed about how the job site conditions and the job site location, how it influences the selection of the machine, as well as the efficiency of the machine. So we have discussed those factors. Now, move on to the next important factor about balancing

interdependent machines, how it is going to affect the selection of your machine. So, generally in many project sites we can see that many machines will be working together.

So when the machines work together, they should have compatible productivity or compatible size. So that cycle time is not wasted much see in this picture, you can see an excavator and a truck working together. So everyone knows about this excavator this is a backhoe, it is very good in excavating the earth below the ground level, but its mobility is very poor. So, it has to depend upon a hauling equipment like a truck to transport the earth. So, both these machines work together.

So, when they work together, their size should be balanced. So, that the productivity will be efficient, so that the entire process will be efficient, you can reduce cycle time. So, you cannot go for a very small truck for a very big excavator or you cannot go for a bigger truck for a small excavator in both the cases that will be wastage of cycle time or idle time of the machine to reduce idle time and to avoid the wastage of the cycle time try to balance the sizes of both the machine.

So general guideline is, you have to go for the truck, which has a capacity of 4 to 5 times the bucket capacity of the excavator. So, in that case, the entire process will be efficient, the productivity will be balanced. So, this guideline is devised based upon the past experience, similarly, you have to balance a number of machines also say for example, the how many excavators and how many trucks you may need for the particular operation, you need to balance depending upon the cycle time of the truck and the cycle time of the excavator.

We will be doing in the upcoming lectures on how to do the balancing of interdependent machines there will be some solved illustrations also to throw more light on that particular topic. So now I am just introducing the topic to you like when planning of the equipment we should keep in mind that if the machines are going to work in a team, then the size of those machines should be balanced and the productivity also should be balanced so that you can avoid the wastage of the cycle time.

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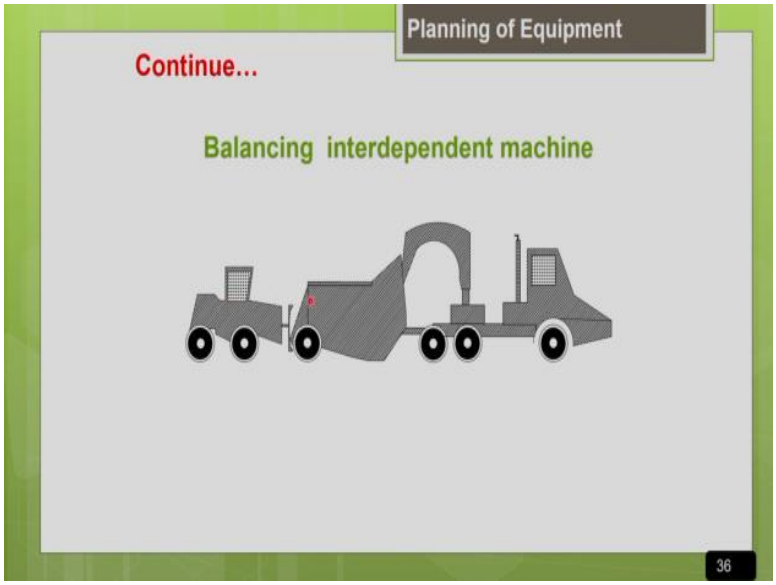

So, this is also another example of how the interdependent machines are involved in the project side. So this is just a schematic picture showing a bulldozer which is pushing a scraper, the scraper is leading end and bulldozer is the rear end. So, you can see that generally this scrapers also earthmoving machine as known to everyone. So, it has a bowl with a cutting edge at the bottom.

So it can cut the earth and fill the bowl. So, during this loading operation, we can supplement the loading power of the scraper with the help of another machine that is the bulldozer. So, the bulldozer is acting like a pusher here that is why we call the bulldozer is a pusher it helps to supplement the loading power of the scraper it is assisting this machine. So, when these 2 machines are working together to enhance the productivity of the scraper.

We have to balance the size of both the machines for a bigger scraper have to go for a bigger size bulldozer so that the productivity of the scraper will be enhanced the same way as I discussed earlier how many of the scrapers are going to be served by 1 pusher so, we have to balance it based upon the cycle time of the scraper and the cycle time of the pusher. So, the number of scrapers and the number of pushers needed for the particular job, we have to work out economically.

We have work out to the economics involved in this particular process and decide and balance the number of scrapers and number of pushers needed for a particular job.

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So, the next important factor is it the mobility required. So, it depends upon the project additional actual activity. So, what is your mobility required with respect to equipment during the particular activity? Or what is the level of mobility needed to move the equipment from one activity to another activity? Or what is the level of mobility needed to move the equipment from one project site onto the project site?

So, depending upon the requirement of the project condition, so, you have to decide the mounting of the machine. So, this picture shows truck mounted concrete pump with a boom. So, basically we prefer this equipment in sites which are very much congested where we cannot even lay pipelines on the ground for conveying the concrete for placing the concrete if you are not even able to place the pipeline into the ground because of the congested site you can go for this option.

So, this is basically a concrete pump mounted on the truck with a boom arrangement just like a crane. So it helps to place concrete at the required location. So, in congested sites, where the mobility is needed, you can go for this particular option. So like this, there are different options available depending upon the requirement and depending upon the conditions at your site, you have to go for the selection of your machine so, now a days people prefer to go for versatile machines.

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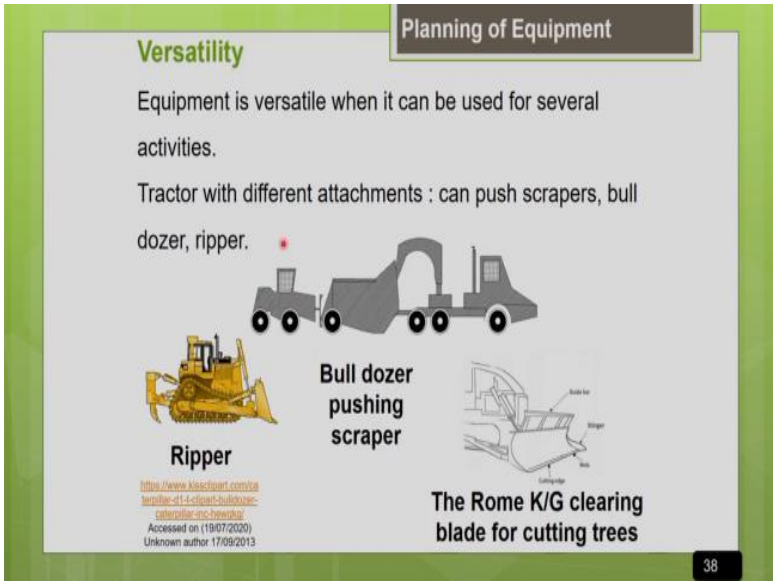

Versatile machines in the sense; equipment is called as a versatile machine when it can be used for several activities in the same project site. So then we call it as a versatile machine. So the best example is your tractor just by changing the attachments, you can use it for different applications say just be fitting earthmoving blade, I can use it as a bulldozer for earthmoving operation.

So if I fit a shank like this, it can act like a ripper for loosening the earth or for even cutting the rock, sometimes weaker rocks you can go for a ripper for cutting instead of drilling and blasting which is going to be very costlier. Ripper is cheaper when compared to the drilling and blasting process and even this can be used for cutting or ripping old pavements, there are different applications, just by changing the attachment you can go use it for different applications.

Similarly, you can use the special blade called is Rome K/G blade, which is specially designed for cutting trees, it is a very efficient way for cutting trees, just by changing the attachment you can use a bulldozer for cutting the trees. The same way as I described just earlier, the bulldozer can be used for pushing or assisting the other machines for towing other machines or pushing other machines you can use the bulldozer. So hence the tractor you can call it as a versatile machine, because by changing the attachments, you can use it for different applications.

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So the next one is the front end the loader, you can see the loader with the different attachments. Just for different applications you can change the attachments and make it more versatile. So you can see the loader with the front end bucket here. So as everyone knows, the loader can be used as a hauling equipment for a very short distance of say, up to 100 meters and it is good at excavating material at or above the ground level.

This is the best equipment this is the best choice. Depending upon your material type you can change the attachment say for example, if I am going to use this loader in a query for handling the short rock, the blasted rock pieces if you want to do and handle it with the loader, then you can go for an attachment with a rock bucket that has a V shaped cutting edge, so with this bucket again, the handle the rock pieces.

Similarly, if I am going to use this loader for handling precast elements, as a lifting device, then I can go for this fork lift attachment. So with this, I can use it for lifting purpose. Similarly, if I am going to use this loader in congested place say for example, I am working on a road, I am doing some digging or dumping job on one side of the road. So, where I prefer side dumping to be done, instead of front dumping, I can go for this kind of attachment and go for side dumping. So, just by changing the attachments, I can use it for different applications.

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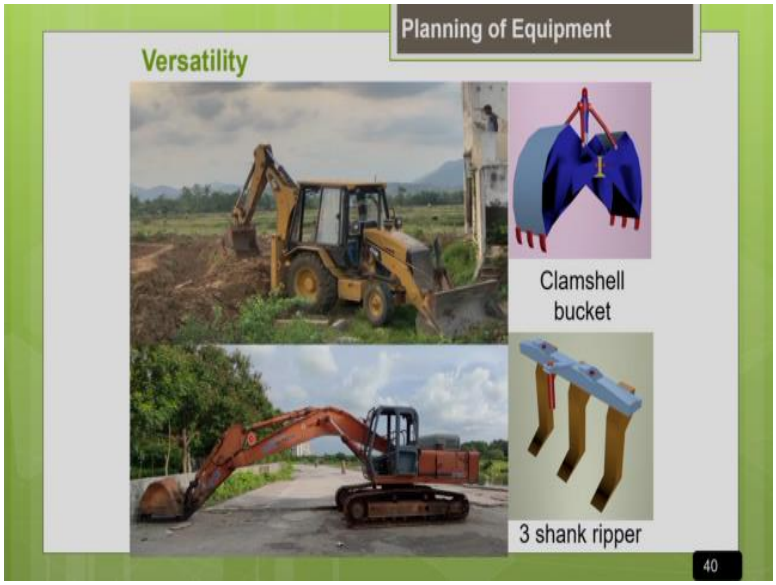

Similarly, you can see this combination this is a combination of a front end loader, a loader and backhoe combination. So, you have the loader at the front end and backhoe at the rear end. So, loader as I told you, it is good for it is efficient in excavating at the ground level or above the ground level and this backhoe is efficient in excavating below the ground level. So, both the jobs can be done with the same machine so, it is more versatile.

And similarly, this excavator, you can see that by changing the attachment like, you can go for this clamshell bucket. So, just by changing this attachment, you can use it for deep digging. Similarly, I can go for this kind of 3 shank ripper and use this excavator for cutting the earth or cutting the rock. So, whatever may be the application accordingly so, you can see like, just by changing the riging devices or changing the attachments, I can use the same machine for different applications.

Another thing to be mentioned here is this excavator is very commonly used for the excavating and for pipe trenching in pipe laying operation, because the same machine you can use for the complete job, say for example, if you wanted to go for the pipeline operation, they use this as an excavator with a bucket equal to the width of the trench. So, then they first excavate the trench so, once the excavation is done, then they change the rigging they go for an attachment, so that they can carry the pipeline.

So, then they carry the pipeline and place the pipeline in the excavated trench with the same machine, then they change the attachment and use this excavator for the filling the trench within the soil. So, the same machine can do the complete trenching and pipeline operation. So, that

is how it is more versatile. So, far we have discussed about different factors, which affects the equipment selection process.

So, I will just summarize like the basically from this discussion that we know that the important factor which affects the equipment selection is your productivity and the costs associated with the machine and you have to look into the contract specifications to know what is the actual job productivity requirement, accordingly you have to select the machine with the corresponding matching the productivity.

And you have to also check that your costs associated with the machine will fit into the project cost. So, other than these things, your job site conditions or the job site location also influences the outcome or selection of the machine significantly.

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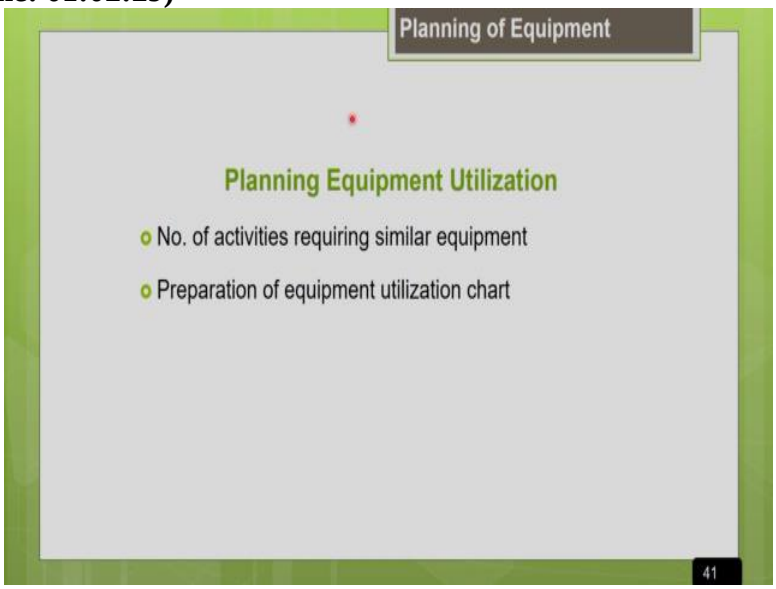

So, now let us move on to the next part of the planning process of the equipment which is the planning of equipment utilization. So, we have invested a huge amount of money in the machine. So we have selected the machine we have purchase a machine. So we have invested huge amount of money in the machine. Now it is our responsibility to make sure that the equipment is utilized in an optimum way in the project site, you should work productively in the project site with less idle time and generate profit for us.

So the equipment should be able to recover all the cost which was invested for its purchase. So, all the costs associated with the machine should be recovered by using the machine productively and by generating the profit. So, now let us see how to plan this equipment

utilization process. So, this is more critical when the same equipment is needed by a number of activities in a project site.

So, in that case we have to plan it very rigorously very carefully. So that there is no idle time for the machine and whenever the resources are limited, there are more chances for the project to get delayed, because of the waiting time. So, we have to plan in such a manner that the project the completion time is not significantly delayed due to the limited availability of the resources. So for that we have to plan the equipment utilization accordingly. So now let us see how to plan it with the help of a utilization chart.

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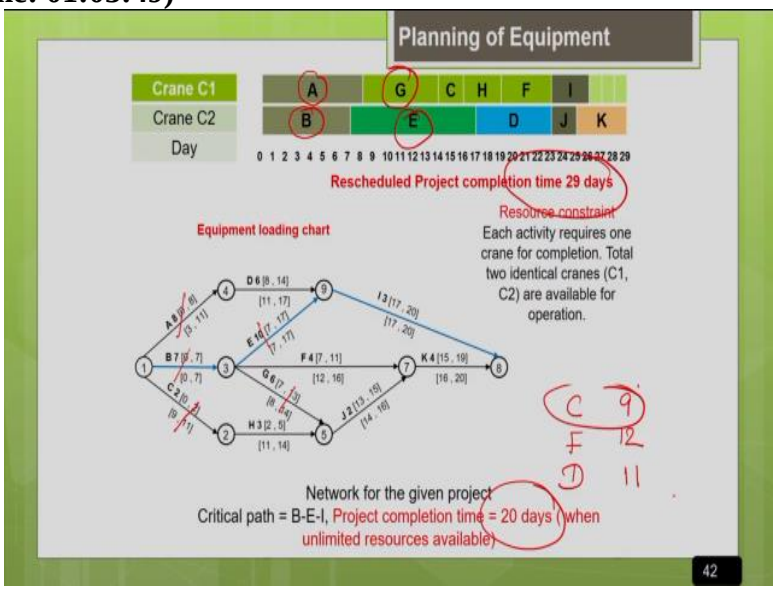

So in this picture, we can see a project network diagram I hope everyone knows about the project scheduling techniques like CPM and PERT. So in this course, I would not be able to dedicate a special time to discuss about the fundamentals of scheduling techniques like CPM, PERT, how to draw the network diagram, all these things I would not be able to discuss in this course, because it is not a part of the scope of this syllabus.

So I will just directly move on to the resource constraints scheduling how to plan the equipment utilization in this particular lecture. If you do not have the information or if you do not have the knowledge on how to do the project scheduling using CPM and PERT, I advise you that you should prefer some textbook on planning scheduling and control projects you will get the necessary information.