Construction Methods and Equipment Management
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Lecture - 1
Planning Process of Equipment

Hello everyone, I welcome you all to this lecture 1 of the course construction methods and equipment management, see the topic of lecture 1 is planning process of equipment.

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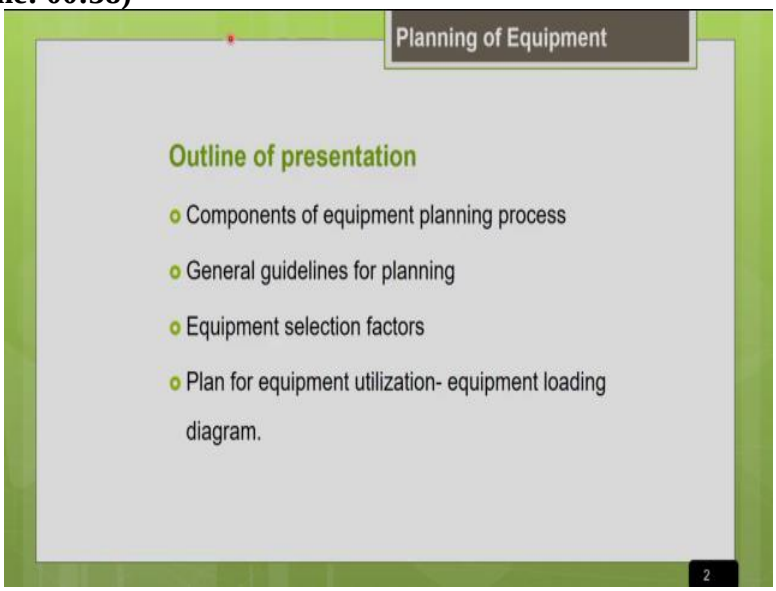

So, this is the outline of the today's presentation, I will just introduce the components of the equipment planning process firstly, followed by a discussion on general guidelines for planning then I will provide you in depth view of various important equipment selection factors, then we will conclude with the how to plan for the equipment utilization with the help of equipment loading diagram.

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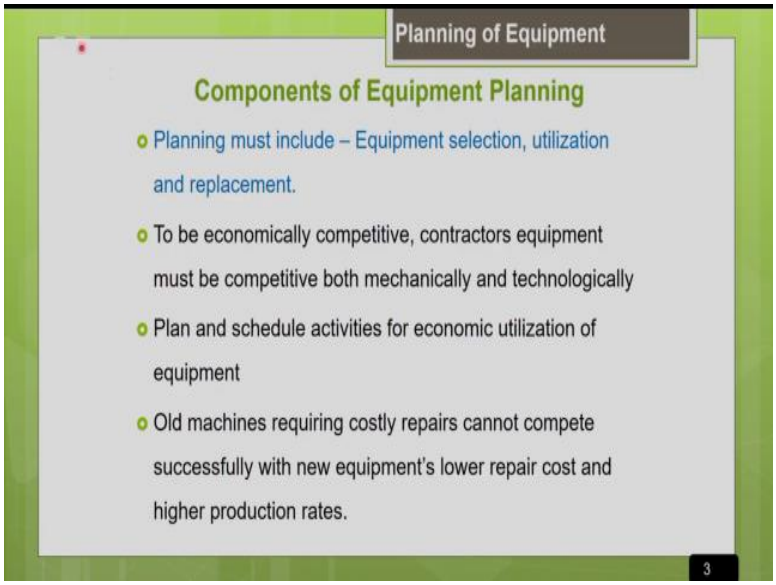

Planning as everyone knows, planning is a very critical task for any construction project implementation. On a similar note, planning of equipment is also very critical because huge amount of investment is involved in the equipment the selection of the equipment is only going to affect your construction methodology of the project, project completion time as well as the cost of the project. Hence, the selection of equipment is very critical for any project. So, now, let us see what are all the components of equipment planning process?

So, the planning must include your equipment selection, then we have to plan for the equipment utilization, then finally, we have to plan for the replacement of the old machine with the new machine basically, as I told you in the introduction lecture, now, we have achieved a lot of advancement in the equipment technology, there are so, many machines available even for the same job.

Now, it is really a tough task for the equipment planner to choose the right machine for the right job. So, generally how do they choose it? So, there are some guidelines generally they go for economical method of approach. So, basically they compare the machine performance in terms of productivity. Whichever machine gives you the maximum productivity at the lowest possible cost then they will go for the selection of that particular machine.

So, this general guideline we should always keep in mind. To be economically competitive in the construction market, the contractor's equipment must be competitive both mechanically as well as technologically. So, not only the equipment meet the functional requirement, it is not sufficient, it should also be technologically competitive in the market. Because there are so,

many competitive models available in the market, which are more technologically competitive which can give you a better productivity and lower costs.

So, our equipment should be competitive both mechanically as well as technologically in the sense it should also give you a very high productivity at the lowest possible cost. Then we have to plan and schedule the activities for the economic utilization of equipment. So, we have invested huge amount of money in the equipment. So, the equipment should work productively, and it should be able to generate profit for us.

So, plan and schedule the activities so, that we can have economic utilization of the equipment in the project with lesser idle time. And another important thing to be noted is we should not just cling on to the old machines, which are either worn out due to wear and tear or the productivity may be lesser with increase in age of the machine we know that the maintenance and repair costs of the machine will increase.

So, when there are so many competitive models available in the market, we should look for the optimum replacement time of the old machine with a new machine because a new machine can give you a better productivity than your old machine and its maintenance and repair costs will be lesser than your old machine. So, there are different replacement analysis guidelines, we should follow that and look for the optimum replacement time of the old machine with the new machine.

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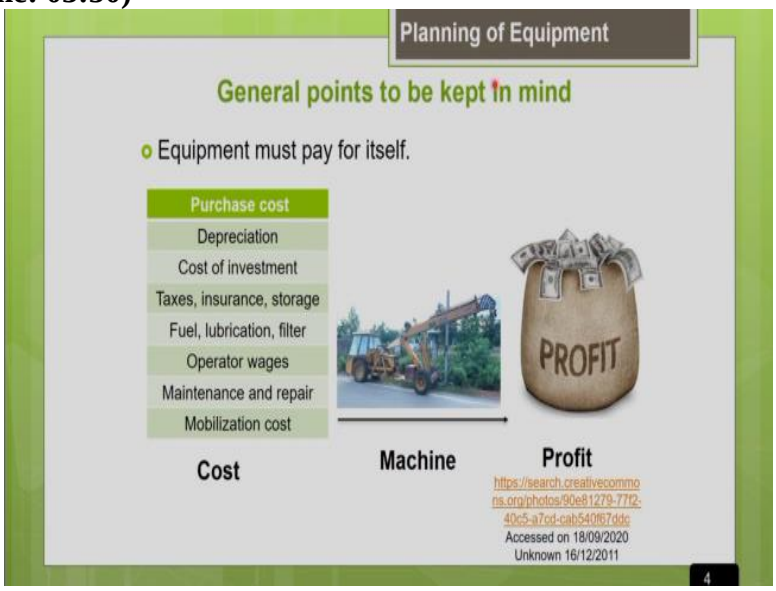

So, before discussing about the list of the important equipment selection factors, let us have a general discussion on the general points to be kept in mind when planning for the equipment. The first point is equipment must pay for itself. So what I mean by that is generally we have invested a huge amount of money in the equipment, there are a lot of costs invested in the equipment.

So everyone knows about the purchase cost associated with the machine other than that there are components of ownership cost also like your depreciation cost, cost of investment, say for example, if you are going to procure the equipment through a loan, you may be paying interest for the loan that is the cost of investment. Similarly, your equipment is an asset so you have to pay the property taxes for the equipment so that is a part of ownership costs.

Similarly, you have to pay the insurance premium to protect the owner of the equipment from the loss of theft or fire or due to accident. So the insurance premium whatever we pay, it forms a part of your ownership cost, then the storage cost of equipment, then the other operating costs, like your fuel costs, lubricating oil costs, filter cost and the wages to pay for the operator, maintenance and the repair cost and the cost of mobilization of the equipment to the project site all these costs make up the cost of the equipment.

So, you should understand that there are a lot of costs involved in the machine. So, how to estimate all these costs we are going to discuss in the upcoming lectures. So, there are many lecture hours dedicated, how to estimate the costs associated with the machine there I will give you in depth information on the estimation part. So, as of now, what we need to know is since lot of cost is invested in the machine.

The equipment must be engaged productively in the construction project site and you should be able to generate profit out of that. The equipment must be able to recover all the costs invested in the particular project and it should be able to generate the profit.

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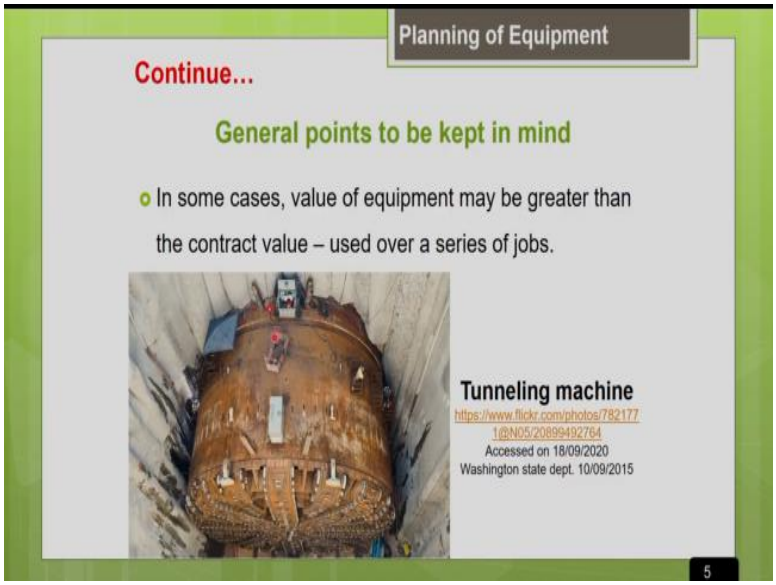

Another point to be kept in mind is in some cases the value of the equipment may be greater than the contract value that means, there are some high end equipments like say tunnel boring machine it may cost so many hundreds or crores. Similarly, cranes of heavy lifting capacity like 2000 tons lifting capacity crane. So, they are all high end machines in this particular case, there are chances that value of equipment may be greater than the contract value.

So, in this particular case, it may not be possible for you to recover all the costs invested in the machine in one particular project itself. So, you may need so many series of jobs to recover the cost invested in the machine. So, when you plan for procurement of such high end machines, we should do proper economic analysis, whether there is a likelihood of future jobs which may involve the utility of the particular machine. And you have to work out the economics before purchasing such high end machines.

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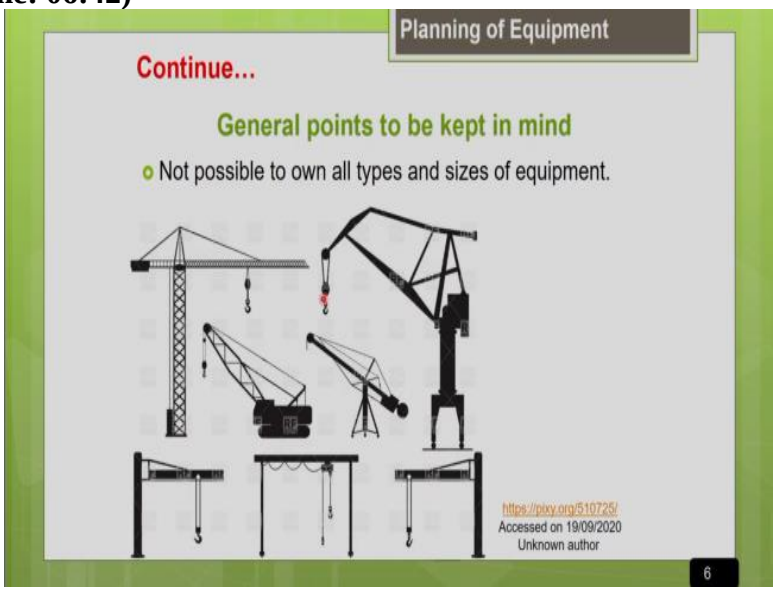

And another general point to be kept in mind is, it is not everyone then it is not possible for a contractor to own all the types and all the sizes of equipment. Say for example, if we take an excavator, there are different bucket capacities of excavator, so, it is not possible for the contractor to have all the bucket capacities models in the project site. Similarly, if you look into the crane, there are different models of crane with different lifting capacity.

So, you can have a horizontal boom crane, you can have a luffing jib crane, you can change the angle of boom that is called as luffing jib crane or you can have a telescopic boom crane. So, different configurations are available with different capacities. So, it is not possible generally to own all the types, but the contractor will generally make a decision whichever equipment is more frequently used for his job.

And based on his experience he can anticipate in his future series of jobs, which is likely to be most frequently those equipments he will purchase the other equipments which are not frequently used, he will generally decide to rent that will be the best decision.

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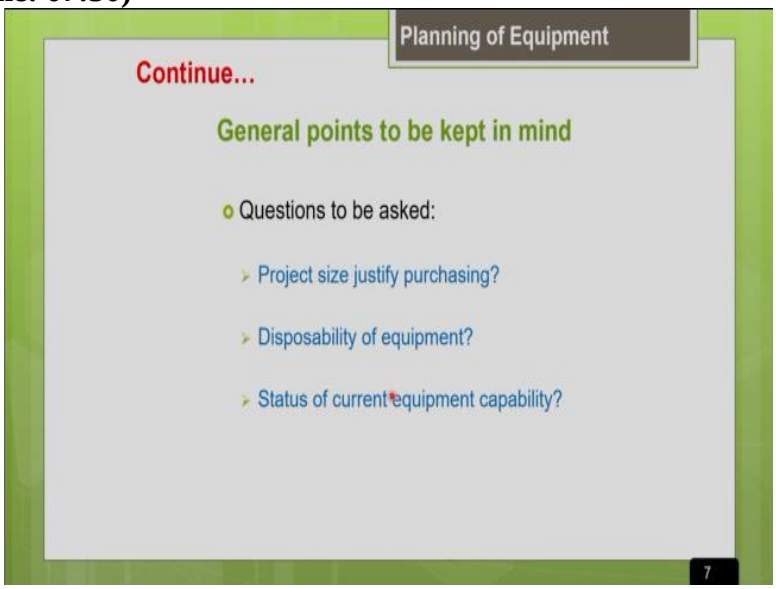

So, these are the general questions to be asked before planning for a purchase of any machine. Whether your project size justify purchasing of the machine? It is a very important question because whatever equipment you buy; the size of the equipment should fit into the size of your project that is the equipment cost should be fitting into the project cost. For a very small project I cannot go for a very high end equipment, it would not justify a purchase.

Similarly, you have to think about the disposability of the equipment also before you plan for the purchase. Say at the end of the useful life of the machine. So, you should be in a position to sell the equipment at a reasonable price, there should be buyers for the equipment. If the equipment is going to be commonly used in many projects, then there will be definitely buyers for the old equipment.

Then before buying a new equipment we should look into the status of the current equipment capability that means what is the current equipment capability? What is the productivity of the current machine? What is the cost associated with the current machine? Why should we go for the purchase of new machine? How a new machine is going to be better in terms of productivity and cost when compared to the current machine? So, this analysis you have to do before planning for the purchase of the new machine.

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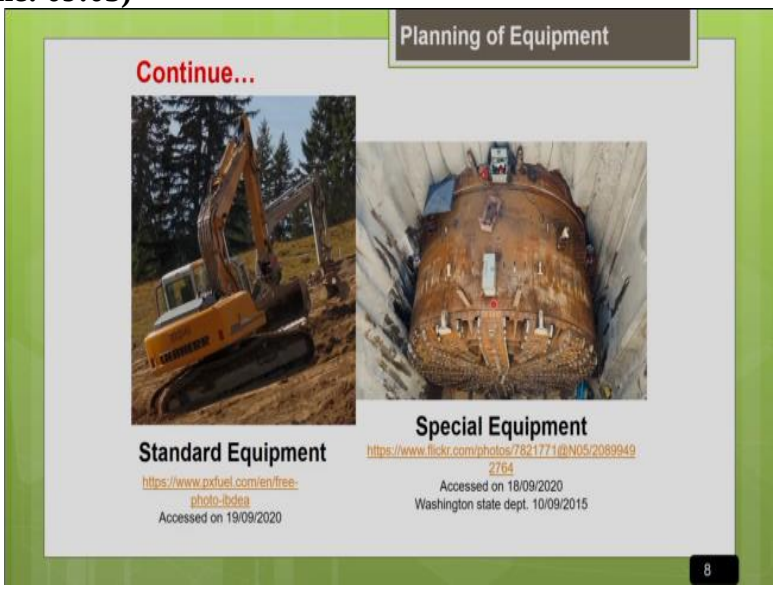

Based on utility of the equipment generally the equipments are categorized into standard equipment and special equipment. See standard equipments are just common equipments which are commonly used in so many construction projects. In so many construction project sites you can see these common equipments like a common earthmoving equipment bulldozers, your excavators. So, similarly concreting equipments, concrete mixer machines.

So, all these are common equipments which are used in so many construction project sites, but there are some special equipments which are of use only in some particular project sites. See, as I told you in the beginning itself, in the introduction lecture, we have achieved a lot of advancement in equipment technology. Like even if there is an equipment which is not existing

in the equipment market, but it is needed for a particular activity or particular project. It can be custom made for the particular project.

So, we have achieved that advancement in the equipment technology. So, those custom made equipments are called as special equipment. It is specially made custom made for the particular project or a particular activity in the project they are called as the special equipments.

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Now, let us look into the merits and demerits going for either standard equipment or special equipment. Let us compare the merits and demerits of both these options. So, when you go for the choice of standard equipments they are basically commonly available because there will be lot of manufacturers available for the standard equipments. Because it is used commonly in so, many construction project sites and its delivery will also be very quicker.

And if your equipment breaks down due to some reason the spare parts availability will also be very quicker. And another advantage is it can be used on more than one project that is also one of the advantages. So, your project will not get delayed due to the non availability of this machine or non availability of the spare parts because these are commonly easily available. And another important thing is at the end of the useful life of the machine.

It is easily possible to dispose it or sell it at a reasonable price that is also possible with the standard equipments. But the issues with the special equipment which are custom made only for a particular project is it may not be easily readily available. So, we have some waiting time for the machine. So, it is delivery may not be quicker because it is being custom made for a

particular project. Even if the equipment is going to break down the spare parts availability may not be easier.

It may get delayed and that delay may even affect the project completion. And at the end of the useful life of the machine, we cannot assure that there will be buyers for this special equipment, it is not being commonly used in all the projects. So, these are some limitations of the special equipment that is why before you plan for the purchase of this special equipment we have to work out the economics of the costs associated with the machine.

And the profit which are likely to generate by purchasing this machine whether there is likelihood of future projects which can make use of this special equipment. All these things we have to plan rigorously and then plan for the purchase of the special equipment.

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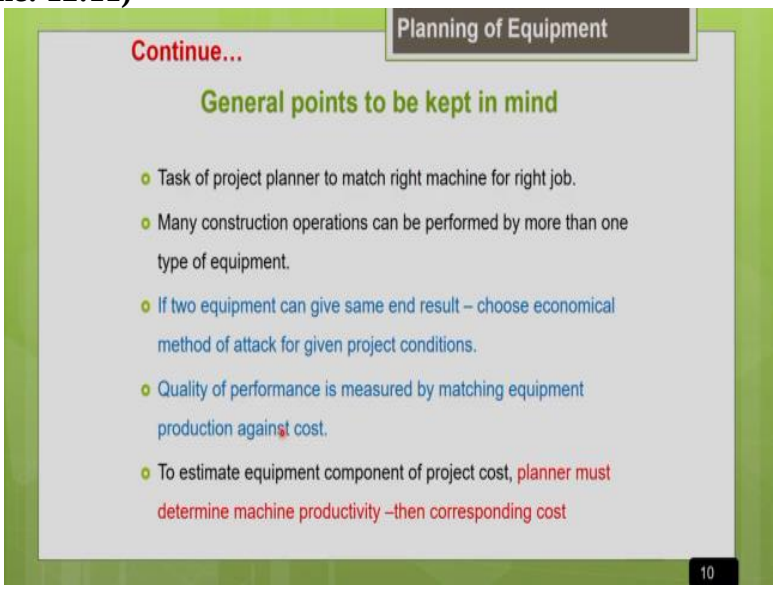

So, what are the other general points which are to be kept in mind while planning of the equipment? As I told you, the task of the project planner is to choose the right machine for the right job. It is really a challenging task now a days as there are so many options available even for the same job in the construction equipment market. So, many construction models are available even for a same particular function.

So, many construction operations can be performed by more than one type of equipment. So, now, how to make the decision? As I told you in the beginning of this lecture, we should go for the economical method of attack. If 2 equipment can give you same end result, choose

economical method of attack for the given project conditions. So, the project conditions also should be taken into consideration while selecting the equipment not only based on economics.

So, the economical method of attack in the sense whichever option whichever equipment or the combination of equipment is going to give you the maximum productivity at the lowest possible cost you have to select the particular option. So, the quality of performance is measured by matching the equipment production against the cost. So, this is a basic guideline, how we make the decision of the selection of equipment based on comparison of the productivity against the cost.

And another important thing is the knowledge of estimation of productivity and the cost associated with the machine is very important to make the selection. And also to estimate the equipment component of the project cost you should know how to estimate the productivity of the machine and the corresponding cost of the machine then only you will be able to estimate the equipment component of the project costs.

That is why knowledge of estimation of equipment productivity and the cost associated with the machine is very critical very important for any project planner or the project estimator. So, how to estimate the productivity and how to estimate the costs we are going to discuss in detail in the upcoming lectures.

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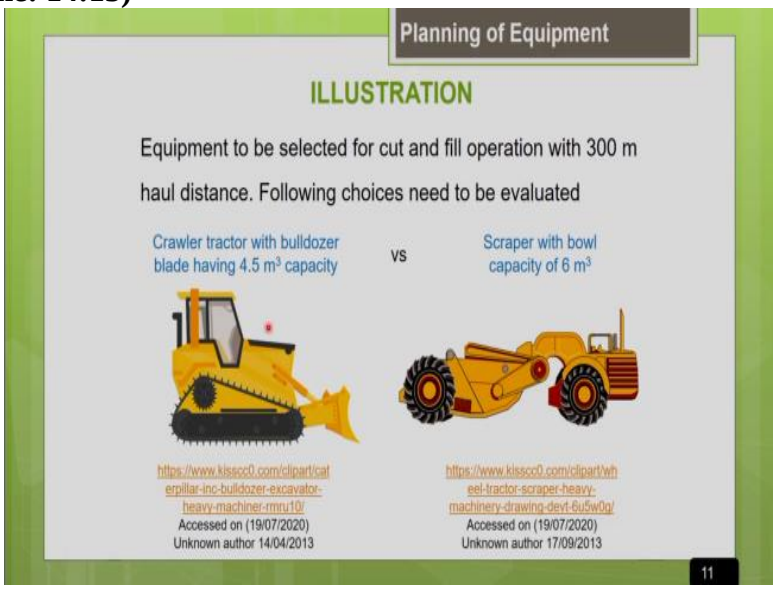

So, let us see a simple example on how to make the equipment selection. See, basically the job assigned here is to choose earthmoving equipment. Equipment has to be selected for cut and

fill earthmoving operation for a 300 meter haul distance. So, there are 2 choices given one is your normal the crawler bulldozer with an earth moving blade having 4.5 meter cube capacity and another option given is your scraper with a bowl of 6 meter cube capacity.

So now we have to make a decision whether to go for the bulldozer for the earthmoving operation or to go for the scraper for the earthmoving operation. Obviously, if you look into the haul distance, the bulldozer can give you maximum economic haul distance of only 100 meters but scraper can give you a longer economic haul distance up to 1000 meters. And also you have to look into the project condition also before making the decision. As of now let us just look into the economics alone to make the decision.

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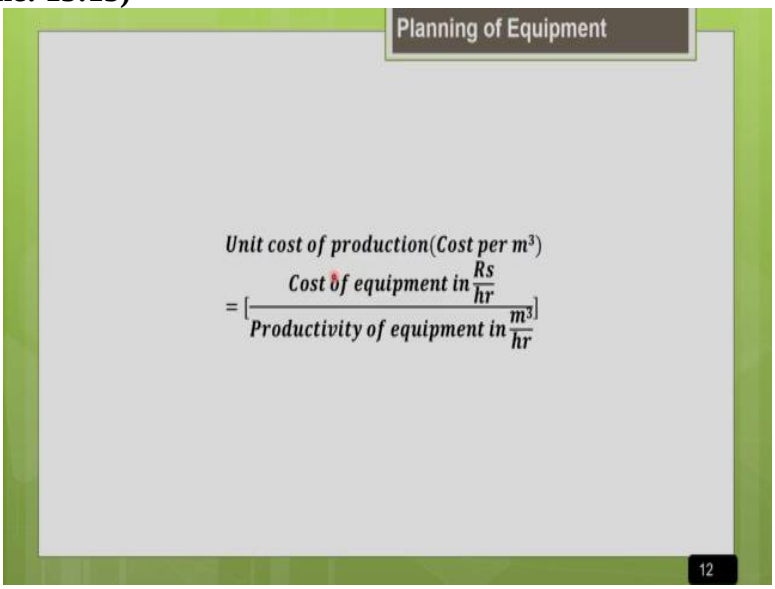

How to consider the economics of the both options? You have to estimate the unit cost of production associated with both the options. How to estimate the unit cost of production? Say what is the hourly cost associated with the machine you have to estimate. As I told you there are different components of cost ownership costs and the operating costs everything you should consider while estimating the cost of the machine and convert it into hourly cost and divided by the hourly productivity of the machine.

$$Unit\ cost\ of\ production(Cost\ per\ m^3) = \left[\frac{Cost\ of\ equipment\ in\ \frac{Rs}{hr}}{Productivity\ of\ equipment\ in\ \frac{m^3}{hr}}\right]$$

Say for example, earthmoving operation, how much volume of earth it is going to move per unit time? If it is going to be earth excavation operation, how much volume of earth it is going to excavate per unit time? If it is going to be concreting operation, how much volume of

concrete is produced per unit time? So, that is how to estimate the productivity of the machines. How to estimate a productivity will be discussed in depth for different types of construction equipment's in the later lecture hours.

So, as of now, you need to know how to estimate the unit cost of production associated with a particular job. So, for that you need to know the hourly cost associated with the machine and the hourly productivity associated with the machine. If you know that, you can estimate the unit cost of production associated with that particular job. Then you can compare the both options see whether I should go for estimating unit cost of production when we employ the bulldozer.

Estimating unit cost of production when you employ the scraper whichever gives you the minimum unit cost of production you have to go for that particular machine selection. This unit cost of production is a very important parameter because when you go for this bidding of projects when you plan for bidding, you work out the unit cost. This unit cost of your equipment also forms a part of the unit cost of your project that is way if you underestimate the cost of the equipment.

If you do not have a thorough knowledge of how to estimate the cost of equipment, you may underestimate the cost of equipment and you may overestimate the profit on paper finally, the contractor may end up in real problem. So, that is why, you should have a knowledge on how to estimate the cost of equipment because this will help you a lot when you plan for bidding.

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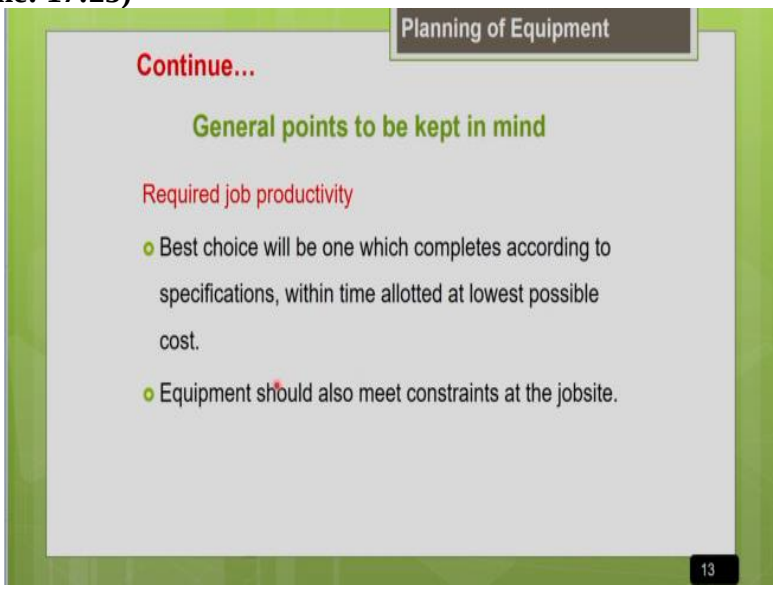

So, what are the other general points to be kept in mind? So far what we discuss is the importance of estimation of productivity of the equipment and the cost of the machine, how it governs the selection of the equipment. Now, you should see that what is the required job productivity for that particular activity? So, that information you can get it from your contract documents. Your contract specifications will let you know like what is the schedule of your project from the work breakdown structure.

You can know what is the time allocated for every activity? And what is the budget allocated for the project? So then you have to match your job productivity with the machine productivity. You have to select a measure of productivity to be matching with your job productivity. So, the best choice of equipment will be the one which will complete according to your contract specifications within the time allotted in the contract at the lowest possible cost, so that equipment you have to select.

So your contract specification is going to be your guideline for the selection of equipment, because that will only tell you what is your project time schedule what is the time allotted for every activity and what is the budget allocated you can get the detail only from the contract specifications and apart from all these things, the another important factor is your equipment selection should also consider the jobsite condition.

Whatever equipment you selected, it should meet the constraints at the jobsite there will be lot of constraints at your jobsite your underfoot conditions may be very poor, it may be a rocky terrain or it may be a steep terrain. So, jobsite may be in a very remote place where accessibility of the machine to the job site be very critical, your jobsite will be at a very high altitude the temperature will be very aggressive there it may be a very cold weather place. So, all these conditions will affect your equipment selection. So, all these things also should be taken into account apart from the economics of your= project.

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Now, having discussed about the general guidelines, which are to be kept in mind, now let us move on to the discussion about the important equipment selection practice. So the first one is your specific construction operation that is a basic factor, an important factor, as I told you your contract specifications in the contract documents that is only going to govern your selection that is going to decide your project time schedule and the budget allocated for that particular project.

And other than that there are different jobsite conditions like your underfoot conditions, your grade, how steep is your grade? And what is the working space limitations for your equipment and how was the excess of the equipment to the site? How is the site access? Other than that where is your site located that is going to decide your weather conditions like temperature, wind, rain, the altitude.

So, all these things will govern your equipment selection. So, apart from this, so, you have to also look for the other interdependent machines which are going to work with your proposed machine. So, machines which are working in team, the selection of one machine will depend upon the productivity of the capacity of the other machines and another important thing is what is the mobility required for equipment at your project site that will also govern your selection and how versatile you want an equipment to be.

So, these are all the important equipment selection factors. Now, let us look into all this equipment selection factors one by one.

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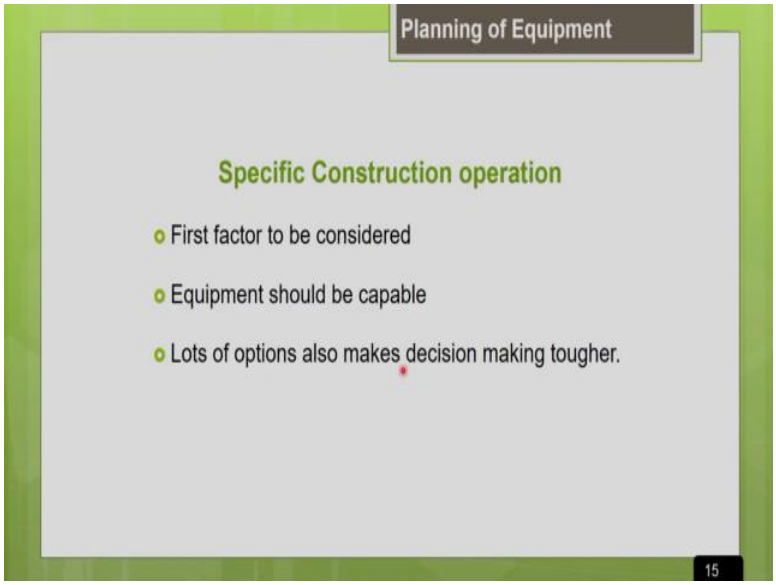

So, the first the selection factor is a specific construction operation. So, this is the first factor to be considered this is the basic factor. So, whatever equipment which we are going to select should be capable of doing that particular operation. Say for example, if we wanted to use an equipment for earthmoving operation, it should be capable of doing the particular earth moving operation that is a basic requirement of that particular equipment.

As I told you earlier a lot of options are nowadays available in the construction equipment market which makes the decision making very tougher for the project planner. So, in that case he has to work out the economics of different options and whichever equipment gives him the lowest unit production cost, he has to go for that particular option.

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Say let us see some examples see if you are going to select an equipment for earthmoving operation. So basically what do you mean by earth moving operation? What are the basic steps

involved? You have to loosen the earth first then excavate it, then haul it and then dump it. These are the basic steps involved in the earth moving operation. So there are different options of machines available for this activity, say I can go for a tractor with a ripper arrangement. So you can see this is a ripper which is attached to the rear end of the tractor.

So with this ripper, I can just loosen the earth so, this is one option available, I can use ripper first, then after that, I can go for a scraper after loosening the earth with the ripper, I can go for this scraper which is also an earthmoving operation, which can cut the earth and load it into the bowl. So, before cutting the earth with the scrapper if you are using the ripper, the job of the scraper will be very easier its productivity will increase.

So, I can go for a combination of ripper and the scraper this is one option possible or otherwise I can go for just a bulldozer with just an earthmoving blade, this is also possible. So, we can also compare the economic haul distance of both the machines. As I mentioned earlier, this one will give you a haul distance of 100 meter maximum and this one can give you a haul distance of up to 1000 meter maximum.

So, depending upon your job requirement, you have to make the choice and another thing is you can also go for a backhoe which is an excavator, greater depth excavation, you can go for this but the problem with this backhoe is it is a good excavator, but it is not a hauling machine. So, in addition to backhoe I need a hauling equipment like a truck. So, the backhoe will just excavate the earth and load it into the truck the truck has to haul the earth now you have to work out the economics of different combinations and whichever combinations will give you the least unit production cost you have to go for that particular combination.

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