Construction Methods and Equipment Management

Dr.G. Indu Siva Ranjani
Department of Civil Engineering
Indian Institute of Technology, Guwahati

Module No # 01
Lecture No # 05
Equipment cost – Caterpillar and Peurifoy method

Hello everyone. I welcome you all to the lecture 5 of this course construction methods and equipment management. So in this lecture 5 we will be discussing about how to estimate the total equipment cost. So far we have discussed about how to estimate the ownership cost and the operating cost components. So in this lecture we will be working out some illustrations on how to estimate the total equipment cost using Caterpillar method and Peurifoy method which are commonly adopted methods.

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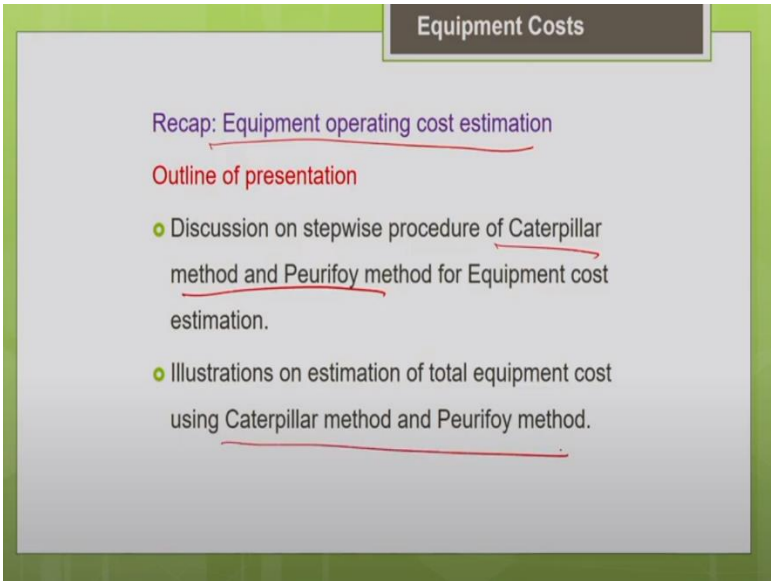

So let us have a recap of what we learnt in the previous lecture. So in the previous lecture in the lecture 4 we discussed about the different operating cost components. So we have looked into how to estimate the various operating cost operation of the equipment. Now let us see the outline of today's presentation. In this presentation we will be discussing the stepwise procedure of how to estimate the estimation cost using Caterpillar method and Peurifoy method. And we will be working out some illustrations using these 2 methods on estimation of the total equipment cost.

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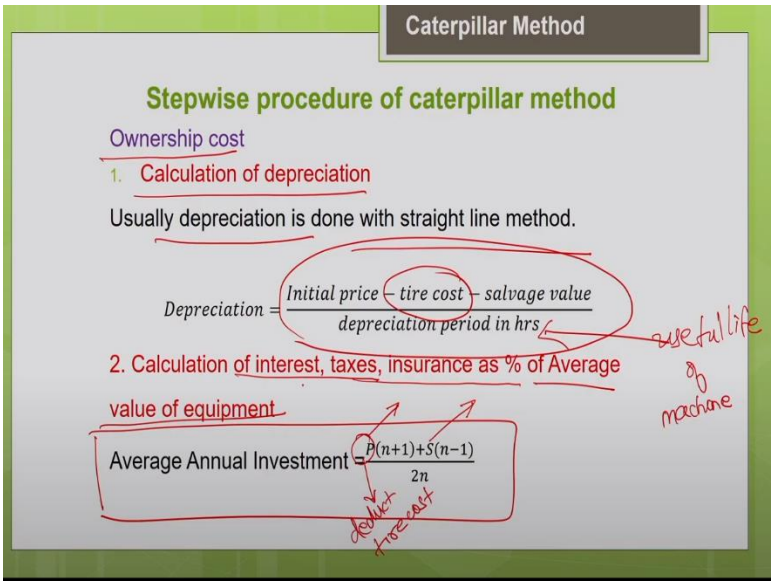

So as I told you these are two commonly adopted methods. One is a Caterpillar method other one is a Peurifoy method. So we are going to discuss this procedure as discussed by Gransberg et. al. So I have referred this text book and it is included in the list of references which will be shared with you towards the end of the presentation. So let us see now the stepwise procedure of the Caterpillar method.

So this procedure you can also find out in the Caterpillar performance handbook which is published by the Caterpillar equipment manufacturing company. So it is a very popular method. So as we know the owner ship cost and operating cost is the two main components. Let us start with the estimation of the ownership cost. So under the ownership cost we are going to estimate the depreciation first.

So in this caterpillar method we are going to adopt these straight line methods for estimation and depreciation. I hope everyone remember what is a straight line method of depreciation? So, how to estimate the depreciation using straight line method? It is nothing but the difference between your initial price minus a salvage value. So obviously I have to deduct the tire cost also because tire cost will be considered separately under the operating cost.

So depreciation is nothing but initial price minus salvage value divided by the depreciation period in hours.

$$Depreciation = \frac{Initial\ price - tire\ cost - salvage\ value}{depreciation\ period\ in\ hrs}$$

So it is nothing but your useful life of the machine. So we are assuming with your machine is going to depreciate over the useful life. So that is why it is written as depreciation period in hours. So this is what the period we take it for the cost accounting purpose.

So you can call it as useful life or service life or the recovery period or the depreciation period. So there are different terminologies to call the service life of the machine. So this is how you calculate the depreciation. You can get the hourly depreciation. Now let us calculate the other components of the ownership cost. It is nothing but the cost of investment, taxes, insurance. So everything will be calculated as a percentage of the average value of equipment.

Hope you remember so how to estimate the average value of the machine using straight line depreciation method we have derived this formula in the earlier lecture.

$$Average\ Annual\ Investment\ = \frac{P(n+1)+S(n-1)}{2n}$$

Here P is the purchase price of the machine and S is a salvage value of machine. In this purchase price you are supposed to deduct the tire cost because the tire cost will be considered separately deduct the tire cost, n is the useful life of the machine.

So we can calculate the average value of the machine over the useful life of the machine using this formula. Then after that you calculate the cost of investment, taxes, insurance everything as a percentage of this average value of the machine.

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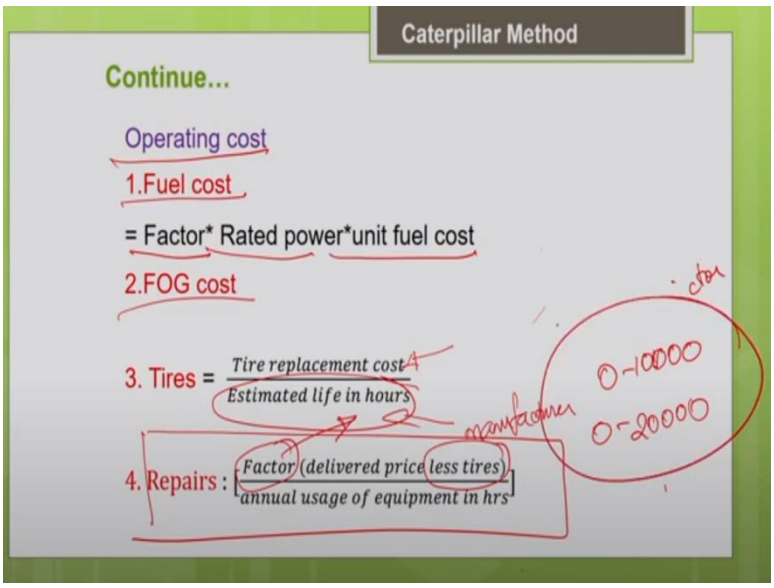

Now the ownership cost is done it is more to the operating cost. So under operating cost we are going to discuss cost of consumable. Firstly, we will discuss about the fuel cost. Fuel costs there are different handbook which provides you the information on the fuel consumption factor. Fuel consumption factor you can get it from different handbooks. So different handbooks are available actually in the real life we are suppose to have some accounting records like you may be having a past record about the performance of your machine.

So from that also you will get the fuel consumption factor for the similar machine or you can go by the manufacturer guide lines as mention in the equipment handbook supplied by the equipment manufacturer. So that will also serve as a guideline to find the fuel consumption factor. So basically as I told you say for example you are looking to caterpillar performance.

In that case they have given the hourly fuel consumption for the different models of machine directly you can get it hourly fuel consumption is provided for the different models of machine manufacture by them. So directly you can get the hourly fuel consumption and they have defined the different load conditions, for which, they have given the values. Say for example I remember we discussed as an example in the early lecture also.

Say for example the excavator if we take a particular model of excavator the different load condition, high load condition, medium load condition and low load condition. What is the hourly fuel consumption you can get the values from the caterpillar performance handbook. Say if they have define the load condition also for high load condition it means your excavator say for example it is working in a rocky terrain. So it means the fuel consumption or the power consumption it will be more in a tuff condition. Similarly, the equipment is working for a longer duration.

Say it is digging at a 95% of the daily work schedule it means your fuel consumption is more it is working for a longer duration, since it is poor rough terrain it will be working at full power. So that is why we called as high load condition. Similarly, for the lower load condition also they have given a definition. Say for example it may be working in a sandy terrain so handling the sand or common earth it is going to be easy for the excavator.

So the power consumption or the fuel consumption are going to be less. Similarly, it may be digging at less than 50% of daily work schedule that means it is working duration is less. So

accordingly your operating cost will be less. That is why they are calling it as low load condition. Similarly, different equipment models so they have given the fuel consumption hourly fuel consumption for different load condition along with the definition of the load conditions.

So you can go through it whichever load condition is matching with your actual project condition, you can take it accordingly and use those values. It is not only in the caterpillar handbook so every equipment manufacturer when he supplies his machine he provides the information on the machine. So manufacturer guidelines are there. So from those guidelines you can get this information.

So again in some handbooks they directly give you the fuel consumption factor instead of giving hourly fuel consumption they will give fuel consumption factor for different working condition say average working condition severe working condition for different types of machines. So it is also expressed in this way. So depending upon the equipment handbook you can see the way it is expressed it will be different.

So directly you can take the fuel consumption factor to the project working condition multiplied with the horsepower of the machine and multiplied by the unit fuel cost you will get the fuel cost. But in the Caterpillar performance handbook you are getting directly the hourly fuel consumption for the particular model. So we need not even multiply for the horse powered machine.

$$Fuel\ cost = Fuel\ consumption\ factor * Rated\ power * Unit\ fuel\ cost$$

You can directly use the fuel consumption value multiplied by the unit fuel cost you will get the hourly fuel cost for the particular model manufactured by them. So depending upon the handbook you have to go through it carefully and make the estimation. There cannot be the common rule for every handbook. And another important thing is FOG is nothing but filter, oil, grease. So these are also the consumables which are consumed during the equipment operation.

So if you looking into Caterpillar performance handbook you can see as I told you the hourly consumption or the filters, hourly consumption of lubricating oil, hourly consumption of grease is available for different equipment models for different operating conditions directly you can take it multiply by the unit cost. You will get the FOG cost. In some other handbooks you can see that they give it as a FOG factor, factor in the sense you have to multiply this factor by the fuel cost.

It will be expressed as percentage of the fuel cost. In addition, you have to apply some labor adjustment factor also to get the accurate value because as you know that the labor skills depending upon the operator skill the labor skill all these operating cost will vary a lot. So that is why and this labors skill will vary from region to region from place to place. So in some of handbook you can see that in every region what is the labor adjustment factor that is also available, accordingly you can adjust your FOG factor.

So there are different approaches to estimate this cost. So depending up on the handbook you are referring so the approach may vary. And another thing to be calculate it is your tire cost it is nothing but your tire replacement by the estimate the life of tires in hours. So this you can get it from your manufacture for different work condition for different terrains or for different operating condition what will be estimated life of the tire of this machine.

You can get it from the manufacturer or from your past record. And similarly your tire replacement cost obviously you can get the cost of tires easily. So you will get your hourly tire cost. So for the tire you can add the repair cost. You can add the just 15% to the tire replacement cost that will give you the tire replacement cost. So another thing is your repair of your machine other than tires.

Tires $= \frac{Tire\ replacement\ cost}{Estimated\ life\ in\ hours}$ So maintenance and repair of your machine excluding the tire cost. So the tire repair we consider separately, separate from the repair cost from the remaining cost of the equipment so, for the repair cost estimation of the equipment. So you can follow this methodology like you can take the repair factor as a percentage of the initial cost of the machine. But excluding the tire cost as a percentage of the delivered price of the machine excluding the tire cost.

$$Repairs = \left[\frac{Factor\ *\ (delivered\ price\ less\ tires)}{annual\ usage\ of\ equipment\ in\ hrs}\right]$$

So that will give you the repair cost. These factors you can get it from the literature for the different project condition or you can get it from the equipment handbook. As I told you in Caterpillar handbook you can see that for different range of the operating hour these repair factors are given. Say for example 0 to 10000 hours you can get a repair factor, 0 to 20000 hours operating hours of the machine.

So accordingly repair factor will vary. So you can get these values accordingly depending upon your handbook your referring so finally divided by the annual usage of the equipment in hours. So in that you can get your hourly repair cost.

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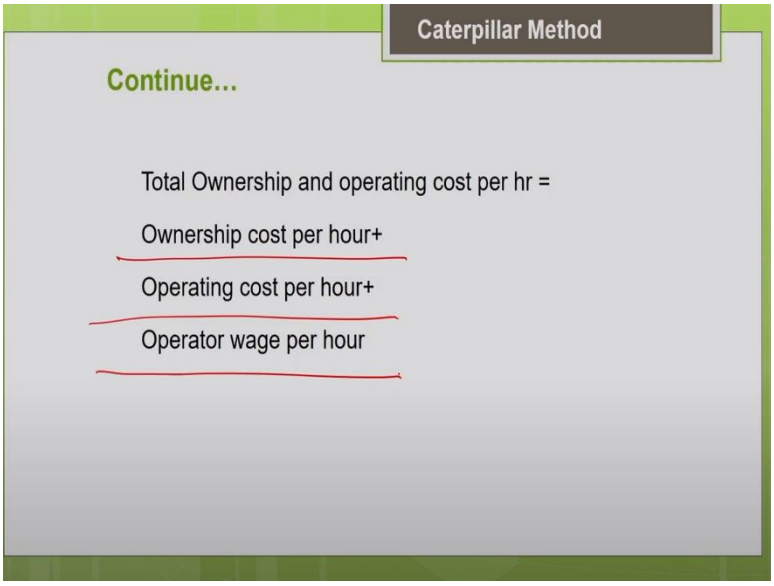

So now the total ownership and the operating cost will be the sum of all the ownership cost components, operating cost components and in addition you have to add the operating wages as I told you earlier. So the daily wages what you pay for the operator, I mean per hourly wages for the operator in addition to all the benefit he gets like the bonus, the over time benefits and even workmen compensation the premium which we paid on behalf of him. So all these thing will be included in the operating wages. So with this the Caterpillar method is done.

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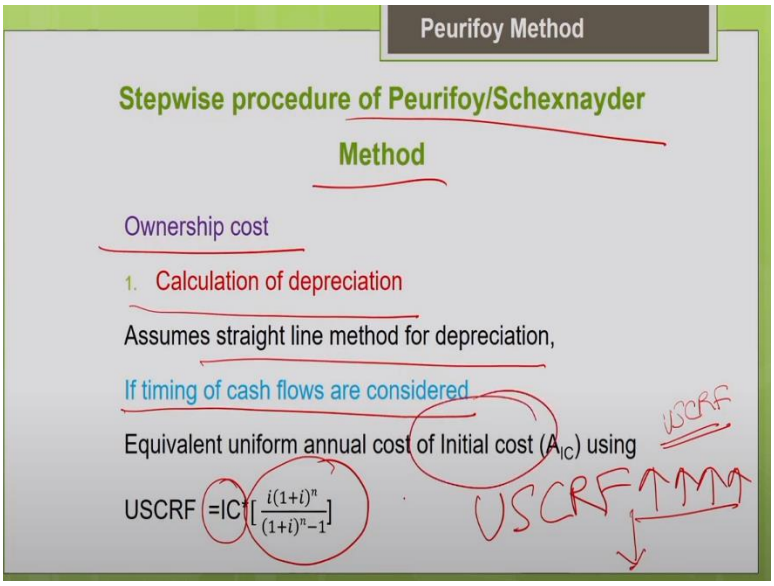

Now let us move on to the stepwise procedure of the Peurifoy method. Peurifoy is very popular method. So he is the very famous person he is even considered as the father of the modern construction engineering. His contribution towards the construction engineering and the construction equipment and the equipment cost estimation is highly appreciated by many people. You can see his approaches of very rational. So let us discuss these guidelines also on how to estimate the equipment cost.

Coming to the ownership cost, under the ownership cost you are going to calculate the depreciation. Here also we are going to follow the straight line method of depreciation. And Peurifoy has discussed 2 different approaches. One is your average annual investment method average annual investment method and the other one is time value method. So you can see if there are 2 approaches discussed by him.

So under the caterpillar method we have discussed this approach already average annual investment method. So we are not going to discuss that again. So this method is really approximate because we are not considering the time of the cash flow which are occurring at different point of time. So there is the limitation of this method. So in this Peurifoy method now we are going to discuss only the time value approach.

So we are going to consider timing of cash flow which gives you more accurate estimation of the cost. So we will make use of different compounding factors to convert the cash flows occurring at

different time period into equivalent value at a particular time period as discussed earlier. So we are going to discuss only that approach in this representation now. So if the timing of the cash flows are considered how to do that we are going to discuss now.

So initial cost of the machine that is the purchase price so that, we are going to convert it into equivalent uniform annual cost using uniform series capital recovery factor. So we have discussed the application all this factors already. So you can convert your initial purchase place into equivalent uniform annual cost using uniform series capital recovery factor.

$$USCRF = \left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

$$Equivalent\ uniform\ annual\ cost\ of\ initial\ cost = Initial\ cost \times \left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

So this is your uniform series capital recovery this is your initial cost you multiply both you will, get your equivalent uniform annual cost of your purchase price or the initial cost.

So here you suppose deduct the tire cost because tire cost will be considered only under the operating cost.

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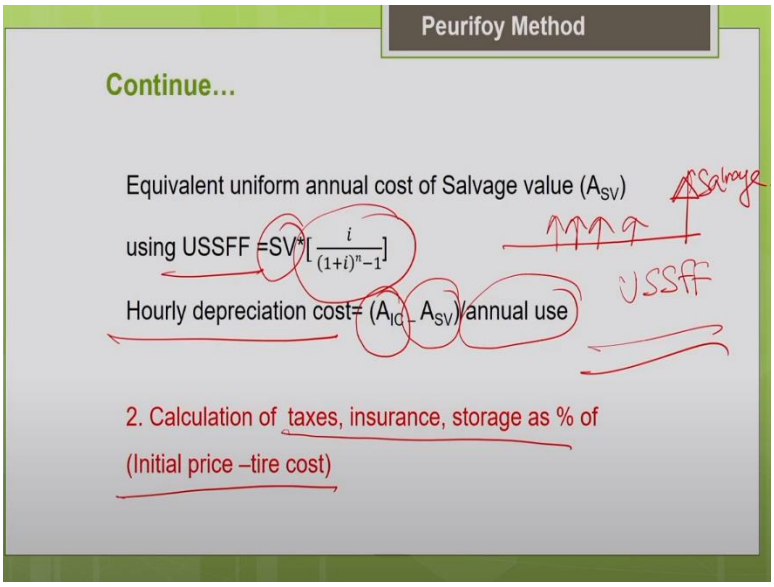

And the next one is your future salvage. The salvage value it is converted into equivalent uniform annual cost using uniform series sinking fund factor.

$$USSFF = \left[\frac{i}{(1+i)^n - 1}\right]$$

$$Equivalent\ uniform\ annual\ cost\ of\ salvage\ value = Salvage\ value \times \left[\frac{i}{(1+i)^n - 1}\right]$$

Your salvage value is converted into equivalent uniform annual cost over the useful life of the machine using uniform series sinking fund factor. So you just multiply the salvage value into uniform series sinking fund factor.

Now the hourly depreciation you can calculate using this straight line depreciation factor. Just the difference between the equivalent uniform annual initial cost, equivalent uniform annual salvage cost. So that will give you the depreciation divided by the annual usage of the machine in hours. So you can get the hourly depreciation cost using this straight line depreciation method.

So we are just trying to recollect or summarize again whatever we have discussed in the earlier lecture. So I hope you remember the application of all these factors. So using this time value concept we have estimate the hourly depreciation accurately in this slide. Now you calculate the other components of ownership cost which are nothing but your taxes, insurance, your storage. So they are calculated as a percentage of the initial price minus the tire cost.

So initial price minus tire cost, so you can calculate it and your taxes, insurance which hs calculated as a percentage of this. So in the earlier caterpillar method hope you remember when you adopt the average value method you have to take all taxes, insurance, storage as percentage of a average value of the machine. So here we are considering it as a percentage of the initial price of the machine.

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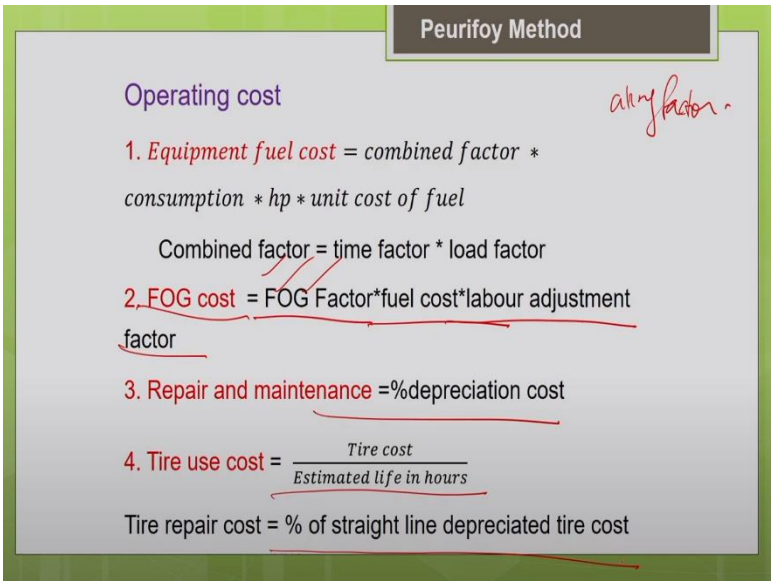

Now coming to the operating cost so equipment fuel cost so you can calculate it based upon the fuel consumption. So this fuel consumption you can get it from your past record or any equipment handbook or the manufacture guideline. So which ever manufacture supply the equipment so they will be provided some guidelines of the handbook in the handbook you can get your information for a particular model on the hourly fuel consumption.

So directly you may get the hourly fuel consumption for the different project conditions or you may be getting the fuel consumption factor for the different project conditions. So accordingly you have to use it. Say for example if you have used some value from a literature there the values given for some standard conditions where the machines is working at maximum output rate. Then you have to adjust that particular consumption factor according to your project condition.

So that combine factor is nothing but your operating factor. It is nothing but the operating factor which reflects your project condition. So, according to your time factor, according to the load factor, so you have to adjust the fuel consumption value taken from the particular literature. So multiplied by the operating factor so that, you can get the consumption for your project condition. So then you have to multiply for the horse power of engine and unit cost of fuel.

So this will give you the hourly equipment fuel cost. So it depends upon the source of your literature from which handbook you are taking the information. So according to that approaches slightly vary. But basically you have to make sure that whatever factors you use it should reflect

your project condition. It should not be too theoretical; it should be the value of which is derived for standard condition.

So you have to adjust it according to your project condition so that you can get a realistic estimate of your equipment cost. So next is your other consumable FOG. As we have discussed just now for the Caterpillar method. So you can get the FOG factor as a percentage of the fuel cost and you can multiply by the labor adjustment factor. So this labor adjustment factor will vary from region to region depending upon the variation of the skill of the labor which is also going to affect your operating cost significantly.

So these values are available of particular handbook which I have listed in the reference you can see. So you can make use of that to make adjustments accordingly or some handbooks as I told you it directly gives you the hourly filter cost and lubricating oil filter cost and grease cost you have to for different projection condition you have to just simply multiply by the unit cost. So for that you can get your FOG cost. So their approaches are different.

So repair and the maintenance they express as the percentage of the depreciation cost. So this is also one way to express the repair and maintenance as we discussed earlier in the operating cost. So another thing is tire use cost is depend upon your tire cost and the estimated life in hours of your tires which you can get it from the equipment manufacturer. And the tire repair cost is express as the percentage of the straight line depreciation tire cost.

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