Construction Methods and Equipment Management

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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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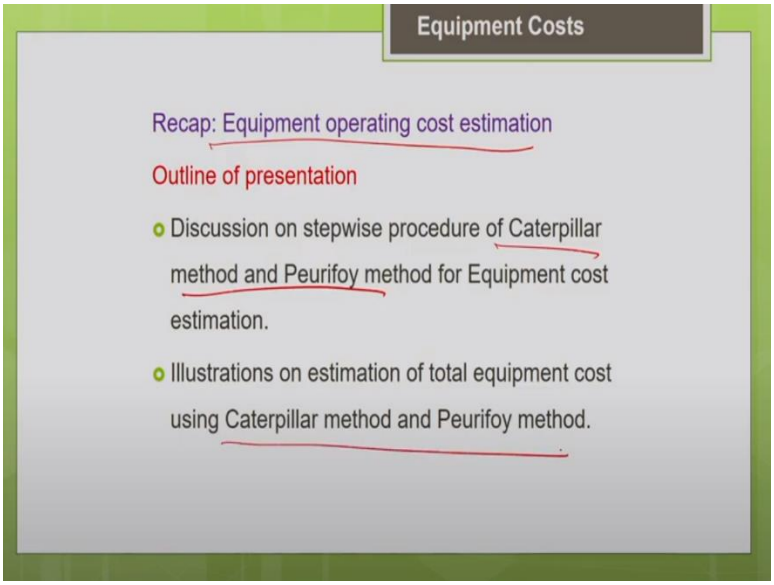

So let us have a recap of what we learnt in the previous lecture. So in the previous lecture in the lecture 4 we discussed about the different operating cost components. So we have looked into how to estimate the various operating cost operation of the equipment. Now let us see the outline of today's 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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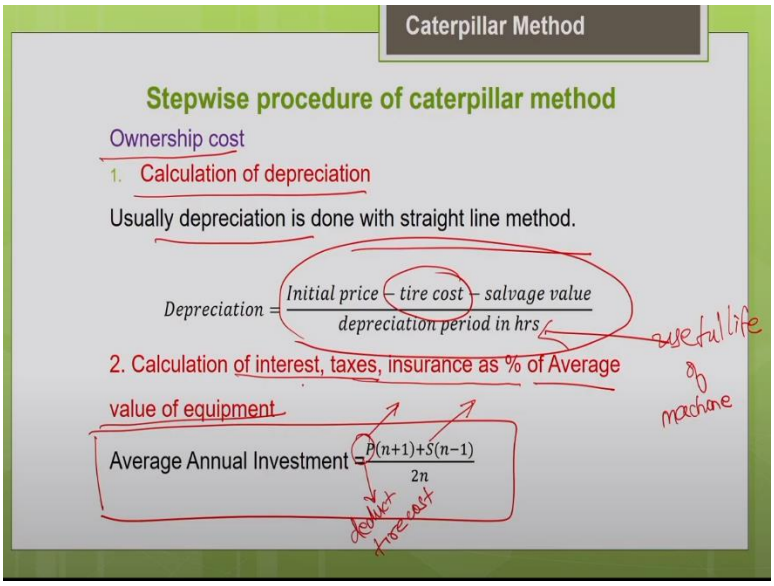

So as I told you these are two commonly adopted methods. One is a Caterpillar method other one is a Peurifoy method. So we are going to discuss this procedure as discussed by Gransberg et. al. So I have referred this text book and it is included in the list of references which will be shared with you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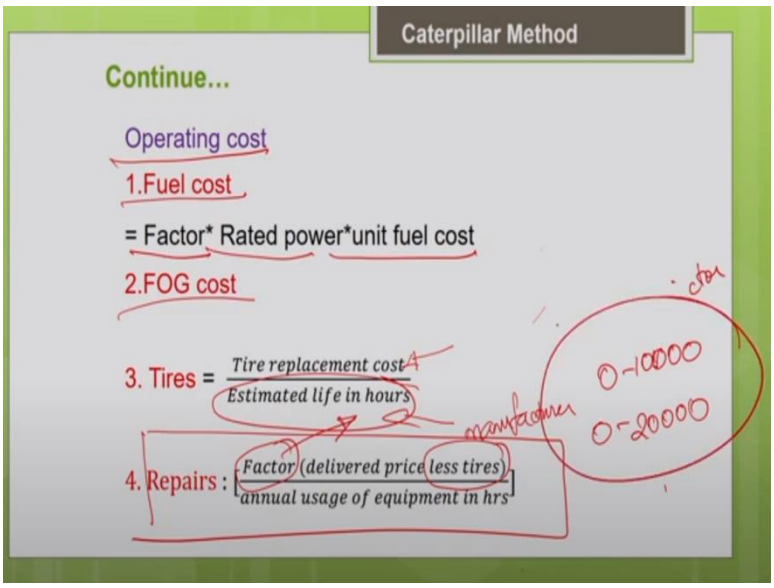

Now the ownership cost is done it is more to the operating cost. So under operating cost we are going to discuss cost of consumable. Firstly, we will discuss about the fuel cost. Fuel costs there are different handbook which provides you the information on the fuel consumption factor. Fuel consumption 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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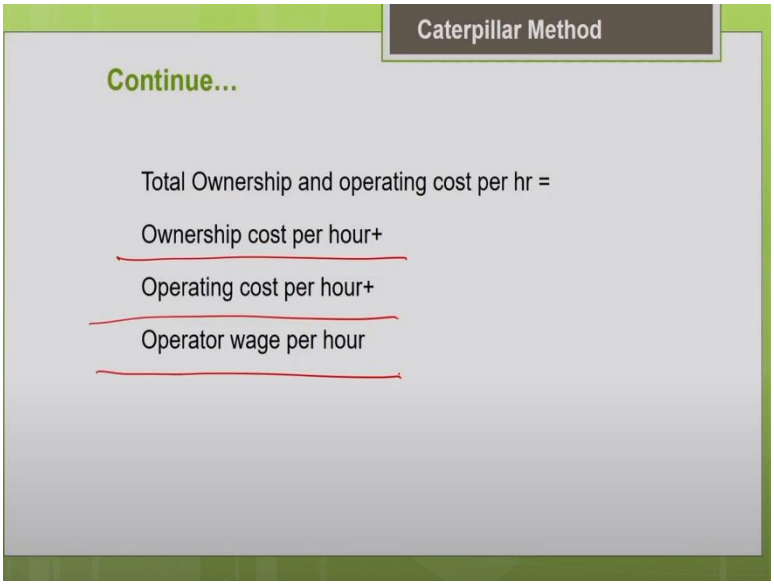

So now the total ownership and the operating cost will be the sum of all the ownership cost components, operating cost components and in addition you have to add the operating wages as I told you earlier. So the daily wages what you pay for the operator, I mean per hourly wages for the operator in addition 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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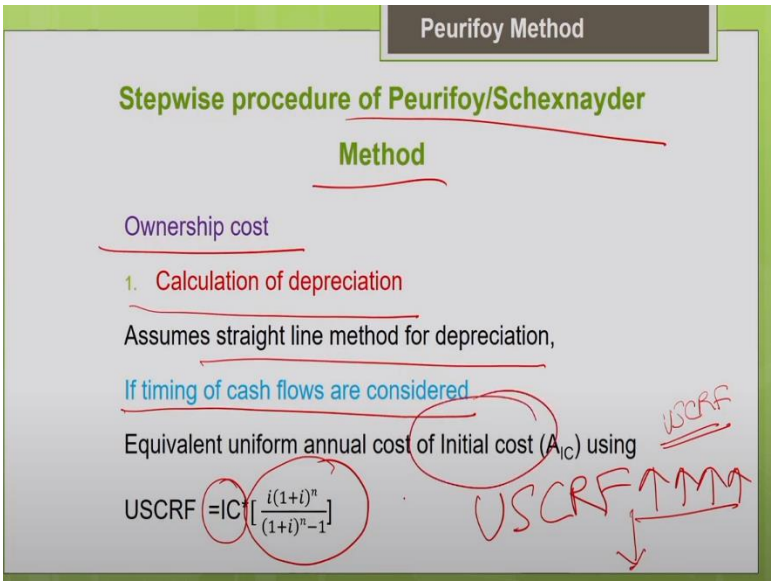

Now let us move on to the stepwise procedure of the Peurifoy method. Peurifoy is very popular method. So he is the very famous person he is even considered as the father of the modern construction engineering. His contribution towards the construction engineering and the construction equipment and the 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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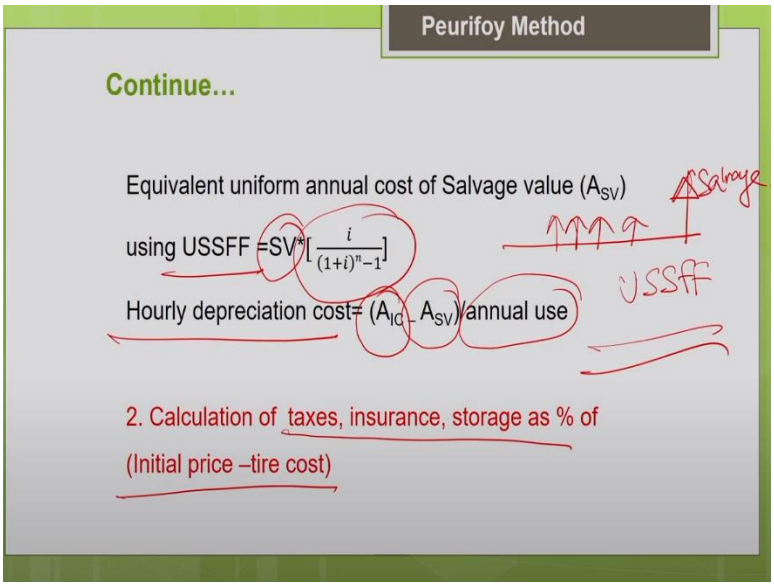

And the next one is your future salvage. The salvage value it is converted into equivalent uniform annual cost using uniform series sinking fund factor.

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

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

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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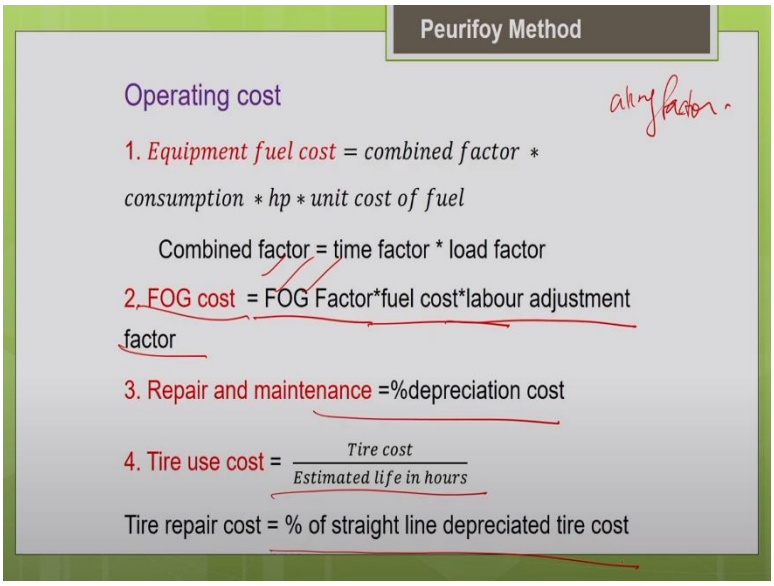

Now coming to the operating cost so equipment fuel cost so you can calculate it based upon the fuel consumption. So this fuel consumption you can get it from your past record or any equipment handbook or the manufacture guideline. So which ever manufacture supply the equipment so they will be provided 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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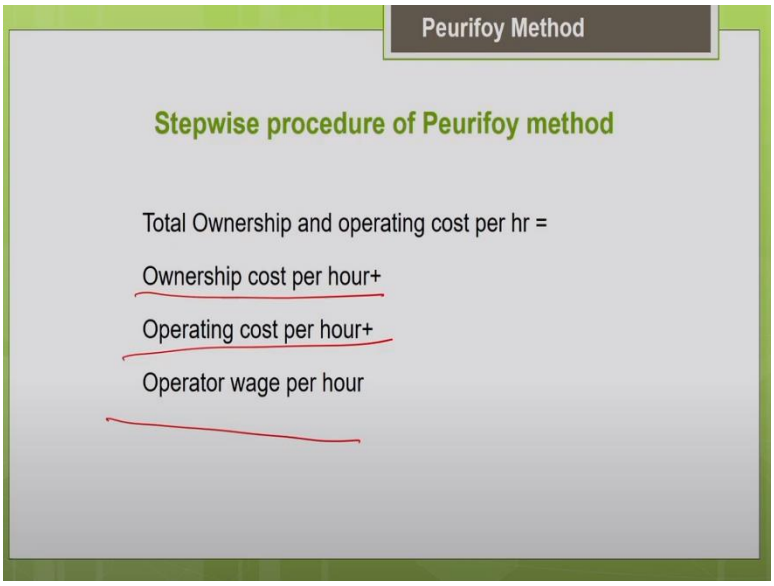

So just add up everything the ownership cost all the operating cost and operating wages also you will get the total ownership and the operating cost following the Peurifoy guidelines. Now let us workout from examples on how to estimate the equipment cost using these 2 methods.

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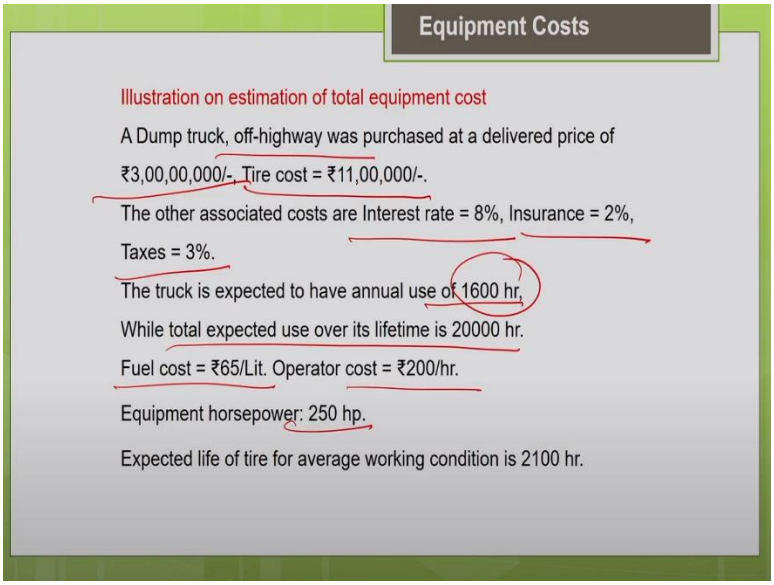

So you can see this problem in this problem you can estimate the cost for the dump truck. It is off highway truck, why we call it as off highway? This truck is not permitted on the public highways. It is an; heavy equipment high end equipment you can see that these trucks will be operated only in the project sites. You can also see some quarry truck. So those heavy machines are not permitted on the public highways. That is why we call it as off highway trucks. The initial cost is given so it was purchased with the deliver price of 3 crores.

So you can imagine it is already high end equipment with special features like you can see it will be kind of articulate machine with any additional features are there with this dump truck that is why you can justify its cost. And the tire cost of this machine is 11 lakhs. Also many of this number I have just made some approximate assumption. So let us not go deep in to this number, the main objective of this illustration is just to show you the methodology of how to estimate the economic cost.

The requirements are according to the type of the machine for which you are going to estimate. You can choose the appropriate estimation handbooks and choose the values estimated accurately. These numbers are just approximate assumptions just to show the methodology of how to estimate the economic cost. So the other associated cost are the interest rate which is nothing but 8% insurance 2% and taxes 3%. So other component of the ownership is also given.

And the truck is expected to have annual use of 1600 hours. So every year the truck is operating for 1600 hours. It depends upon every day how many hours it is operating and how many days it is operating in a particular year. So, according to that we can calculate this 1600 hour. Similarly, throughout this entire life its useful lifetime the hourly usages 20000 hours, and the local cost of the fuel in the particular space is 65 rupees per liter and the operating cost the wages per hour is 200 rupees per hour.

And the horsepower of the engine is 250 and the expected life of tire, this data is given to you directly you can take it from the handbook according to your requirement. But I have given you some approximate number for average working condition nothing but 2100 hours for this particular tire.

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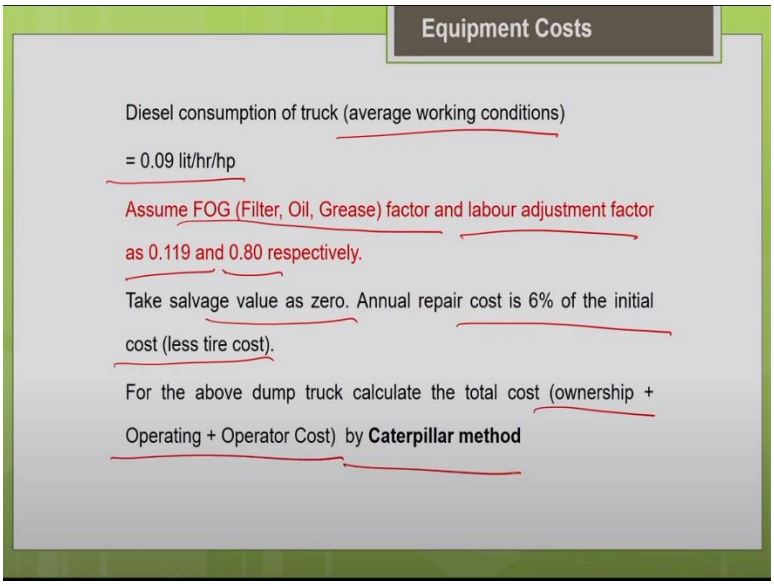

Then the diesel consumption of the truck for average working condition is 0.09 liters per hour per horsepower. So this value also I have assumed it approximately, you can look into the literature for the particular type of the machine in the particular work condition and you can get the value accurately for the particular model of machine from the equipment handbook. And similarly filter oil grease I have given the factor 0.119 and the labor adjustment factor I have used it as 0.8 approximately, the assumption for the particular region.

Take the salvage value 0 for this particular problem and the annual repair cost is 6% of the initial cost excluding the tire cost. The repair factor is also given to you directly. So for the above truck above dump truck you calculate the total cost your ownership plus operating plus ownership cost by the Caterpillar method first. We are going to estimate by the Caterpillar method first.

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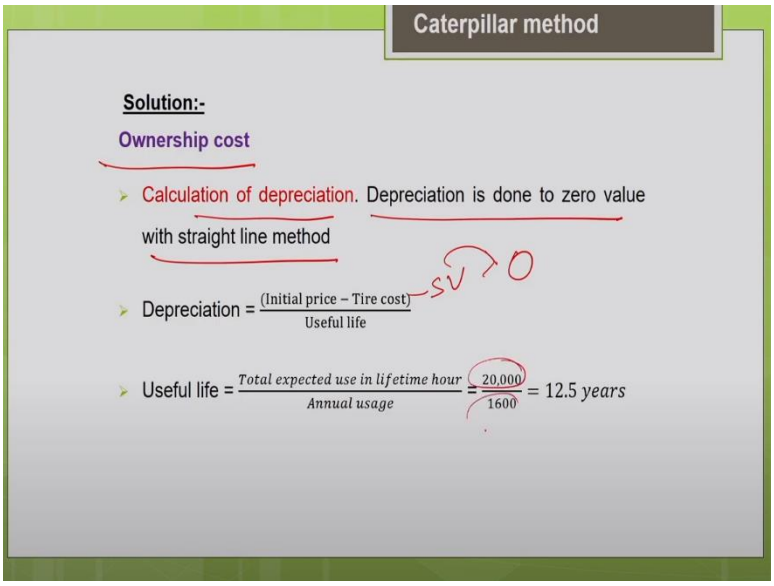

So under the ownership cost let us calculate the depreciation first.

$$Depreciation = \frac{(Initial\ price - Tire\ cost)}{Useful\ life}$$

So we are going to further straight line method since the salvage value 0 here in this problem. So the depreciation is done to 0 value you can say that it is nothing but initial price minus tire cost minus salvage value, salvage value is 0 divided by the useful life of the machine. How to find the useful life of the machine? So they have given you the total expected use of the machine in life time.

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It is given in the equation you can recollect the total expected use of the machine over its life time is. So you can see the total expected the use of the machine of over its lifetime is 20000 hours so it is given to you. And the annual use of the machine every year in hours is 1600 hour. So if you divide both you will get the 20000 hours it is the total lifetime use of hours every year it is used for 1600 hours.

$$Useful\ life = \frac{Total\ expected\ use\ in\ lifetime\ hour}{Annual\ usage} = \frac{20{,}000}{1600} = 12.5\ years$$

This will give you the useful life of a machine in years. That is what we calculating here. 20000 divided by 1600 gives you the useful life of the machine in years 12.5 years.

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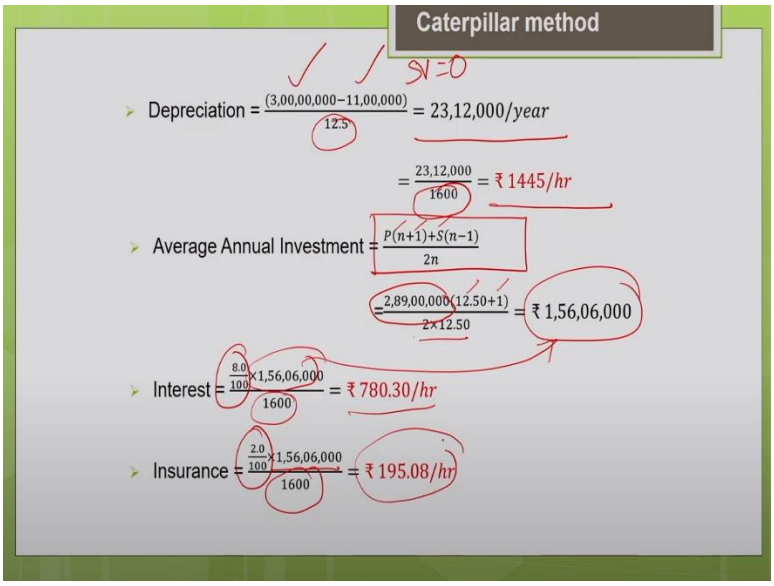

Now we shall calculate the depreciation. So depreciation is nothing but your initial price minus the tire cost minus the salvage value divided by the useful life of the machine. So initial price is 3 crore's minus the tire cost is 11 lakhs obviously your salvage value is 0 in the given equation and the useful life of the machine is 12.5 years. So now you can get your annual depreciation like this.

$$Depreciation = \frac{(3,00,00,000 - 11,00,000)}{12.5} = 23,12,000/year$$

It is nothing but 23,12,000 per year.

$$= \frac{23,12,000}{1600} = ₹\,1445/hr$$

So now just divided by the annual usage of the machine in hours you can get the hourly depreciation as rupees 1,445 per hour. So this is how we estimate the hourly depreciation. So this is approximate estimation because we are not considering the timing of the cash flow here. So another thing what we do in the Caterpillar method is we estimate the average annual investment.

Hope you remember the formula.

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

$$= \frac{2,89,00,000(12.50+1)}{2 \times 12.50} = ₹\,1,56,06,000$$

P is nothing but your purchase price minus your tire cost. It is nothing but your 3 crore - 11 lakh, 11 lakh is your tire cost that gives you 2 crores 89 lakhs, so multiplied by n + 1 ok, n is 12.5 + 1,

salvage value is 0. So divided by 2 into n, 2 into 12.5 so this gives you the average value of the machine over its useful life as you can say 1,56,06,000.

So over its useful life the average the value of the machine is 1,56,06,000. So now all the other components of the ownership cost you are going to estimate it as the percentage of the average of the machine. So your cost of investment interest is 8% multiply by the average this is your average value you can say. So this is the average value of the machine divided by the annual usage of machine in hours.

$$Interest = \frac{\frac{8.0}{100} \times 1{,}56{,}06{,}000}{1600} = ₹\,780.30/hr$$

So that you can get the interest hourly interest it is nothing but rupees 780.3 per hour. Similarly, insurance is nothing but 2% of the average value of the machine. 2% of the average value divided by the annual usage of the machine in hours that gives you hourly insurance cost is rupees 195.08 per hour insurance charges.

$$Insurance = \frac{\frac{2.0}{100} \times 1{,}56{,}06{,}000}{1600} = \frac{₹\,195.08}{hr}$$

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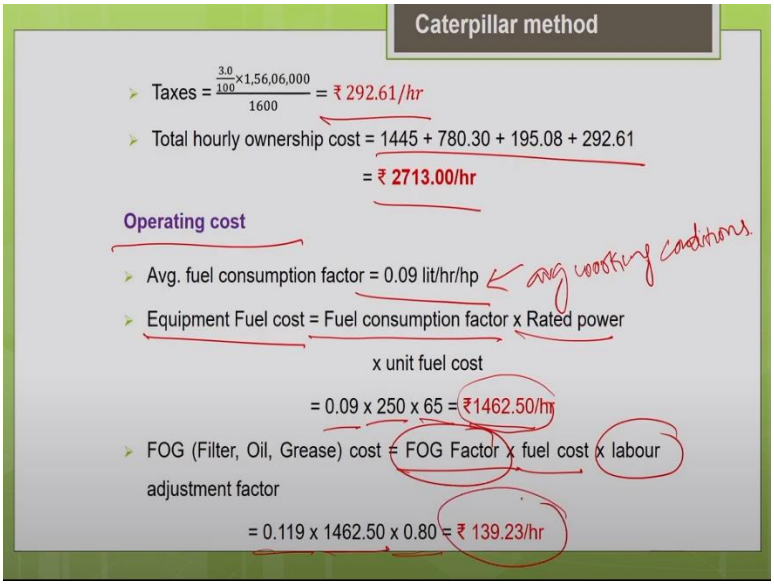

Similarly, your taxes it is taken as 3% of the average value of the machine / hourly usage of the machine in a year. It is nothing but 1600 that give you the hourly taxes cost as rupees 292.61 per hour.

$$Taxes = \frac{\frac{3.0}{100} \times 1{,}56{,}06{,}000}{1600} = ₹\ 292.61/hr$$

Now you calculate all the total ownership cost components. So it is nothing but so total ownership cost component you can see that one is your hourly depreciation, so other is your hour interest and hourly insurance charges and hourly taxes. So all these things if you add you will get your total hourly ownership cost as rupees 2713 per hour.

Total hourly ownership cost = 1445 + 780.30 + 195.08 + 292.61

= ₹ 2713.00/hr

Now let us move on to the operating cost estimation. So I have given you the question the average fuel consumption factor is 0.09 liters per hour per horse power. So based upon that you can calculate the equipment fuel cost so, this fuel consumption factor is derived from the particular average working condition from the handbook.

According to this question it should be for average working condition and it is derived. So I have assumed some figures here you can determine the values accurately from the appropriate equipment handbook or the manufacture guidelines. So the fuel consumption factor point 09 multiplied by the horse power engine it is nothing but 250 and the local unit fuel cost is 65 rupees per liter.

Equipment Fuel cost = Fuel consumption factor x Rated power x unit fuel cost

= 0.09 x 250 x 65 = ₹1462.50/hr

So that will give me the hourly equipment fuel cost as rupees 1462.5 similarly filter oil grease here I have given you FOG factor. So FOG factor is you are calculating the FOG factor as a percentage of your fuel cost. So the FOG factors for different types of machines are available in the equipment handbook for different operating condition. You can take it directly multiply the fuel cost.

Your fuel cost is nothing but 1462.5 multiply by the labor adjustment factor which I told you according to the region the labor skills may vary. So we have to account for those variation by using the labor adjustment factor for the particular region it is available in some of the handbooks.

FOG (Filter, Oil, Grease) cost = FOG Factor x fuel cost x labour adjustment factor

$$= 0.119 \times 1462.50 \times 0.80 = ₹\ 139.23/hr$$

So FOG factor is given 0.119 fuel cost we have estimated already and the labor adjustment factor is 0.8 this gives you FOG cost as rupees 139.23 per hour.

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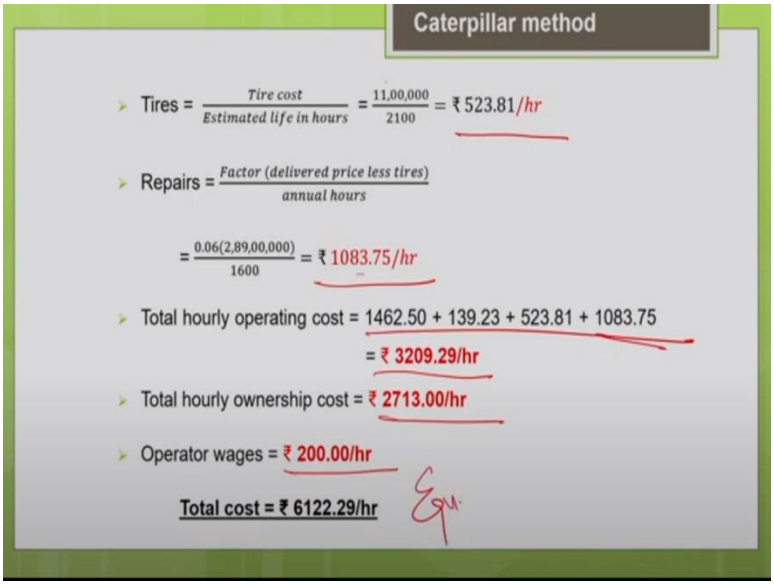

Now let us estimate the tire cost. So tire cost is nothing but the cost of the tire divided by the estimated life of the tires in hours. Cost of the tire is given to you in the problem 11 lakh divided by the estimated life of the tire. So depends upon the project working condition, you can get from the equipment manufacturer or from your past record in the question it is given as 2100 hours. Ok you can divide and get the hourly tire cost as rupees 523.81.

$$Tires = \frac{Tire\ cost}{Estimated\ life\ in\ hours} = \frac{11,00,000}{2100} = ₹\ 523.81/hr$$

Similarly, your repair factor for the machine so the repair factor is given as, 0.06 multiplied by the initial price of the machine. Initial price of the machine excluding the tire cost. So it is nothing but your 3 crores - 11 lakh that give you 2,89,00,000 multiplied by the repair factor. So divided by; the annual usage of the machine per hour that will give you the repair cost hourly repair cost as 1083.75.

$$Repairs = \frac{Factor\ (delivered\ price\ less\ tires)}{annual\ hours}$$

$$= \frac{0.06(2,89,00,000)}{1600} = ₹\ 1083.75/hr$$

So now add all your operating cost components. So what are all the different operating cost components we have estimated so far. So you can see that the equipment fuel cost we have estimated the FOG cost we have estimated we are going to add that. Then the tire cost we have estimated 523.81 and the repair cost we have estimated 1083.75. Add everything, you will get the total operating cost as rupees 3209.29 per hour.

Total hourly operating cost = 1462.50 + 139.23 + 523.81 + 1083.75

*= ₹ **3209.29/hr***

*Total hourly ownership cost = ₹ **2713.00/hr***

*Operator wages = ₹ **200.00/hr***

Total cost = ₹ 6122.29/hr

So you know that the total hourly ownership cost, you know the operator wages, you know the total hourly operating cost. Add all this 3 you will get the total equipment cost. So this gives your total equipment cost as rupees 6122.29 per hour. So let us continue with the same problem with the Peurifoy approach.

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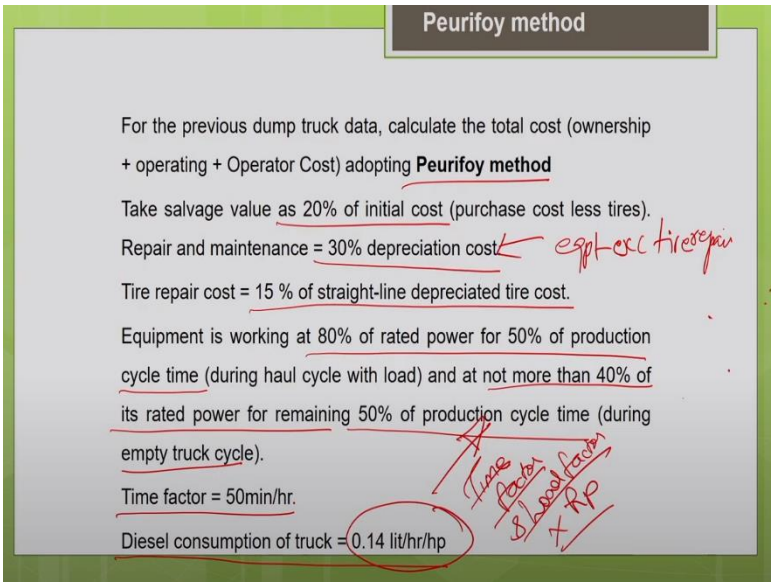

So as I mentioned earlier Peurifoy is considered as the father of the modern construction engineering. His contribution towards equipment management, equipment cost estimation guidelines are really appreciated a lot. So let us continue with the same problem now for the

previous dump truck data it is calculated by the total cost that is the ownership plus operating plus operator cost adopting the Peurifoy method. So in this way of some more assumptions like we are taking this salvage value as 20% of the initial cost.

So initial cost the excluding the tire cost. So hope you remember the initial cost, the initial cost for this machine was 3 crores and the tire cost was 11 lakhs. So we have to take the salvage value as 0.2 into salvage value as 0.2 into initial cost minus tire cost. So that will give you the salvage value. So now the repair and the maintenance it is taken as the percentage of the depreciation cost here.

So repair and maintenance is equal to 30% of depreciation cost and this repair; and maintenance the entire equipment excluding the tires repair. So tire repair is considered separately here it is nothing but the 15% of straight line depreciated tire cost. And another important thing here the operating conditions are defined clearly like the equipment is working at 80% of the rated power, 50% of production cycle time.

That is the truck is using 80% of the power consumption for during this haul cycle when it is traveling with the load. So that haul cycle will contribute to 50% of the total production cycle. So during this haul cycle when it is carrying the load it works as 80% of the rated power. The power consumption is 80%. But during the empty return cycle when there is no load in the truck that cycle time will be 50 % of the total production cycle time.

So during that cycle it is functioning at not more than 40% of the rated power. So during the haul cycle with the load it carries it is working at 80% of the rated power and the cycle time is almost 50% of the total production cycle. So that means 0.8 into 0.5. Similarly, during the return empty cycle which is 50% of the production cycle time it is working at the power of not more than 40% that is 0.4. So with this we can calculate our load factor and the time factor is also given.

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Time factor is nothing but the working efficiency of the machine. How long the machine is working say 50 minutes per hour that is what, is the time factor? So this fuel consumption factor is given from the literature where it is where the machine is working at standard condition. That is it is working at maximum output rate. So you have to adjust this fuel consumption factor according to this operating condition you have to adjust this according to the time factor and the load factor

and according to your horse power of the machine. So all these things you have to consider and adjust these fuel consumption factor.

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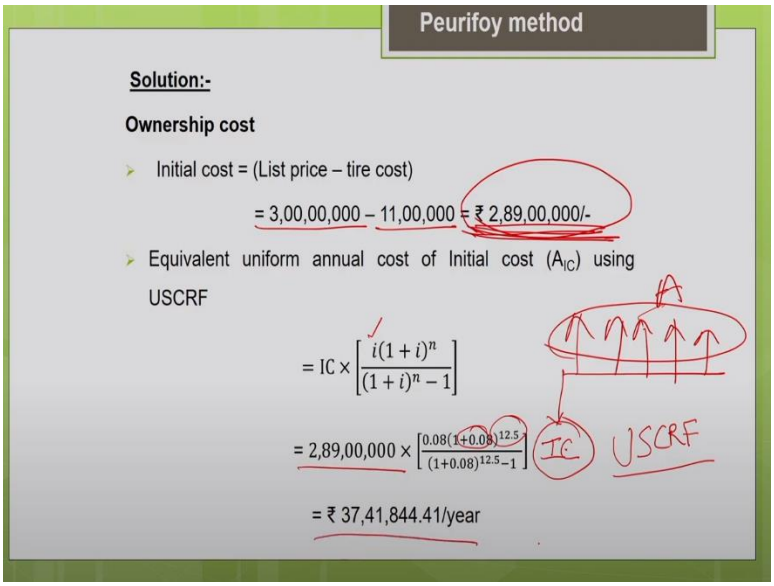

Now let us workout the ownership cost starting with the depreciation estimation. Peurifoy has given 2 different approaches. One is the approximate approach of average annual investment method AAI average annual investment method where we considered the average value of the machine over the life of the machine. So that is in approximate approach this I have discussed in the Caterpillar method just now.

So another method what he has discussed is about the time value method where we considered the timing of cash flow. And we convert the cash flow which are occurring at different point of time different period of time into equivalent cash flow at a particular period using the compounding factor which is more accurate to measure it. So in this problem we are going to assume the time value method one of the time value method so that we can look for a accurate estimate.

So first let us estimate the initial cost deduct the tire cost from the initial cost. So the initial cost is 3 crores minus the tire cost is 11 lakh, deduct it we will get 2,89,00,000 ok as the initial cost the after deducting the tire cost. Now you convert this initial cost into equivalent uniform annual cost using the compounding factor. So remember which compounding factor we are supposed to use say this is the initial cost ok, this initial cost we are converting into equivalent uniform annual cost A.

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

$$= 2{,}89{,}00{,}000 \times \left[\frac{0.08(1+0.08)^{12.5}}{(1+0.08)^{12.5} - 1} = \text{₹}\ 37{,}41{,}844.41/year\right]$$

So this IC is named equivalent to A using uniform series capital recovery factor. The initial cost is converted into equivalent uniform annual cost, annualized cost we call it as annualized initial cost using uniform series capital recovery factor. So the initial cost is nothing but your 2,89,00,000 what you have determine just now after deducting the tire cost, 2,89,00,000 lakh multiplied by your uniform series capital recovery factor which is nothing but I into 1 + i whole power n by 1 + i whole power n - 1.

The interest rate you know it is nothing but 8 percent and n is 12.5 years. So you can get the annualized initial cost as 37,41,844.41 per year. So we have converted the initial cost into annualized initial cost using this uniform series capital recovery factor.

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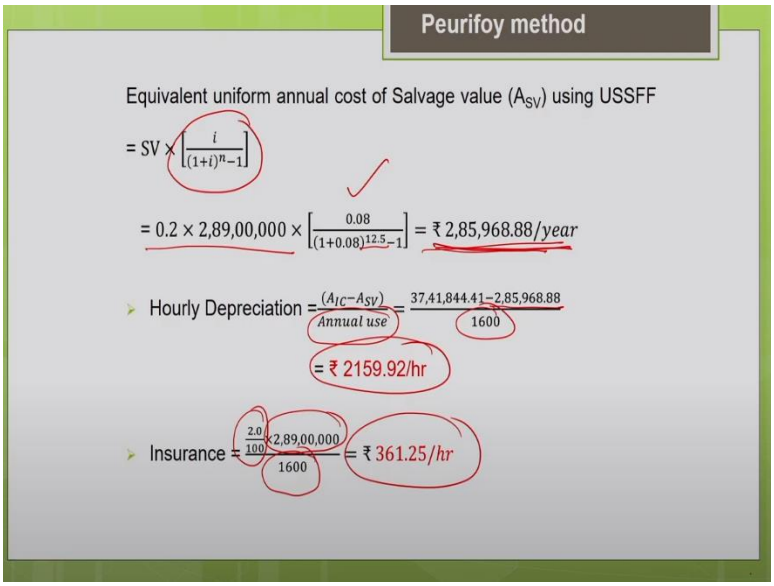

Now let us move on to the salvage value. So now I need to convert the future salvage value into equivalent uniform annual cost. So the salvage value will be converted into equivalent uniform annual cost.

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

$$= 0.2 \times 2{,}89{,}00{,}000 \times \left[\frac{0.08}{(1+0.08)^{12.5} - 1}\right] = ₹\ 2{,}85{,}968.88/year$$

How to convert it using uniform series sinking fund factor? So hope you remember this sinking fund factor is nothing but i divided by 1 + i to the power n minus 1 you multiply by this salvage value.

Salvage value is nothing but 20% of the initial cost minus the tire cost. So now you substitute the value the interest rate and the useful life of the machine n = 12.5 you will get the annualized salvage value as 2,85,968.88 per year. Now you can calculate the hourly depreciation. Hourly depreciation, depreciation is nothing but the difference between the initial cost minus the salvage value and you are going to divided by the annual use of the machine in hours.

So that I can get the hourly depreciation directly so your initial cost annualized initial cost is nothing but 37,41,844.41 minus your salvage value annualized salvage value is nothing but 2,85,968 divided by annual use of machine in hours is 1600.

$$\text{Hourly Depreciation } = \frac{(A_{IC} - A_{SV})}{Annual\ use} = \frac{37{,}41{,}844.41 - 2{,}85{,}968.88}{1600}$$

$$= ₹\ 2159.92/hr$$

So this will give me the hourly me the hourly depreciation as 2159.92 per hour. Now the other components of the ownership cost the insurance, taxes, storage everything we are going to calculate as a percentage of the initial cost minus the tire cost.

So, insurance percentage is 2% of the initial cost minus the tire cost divided by the 1600 hours that is the annual usage of machine in hours.

$$Insurance\ = \frac{\frac{2.0}{100} \times 2{,}89{,}00{,}000}{1600} = ₹\ 361.25/hr$$

That will give you the hourly insurance cost as rupees 361.25 per hour.

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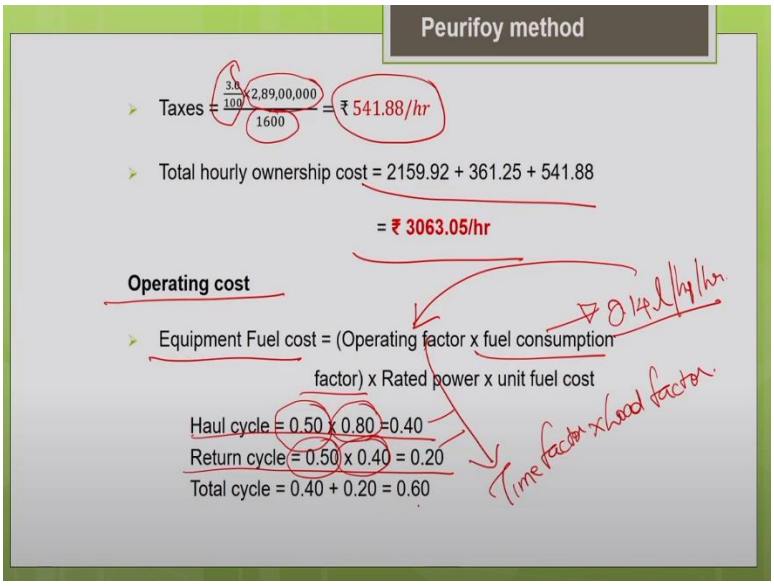

Now let me, calculate the taxes, tax percentage is 3% of the initial cost minus the tire cost divided by the hourly usage of the machine in a year.

$$Taxes = \frac{\frac{3.0}{100} \times 2,89,00,000}{1600} = ₹\,541.88/hr$$

So that will give me the hourly taxes rupees 541.88 per hour now add the total hourly ownership cost at all the components. So one is here that depreciation so you got the hourly depreciation as 2159.92 + insurance process rupees 361.25 + your taxes 541.88.

Total hourly ownership cost = 2159.92 + 361.25 + 541.88 = ***₹ 3063.05/hr***

So if you add everything you will get the total hourly ownership cost as rupees 3063.05 per hour. Now let us estimate the operating cost so first let us estimate the consumption of cost the fuel cost. So this fuel factor consumption power as I told you it is given for a standard condition for maximum output rated condition. So for this consumption hope you remember what is the fuel consumption factor? So it was 0.14 liter per horse power per hour.

So this fuel consumption factor I have to adjust according to the operating factor in my project condition. So operating factor is nothing but the product of time factor and the load factor. So now let us estimate for the haul cycle as well as the return cycle and the load factor because the power consumption is different for the haul cycle then load and empty the return cycle without the load the power consumption is different. As discussed in the question earlier.

So in the haul cycle it will contribute to 50% of the total production cycle and the return cycle it will contribute the 50% of the total production cycle time. And during the haul cycle the power consumption is 80% and during the return cycle when the truck is empty the power consumption is 40%. So multiply by the time multiply by the power consumption ratio you will get the load factor. So now add both 0.4 + 0.2 for the total production cycle you can get the load factor this is your load factor.

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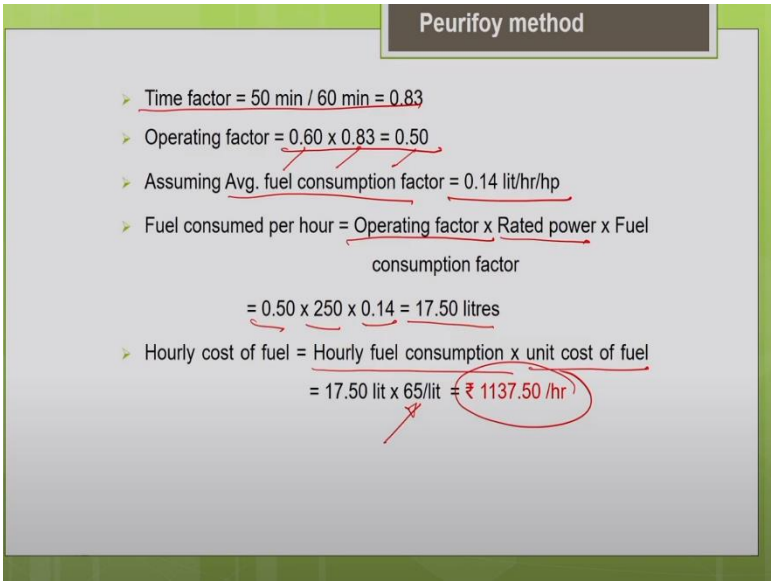

Now the time factor is directly given it is nothing but your working efficiency your machines working for 15 minutes per hour, 50 by 60 = 0.83 that is the working efficiency of your machine. Now the operating factor is nothing but time factor multiply by the load factor. Load factor is 0.6 time factor is 0.83 your operating factor is 0.5. Now you adjust your fuel consumption factor that is 0.14 liters per hour per horse power with the operating factor and the horse power of the engine.

Fuel consumed per hour = Operating factor x Rated power x Fuel consumption factor

= 0.50 x 250 x 0.14 = 17.50 litres

Hourly cost of fuel = Hourly fuel consumption x unit cost of fuel

= 17.50 lit x 65/lit = ₹ 1137.50 /hr

So we are going to adjust according to your machine and the according to the project working condition. So operating factor is nothing but 0.5 and the horsepower of the machine is 250 and the fuel consumption factor for the literature is 0.14. So the final fuel consumption per hour is 17.5

liters. Now we have to estimate the hourly cost of the fuel so for that you have to multiply the hourly fuel consumption by the unit cost of the fuel. Unit cost of the fuel in the local price 65 per liter. So when you multiply it you will get the hourly fuel cost 1137.50 per hour.

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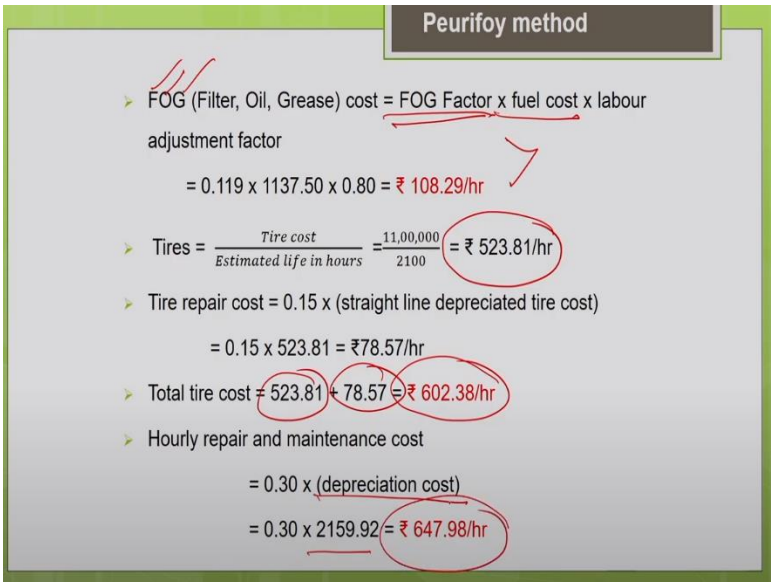

Now let us estimate the other consumable FOG filter, lubricating oil and grease. As I told you there are different ways to estimate it in some handbooks to get the FOG factor for different equipment for different operating conditions. This factor it can be express as the percentage of the fuel cost. So this FOG factor is derived for the particular equipment for the particular working condition. Say in this case for the dump truck say for the average conditions I have assumed the value as 0.119.

These are just approximate assumptions you can take it appropriate from the handbook. So then the fuel cost we have derived earlier hope you remember 1137.5 per hour. So you multiply the fuel cost then labor adjustment factor. So as I told you the labor skills will vary from place to place or region to region. So in some handbooks we can also get the information of the labor adjustment factor for the particular region.Then accordingly you can adjust your factor according to the labor available in the particular place.

FOG (Filter, Oil, Grease) cost = FOG Factor x fuel cost x labour adjustment factor

= 0.119 x 1137.50 x 0.80 = ₹ 108.29/hr

So you will get the FOG cost as rupees 108.29. So now you have estimate the consumable cost. Now let us move on to the estimation of the cost of tires. You know the tire cost is nothing but the 11 lakh and what is the estimate life of the tire for that particular project condition you can get it from the manufacturer or based upon your past accounting cost records you can get this information. This value is given directly in the question is 2100 hours. So

$$Tires = \frac{Tire\ cost}{Estimated\ life\ in\ hours} = \frac{11,00,000}{2100} = ₹\ 523.81/hr$$

gives you the hourly tire cost as rupees 523.81. Now calculate the tire repair cost as 15% of the straight line depreciated tire cost. So this is also given in the question. So if it is not given in the question you can assume the tire repair cost as 15% of the tire cost. 0.15 of the tire cost is 523.81.

$$Tire\ repair\ cost = 0.15\ x\ (straight\ line\ depreciated\ tire\ cost)$$
$$= 0.15\ x\ 523.81 = ₹78.57/hr$$

So that gives you 78.57 per hour. Now calculate the total tire cost. So total tire cost is

$$Total\ tire\ cost = 523.81 + 78.57 = ₹\ 602.38/\text{hr}.$$

So in this the repair and maintenance of the equipment excluding the tire is expressed as the percentage of the depreciation cost of the equipment. So the depreciation cost of the equipment is 2159.92.

Hope you remember your estimate of the depreciation cost is 2159.92. For that value we are going to use here to find the repair and maintenance cost 30% of the depreciation cost. So that will give you the value is 647.98 per hour.

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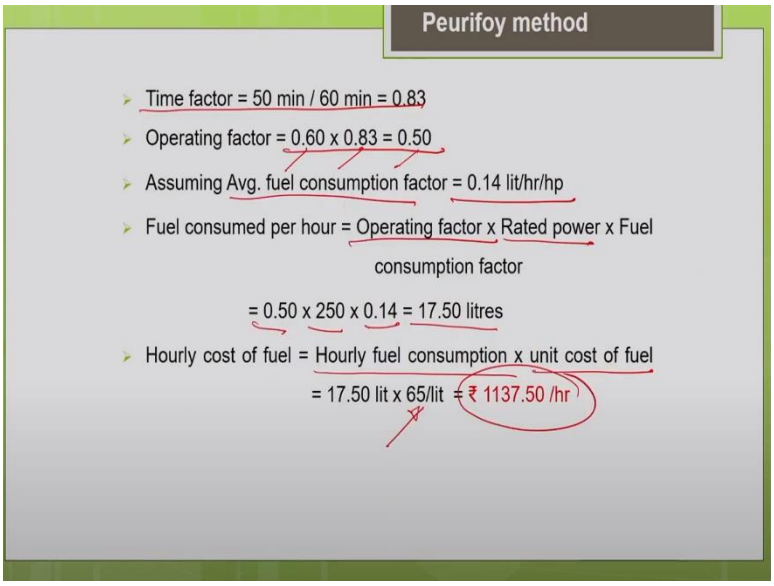

Now the total hourly operating cost you have to add the fuel cost, fuel consumption cost, your FOG cost, your tire cost and your repair and maintenance cost. So this is your repair and maintenance cost of the equipment. Already we have estimated the total hourly ownership cost you add both ownership along with the operator wages which is given as 200 rupees per hour in the particular place. So it varies from region to region.

Total hourly operating cost = 1137.50 + 108.29 + 602.38 + 647.98 = ***₹ 2496.15/hr***

Total hourly ownership cost = ***₹ 3063.05/hr***

Operator wages = ***₹ 200.00/hr***

So when you add all these three we can get the

Total cost of the equipment = 5759.2/hour

So using the Peurifoy approach particularly using the time value concept we have derived the value as 5759.2. So early in the caterpillar method I think the assumption were different and the value derived was 6122.29. So which method we are going to use for a particular company for the cost accounting purpose is totally it is a business policy.

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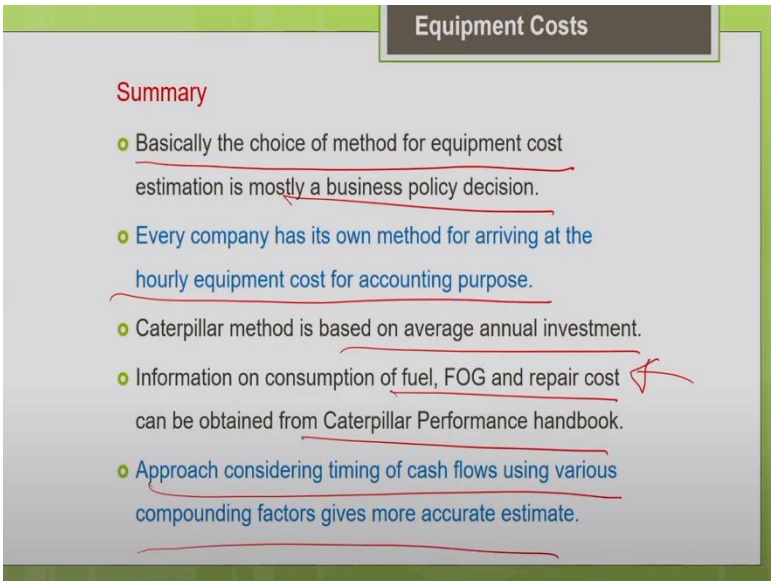

So it is totally left to the company. There is no constrain or any company owner or the project estimator that we have to follow only this particular method to estimate the equipment cost. There is no such constrain. It is totally left to the freedom of the particular company depends upon your company policy or the business policy. So basically the choice of the method of the equipment cost estimation business policy decision mostly.

Every company has its own method internal method for arriving at the hourly equipment cost for the accounting purpose. Then let us summarize what we learnt earlier in this lecture. The Caterpillar method we found it is based on average annual investment method which is approximate. And the information on the consumption of the fuel FOG repair cost everything is available for different equipment models and for different project conditions with a definition project working conditions from the caterpillar handbook.

Similarly, you can find this in many other handbooks which are available so lot of source of literature there to get this data. So most of the equipment supplier they provide the equipment handbook which have sufficient data of its parameters. And the; approach the time value method considering timing of cash flows using various compounding factors gives you the more accurate estimate. So with this we have come to the end of the lecture 5.

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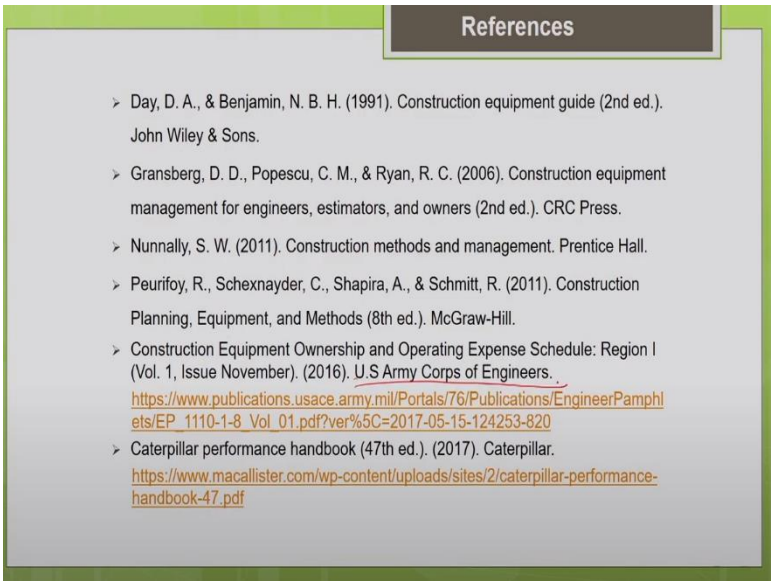

So these are the references which I have used for this lecture preparation. As I told you there are so many preparation handbooks. One such equipment handbook I have cited here is by US Army Corps of Engineers. You can try to go through all these handbooks so that you can get through on the information on the various factors which we have mention the fuel consumption factor or the FOG, labor adjustment factors.

And they have also given you the illustration of how to do the equipment cost estimation. So, I advise you to go through some of the equipment handbook to get more information on this related to this topic. Thank you.