Construction Methods and Equipment Management

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Lecture - 2
Equipment cost - Ownership cost (Average annual investment method)

Hello everyone, I welcome you to this lecture 2 of the course construction methods and equipment management. In this lecture, we will be discussing about the equipment cost estimation specifically they will be discussing about the ownership cost estimation using average annual investment method.

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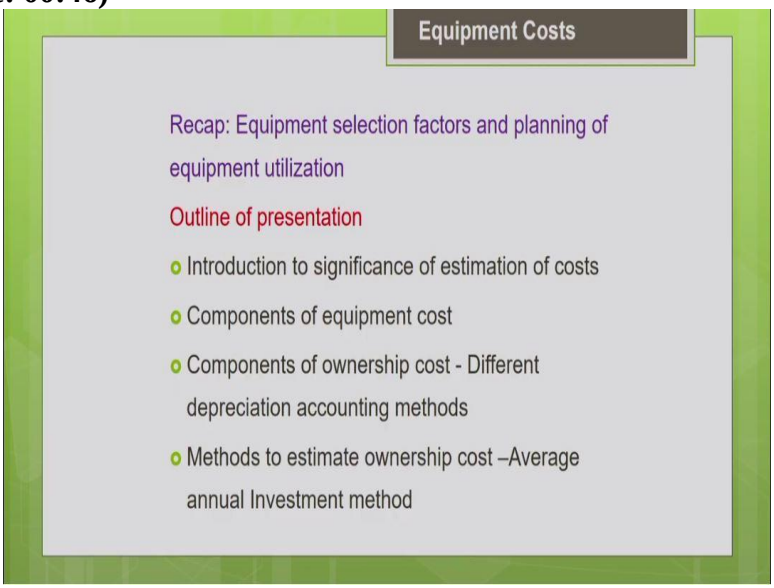

It is the recap of what we learnt in the lecture 1. So, in the lecture 1 we discussed about the planning process of equipment, highlighting on the equipment selection factors and learning of the equipment utilization using the equipment loading diagram. So, this is the outline of the today's presentation. So, I will be just introducing to you the significance of the estimation of the cost of the equipment followed by discussion on what are all the components of the equipment cost components of the ownership cost.

And we will be discussing about the different depreciation accounting methods to estimate the depreciation of equipment and followed by the illustration for how to estimate the ownership cost of the equipment using average annual investment method. So, let us see what is the significance of estimation of the cost associate with the machine?

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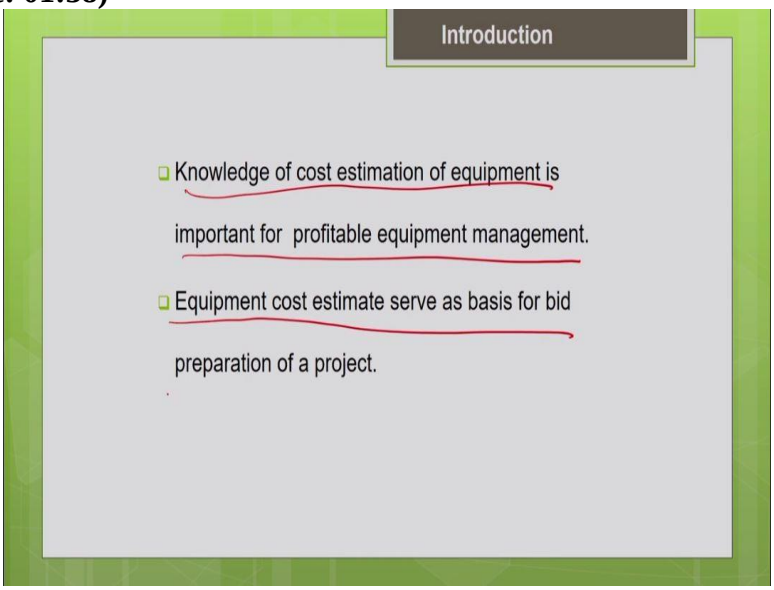

Knowledge of cost estimation is very important for profitable equipment management and we know that equipment cost estimate serves as a basis for the bid preparation of project generally, when we go for the preparation planning of your bid the unit rate what you are quoting it involves a component of your equipment also. So, we underestimate the cost of equipment because of lack of knowledge on how to estimate the cost of equipment, if you are under estimating the cost of the equipment, you may overestimate the profit.

So, finally, the contractors or the project estimators they end up in real problem. So, that is why equipment cost estimates it is very important for profitability equipment management. So, in the last lecture also discuss it during the selection process of equipment we should have a knowledge on how to estimate the productivity of equipment and the cost associated with the equipment both are a very important factors for the planning equipment selections also. So, to know the exact component of a project cost, you should have a knowledge on how to estimate the equipment cost.

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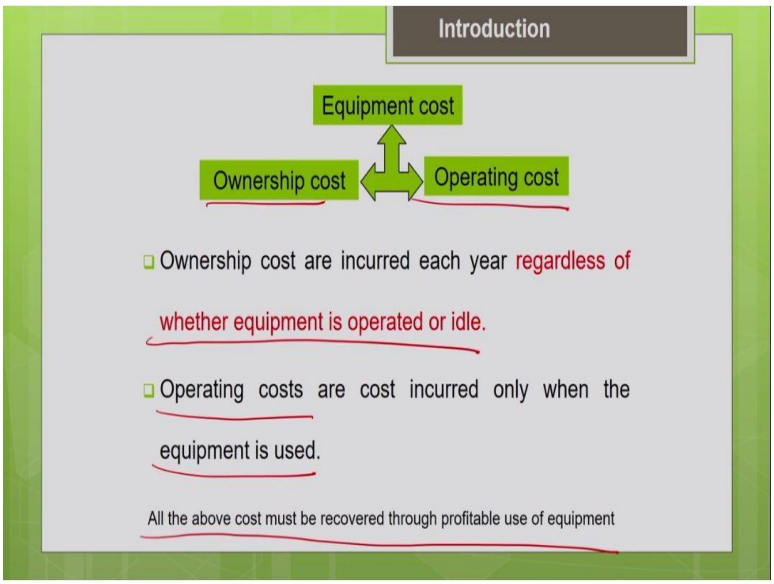

So, let us see what are all the important components of the equipment cost? So, these are the 2 main important components one is an ownership cost other one is the operating cost. So, ownership cost is nothing but these costs we incur every year regardless of whether the equipment is operated or idle. So, that means whether the equipment is employed productively in a project site or it is going to remain idle in both the cases we are going to incur some fixed ownership costs every year.

So, these are relatively fixed costs which occur every year. So, many times we can see that the project estimators they overlooked to the ownership costs, there are different components of the ownership costs, which should also be included in the estimation of the cost of the machine. So, people think that only when the equipment is operated, we are incurring costs. So, that is how they make wrong estimation of the cost of equipment and other part is an operating costs, these are the costs incurred only when the equipment is used.

So, that means when you are using your equipment the more you operating your equipment, the operating costs will be more the fuel consumption will be more, it also depends upon your project conditions. So, we will be discussing in depth about the various components of this ownership cost and the operating costs in the upcoming slides. So, one thing we should always keep it in mind is all the above costs must be recovered through profitable use of equipment.

That means we have invested huge amount of cost with in the equipment different components of ownership costs are there different forms of operating costs are there so huge amount of cost is

invested in the equipment. So, the equipment should be most productivity in the project site and it should be able to recover all the costs associated with it and it should be able to generate profit for us. So, that is what they said commonly equipment must pay for itself. That means it should work productively and recover all the costs invested and generate profit for us.

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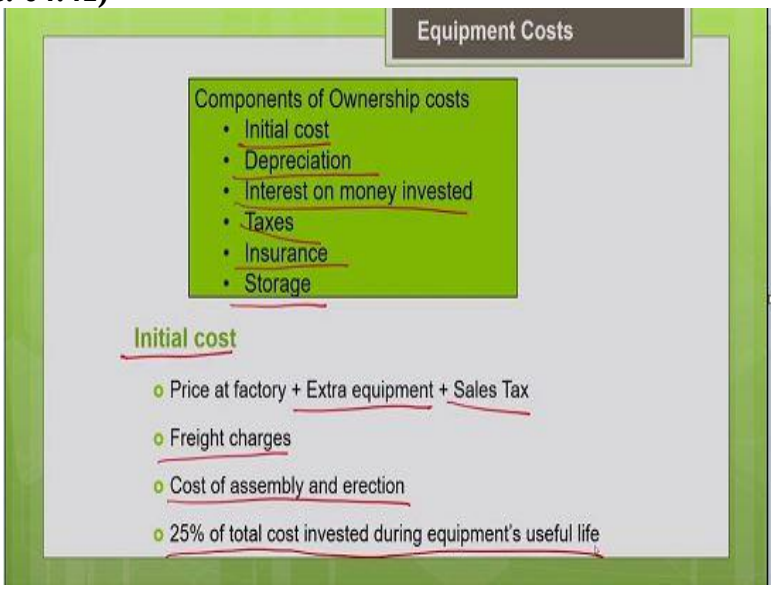

Now, let us see what are all the components of the ownership cost? So these are the different components of the ownership cost, initial costs, depreciation, the cost of investment that is interest on the money invested, taxes, insurance and storage, so these are all the different components of the ownership cost, which we are going to discuss one by one now. So, first is the initial cost, everyone is aware of the purchase cost of the machine.

So, it includes the price of the factory plus any extra equipment you may need for the installation purpose or maybe some accessories you may need including everything. So, initial cost includes all the extra components, the sales tax, and the freight charges, the delivery charges or transportation charges or the freight charges are needed for the mobilization of equipment to the project site, and also the cost of assembly and erection of equipment.

It means, it includes all the costs, including the purchase price and mobilizing the equipment to the site and getting it ready for the operation. So, what are all the costs involved in this entire process of purchase mobilization and getting it ready for the operation, all these things comes into

the initial cost. So, approximately you can say it amounts 25% of the total cost invested in the equipment's useful life. So, it is a significant proportion of the total cost invested in the machine.

So, generally, the other components of the equipment costs are usually expressed as a percentage of initial cost, because it is easier to accurately estimate the initial cost. So, to get the values of initial costs is easier. So the other components are usually expressed as a percentage of the initial cost. So, now, let us move on to the next important component of the ownership costs, which is the depreciation.

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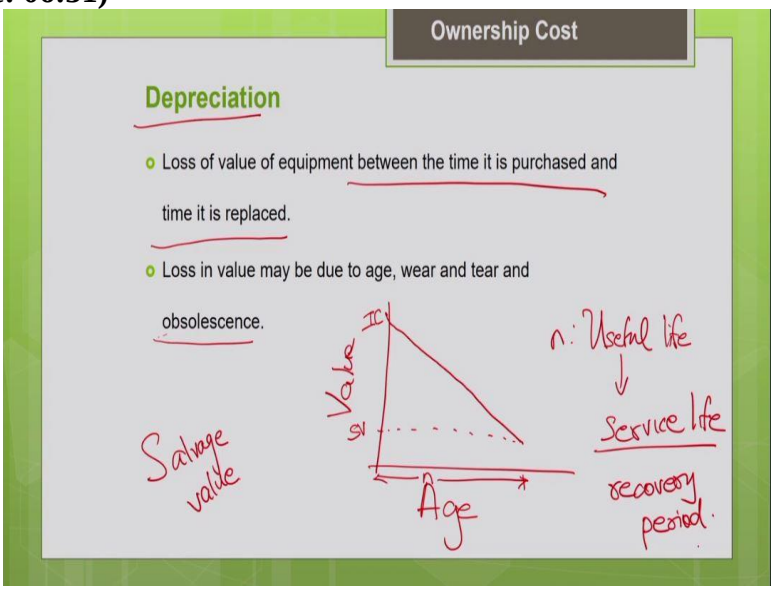

So, depreciation is nothing but loss in the value of the equipment between the time it is purchased and the time it is replaced. So, as everyone knows, equipment is an asset. So, every asset will lose its value with time, there is a loss of value always with the time this loss in value may be due to increasing age of the machine due to wear and tear or due to loss in productivity of the machine due to age or due to increase in repair and maintenance cost or your machine might have become technologically obsolete.

There may be some new competitive models in the market, which may be more technologically competitive than the machine which you are processing like the productivity of the new models in the market may be greater than the machine what we are possessing. So, it might have become technologically obsolete or the customer tastes would have changed. So, there will be different reasons for the loss of value of the machine, with the age of the machine.

So, this loss in value is called as a depreciation. So, this is a very important component of the ownership costs, this is not actually a physical cash flow, but still it is considered as an expenditure in the cash flow analysis, it is considered as a component of the ownership cost estimation purpose. So, graphically we can represent it like this, like you have this age of the equipment in the X axis and the value of the asset in the Y axis.

So, now, you can see that when you purchase equipment, the initial price will be like this. So, say this is the useful life of the machine. So, you are purchase a machine, they take this initial cost so what is this n so n refers to the useful life of the mission. So, that means beyond this particular period, your equipment does not have any utility. So, it is not economical to hold this particular equipment beyond this useful life, we have to either scrap it or sell it at a reasonable price to any buyer.

So that period is called as useful life you can also call it as service life or recovery period. So, there are different ways to call this. So, basically, it means see the time interval between the moment you make the purchase of the machine and the moment you scrapped it, this time interval is called as the service life of the machine, this is basically for the accounting purpose in many cases you can see to beyond the service life also, that machine will be functioning in the project site, it may not be physically scrap in that case it is actually bonus for us.

So basically useful life refers to the period during the machine is going to be utility value, beyond that it is not economical to hold the machine even though if it is functioning in the project site, it is not economical to hold maybe its productivity may be less or its repair and maintenance costs would have increased due to the age. So that is what is the definition of useful life of the machine. So, at the end of this life, say for example, this is the end of the useful life, if I am able to sell this machine at the end of this life at a particular value.

So that is called as a salvage value. So salvage value is nothing but the cash inflow which we get at the end of the useful life of the machine by selling the machine at a reasonable price that is

called as salvage value. So, now the total depreciation should be the difference between the initial cost and the salvage value.

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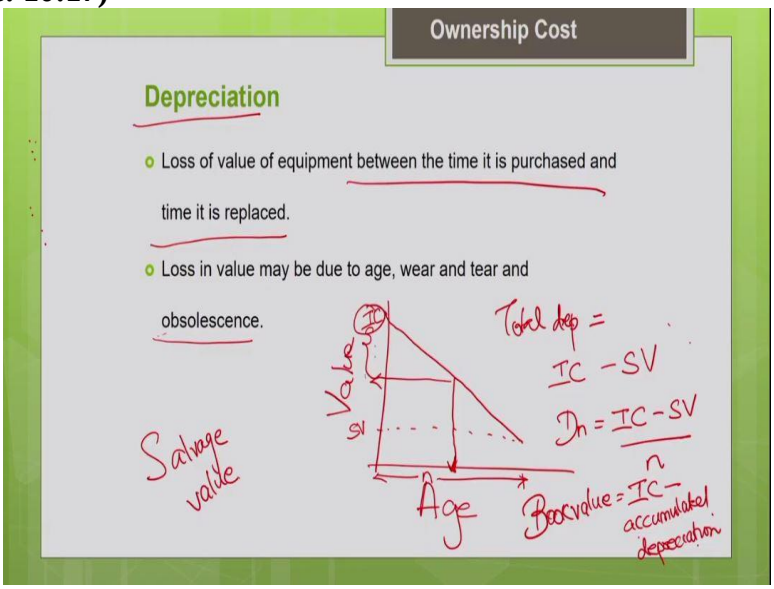

So, the total depreciation should be equal to your initial cost minus your salvage value. So, if I wanted to know the annual depreciation, depreciation every year then in that case I have to calculate divided by the number of years the useful life of the machine. So, this will give you the annual depreciation. So, another advantage of estimating depreciation is it you can get to know what is a current value of your machine current book value, book value means the value of the asset which you enter in your accounting book for the recording purpose.

So, what is the current value of the asset I can estimate if I know the depreciation say for example, at a particular age say this particular age, I wanted to know the current value of the asset. So, what is the value we have to calculate by; if you know the initial cost and if you know the accumulated depreciation over this particular period? So, if you want to estimate the book value at a particular period to know the initial cost and accumulated depreciation over a particular period, if you know these 2 data, we can find the book value at a particular period.

So, book value is nothing but your initial cost minus the accumulated depreciation till the particular period say for example, if we wanted to know the current value of the asset at this particular age, then if you know the initial cost and if we know the accumulated depreciation over this period,

you can find the book value. So, this helps you to get an idea of about the current value of the asset it is very important parameter.

Because if you know the current value of equipment, it will help you to fix a rental charges for the machine, so, if someone is renting your equipment in this current value of the asset will give you a data how to fix up the rental charges. So, this is the importance of depreciation you can also with the help of depreciation you can know the current value of your asset.

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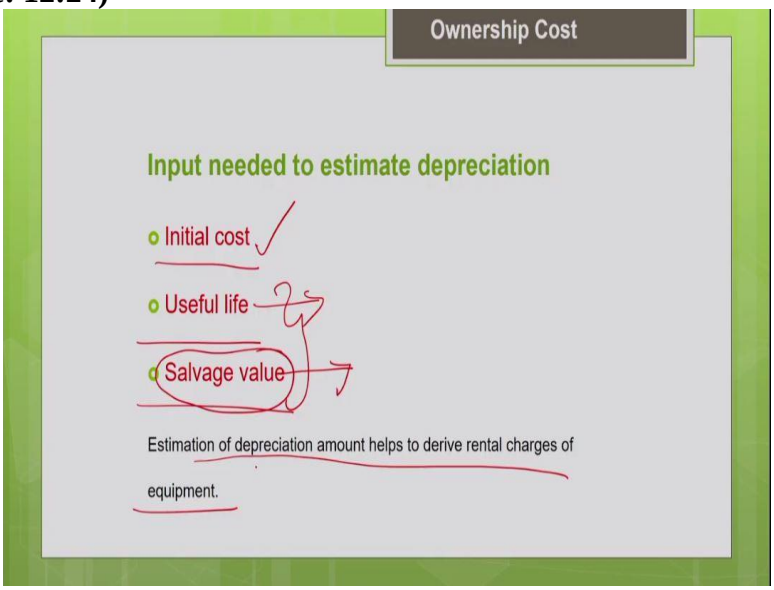

So, what are all the input needed to estimate the depreciation so, important thing is your initial cost your useful life and the salvage value, if you have these 3 important input then you can estimate the depreciation initial cost, you can do it accurately you can get the information easily, but these 2 are a little bit uncertain, because how long the machine is going to be useful what will be the end of the useful life, at what point the period is good to scrap your machine.

So, that depends upon your usage of the machine depends upon the project condition. So, based upon your past experience with similar type of the machine, and you can get the information approximately about the useful life of the machine similarly at the end of the useful life, at what price you are going to sell it or at a reasonable price or you are going to resell it. So, this is called as a salvage value. So, this is also a little bit uncertain.

So, approximately you can estimate based upon your past experience with similar equipment. So, with these 3 input parameters, you can get estimate your depreciation associated with this machine. As I mentioned earlier, your depreciation estimation will help you to derive the rental charges for the equipment. So, you can know the current value, what is the book value of the asset, book value means for the accounting purpose in the accounting book, you record the current value of the asset. So, that value can get it if you are able to estimate the depreciation of the machine.

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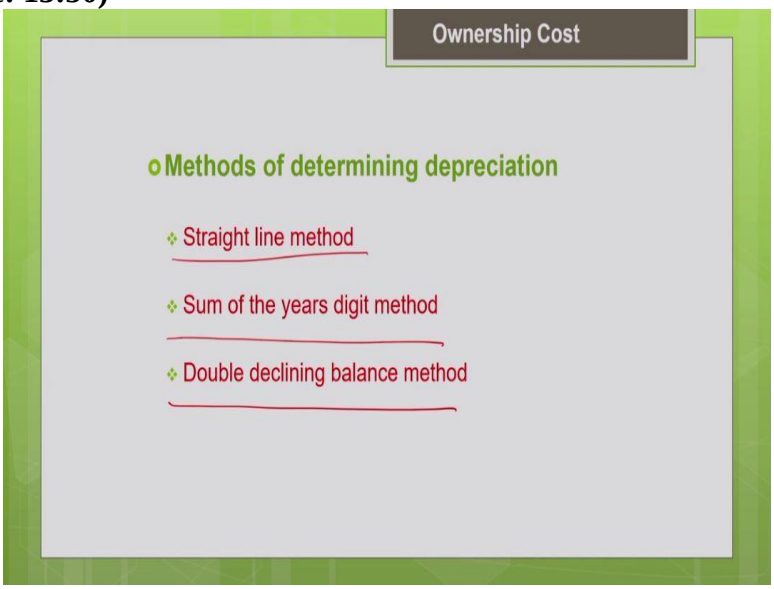

So, there are different accounting methods to estimate depreciation. So, let us see the important accounting methods which are commonly used by the various constituent companies. So, they are the straight line method, sum of the years digit method and double declining balance method. So, we are going to discuss these depreciation methods, accounting methods one by one.

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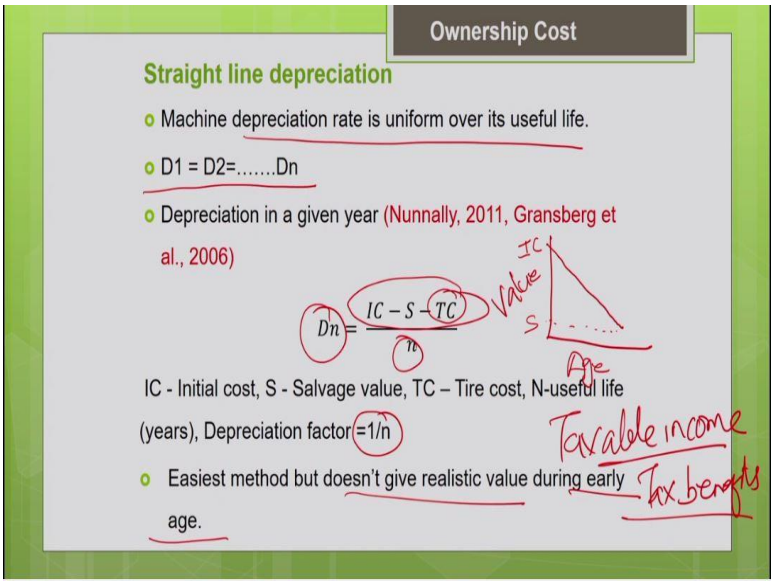

So, first is your straight line method as the name indicates the depreciation is going to be uniform. So, if you look into the trend, so, we drawn this diagram earlier age of the equipment and the value of the asset. So, it increasing age you can see that the loss of value will be linear. So, in this straight line method, we assume that the depreciation rate is uniform over its useful life so, the rate is uniform over the useful life you have every year the machine is going to lose the same value that is what is the assumption for the accounting purpose.

That means D1 = D2 = Dn every year the depreciation is going to be same. Now, how to calculate the depreciation so, depreciation is nothing but your initial cost? Whatever your purchase initial cost and at the end of the useful life at what price you are going to sell salvage value is whatever they indicate S your salvage value is S. And one more important thing you have to note is you are going to deduct the tire cost.

So, because your tire depreciates at a different rate from the rest of the equipment particularly rubber tires, you can say that the life of the tire rubber tire will be different from the life of the remaining part of the equipment. So, the tire will depreciate faster. So, that is why we consider the tire cost the operating costs it is not considered under the ownership cost estimation. So you deduct the tire cost from the initial cost.

$$D_n = \frac{IC - S - TC}{n}$$

So, this will give you the total depreciation divided by the number of years in the useful life of the machine that will give you the annual depreciation every year. So here the rate of depreciation is 1 / n depreciation factor is 1 / n. This is the easiest method and most convenient method to calculate the depreciation but it is not commonly adopted because this gives lesser amount of depreciation in the early age of the machine. So, lesser amount of depreciation is experienced when you use this method.

So, that is why they say it is not giving a realistic value people always prefer to have accelerated depreciation, they prefer to have higher depreciation for the accounting purpose, this is because the depreciation expenses are not accounted in taxable income. So, it is not accounted in the taxable income. So, you will be able to get the tax benefits by projecting higher depreciation for accounting purpose that is why people always prefer to go for the accounting method which will give you higher or accelerated depreciation. So, that; they can get the tax benefits because depreciation expenses are not accounted in the taxable income.

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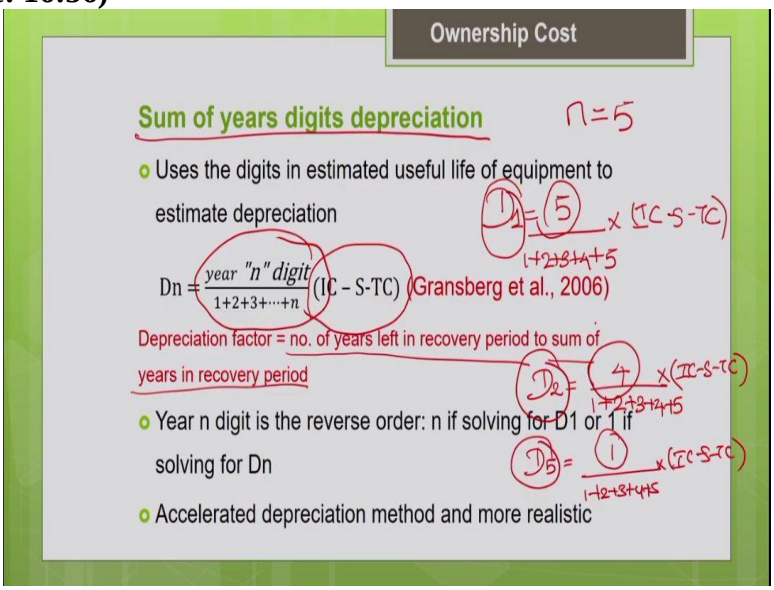

So, now let us move on to the next method of estimation of depreciation that is your sum of the years the digit depreciation method. So, how this method is going to be different from the earlier method we will see now. So, here this is an accelerated method when compared to the straight line method that means, it will give you higher depreciation in the early age of the machine during the early ages of machine it projects higher depreciation.

So, how do you calculate here annual depreciation is nothing but your depreciation factor multiplied by initial cost minus salvage value minus tire cost? So, this is a depreciation factor for the rate of depreciation for this method. So, how do you calculate this depreciation factor? It is nothing but number of years left in the recovery period to some of the years the recovery period. And can be expressed as:

$$D_n = \frac{year\ "n"\ digit}{1 + 2 + 3 + \cdots + n}$$

So, this is how we calculate the depreciation factor in straight line method. The depreciation factor was 1 / n here it is number of years left in the recovery period as I told you your useful life, your service period recovery period everything remains the same why we call it as recovery period, because we are going to recover all the costs invested in the machine during the useful life of the machine, so that is why we call it as a recovery period. So now say for example, if I am going to calculate the depreciation for the first year.

D1 what will be in the numerator for the depreciation factor, number of years left in the recovery period from the beginning of the year for which we are going to calculate the depreciation to the end of the useful life? So from the beginning of this year to the end of the useful life, what is the number of years left say for example, the useful life of the machine n = 5. So, number of years left in the recovery period will be 5 divided by sum of the years of useful life of the machine 1 + 2 + 3 + 4 + 5 multiplied by initial cost minus salvage value minus tire cost.

This is how you calculate the depreciation for the first year. So, now how to calculate the depreciation for the second year? So, number of years left in the recovery period from the beginning of second year to the end of useful life. So, it will be equal to 4 only one year is completed. So, 4 divided by 1 + 2 + 3 + 4 + 5. So multiplied by initial cost minus salvage value minus tire cost. This will give you the depreciation for the second year.

Similarly, depreciation for the last year D5 it will be equal to 1 the number of years left in the recovery period is 1, 1 divided by 1 + 2 + 3 + 4 + 5 multiply by initial cost minus salvage value minus tire cost. So one shortcut you can remember is year and digit or in reverse order. If you are

calculating the depreciation for the first year, the digit in the numerator will be in the reverse order second year, it is equal to 4, for 5th year the digital the numerator will be 1.

So year and digit in the numerator are in reverse order. So keep that in mind. So if you are going to calculate the depreciation for the first year, the digit in the numerator will be n. So if you are going to calculate the depreciation for the last year, the digit in the numerator will be 1 that is what is given. So, it is a more accelerated depreciation method and more realistic people prefer accelerated depreciation method as I told you, because of the tax benefits they get because of the depreciation expenses.

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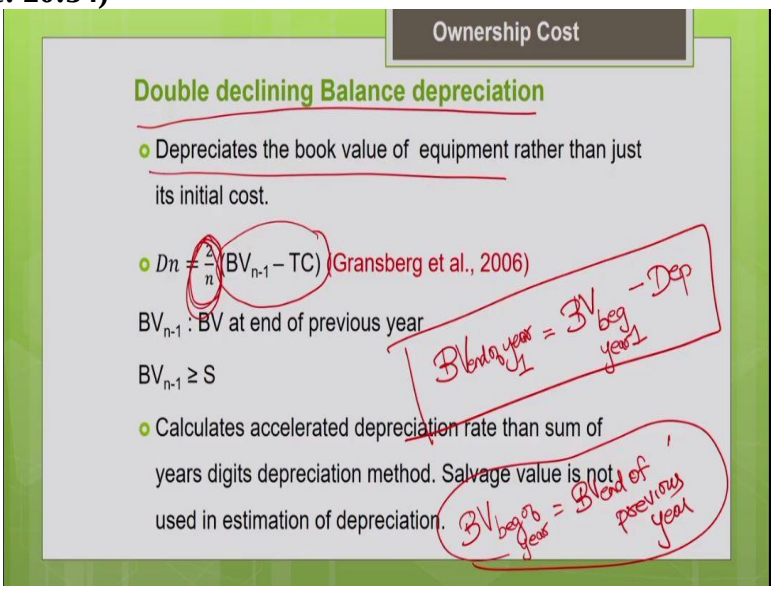

Now, let us move on to the next method of estimating the depreciation is nothing but your double declining balance depreciation method. So, this method is more accelerated method when compared to the sum of the years digit method. That means, the depreciation estimated is going to be more in the early age of the machine, even when compared to sum of the years digit method, people more commonly prefer this method as I told you to get enjoy the tax benefits.

And one more important thing to be noted here is here the depreciating the instantaneous is book value of the equipment, so we do not consider the estimation of the sum of the years digit method there we used to estimate initial cost minus salvage value. So that way we do not estimate here, we do not even use the salvage value in the estimation of the depreciation, you are going to

depreciate the book value of the machine instantaneous book value of the machine let us see how it is expressed.

$$D_n = \frac{2}{n}(BV_{n-1} - TC)$$

Here depreciation is calculated as you can see this is the depreciation factor 2 / n multiplied by book value at the end of the previous year minus tire cost. So, 2 / n the straight line method remember, the depreciation factor was 1 / n. So, it is double the straight line method that is why it is called as double declining balance depreciation method it is also called as 200% declining balance method there are some other method called as 150% declining balance methods also.

So, but today in this lecture, we are going to discuss only about 200% declining balance method it is called as double declining balance method and this factor is fixed this depreciation factor is fixed that is what it is also called as fixed depreciation method. And one more important thing you have to note here is your ratio depreciation Dn developed by the book value this ratio is going to be fixed for every year, Dn divided by book value is going to be fixed for every year and how to calculate this book value.

So, already I told you in the previous slide, like book value to know the book value you should know the initial cost minus accumulated depreciation. If you are going to calculate the book value for every year say for example, book value at the end of year 1. So, end of year 1, I need to know the book value. So, you should know the book value at the beginning of year 1. So, if you know the book value at the beginning of year 1 minus the depreciation for that particular year then you can calculate the book value the end of year.

This is how we are going to calculate so book value at the end of year is equal to book value of the beginning of the particular year minus the depreciation for that particular year. And one more important thing to be noted here is your book value at the beginning of a particular year is same as book value at the end of previous year, this also we should know so book value at the beginning of a particular year is same as book value at the end of the previous year.

And during this analysis, when you estimate the depreciation you have to make sure that your book value should never go below the estimated salvage value of the machine. So, this thing you have to keep in mind book value should be greater than or equal to the salvage value. So, if suppose there are many chances that your estimated book value at the end of the useful life may go below the salvage value, if that situation occurs, you have to recalculate back calculate.

So back calculate the depreciation in such a way that your estimated book value should be made equal to the salvage value it should never go below this salvage value, when we do some illustrations, we will be able to understand better. So, this method calculates the accelerated depreciation rate, than the sum of years digit method and one more thing to be noted is you are not using the salvage value during estimation of depreciation. So, this also you should keep in mind.

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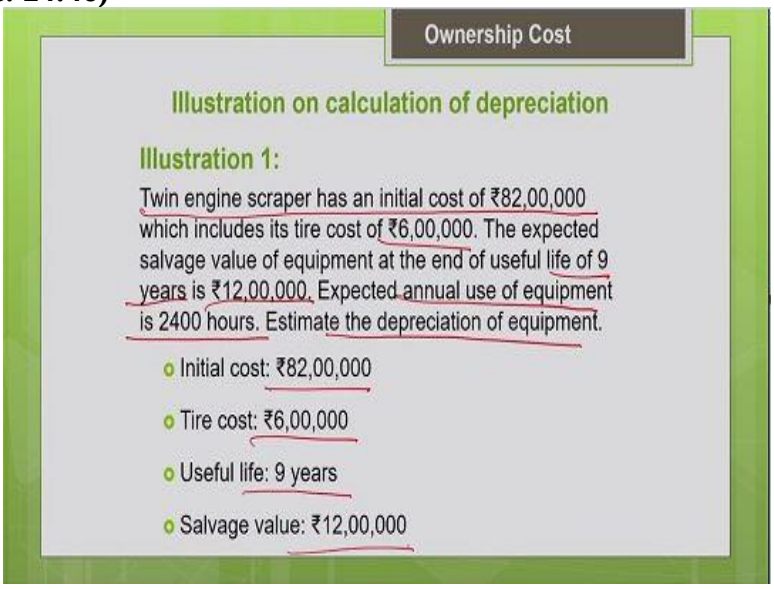

Now, let us work out an example on how to estimate the depreciation but all the 3 methods which we have discussed so far. So, this is a problem.

A twin engine scraper machine has an initial cost of 82 lakh it includes a tire cost of 6 lakh the expected salvage value of equipment at the end of useful life of 9 years. The useful life of the machine is 9 years and the salvage value 12 lakh the price at the end of 9 years, I will be able to sell this machine at 12 lakh that is known salvage value now expected annual use of the equipment is 2400 hours.

So, it depends upon how many hours you are going to use your equipment every day. Say for example, you are going to use a equipment 10 hours per day and depending on the number of days the equipment is operated in a year you can calculate the annual use of the machine in hours. Now estimate the depreciation of the equipment now let us summarize input data initial cost is given 82 lakh tire cost is 6 lakh useful life of 2 machines 9 years and the salvage value is 12 lakh.

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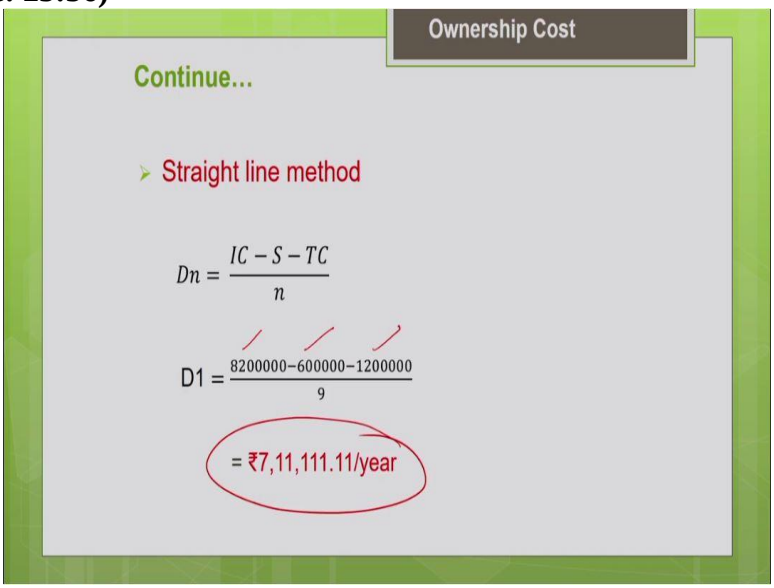

First, it is using straight line method to estimate the depreciation.

$$D_n = \frac{IC - S - TC}{n}$$

$$D_1 = \frac{8200000 - 600000 - 1200000}{9} = ₹\,7{,}11{,}111.11/year$$

So, depreciation is nothing but your initial cost minus salvage value minus tire cost divided by n. So, here the factor of depreciation is 1 / n. So 82 lakh is the initial cost, the salvage value is 12 lakh and your tire costs is 6 lakh. So, divided by 9, you will get the annual depreciation for every year? So you will get the annual depreciation for every year, it is going to be the same for every year, it is a straight line method.

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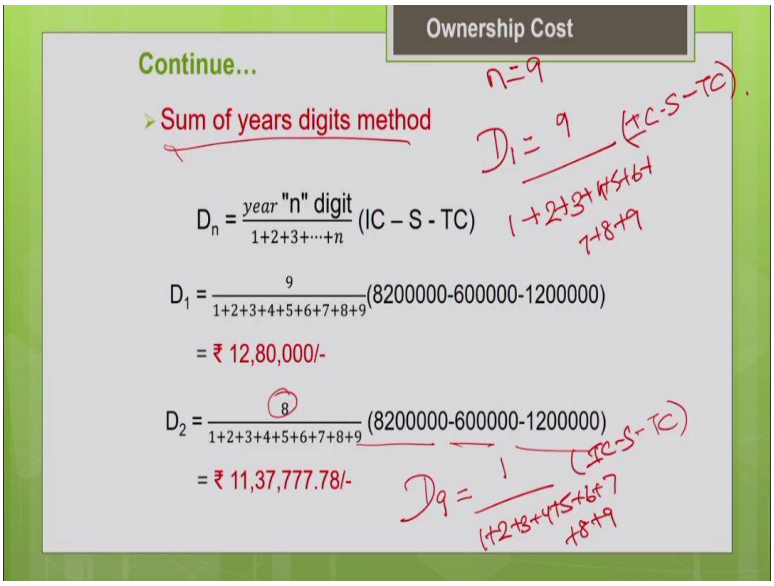

So, next is a sum of the years digit method. So, here, how do you calculate the depreciation for the first year when you calculate the number of years left in the recovery period is say n = 9. So, number of years left in the recovery period is 9 divided by the sum of the years in the useful life 1+ 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 multiplied by initial cost minus the salvage value minus tire cost. So, this will give you the depreciation for the first year.

$$D_n = \frac{year\ "n"\ digit}{1+2+3+\cdots+n}$$

$$D_1 = \frac{9}{1+2+3+4+5+6+7+8+9}(8200000-600000-1200000)$$
$$= ₹\,12{,}80{,}000/-$$

Similarly, depreciation for the second year number of years left in the recovery period is nothing but number of years left in the recovery period from the beginning of the second year to the end of the useful life of the machine is 8 year. So divided by the sum of the years in the useful life multiply by a initial cost minus tire cost minus salvage value. Similarly, we calculate the depreciation for every year.

$$D_2 = \frac{8}{1+2+3+4+5+6+7+8+9}(8200000-600000-1200000)$$
$$= ₹\,11{,}37{,}777.78/-$$

Say for the example depreciation for the 9th year it should be number of years left in recovery period will be 1 divided by 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 multiplied by initial cost minus salvage value. So, this is all the estimated depreciation using sum of the years digit method.

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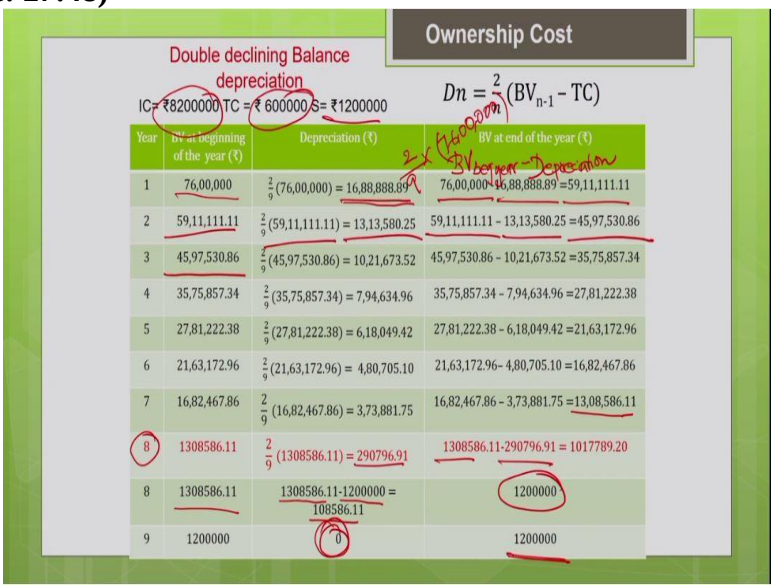

Year	BV at beginning of the year (₹)	Depreciation (₹)	BV at end of the year (₹)
1	76,00,000	$\frac{2}{9}$(76,00,000) = 16,88,888.89	76,00,000-16,88,888.89 =59,11,111.11
2	59,11,111.11	$\frac{2}{9}$(59,11,111.11) = 13,13,580.25	59,11,111.11 - 13,13,580.25 =45,97,530.86
3	45,97,530.86	$\frac{2}{9}$(45,97,530.86) = 10,21,673.52	45,97,530.86 - 10,21,673.52 =35,75,857.34
4	35,75,857.34	$\frac{2}{9}$(35,75,857.34) = 7,94,634.96	35,75,857.34 - 7,94,634.96 =27,81,222.38
5	27,81,222.38	$\frac{2}{9}$(27,81,222.38) = 6,18,049.42	27,81,222.38 - 6,18,049.42 =21,63,172.96
6	21,63,172.96	$\frac{2}{9}$(21,63,172.96) = 4,80,705.10	21,63,172.96- 4,80,705.10 =16,82,467.86
7	16,82,467.86	$\frac{2}{9}$(16,82,467.86) = 3,73,881.75	16,82,467.86 - 3,73,881.75 =13,08,586.11
8	1308586.11	$\frac{2}{9}$(1308586.11) = 290796.91	1308586.11-290796.91 = 1017789.20
8	1308586.11	1308586.11-1200000 = 108586.11	1200000
9	1200000	0	1200000

Now, let us move on to the double declining balance method. In double declining balance method it is totally different from the earlier method as I told you here, we are not using salvage value in the estimation of the depreciation of the machine. So, you are going to depreciate the instantaneous book value. So, for the first year, what is the book value at the beginning of the year? It is 76 lakh how did you get this up to 76 lakh your initial cost is 82 lakhs minus your tire cost 6 lakh.

$$D_n = \frac{2}{n}(BV_{n-1} - TC)$$

So, that will give you the book value at the beginning of your 76 lakh now what is the depreciation for the year 1 it is nothing but 2 / n multiplied by book value. So, already we have deducted the tire cost. So we need not deduct the tire cost. So 2 / n multiply by the book value, so n is 9. So, 2 by your n is 9 multiplied by the book value is nothing but 76 lakhs. So, that gives you the depreciation once the depreciation is estimated.

Now, what is the book value at the end of the year it is nothing but your book value at the beginning of year minus your depreciation that gives you the book value at the end of the year so book value at the beginning of year is 76 lakh and depreciation is 16,88,888 when you subtract both you will

get the book value at the end of the year. So, this is all estimate. Now, book value at the end of year will become the book value at the beginning of the next year.

So, book value at the beginning of next year is 59,11,111.11 does the same way to calculate the depreciation 2 / n, n is 9 multiplied by the book value will give that depreciation. So, once you know the depreciation, again calculate the book value at the end of the year. It is nothing but book value at the beginning of year minus your depreciation that gives you book value at the end of the year. Now the book value at the end of this year becomes a book value at the beginning of the next year third year. The same way you calculate the depreciation for all the years?

And one important thing here you have to note here as I told you there are more chances that your book value estimator can go below the salvage value. So, say for example for the 8 year you have estimator the depreciation now when I estimate the book value at the end of the year you can see it is 10,17,789. So, your salvage value is 12 lakh so, it has gone below the salvage value, so, this is not accepted now, you back calculate so, that is calculated for the 8 years again so how do you back calculate.

So, book value at the end of the 7^{th} is the beginning of your 8^{th} year now, you fix up the book value at the end of 8 year you cannot go below salvage value. So, fix the book value is 12 lakh now, you back calculate the depreciation. So, the book value of the beginning of the year minus 12 lakh gives you the depreciation. So, you have to back calculate. Now for the 9th year depreciation will be 0 because I cannot depreciate further I have already reached the salvage value. So, that is why depreciation is 0.

So, finally, you can see at the end of the 9th year salvage value is 12 lakh as estimated earlier. So, this is how we estimate the depreciation using double declining balance method.

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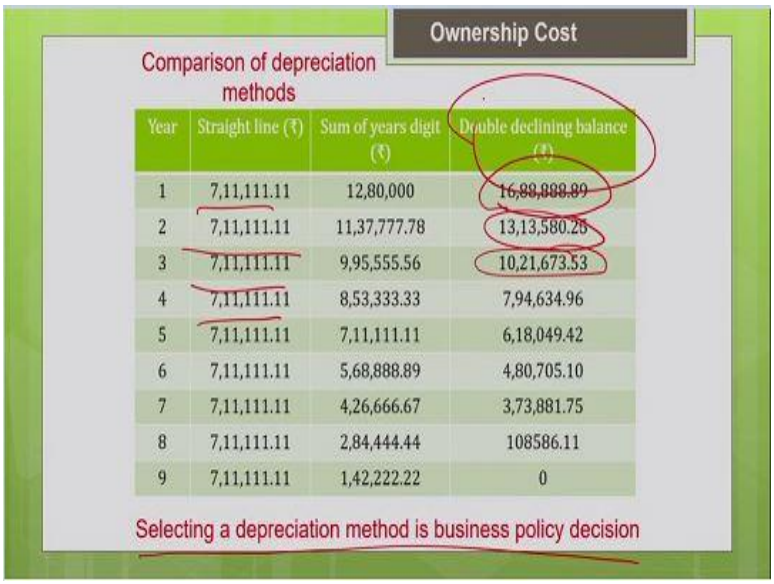

Now, let us compare the depreciation estimated using 3 different methods you can say straight line method depreciation is always same every year. So, when you compare sum of the years as well as the double declining method, you can see that the double declining method is giving accelerated depreciation that means more depreciation in the early age of the machine when compared to the other methods.

So, more depreciation in the early age of the machine. So, when compared to the other methods, this is what people prefer as a total to get the tax benefits. But however, selecting the depreciation is totally a business policy decision there is no constraint or any project estimator any company that they have to follow only this particular depreciation method for accounting purpose. So, they are free to choose any method according to their business policy, but generally people prefer only more accelerated method. So, this double declining method is more commonly used.

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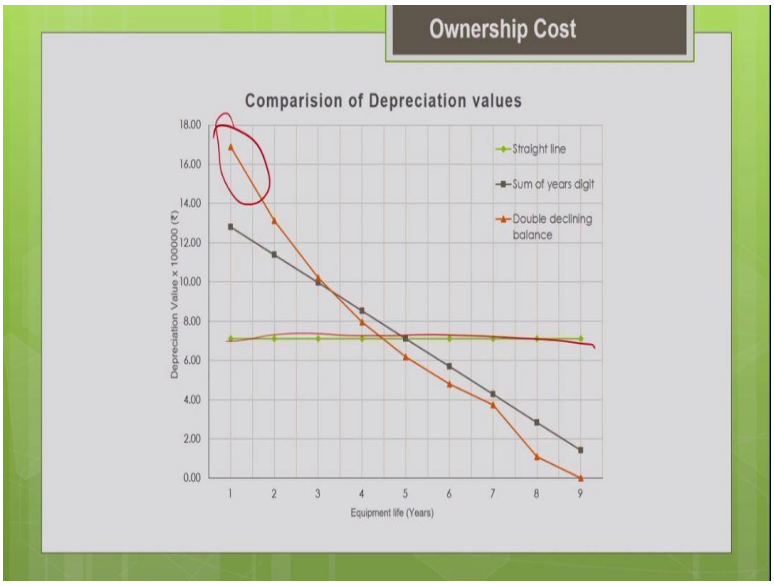

This is just a graphical representation of the depreciation values estimated by 3 different methods you can see straight line method is always constant double declining method this one is giving you the accelerated depreciation more depreciation in the early age of the life of the machine.

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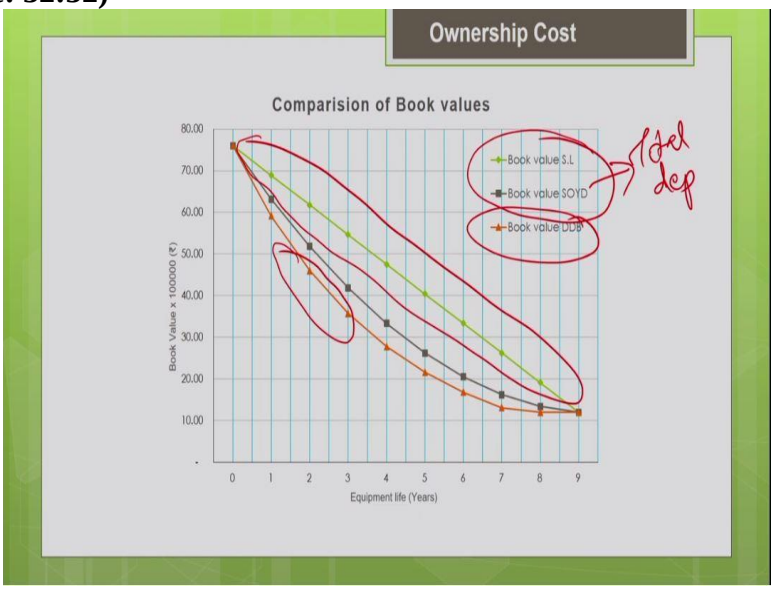

In the same way you can also compare the book value. So, you can see that the straight line method there is a linear reduction. So, the reduction the book value is linear, but for the other 2 methods it is nonlinear and you can see for the double declining method it is more accelerated. So, this is more accelerated depreciation the book value deduction is more. So, one thing to be noted is the rate of reduction is different for different methods.

So, when you compare your straight line method and the sum of the year digit method, you can keep in mind that the total depreciation will be same the total depreciation there is a difference between your initial cost minus salvage value is going to be the same, but the rate of reduction will be different depreciation factor is different, but in double accounting method, the way you estimate the depreciation and there are more chances that the total depreciation may not be the same. So, and your book value can go below the estimated salvage value. So, then we have to back calculate and make it equal to the salvage value.

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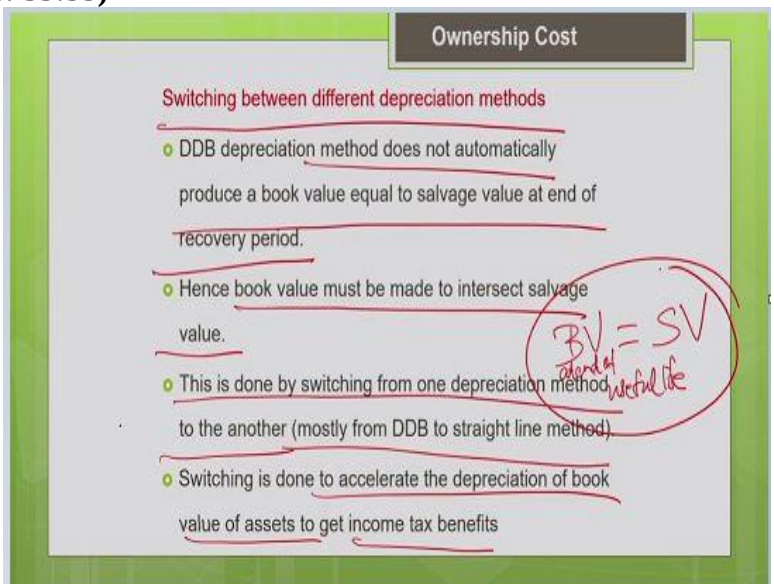

So, another important factor which we are going to discuss today is about switching between different depreciation methods, this is very important as I told you, DDB stands for double declining balance the depreciation method, so, DDB method does not automatically produce a book value equal to the salvage value at the end of the recovery period many cases you can see that the estimated book value can go below the salvage value.

So, now we have to make the book value to intersect with the salvage value that is fair I told you I mean the earlier example we back calculate depreciation. So, there is one way we can also use this methodology where this switch between different depreciation methods, this switch between the speeds from one depreciation method to another depreciation method. So, that your estimated book value you should match with your salvage value.

So, you can switch from one depreciation method to the, another mostly from the DDB method to the straight line method. The reason why we switch as I told you we have to actually take depreciation of the book value people prefer acceleration of the depreciation of the book value of the assets to get the income tax benefits. That is why as we discussing double declining balance method in the early age you can see that the depreciation will be more when compared to straight line method. But as age have taken increases.

Have some point of time you have straight line method of depreciation may become more than the double declining balance method in that the case you can switch over from the double declining balance method to straight line method so that I can get the benefits of higher depreciation to get tax benefits just for the accounting purpose. So, this switching method constitutes accelerated depreciation.

So that you can get tax benefits and another important reason just now what we discuss is your estimated book value should match your estimated salvage value, book value at the end of useful life should intersect with your salvage value. So, this is another reason why we go for switching over between different depreciation methods.

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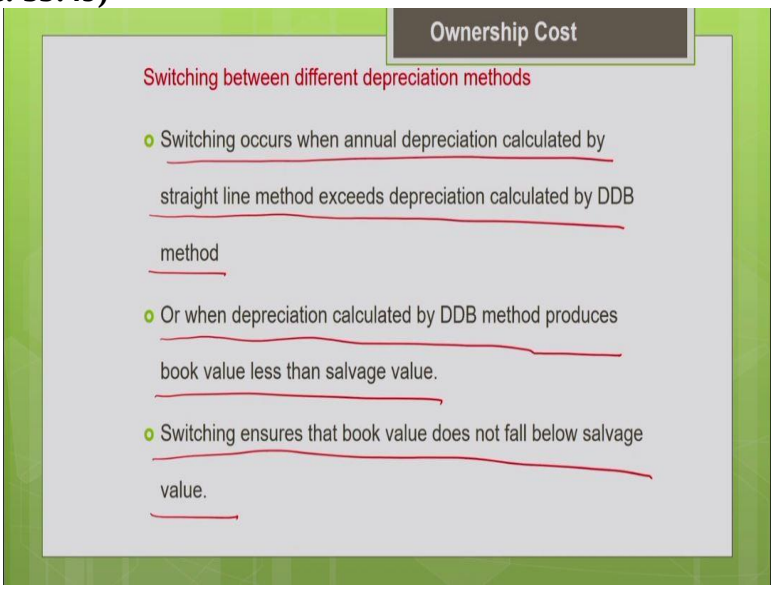

So, switching occurs when the as we discussed just now switching occurs when the annual depreciation calculated by the straight line method exceeds the depreciation calculated with a DDB method it occurs as the initial stage of DDB may be higher than the straight line method as the age

of the equipment increases. So, DDB method depreciation may go below the straight line method in that case we have to switch over another case where we switch over is when the depreciation calculated by the DDB method produces book value less than the salvage value.

This we do not want to occur we want the book value at the end of useful life to match with the salvage value. So, in that case also we have to switch over from one method to another method switching will ensure that the book value does not fall below the estimated salvage value.

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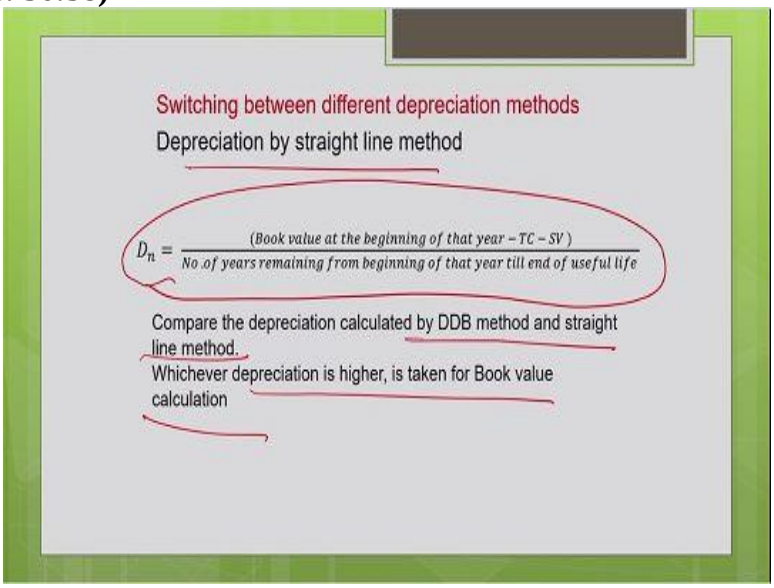

So, when we do this the switching process. So, we have to remember that when we estimated straight line method, the formula will not be the same as a regular straight line depreciation however, it is different when we switch over we can see now. So, for straight line method when you switch over with the depreciation according to this formula, it is nothing but your book value at the beginning of that year, minus tire cost minus salvage value as usual divided by a number of years remaining from the beginning of that year till the end of the useful life.

$$D_n = \frac{(Book\ value\ at\ the\ beginning\ of\ that\ year\ -\ TC\ -\ SV)}{No.\ of\ years\ remaining\ from\ beginning\ of\ that\ year\ till\ end\ of\ useful\ life}$$

So, this is how we calculate the depreciation using straight line method, when we follow the switching process. So, in our regular straight line method depreciation we pay initial cost. So, here we are taking book value at the beginning of every year for every year we are calculating the

depreciation and that is going to be different here and we have to estimate the book value at the beginning of every year for the depreciation calculation.

In the earlier method, when we discussed the straight line method n we have to take the total n number of years and the useful life of the machine. But here similar to your sum of years digit method formula, here we are taking number of years left in the recovery period number of years left in the recovery period from the beginning of the year for which you are going to calculate the depreciation till the end of the useful life.

So, this is how we are calculating the n here. So number of years left in the recovery period from the beginning of the year for which you are going to calculate the depreciation till the end of the useful life. So this will give you the annual depreciation when we do this switching process and here you can note that even when you go for straight line method depreciation every year is going to be different in this approach, when we will work out the demonstration we will understand better.

So now you compare the depreciation calculated by the DDB method every time you have to compare the depreciation calculated by the DDB method and straight line method whichever gives you higher depreciation. The depreciation will be used for book value estimation. So this guideline you have to keep in mind? In every time calculate the depreciation by both the methods, whichever depreciation is higher, you set a depreciation for the estimation of the book value that you are going to switch over from this method to the next method.

Now let us work out an illustration how to do the switching process from the DDB method to the straight line method.

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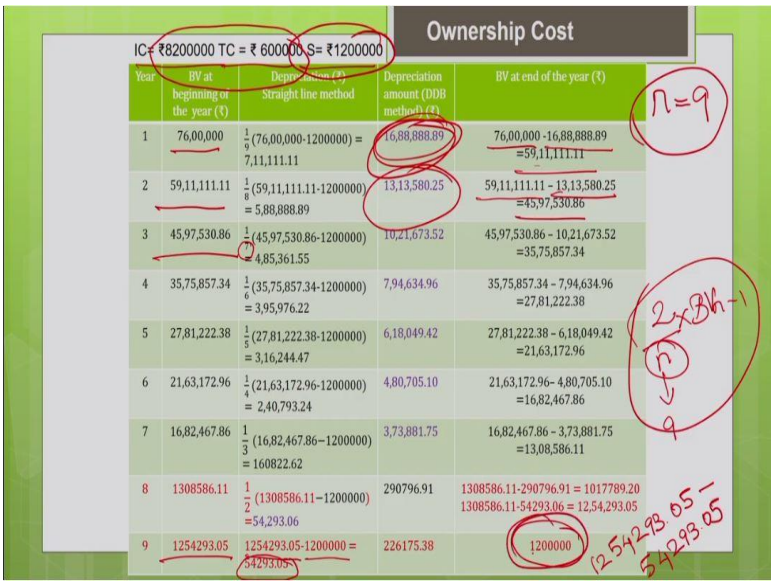

I have used the same input data for the previous problem, it is just a continuation that I am going to show you the methodology of switching from one method to another depreciation method. So, the initial cost is say 82 lakh tire cost of 6 lakh and salvage values are 12 lakh and the useful life of the machine as it is earlier as it is going to be n = 9. So, the book value at the beginning of the year is 76 lakh we know how we estimated here 82 lakh minus 6 lakh initial costs minus tire costs gives us the book value at the beginning of the year.

Now we calculate the depreciation using the straight line method. Straight line method we just now discussed how to estimate like it is nothing but your book value at the beginning of the year 76 lakh minus your salvage value divided by the number of years left in the recovery period. So, at the beginning of year 1 from the beginning of year one if you calculate number of years left in the recovery period is 9 because n = 9, so, number of years left in the recovery period is 9.

So, now you estimate a depreciation 76 lakh minus 12 lakh divided by 9 that will give you the depreciation now, depreciation by DDB method you already know it has nothing but a 2 / n multiply by the book value this is how we estimate we have already estimated I am not going to repeat explain the calculations again but one thing you have to note here is here n refers to 9 it is a total number of years the useful life of the machine so n is fixed every year.

So, here we are not going to change the n every year. So, this is how we estimate the double declining balance depreciation value. Now, at the end of year is nothing but your book value at the

beginning of the year 76 lakh and whichever depreciation is higher compared straight line method and DDB obviously a DDB method depreciation is higher. So, you are going to use this for the book value estimation. So, your book value at the end of the year is 59,11,111.11.

So, book value at the end of this year becomes a book value at the beginning of the next year the same way calculate the straight line depreciation. Now the number of years left in the recovery period from the beginning of the second year to the end of the useful life is 8 that is why 8 number of years left in the recovery period 8 now, this is your book value at the beginning of this year minus your salvage value.

This gives you the depreciation now DDB method you can calculate now the book value at the end of the year is nothing but book value at the beginning year minus whichever depreciation is higher, obviously, depreciation DDB is higher. So, I have taken that so, this is your book value at the end of year similarly to continue like the book value end of this year becomes the beginning of the next year number of years left in the recovery period now is 7 already 2 years are completed from the beginning of third year till the end of the useful life it is 7.

The same way you calculated the depreciation for all the years, but one thing you have to note here is 8th year what is happening 8th year your straight line depreciation is 54,293 your double declining balance depreciation is 2,90,796. So, which depreciation is higher obviously have to go for this only DDB. So, when we take the DDB when you estimate my book value, so, book value at the beginning of the year minus DDB depreciation gives you the book value at the end of the year.

You can see that your book value the end of year falls below a salvage value your salvage value 12 lakhs so it falls below the salvage value. So, now I have to switch over from DDB method to straight line method because your depreciation estimated is higher. So, we have to use the straight line depreciation, so that I can bring the book value to the salvage value. So, for that purpose, I have to switch over. So now how I am going to switch over you can see here the same book value at the beginning of the year.

Now I take straight line depreciation for the estimation of book value this is my new book value. So, this book value will be used in the estimation of the next depreciation. So, book value at the end of 8th year becomes a book value at the beginning of 9th year. So, now I switched over from DDB method to straight line method you can switch over only once. So, here we are going to confine to the straight line method of depreciation.

So, you can see that we calculate the depreciation by straight line method the book value at the beginning of year minus the salvage value of the machine it gives you 54,293 that is a depreciation. So, how will you calculate the book value at the end of the year it is nothing but book value at the beginning of year 12,54,293.05 minus the depreciation by straight line method is 54,293.05 so, that gives you 12 lakh so this is the estimated salvage value?

So, the book value at the end of useful life is coinciding with the salvage value. That is a purpose of switching over we switched over in the 8th year from DDB method to straight line method. So that I can intersect my book value at the end of the useful life of the machine with the salvage value of the machine.

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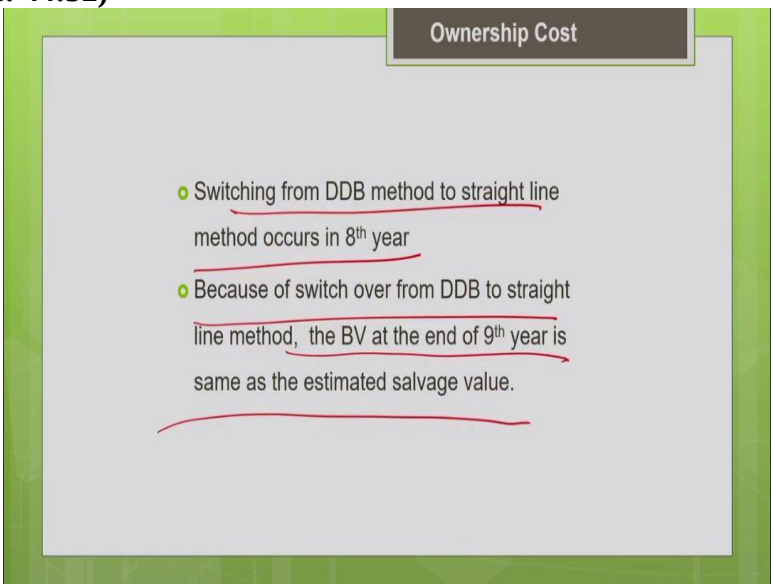

So switching from DDB method to straight line method, we have done it in the 8th year so because of the switchover I am able to see that book value at the end of 9th year is same as estimated salvage value. So, this is the benefit of switching over from one method to another method. So, as

I told you one requirement is to match the book value at the end of useful life to salvage value and another requirement is to accelerate the depreciation so, that I can get the tax benefits.

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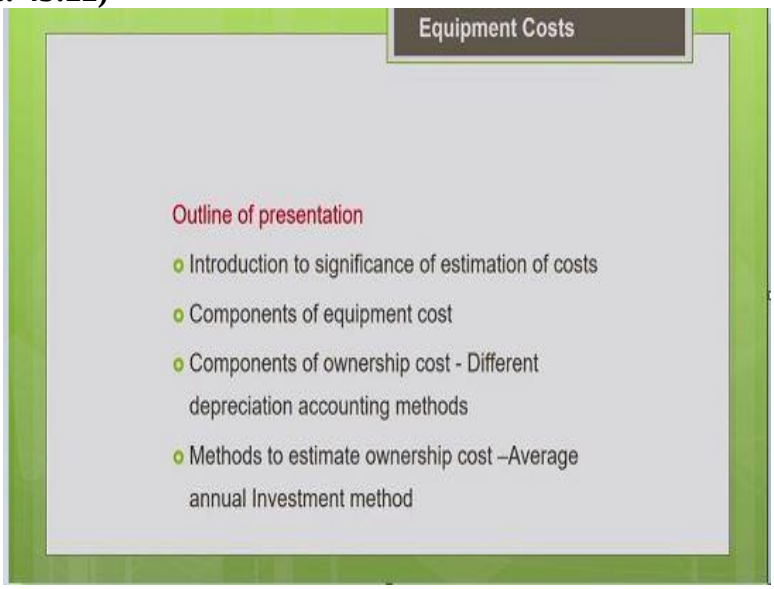

So, we have discussed so far about how to estimate the depreciation using different accounting methods and we have as compared to depreciation values that you are using 3 different methods that is straight line method, sum of the years digit method and our double declining balance method and we will compare the book values we found the difference between the different accounting methods.

And we also discuss how to switch over from one depreciation accounting method to another depreciation accounting method to get the benefits of higher depreciation or to match the estimated the book value at the end of the useful life of the machine the salvage value of the machine. So, what are the advantages of going for switching over from one depreciation to another depreciation which we have discussed so, far?

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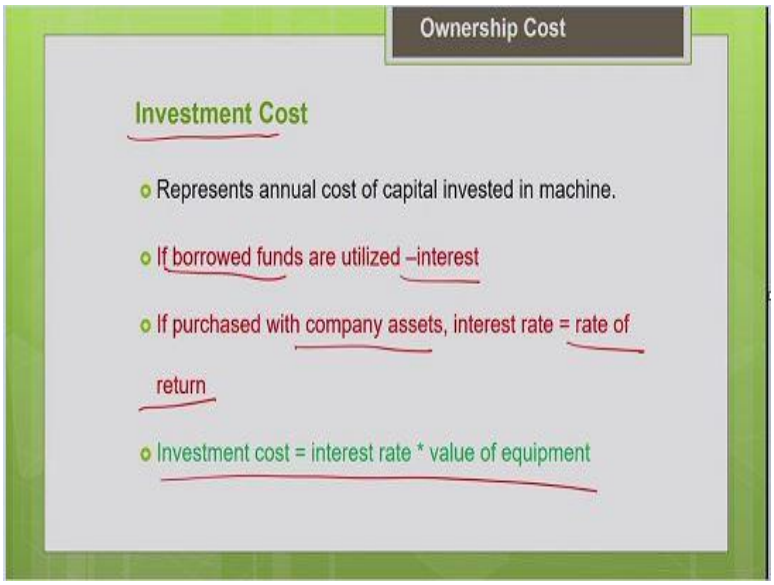

Now, let us move on to the next important component of the ownership cost and that is your cost of investment. So, investment cost it represents the annual cost of capital invested in the machine? So, it is similar to the cost of acquiring the ownership of the machine. So, you may have to purchase a machine or the equipment, either through borrowed funds, or you might have purchased either with your company assets, so in both the cases, you have to go for the cost of an investment.

Say if you are going for the borrowed funds, say for example, if you are going for the loan, so, the interest rate for to pay for the loan that will be considered as the cost of the interest. So, if you are going for the company assets, in that case, also you have to take the interest rate as the rate of return. So, for example, instead of investing this money in the purchase of machine, if you invested this particular money in something else, you might have achieved some rate of return.

So, that rate of return should be taken as the cost of investment. So, in this case, we are purchasing equipment with your own company assets. So, you have to take the interest rate equal to the rate of return. So in both cases, whether you are going for borrowed funds or your purchase from your own companies, it is in both cases, you have to take the cost of investment. So, either in this case, the interest will be the interest for the loan what you are paying in this case.

The interest rate will be the rate of return you might have achieved by investing the money in something else instead of buying the equipment. So, basically, investment costs is nothing but your

interest rate multiplied by the value of your equipment. So, you can see that interest rate multiplied by the value of equipment gives you the investment cost.

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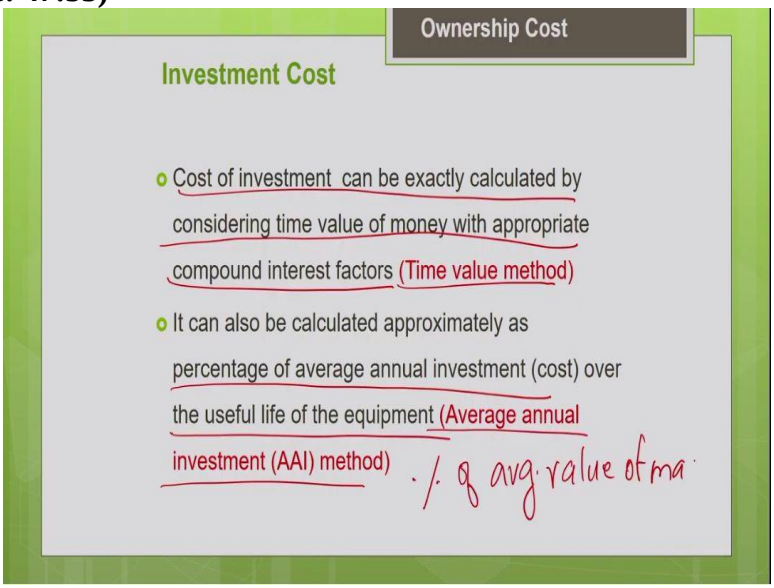

So, the cost of investment can be calculated by 2 different methods, as I told you earlier, one is a time value method other one is an average annual investment method. So, time value method is going to be very accurate method. Actually, there will be a separate lecture dedicated on this topic, I will just introduce to you what is this time value method as of now, so, basically you know that the cash flows are occurring at different time intervals in any construction form before we can see inflows and outflows will be occurring at a different period of time.

So, when you are making some analysis. So, we have to convert all the cash flows, which are occurring at different time period to a particular time period, you have to convert it into an equivalent value at a particular time period and then make the comparison of the analysis. So, that will be more rational. So, that is where we are considering the timing of cash flows in the time value method, which is more accurate. So, the cost of investment can be exactly calculated the considering the time value of money.

So, you will be using some appropriate compound interest factors in this method to convert the cash flows, which are occurring at different time interval to a particular time period, I need to use a compounding interest factors. So, you will be making use of debt in the time value method which

is more accurate, there is another method which is going to be approximate it is called as average annual investment method.

So, in this method, you are going to calculate the thing approximately as a percentage of average annual investment over the useful life of the machine that means, your cost of investment will be expressed as a percentage of average value of machine. So, you know that your machine is going to depreciate gradually over a period of time over its useful life, it is going to depreciate. So, in order to make our calculations convenient, as you know that all the components of the ownership costs which are expressed as a percentage of the value of the machine.

It will also depreciate according to the value of the machine. To make our calculations easier. Let us approximate or fix up the average value of the machine and express all the components of the ownership costs as a percentage of the average value of the machine, so this is what we do in the average annual investment method. So, here we will calculate the cost of investment as a percentage of average value of machine over its useful life, how to calculate the average value of the machine, we are going to see in the upcoming slides. The next important components of the ownership cost are the insurance costs, taxes and the storage cost.

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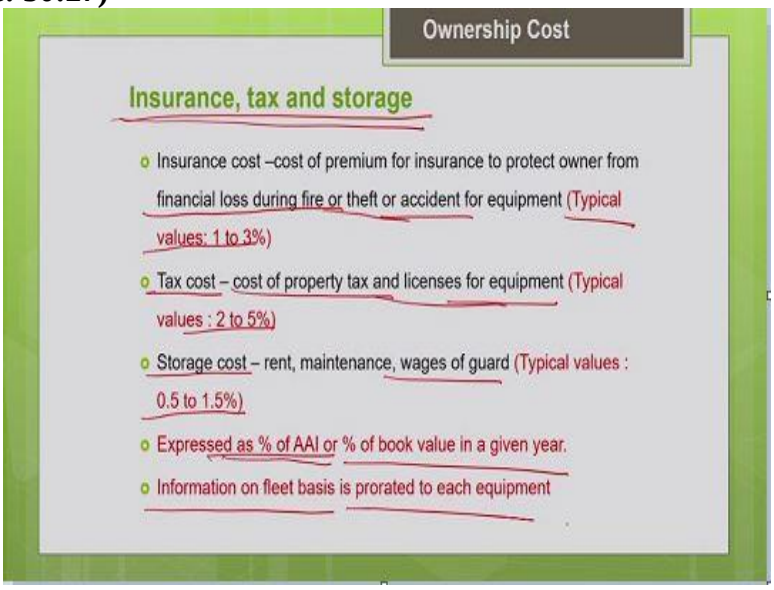

So, insurance costs just like the insurance premium, which would pay for our cars and other equipments. So, we need to pay the insurance premium also for the construction equipment to protect the owner from the financial loss in case of fire or theft or accident or whatever case, so to

protect the owner from the financial loss, so, we pay some insurance premium. So, that is a part of the ownership cost.

So, this insurance costs will be usually expressed as a percentage of the value of your machine. So, a typical value may range from 1 to 3 percentage of the value of the machine. So, it depends upon the value of the machine, it depends upon the location, it will vary depending upon the location. And another thing is if tax cost, say it is the property is it is a asset, so, you have to pay the property tax for the equipment you have to pay the property tax to the government.

So, the cost of the property tax and the licenses for the equipment will come under this tax cost. So, the typical values as reported in the literature, it varies from 2 to 5% of the value of your machine, this will also vary according to the location vary from place to place. So, then storage cost see, when the equipment is not operating, we have to store it in the storage yard. So, the rental charges what to pay for the storage yard and the maintenance charges for the storage yard.

And the wages what you pay for the security guard, all these are considered under the storage cost. So, the rental charges and the maintenance charges for the storage facility. And then for the security guard for the storage facility, we have to pay the wages, all these things comes into the storage cost. So, the typical values will vary from 0.5 to 1.5 percentage of the value of the machine. So, all these components of the ownership cost are expressed as a percentage of average annual investment or the average value of the machine.

Just now in the previous slide we have discussed what is the average value of the machine? So, these components of the ownership costs or express as a percentage of the average annual investment or the average value of the machine or the percentage of the book value in a given year. So, this information, we may be getting it on a fleet basis entire equipment fleet basis, then you can prorate it to the individual or each one according to your requirement. So, the entire information will be available for the entire equipment fleet. So, this we have to prorate it to each equipment.

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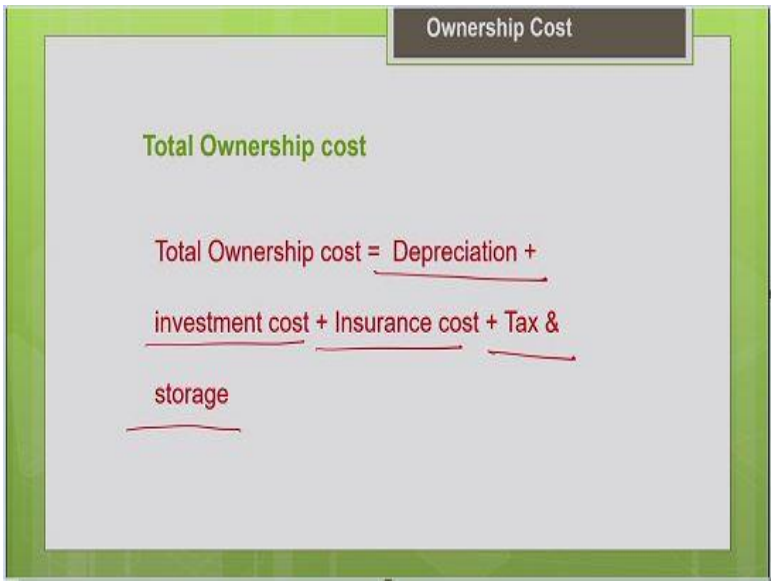

So, let us summarize what are all the components ownership costs we have discussed so far. So, the components of the ownership costs are the depreciation, the cost of investment, insurance cost, the property taxes and the storage cost, all these sums up to the ownership cost.

Total Ownership cost = Depreciation + investment cost + Insurance cost + Tax & storage

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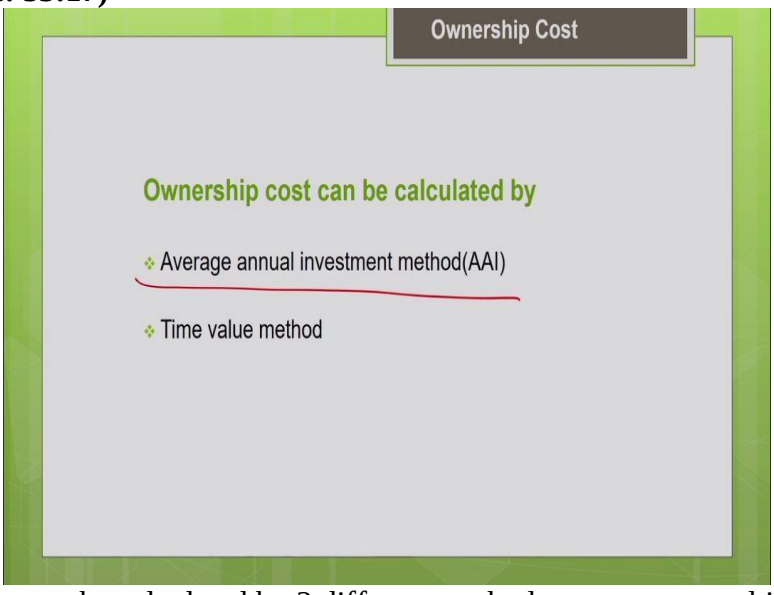

So, ownership costs can be calculated by 2 different methods, average annual investment method and time value method. So, in today's lecture, we are going to discuss about the average annual investment method which is an approximate method of estimation of the cost of investment.

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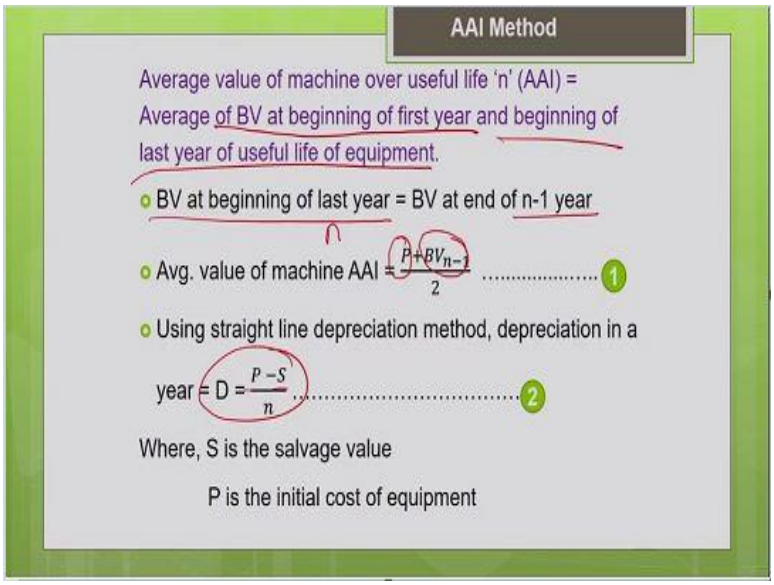

So, average annual investment method, how to estimate this average annual investment over the useful life of the machine or how to find the average value of the machine over its useful life. So, that is what we are going to discuss now, average value of the machine over the useful life is equal to the average value of the book value at the beginning of the first year and beginning of the last year of the useful life of the equipment, when you take the average of these 2 values, you will get the average value of the machine over its useful life.

$$AAI = \frac{P + BV_{n-1}}{2}$$

So, the first year what is happening that is your purchase. So, the average of book value at the beginning of first year is nothing but your purchase price purchase cost and beginning of the last year of the useful life of the equipment. So, that book value you have to take both the book values if you find the average you will get the average value of the machine. So, one more important thing which I told you earlier also.

So, book value at the beginning of a particular year is equal to the book value at the end of the previous year. So that is why book value at the end of the last year say n the total number of years is n book value at the beginning of last year n is equal to book value the end of the previous year previous is nothing but n minus 1 year. So this guideline you should remember now how to find the average value of the machine.

Just now I told you, you take the average of the initial book value that is nothing but your purchase price and the book value at the beginning of the last year of the life of the machine last year nothing but the end of the previous end of n minus 1 year. So, book value at the beginning of the last year n is same as the book value at the end of n minus 1 year. So, that is what we are written here book value at the beginning of last year n is same as book value at the end of n minus 1 year. So, we have taken that into this and we are finding the average year divided by 2.

Now, I hope you remember what we discussed for the straight line depreciation method. So, how to calculate the annual depreciation using straight line accounting method it is nothing but the difference between your purchase price and the salvage value divided by the number of years in the useful life of the machine that will give you the annual depreciation using straight line method. So, difference between the initial cost of the machine minus the salvage value divided by the n it gives you the annual depreciation which is occurring every year, which is going to be same for every year in this straight line method of depreciation.

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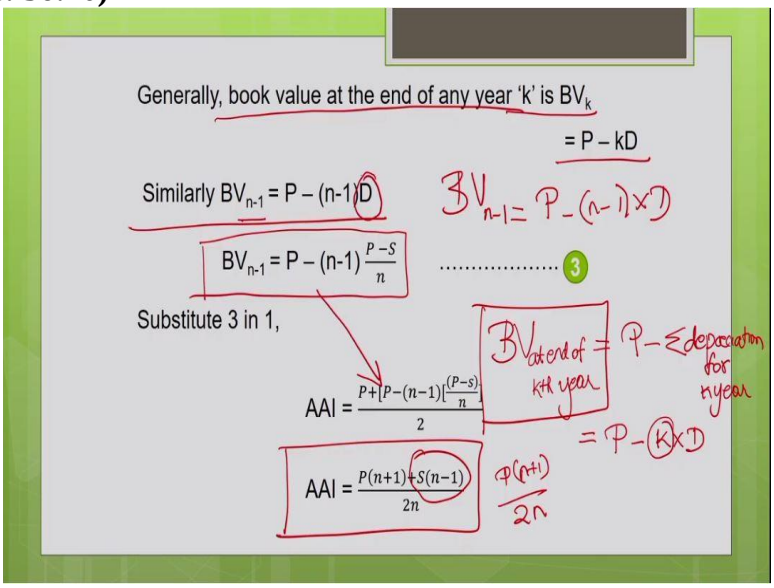

Now, another important thing you have to keep in your mind how to find the book value at the end of a particular year. So, this thing I have discussed in the earlier lecture. So, book value for a particular period book value at the end of a particular period at the end of k^{th} year, I just wanted to find a book value at the end of k^{th} year. So, I how will you find that? If you know the initial cost of the machine purchase price of the machine minus the accumulated depreciation for the k years. So, what is the accumulated depreciation for k years?

So, that will give you the current book value at the end of the kth year. So, when you follow the straight line depreciation, the depreciation is going to be same for every year. So, in that case how to find that P - k into D, D is a depreciation for every year using straight line method. So, number of years is k k into d. So, this will give me the book value at the end of the kth year. So, that is what is written here book value the end of any year k is nothing but P - k into D the initial cost minus the accumulated depreciation for the k number of years.

Similarly, for book value at the end of n minus 1 year I need to calculate book value at the end of n minus 1 year I need to calculate. So, the initial cost is nothing but P - n - 1 years multiplied by the depreciation if we go by straight line method P - n - 1 into D that is what is written here book value at the end of n - 1 here is nothing but initial cost minus n - 1 years multiply by the depreciation for every year now substitute the value of depreciation from the earlier thing whatever you got D = P - s / n substitute that in this equation.

$$BV_{n-1} = P - (n-1)\frac{P-S}{n}$$

Now, you will get P - n - 1 into P - s / n. Now, what do you substitute this equation 3 in the first equation, your first equation is nothing but your average value of the machine instead of BV n - 1, whatever your direct you substitute is BV n - 1, it can express everything in terms of P - s n. So that is what we are doing. Now so, you will get this P plus instead of this BV n - 1 we have substituted this one here.

$$AAI = \frac{P + [P - (n-1)[\frac{(P-s)}{n}]}{2}$$

So, P - n - 1 into P - s / n divided by 2 simplify it will get the average value of the machine as this. So we have to remember this formula P into n + 1 + s into n - 1 divided by 2n to get the average value of the mission over its useful life n, say if the salvage value of the mission is 0, then this will disappear, your formula will become P into n + 1 divided by 2n that will give you the average value of the mission in case salvage value is 0 at the end of the useful life of the machine. So, this formula you are going to remember.

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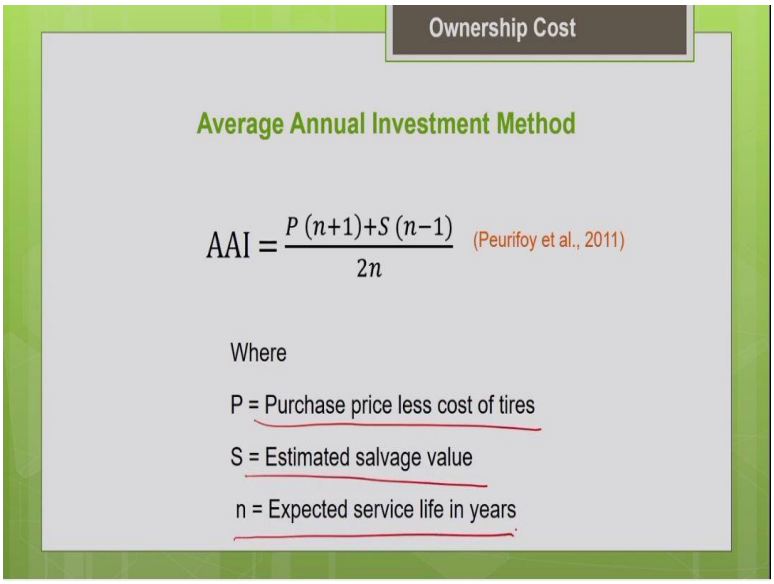

$$\text{AAI} = \frac{P\,(n+1) + S\,(n-1)}{2n}$$

Where

P = Purchase price less cost of tires

S = Estimated salvage value

n = Expected service life in years

And all the components of the ownership cost, we are going to express as a percentage of the average value of the machine when you follow this methodology for the estimation of the ownership cost. So P is a purchase price obviously you deduct the cost of tires, because tire costs will be considered under the operating cost. Then s is the estimated salvage value and n is the service life of the machine.

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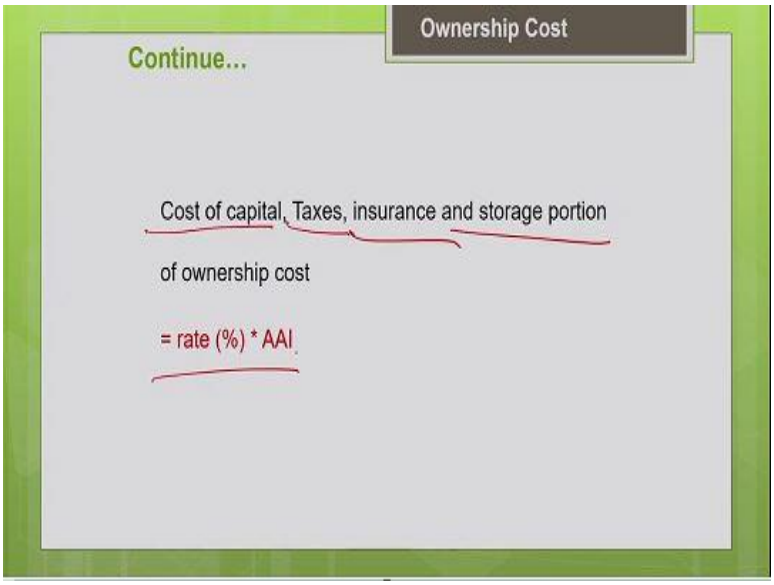

So other components of the ownership cost there is a cost of capital investment costs, your taxes, insurance, storage costs, everything is expressed as a percentage of the average value of the machine that is nothing but average annual investment over the life of the machine.

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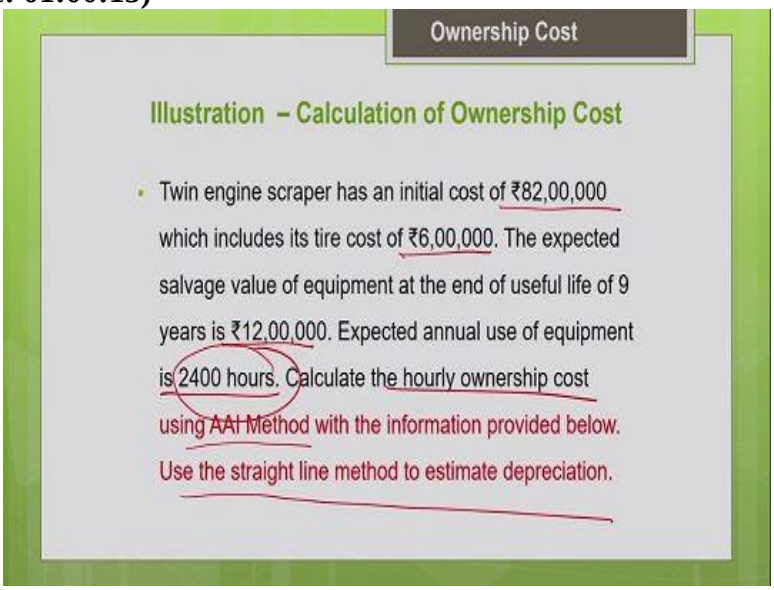

Now, let us work out an example on how to estimate the ownership cost of the machine using average annual investment method a twin engine scraper machine as an initial cost of 82 lakhs. So, this includes its tire cost of 6 lakh, the expected salvage value of the equipment at the end of the useful life of 9 years is 12 lakh. So, the useful life of the machine is 9 years, at the end of the 9 years I will be able to sell the machine at a price of 12 lakh.

Now, the annual use of the equipment is 2400 hours. So, it depends upon every day, how many hours or equipment is going to be operated, and how many days are going to work in a year. Depending upon that you can find what is the annual use of the equipment is 2400 hours. Calculate the hourly ownership cost. So, we always prefer to estimate the equipment cost in on hourly basis so, we are going to calculate it using AAI method average annual investment method and we are going to follow the straight line method to estimate the depreciation to make it more easier.

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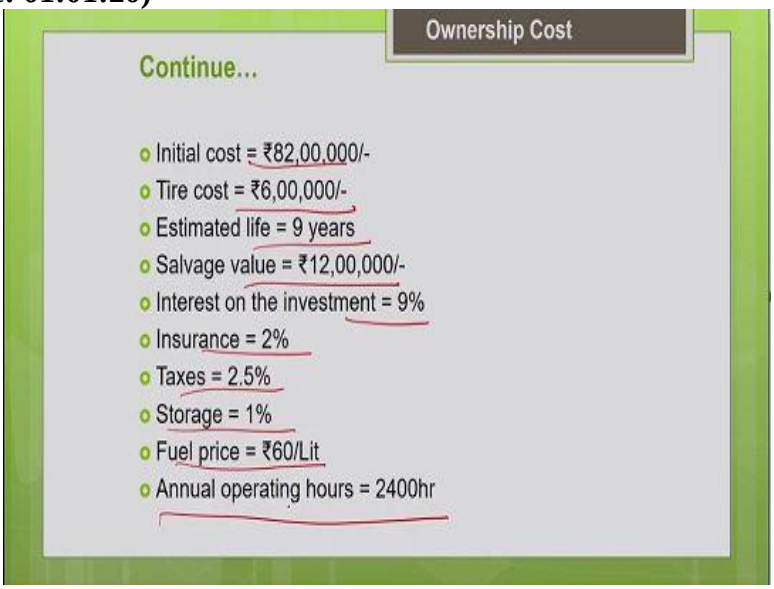

So, this is a summary of the input data given initial cost your tire cost life of the machine the salvage value interest the cost of investment interest on investment is 9% insurance costs 2% taxes 2.5% storage cost is 1% your fuel prices given will be useful operating costs estimation basically, then annual operating hours is 2,400 hours. So, with this is the input data, now, we are going to estimate the ownership cost for this particular machine using AAI method.

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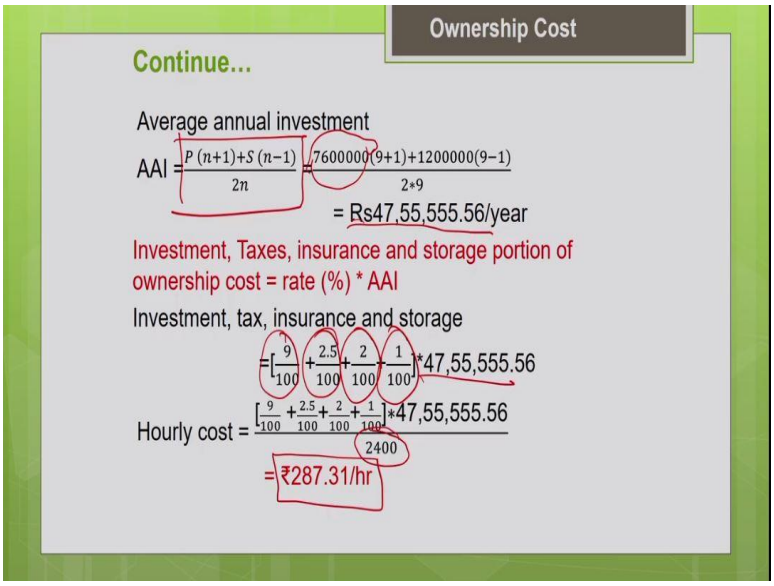

So, how to find this AAI average annual investment; we know the formula P into n + 1 + s into n - 1 / 2n.

$$AAI = \frac{P\,(n+1) + S\,(n-1)}{2n}$$

$$AAI = \frac{7600000(9+1) + 1200000(9-1)}{2*9} = ₹\,47{,}55{,}555.56/year$$

So, we are going to use this formula to determine so, you know P, P is nothing but 76 lakhs hope you know how to determine this 76 lakhs. So, the purchase price of the initial cost of the machine is 82 lakh the tire cost is 6 lakhs. So, 82 lakhs minus 6 lakhs gives you 76 lakhs into n is 9.

So, 9 + 1 plus salvage value is 12 lakh, 12 lakh into n - 1 that is 9 - 1 divided by 2 into 9 this gives you the average value of the machine. It is nothing but 47,55,555.56 per year. Now, estimate your investment, taxes, insurance and storage as a percentage of the average value of the machine how to estimate it you know the investment cost is 9% tax is 2.5 insurance 2% storage is 1% add everything find the percentage of the average annual investment and we wanted the hourly costs so divided by number of hours of usage of machine in a year.

$$Hourly\ cost = \frac{[\frac{9}{100} + \frac{2.5}{100} + \frac{2}{100} + \frac{1}{100}]*47,55,555.56}{2400} = ₹287.31/hr$$

So, annual usage of the machine in hours 2400 hours divided you will get the hourly cost of all these components of the ownership cost. Now, we are ready to determine the depreciation costs which is also an important component of the ownership cost.

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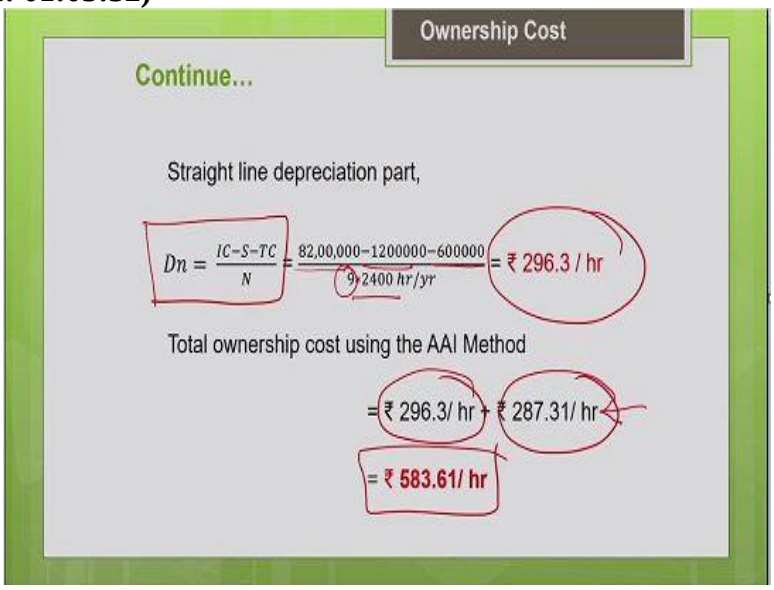

So, depreciation we are going to follow straight line method as it was asked to follow the straight line method in this problem you know how to find the straight line depreciation it is nothing but initial cost minus salvage value minus your tire cost divided by your so, initial cost 82 lakh salvage value 12 lakh and your tire cost is 6 lakh divided by number of years is 9 you multiply by the 2400 hours.

$$Dn = \frac{IC - S - TC}{N} = \frac{82,00,000 - 1200000 - 600000}{9 * 2400\ hr/yr} = ₹\ 296.3\ /\ hr$$

So, that you can get hourly costs directly you will get the hourly cost of depreciation now add up all the ownership cost. So, this is your depreciation costs and these are other ownership components, your insurance, taxes, storage, cost of investment everything add up you will get the total hourly ownership cost using the average annual investment method. So, this is how we estimate the ownership cost using the AAI method.

Total ownership cost using the AAI Method = ₹296.3/ hr + ₹287.31/ hr = ***₹ 583.61/ hr***

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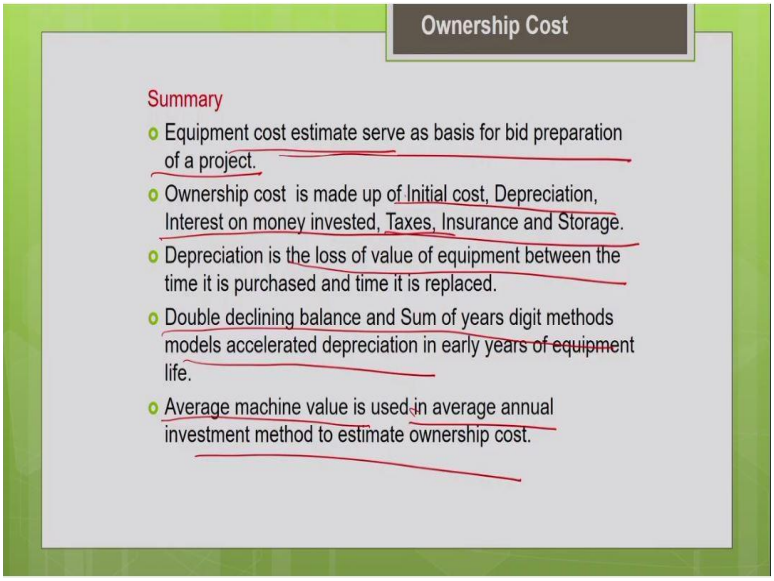

So, let me know summarize. So, what are all the points we have discussed so far. So, basically introduced to you what is the significance of the estimation of the equipment costs because equipment costs will serve as a basis for the bid preparation of the project? Your equipment costs need to be accurate if you have a thorough knowledge of how to estimate the cost of the equipment, then only you will be able to plan your bid properly because your equipment corresponds a part of the project costs.

So, if you underestimated equipment cost; you may overestimate a profit in paper and finally, you may end up in problem. So you should have knowledge and how to estimate the equipment cost. And what are the components of ownership costs we have seen it is made up of the initial purchase price costs of depreciation, cost of investment, taxes, insurance and storage. So, then we discuss what is depreciation, it is nothing but the loss of value of the machine between the time it is purchased and time it is replaced.

So, there will be gradual loss in any asset with time the loss value of the asset as depreciation then there are different methods and we found the double declining balance method and sum of the years digit method models accelerated depreciation in the early age of the machine and people prefer accelerated depreciation because it gives you tax benefits and we have to determine the average machine value over the useful life of the machine. If you are going to use average annual investment method to estimate the ownership cost and how to derive the average machine value, we have discussed just now.

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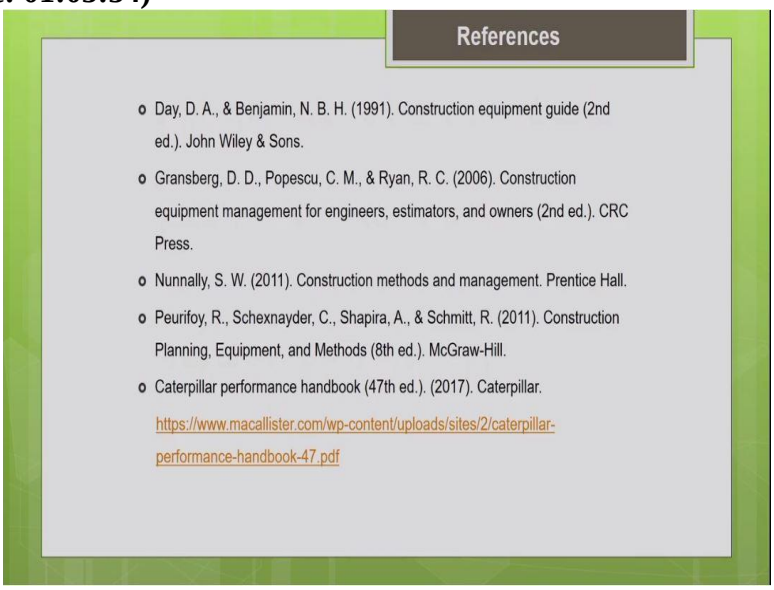

So, these are the textbooks to which I have referred for this particular lecture. So, you can try to procure these textbooks for the future reference. So, with this I would like to end up the lecture to. Thank you.