**Construction Methods and Equipment Management**
Dr. G. Indu Sive Ranjani
Department of Civil Engineering
Indian Institute of Technology, Guwahati

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.

(Refer Slide Time: 00:46)
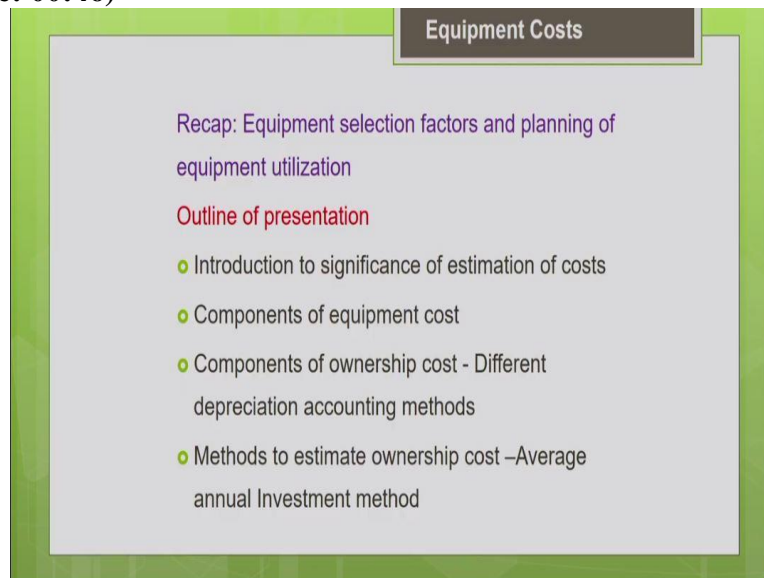
It is the recap of what we learnt in the lecture 1. So, in the lecture 1 we discussed about the planning process of equipment, highlighting on the equipment selection factors and learning of the equipment utilization using the equipment loading diagram. So, this is the outline of the today's presentation. 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?
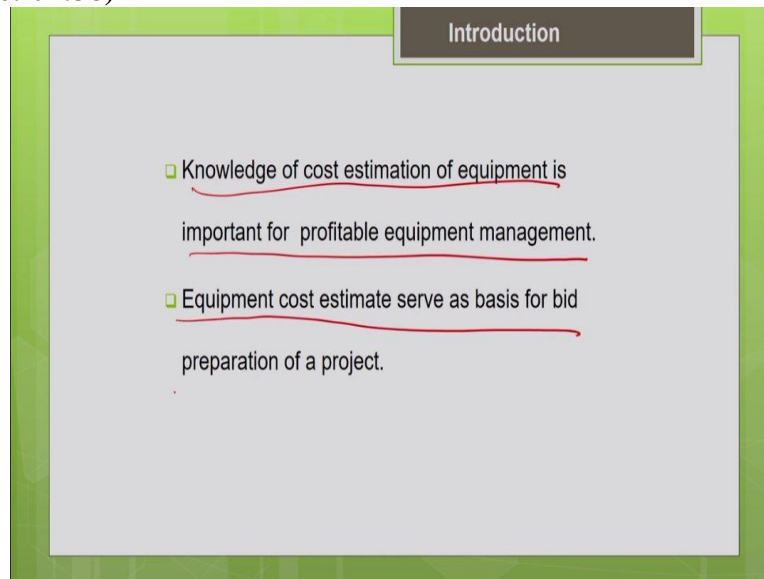
Knowledge of cost estimation is very important for profitable equipment management and we know that equipment cost estimate serves as a basis for the bid preparation of project generally, when we go for the preparation planning of your bid the unit rate what you are quoting it involves a component of 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.
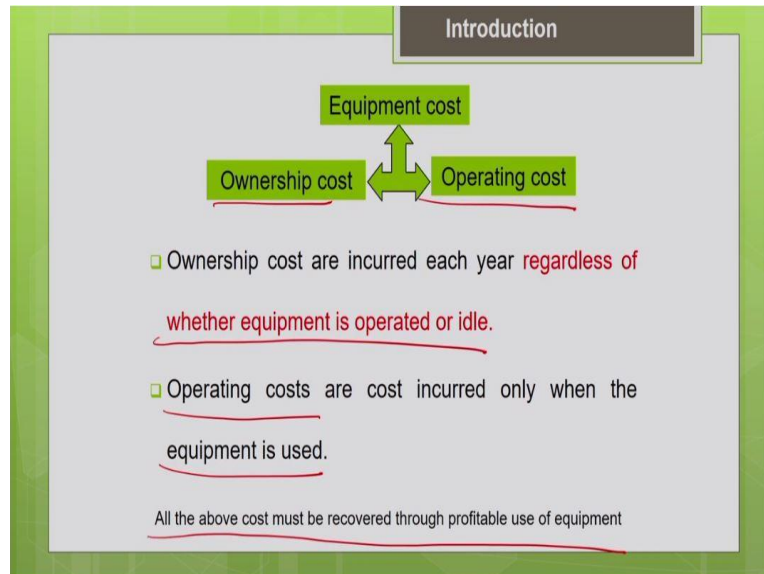
So, let us see what are all the important components of the equipment cost? So, these are the 2 main important components one is an ownership cost other one is the operating cost. So, ownership cost is nothing but these costs we incur every year regardless of whether the equipment is operated or idle. 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.

(Refer Slide Time: 04:41)
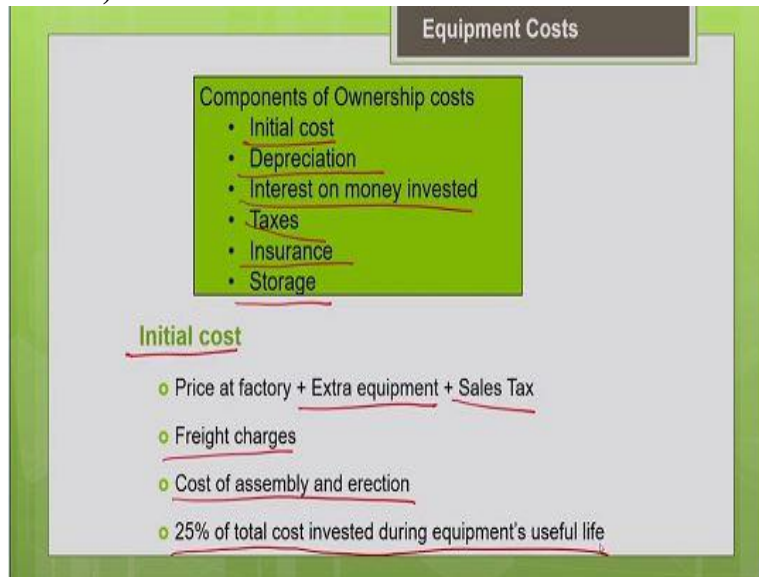
Now, let us see what are all the components of the ownership cost? So these are the different components of the ownership cost, initial costs, depreciation, the cost of investment that is interest on the money invested, taxes, insurance and storage, so these are all the different components of the ownership 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.

(Refer Slide Time: 06:31)
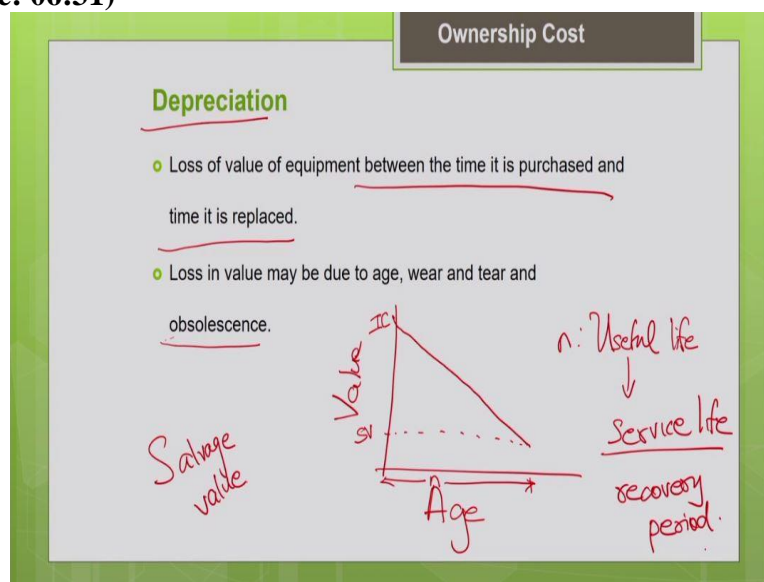
So, depreciation is nothing but loss in the value of the equipment between the time it is purchased and the time it is replaced. So, as everyone knows, equipment is an asset. So, every asset will lose its value with time, there is a loss of value always with the time this loss in value may be due to 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.

(Refer Slide Time: 10:17)
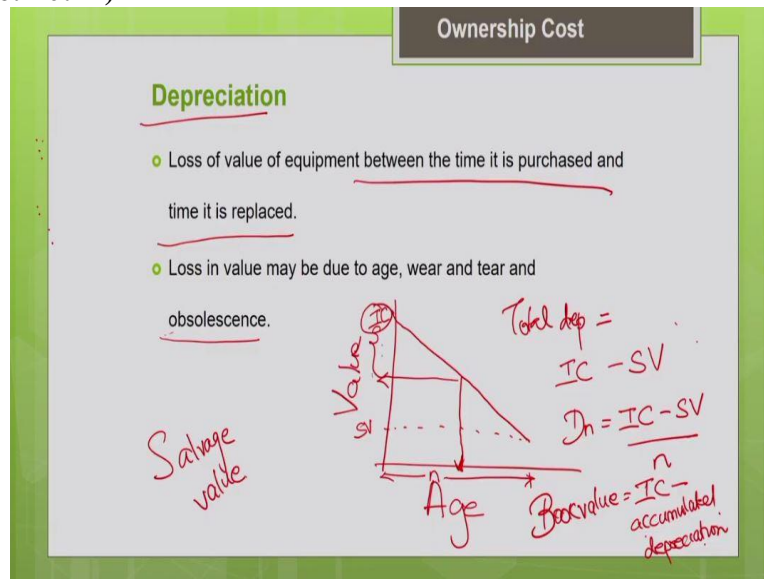
So, the total depreciation should be equal to your initial cost minus your salvage value. So, if I wanted to know the annual depreciation, depreciation every year then in that case I have to calculate divided by the number of years the useful life of the machine. So, this will give you the annual depreciation. 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.

(Refer Slide Time: 12:24)
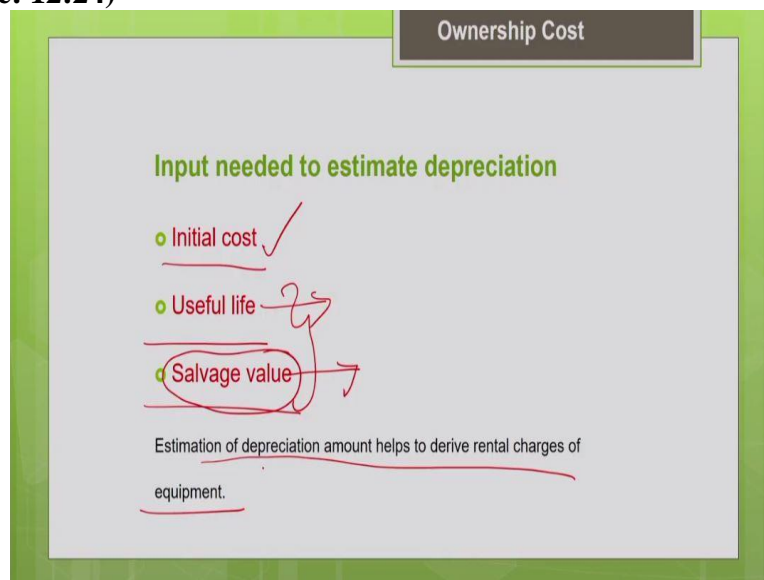
So, what are all the input needed to estimate the depreciation so, important thing is your initial cost your useful life and the salvage value, if you have these 3 important input then you can estimate the depreciation initial cost, you can do it accurately you can get the information easily, but these 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.

(Refer Slide Time: 13:50)
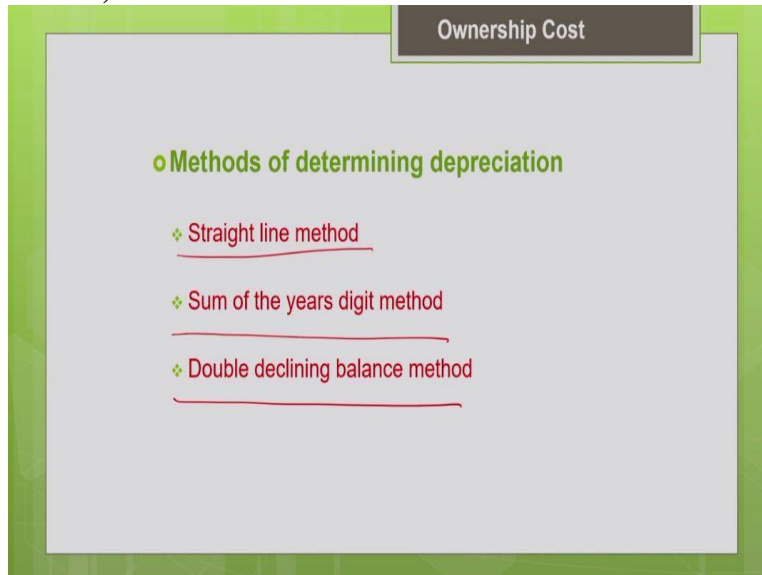
So, there are different accounting methods to estimate depreciation. So, let us see the important accounting methods which are commonly used by the various constituent companies. So, they are the straight line method, sum of the years digit method and double declining balance method. So, we are going to discuss these depreciation methods, accounting methods one by one.

(Refer Slide Time: 14:10)

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.

(Refer Slide Time: 16:56)

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.

61

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.

(Refer Slide Time: 20:34)

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.

(Refer Slide Time: 24:46)

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.

(Refer Slide Time: 25:56)

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.

(Refer Slide Time: 26:27)