So that is what n calculating with this. So there are different applications for this uniform series capital recovery factor. It helps you in determining your known repayment schedule. Say for example if you have purchased equipment through loan. So you are lender will find out the loan repayment schedule using this uniform series capital recovery factor. See basically it tells you how to recover the capital invested. How to recover the loan which you have lent to your borrower?

So to find it I can make use of it uniform series the capital recovery factor. So one thing is a loan repayment schedule and another that is what we are recovering your, the capital cost. Say another important application in the equipment economics is you know the purchase price of the machine, what you make at the beginning. That is the present value purchase place of the machine is known to you. The present value is known. How to convert it into equivalent uniform cash flows?

How to convert the purchase place into equivalent uniform cash flows over the useful life of the machine? So how to; convert the purchase price into A? How to convert purchase price into A? So purchase price is known to you, A is unknown. So you can calculate using this uniform series capital recovery factor. So that is what is written here. It also estimates the equivalent uniform annual cost of owning and operating equipment.

You can convert the purchase price of the equipment into equivalent uniform annual cost of owning the operating machine using this formula. So this will help you in the equipment cost estimation. How to estimate the annual cost of the machine? And how to, estimate the hourly cost of a machine? Which; we are going to see in the upcoming slides.

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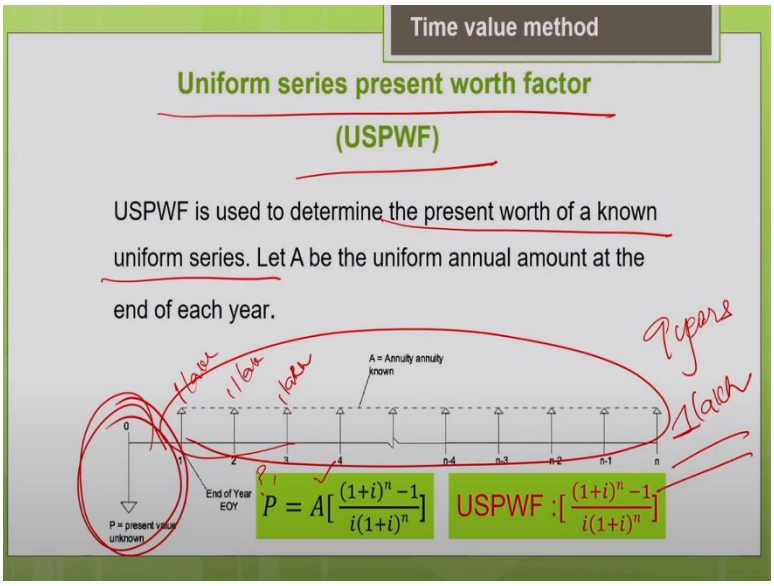

So another important factor which we are going to discuss now is your uniform series present worth factor. It is an inverse of what we discussed earlier.

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

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

So there A is unknown, P is known. So here A is known P is unknown. So it is just by transposing this equation you can find this uniform series present worth factor. It is used to determine the present worth of a known uniform series. So the series is known, the series of cash flow is known. What is it present value? I can determine from this compounding factor.

Say for example for 9 years, my plan is for 9 years at the end of every year I need 1 lakh as a rate of return from the bank. So for that how much amount I should need to deposit in the bank. So that I can get the return of 1 lakh for 9 years at, the end of every period over the period of 9 years. So I need 1, lakh money. At the end of every year I need a return of 1 lakh for 9 years.

So how much should I need to invest now? Ok. So that is what I am calculating from here. So I can find the present worth of known series of cash flows using this uniform series present worth factor which is nothing but the transpose of the earlier formula whatever we discussed. It is a

transpose of uniform series capital recovery factor. So here you can see the P is made equivalent to A by this uniform series present worth factor.

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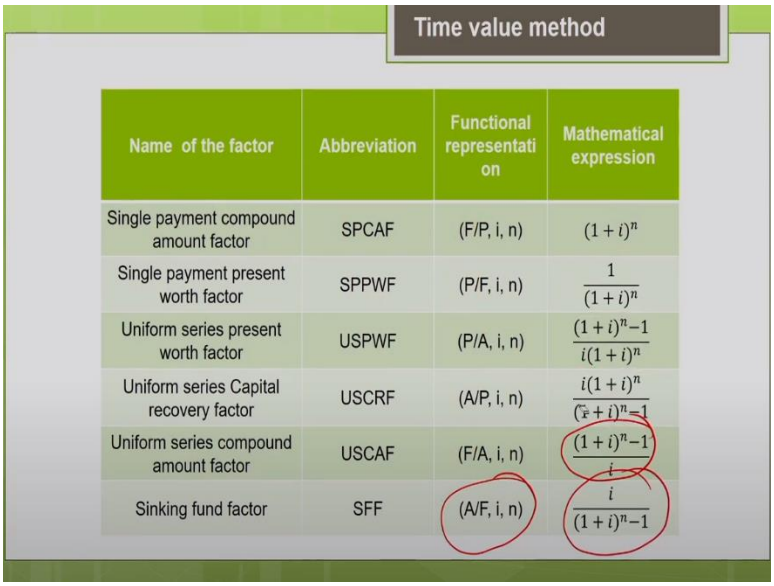

So let us now summarize what are all the different compounding factors which we have learnt single payment compounding amount factor you know that to determine F for known P, i and n. So F is made equivalent to P by using this factor. So, single payment present worth factor to determine P for the known F, i and n. P is made equivalent to F by this factor. For the uniform series payments, uniform series present worth factor determine P for the given A, i, n.

This is the factor which makes equivalent. So this is to determine A, the annual cash flow your determining the annual cash flow for the known P, i and n this is the factor. Then the uniform series compound amount factor to determine F for given A, i, n. So basically to know what is the current series to known. If you want to know the future value of the current series, then you can use this factor. Then sinking fund factor it is just an inverse.

So determine A for the known F, i and n. So they have made equivalent by this factor. So basically if you see that these two, are inverse of each other. Similarly, these two are inverse of each other. See if you know one you can calculate the other one. You need not remember all the compounding factors at least one of every important factors of this you should remember. So let me summarize what we have discussed so far.

I introduced to you the importance of considering the timing of the cash flows. And how to use the various compounding factor to convert the cash flow which are occurring at different time period to equivalent cash flows at the particular time period.

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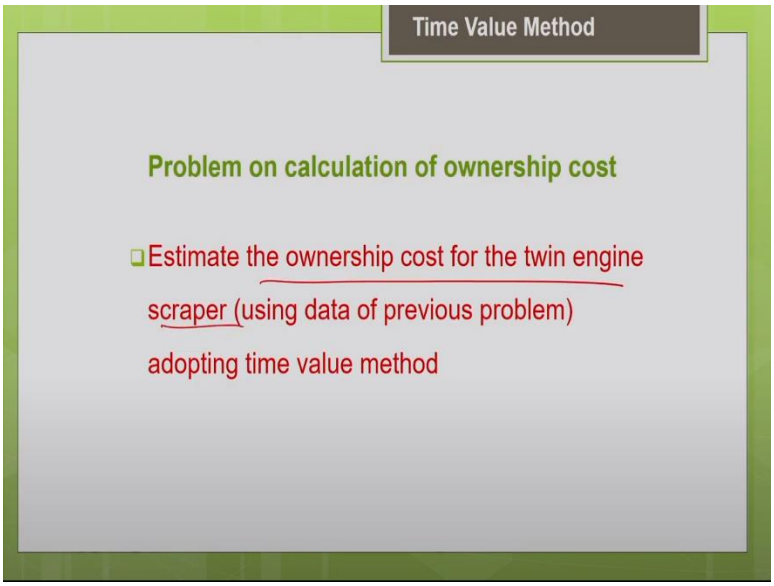

So now let us proceed on how to estimate the ownership cost using this time value concept. The same problem which we have worked out earlier but using the time value method. So estimate the ownership cost of the twin engine scraper machine, using the data previous problem what we have used earlier for the other method it is average annual investment method is the same data we are going to use here. But we are going to work out using the time value method here.

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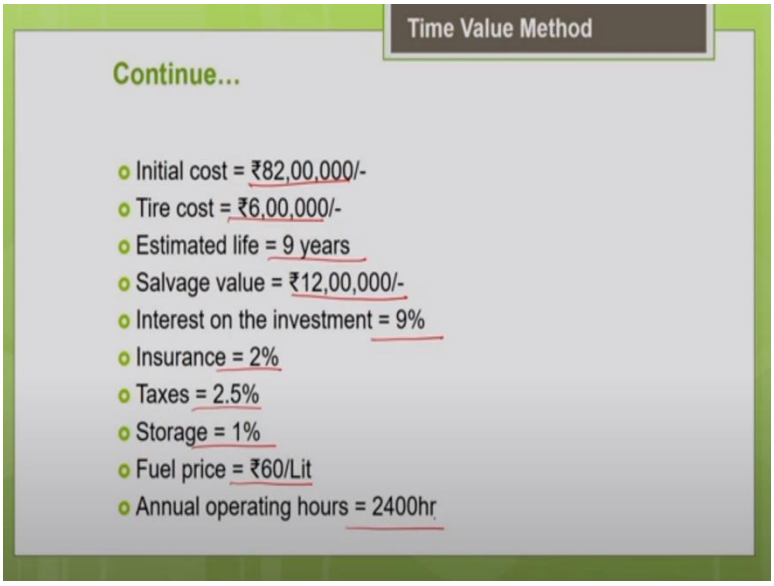

So let me summarizing the input data of the given in the problem. So the initial cost of the machine is 82 lakhs. The tire cost is 6 lakhs and the estimated life of the machine is 9 year. So at the end of 9 years we will be able to sell this machine at a salvage value 12 lakh. So the interest of the investment is 9%, insurance percent is 2%, tax is 2.5%, storage is 1% and fuel price is given as 60 rupees per liter which will be used for operating cost estimation. Then the annual operating hours equal to 2400 hours. So the use of machine in hours in years is 2400 hours.

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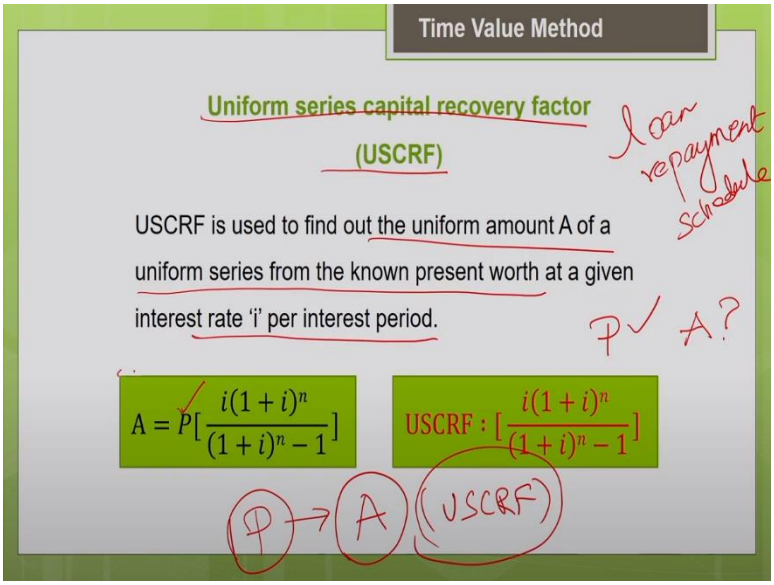

Now let me recollect the important compounding factor which we discussed earlier which we are going to use again now in the ownership cost estimation using time value method. So the important factor which we are going to use now is uniform series capital recovery factor. So basically this factor is used to find out the uniform amount A of a uniform series from the known present worth at a given interest rate i per interest period.

So in this case your present worth of your money is known. You are going to find the uniform amount A. So for a given P we are going to find A. So basically we discussed about this factor earlier. It helps you to determine at what rate your capital can be recovered. Using this factor we can also find what is the loan repayment schedule for the equipment. So the lender will fix the loan repayment schedule using this uniform series capital recovery factor.

So at what rate you can recover your loan. What will be your loan repayment and schedule? So that we can calculate using this so basically for the given P you can find the A. Say you know the

present purchase price of the machine P. So you can convert it into annualized purchase price or equivalent annual the uniform cost so using this uniform series capital recovering factor. So the purchase price of the machine can be converted into equivalent uniform annual cost over the useful life of the machine using uniform series capital recovery factor.

So we are going to determine A for the given P to know the present value. So this is given you are going to find the A. So this is your uniform series capital recovery factor. So the A is made equivalent to P by this factor.

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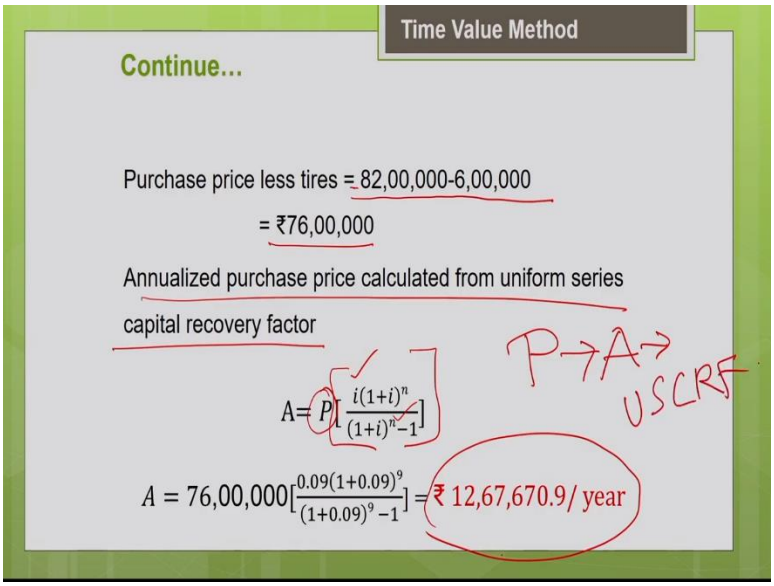

Let us see how to use this factor to find the annualized purchase price of the machine. So first let us calculate what is the purchase price of the machine less the tire cost? So 82 lakhs is the purchase price minus the tire cost because the tire will; be cost of the considered under the operating cost. Now the purchase price less the tire cost will be 76 lakhs. Now how to find the annualized purchase price from the uniform series capital recovery factor?

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

$$A = 76,00,000[\frac{0.09(1+0.09)9}{(1+0.09)9\ -1}]\ =\ ₹\ 12,67,670.9/\ year$$

So you know the P value purchase price less the tire cost that is 76 lakh multiply by this uniform series capital recovery factor. You know the i value, you know the n value. So you can substitute it and find the annualized purchase price of the machine. So now you have converted the present purchase price into annualized purchase price using this uniform series capital recovery factor. Now let us move on to the next part.

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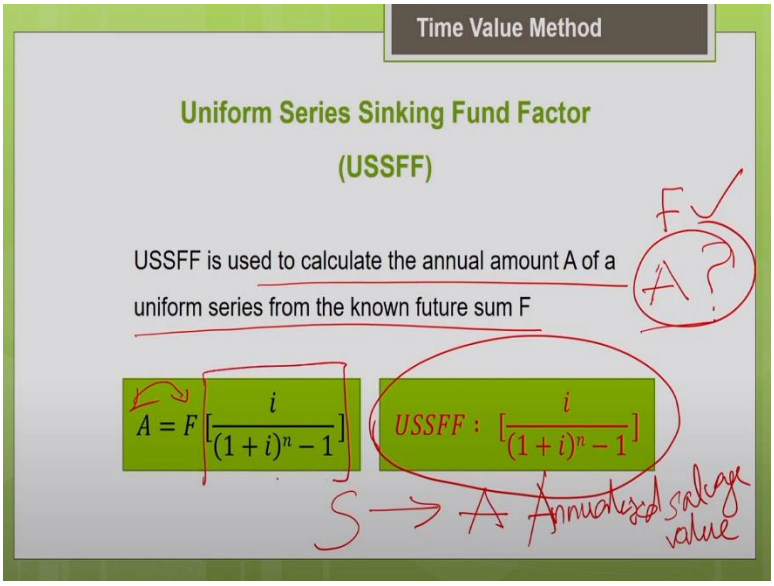

So now we are going to use this factor uniform series sinking factor. Let us recollect what is sinking factor? Ok. So basically it is used to calculate the annual amount A of a uniform series from a known future sum F. So if the future sum F is known then you can convert it into equal and uniform series A. So here you are calculating A for the given F. The future sum is known, the future value particular the money is known we are going to convert that future some into equivalent reform series A using this uniform series sinking fund factor.

So now how are you going to use this in the ownership cost estimation let us see. You know the future salvage value of machine, salvage value is nothing but at what price you are going to sell the machine at the end of the useful life. So the future salvage value is known you can convert it into equal and reform series A that is you can convert it into annualized salvage value using this uniform series sinking fund factor. So here the A is made equivalent to F by this uniform series sinking fund factor. Let us see how it is applied.

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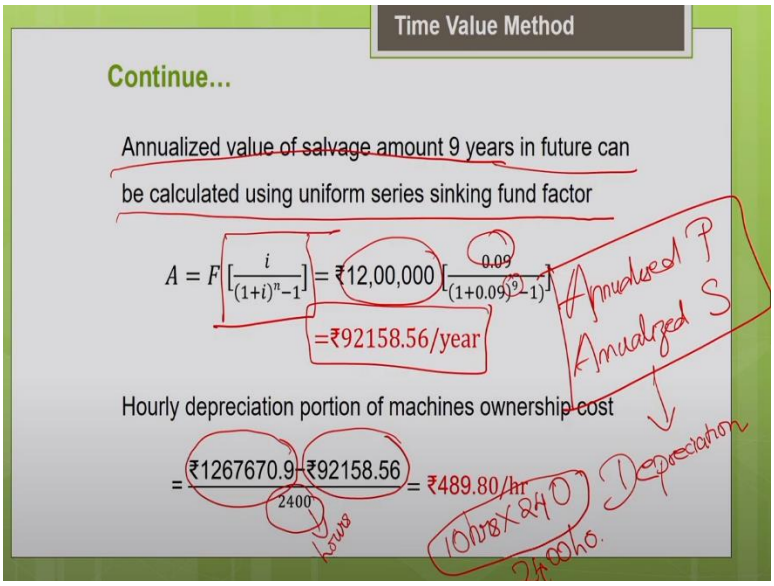

Now the annualized value of salvage amount 9 years in future can be calculated using uniform series sinking fund factor as below.

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

$$= \text{₹}12{,}00{,}000\left[\frac{0.09}{(1+0.09)9-1)}\right] = \text{₹}92158.56/year$$

F is the future salvage value 12 lakh. You know the interest rate, you know the n. So this is your uniform series sinking fund factor. So you can multiply the sinking fund factor with the salvage value you will get the annualized salvage value as below. So now you know the annualized purchase price you know the annualized salvage value.

If you find the difference you will get your depreciation. So that is what is the straight line method says difference between the purchase price minus the salvage value. Here you are going to find the annualized value then we will convert it into hourly cost. So hourly depreciation portion of the machine ownership cost we are calculating with the straight line depreciation method. It is nothing but your annualized purchase price minus your annualize salvage value divided by the annual use of the machine in hours.

$$= \frac{₹1267670.9\text{-}₹92158.56}{2400} = ₹489.80/hr$$

So the total hourly usage of the machine. Say for example every day you are using the machine for 10 hours. So you are going to operate the machine for 240 days in a year. So the total annual usage of the machine, hourly usage of the machine in a year will be equal to 2400 hours. So this is how you calculate the hourly depreciation. Now let us calculate the other components of the ownership cost.

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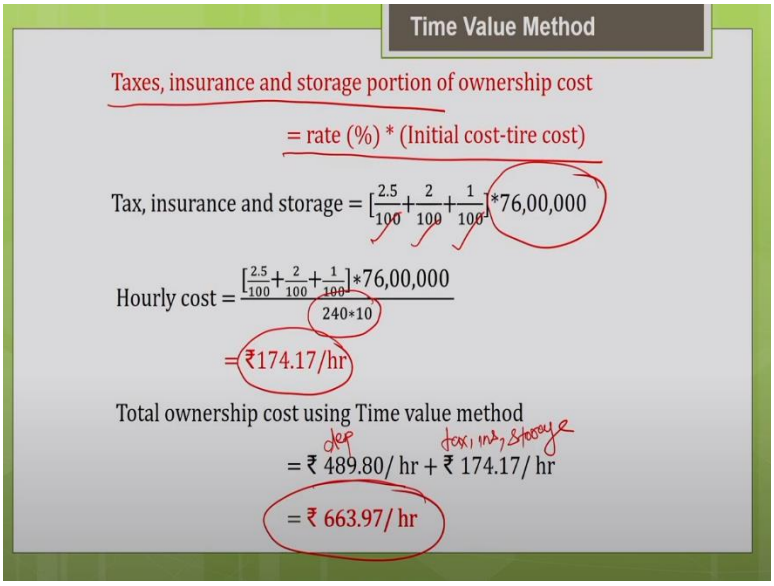

So the other components of the ownership cost taxes or insurance and storage. So they are express as a percentage or the initial cost minus the tire cost. So in this time value method instead of taking the average value of the machine we are calculating as a percentage of the initial cost of the machine, obviously after deduct the tire cost. So at the tax component, insurance component and the storage percentage so calculate the percentage of the initial cost minus tire cost divided by the total hourly usage of the machine in a year.

$$Tax, insurance\ and\ storage\ (hourly\ cost) = \frac{[\frac{2.5}{100} + \frac{2}{100} + \frac{1}{100}]*76,00,000}{240 * 10}$$

$$= ₹174.17/hr$$

So that is divided by 2400. So you will get hourly cost at rupees 174.17 per hour. Now you are going to calculate the total ownership cost. So earlier whatever you are calculated the depreciation and now you have calculated your other part taxes, insurance and storage add both. This is your depreciation part, this is your taxes insurance and storage part, add everything you will get the total ownership cost using the time value method .

$$Total\ ownership\ cost\ using\ Time\ value\ method = ₹\,489.80/\,hr\ +\ ₹\,174.17/\,hr$$

$$= ₹\,\mathbf{663.97/\,hr}$$

So you have calculated hourly cost. So this is how the estimate the total ownership cost using time value method. Earlier I have calculated using average annual investment method which was a approximate without considering the timing of cash flows,. So this is what accurate method. You can compare the cost using both the methods.

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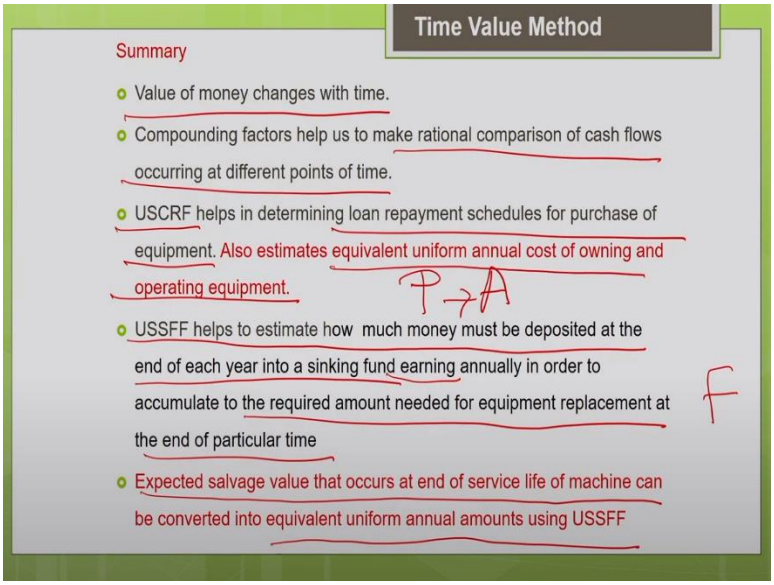

Now let me summarize, so whatever we have discussed so far in this particular lecture on time value method. As everyone know the value of money is changing with time and we found that the compounding factors are very helpful to make the rational comparison of the cash flows occurring at different point of time. It helps you to convert the cash flows occurring at the different period into equivalent value at the particular period for making the analysis of comparison.

So then we saw the application of this uniform series capital recovery factor it helps in determining the loan repayment schedule for the purchase of the equipment. It helps you to determine at what rate you recover the capital invested. Also it estimates the equivalent uniform annual cost of owning and operating equipment. It helps you to convert the present purchase price into annualized purchase price.

So that is how we estimated the depreciation in the time value method hope you remember. Similarly, this uniform series sinking fund factor helps to estimate how much money must be deposited at the end of each year into the sinking fund earning annually in order to accumulate to the required amount needed for the equipment replacement at the end of the particular time. Say I told you about the sinking fund.

Generally, when we plan for the purchase of a new equipment or replacement of the old equipment with new machine so what we do is? We deposit some amount of money into the pool of funds go to the sinking funds every year, planning for the purchase for the replacement. So that at the end of the particular period that money will grow into particular sum which will enable you to either purchase in new machine or replace old machine with the new machine.

So this sinking fund factor will help you to determine how much money I should deposit in the pool of funds every year. So that it will grow into the future value F at the end of the n years. Also with the help of the uniform series sinking fund factor I can convert the salvage value that occurs at the end of the service life of machine into equivalent uniform annual amounts. So that is what we found in the time value method estimation.

So we convert the future salvage value into annualize salvage value using uniform series sinking fund factor. So with this we have come to the end of the lecture 3.

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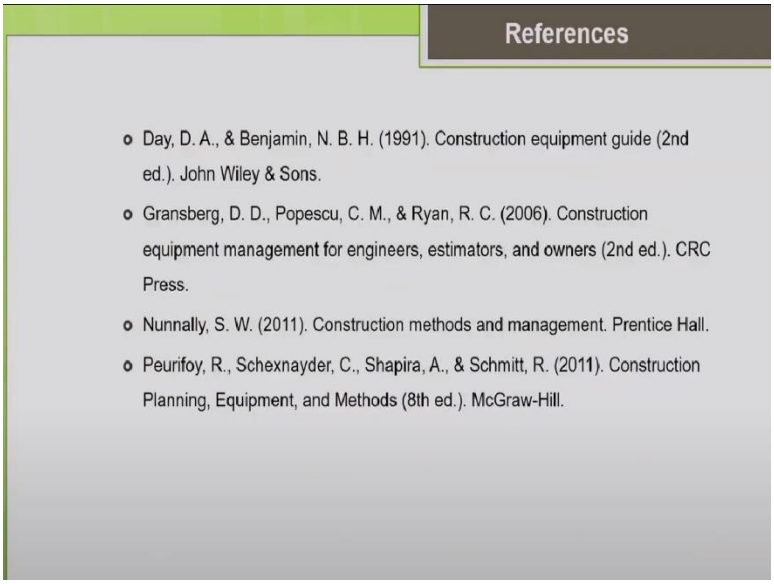

So these are the important references which I have referred for this lecture preparation. You can refer these textbooks for the post preparation. So in the next lecture we will be discussing about how to estimate the equipment cost particularly the operating cost. How to estimate the operating cost we are going to discuss in the lecture 4. Thank you.