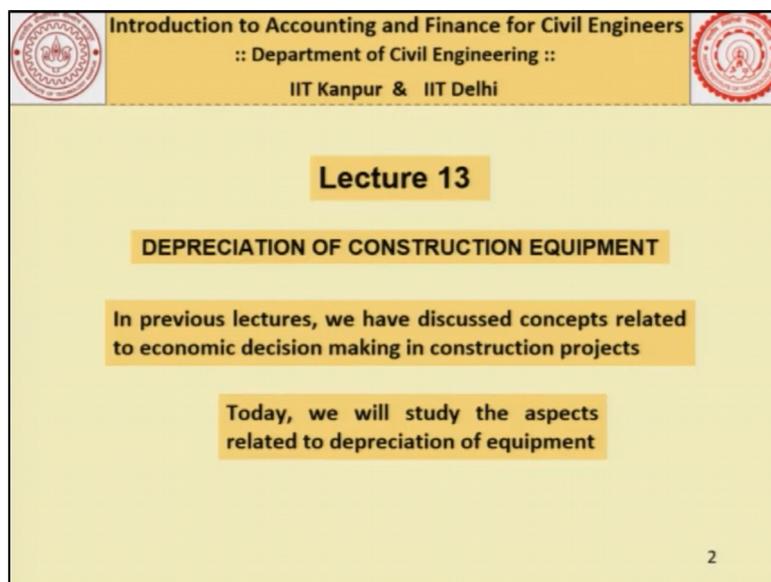


**Introduction to Accounting and Finance for Civil Engineers**  
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**Module No. #03**  
**Lecture No. #13**  
**Depreciation of Construction Equipment**

Namaskar, and welcome once again, to this course on, Introduction to Accounting and Finance for Civil Engineers.

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**Lecture 13**

**DEPRECIATION OF CONSTRUCTION EQUIPMENT**

In previous lectures, we have discussed concepts related to economic decision making in construction projects

Today, we will study the aspects related to depreciation of equipment

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And, in this lecture, we will be talking of, some issues relating to, Depreciation of Construction Equipment. In the previous lectures, in this course, we have been discussing, concepts relating to economic decision making, which is very, very important, as far as, construction projects and their management is concerned. In our discussion today, we will focus on, different aspects relating to, depreciation of equipment.

But, before we go into this, we should understand, what is the importance of, procurement of equipment, the fact that they have a finite service life, and so on. Some of these concepts, we had alluded to, and talked in some detail, when we were talking about, the general issues relating to construction projects, in the outset of this course.

**(Refer Slide Time: 01:10)**

The slide features a yellow background with a white border. At the top, there are two circular logos: the IIT Kanpur logo on the left and the IIT Delhi logo on the right. Between them, the text reads: "Introduction to Accounting and Finance for Civil Engineers :: Department of Civil Engineering :: IIT Kanpur & IIT Delhi". Below this, the word "Introduction" is centered in a yellow box. A larger yellow box contains three bullet points: "• Mechanization and use of heavy construction equipment is an important part in modern infrastructure projects.", "• The affect on productivity and total cost incurred could be governing factors in selecting an equipment.", and "• Construction equipment is costly !!". The number "3" is in the bottom right corner.

Now, coming to introducing this topic, we understand that, mechanisation and the use of heavy construction equipment, is an important part of modern infrastructure projects. When we see any of these infrastructure projects, whether it is a flyover, or a metro construction going on, we find a lot of equipment's at site. Of course, we must also remember that, it is not only the equipment at site, which is used, but there are equipment's, which are not easily seen at sites, they are also part of the mechanical equipment and so on, which are important, as far as, construction industry is concerned.

Now, the effect on productivity, and total cost incurred, could be a governing factor, in selecting an equipment. And also, we should remember that, construction equipment, is a very costly item. And, companies need to make a careful decision, when it comes to procuring a construction equipment. Also, there could be options in, different equipment. And, that is what, we have been talking about, in the previous lectures, as to how, we evaluate different options.

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Common equipment used during construction		
S. No.	Job / activity	Typical equipments used at site
1	Excavation / loading	Crane, clamshell, dragline, back-hoe, pile-driver, shovel
2	Compaction / grading	Sheep foot roller, grid roller, vibratory roller, steel wheel roller
3	Drilling	Percussion drills, rotary drills, Tunnel Boring Machine
4	Lifting / erecting	Derricks, boom type tower cranes
5	Concreting	Batching and mixing plant machinery, mixers, transit mixers, pumps

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Now, moving forward from here, let us look at this table of, typical construction equipment, which is used at site. And, we can see, the depending on the kind of activity, which is involved, there are different equipment's, which are used. Now, I am not getting into the details of, this aspect here. But, as a home assignment to you, I would expect, I would like that, some of you at least, should try to understand, some of these equipment's a little better. Understand it from, the point of view of, who are the makers, or manufacturers, of these equipment's.

What are the kind of specifications, that we deal with, when we talk of construction equipment? For example, if it is a crane, what are the kind of different cranes? What is their cost? Which are the manufacturers of these equipment's, in India? So, once you get into, this kind of a literature search, you will be able to understand, the importance of construction equipment, and the construction industry, the role that construction equipment plays, in the construction industry, and so on.

**(Refer Slide Time: 03:27)**

The slide is titled "Introduction to Accounting and Finance for Civil Engineers" and is from the Department of Civil Engineering at IIT Kanpur & IIT Delhi. The main heading is "Investment on equipment". A handwritten word "Asset" is circled in red in the top right corner. The slide contains three text boxes: the first states that construction equipment is very expensive and requires a 'capital investment'; the second states that productivity and total cost are governing factors; the third is a bulleted list stating that construction equipment is not sold in large numbers and can be used at multiple sites during its service life. The slide number "5" is in the bottom right corner.

So, moving forward, as far as, the construction equipment is very expensive, and calls for, what is called, capital investment. And, that is what is to be made by the companies, when they procure this equipment's. We will talk about, assets and liabilities, later on in this course. But we should remember that, given the fact that, these are extremely costly items. Basically, these construction equipment's, are assets, as far as, the companies are concerned. And, different resources are used, to procure these assets.

And, as far as the companies are concerned, we will talk about it later again. There is a book value. They have to show, the distribution of their assets, the total assets. In what form, they are being held, bank guarantees, term deposits, equipment, and so on and so forth. So, this equipment's also constitute, one of the forms of assets, as far as, construction company is concerned. And, today's discussion in fact, is largely focused on, how the asset value, or how the value of this asset, changes over a period of time.

The productivity, and the total cost incurred, are two of the governing factors, in selecting an equipment. Construction equipment, are not sold in large numbers. And, it may be used, at multiple sites, during its service life. So, these are some of the things, which we have talked about earlier, as well. I am not going to spend, too much time on it.

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**Some important definitions**

**Service life:** The period of use (of the equipment) in operation. In other words, the period elapsed between the event of purchase and event of scrapping.

*This is an 'accounting definition' and not really an engineering or technical definition, as the equipment can continue to be used beyond this period.*

**Initial cost:** The capital investment required to own the equipment, which includes purchase cost, sales tax, transportation cost involved in bringing the equipment to company's storage yard, cost of assembly and installation.

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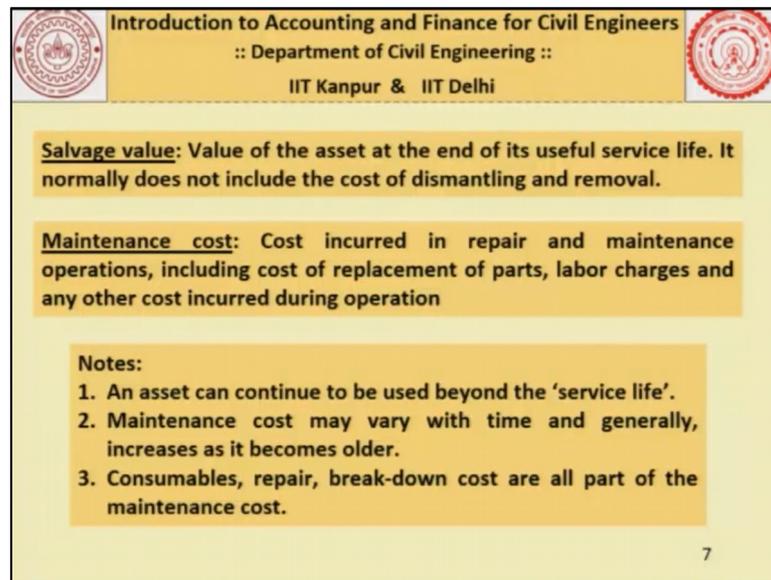
Let us try to come to, some important definitions, formally. Service life. It is the period of use, of the equipment, in operation. In other words, the period elapsed, between the event of purchase, and the event of scrapping. So, purchase, and scrapping, are well defined events, as far as, their occurrence, and the time axis is concerned. There is a specific time, when the equipment has been, purchased, or it has come into operation.

There may be, a small difference between the two, but let us ignore that. There is a specific time, when it becomes operational. And, there is a time, when it has to be scrapped, it can no longer be used. And, this difference in the time, is the service life of this equipment. We should remember that, there is an accounting definition, and there is an operational definition.

So, when we take a service life, in this case, as far as, our discussion today is concerned, we will talk about the accounting definition. That is, we will talk about, that period beyond which, the equipment can be considered to be, as good as scrap. It has already reached its salvage value, as we will define. That does not mean, of course, that the equipment needs to be, physically scrapped. The equipment can continue to be used, even beyond its accounting service life.

Initial cost, that is the capital investment required, to own the equipment, which includes the purchase cost, sales tax, transportation cost involved, in bringing the equipment to the company storage yard, cost of assembling and installation, and so on. So, that basically is the, initial cost of the equipment.

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The slide features a yellow header with two circular logos on either side. The text in the header reads: "Introduction to Accounting and Finance for Civil Engineers :: Department of Civil Engineering :: IIT Kanpur & IIT Delhi". Below the header, there are three yellow text boxes. The first box defines "Salvage value" as the value of the asset at the end of its useful service life, excluding dismantling and removal costs. The second box defines "Maintenance cost" as the cost of repair and maintenance operations, including parts replacement, labor, and other operational costs. The third box, titled "Notes:", lists three points: 1. An asset can be used beyond its service life. 2. Maintenance cost varies with time and generally increases as the asset ages. 3. Consumables, repair, and breakdown costs are all part of the maintenance cost. A small number "7" is located in the bottom right corner of the slide.

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**Salvage value:** Value of the asset at the end of its useful service life. It normally does not include the cost of dismantling and removal.

**Maintenance cost:** Cost incurred in repair and maintenance operations, including cost of replacement of parts, labor charges and any other cost incurred during operation

**Notes:**

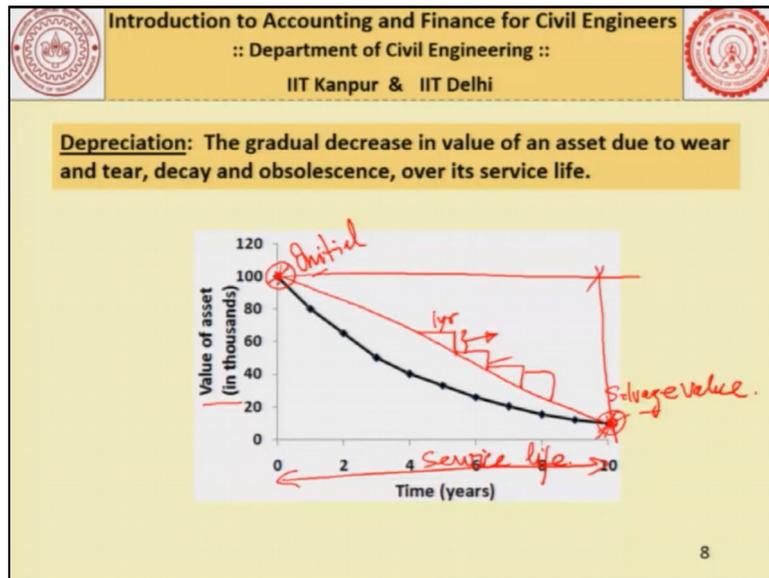
1. An asset can continue to be used beyond the 'service life'.
2. Maintenance cost may vary with time and generally, increases as it becomes older.
3. Consumables, repair, break-down cost are all part of the maintenance cost.

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Continuing further, there is something called, a salvage value. And, it is the value of the asset, at the end of its useful service life. Once again, here we are referring to the, accounting service life. And, it normally does not include, the cost of dismantling and removal. But, that is something, which can always be incorporated, once you want to do that. Then, there is maintenance cost, which means, cost incurred in repair and maintenance operations, including cost of replacement of parts, labour charges, and any other cost, incurred during the operation of that equipment.

Let me caution you, on a couple of points. An asset can continue to be used, beyond its accounting service life, that already we have mentioned. Maintenance cost may vary with time, and generally increases, as the equipment becomes older. And, consumables, repair, breakdown costs, are all, part of the maintenance cost.

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Depreciation is another term, which we use. In fact, that is the title of our discussion, today. That is the gradual decrease, in value of an assets, due to wear and tear, decay, and obsolescence, over its service life. This picture here, represents, how the value of the asset, whether it is in thousands or lakhs, it really does not matter, how it changes, from the initial value, which is plotted here, to a final value, which is what we are calling as the, salvage value.

And, this period here, is really the accounting service life. So, the point basically for our discussion today is, given an initial value, given a salvage value, what is the route that it takes, from that Point-A, to this Point-B. Whether, it is linear, if it is not linear, what are the other methods available to us, is not a matter of, what methods we can invent. There are some standard methods, which are used, as far as the, industry is concerned.

And, that is what we will, seek to introduce to you. As the value changes, from the initial value, to the salvage value, the change that occurs, over a period of 1 year, this is what is called, the depreciation, in the equipment, for that particular year. And, if we add up this depreciation, which is occurring on a year to year basis, we should get obviously, the total depreciation, that we are talking about. In the case of a linear depreciation obviously, all these, individual depreciations annually, would be the same.

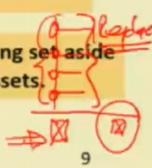
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**If a company has to replace expensive equipment in a given year, it is not advisable to use (all) funds from any (single) year alone!**

- Thus, it is important that funds are set aside every year during its (service) life to facilitate replacement.
- It may be noted that this 'expense' is only technical in nature and the funds are not really transferred out of the system.
- Thus, we can think of an imaginary 'pool' to collect funds for replacing or buying equipment.

In fact, the taxation system allows tax benefits for funds being set aside for procurement of equipment, and, generation of capital assets.


  
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If a company has to replace, expensive equipment in a given year, it is not advisable obviously, to use all the funds, from any single year alone. So, at the end of it, we must remember that, there is a certain revenue, or a receipt, which is taking place, as far as a construction company is concerned. And, whether or not, the decision to purchase an equipment, should be completely supported by the revenues of a particular year, is a very important decision.

Given the nature of the construction equipment, it will not be appropriate to, just use the funds of one single year, for obvious reasons. Therefore, it is important that, funds are set aside every year, during its service life, to facilitate replacement. It may be noted that, this expense is only technical in nature, and the funds are not really transferred out of the system. Thus, we can think in terms of an imaginary pool, to collect funds for replacing, or buying equipment.

Now, replacement of equipment, is only one part of the, total asset procurement. What we are really saying is, that a company may have, certain equipment. Now, this equipment's may have, different service lives, and will need to be replaced. Now, as far as the replacement of these assets, or existing equipment in the company is concerned, this business of trying to set aside funds, while this equipment's are being used, so that, this equipment's can be replaced, is one part of the story.

Another, completely different part of the discussion is, that apart from these existing equipment, how do we fund, an entirely new equipment, at some point in time. Whether, it

happens here, whether it happens here, whatever it is. So, now for that, and as far as my new equipment is concerned, there is sometimes, the taxation systems and policies, which allow or incentivise, procurement of new equipment. And, that is something, which we have alluded to, in the previous discussion. And, I do not think, we will go into that today.

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One way of looking at depreciation could be 'an amount of money set aside every year, so that at the end of the service life, funds will be available to REPLACE that equipment'.

**Notes:**

1. If an equipment is not actually scrapped at the end of the service life, its continuing performance is essentially a BONUS.
2. In the above concept, the idea of inflation – or the change in the cost of the equipment with time, can also be accounted for, with an appropriate modification.

Diagram: A flow from a circle 'P' to a circle 'n' to a circle 'P' with an upward arrow. A bracket below the second 'P' is labeled '(1+I)^n'.

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Coming to summarise this discussion, that we had in principle, one way of looking at depreciation could be, this is an amount of money set aside every year, so that, at the end of the service life, funds will still be available, to replace that equipment. Some of the things, that you should remember, as far as this summary is concerned, if an equipment is not actually scrapped, at the end of the service life, or its accounting service life, its continuing performance, is essentially a bonus.

In the above concept, the idea of inflation, or the change in the cost of equipment with time, can also be accounted for, with an appropriate modification. So, in all the discussion that we will do today, we will essentially stick to the formulation that, if an equipment costs  $P$ , to begin with, has a service life of, let us say,  $N$  years, even when we go to replace this equipment, it will still cost  $P$ . That is, we are really considering the situation, where only a fund of  $P$ , needs to be arranged, at the end of this  $N$  years' period.

And, when I say that, the inflation is not accounted for, that is what it means. That, this  $P$ , is not really  $1.1$  times  $P$ , or whatever it is, which is how, inflation can be accounted for. But, once we understand the principle, that okay, well, so long as you are able to arrange  $P$ , we can

always arrange, 1.1 P, or 1.2 P, or whatever it is, depending on, how we foresee, the changes in the cost of the equipment, is concerned.

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**Models of depreciation**

- Straight line method
- Sum-of-years method
- Declining balance method
- Sinking fund method

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Now, let us come to the models, which are used, as far as, depreciation is concerned. The first and the simplest, is the Straight-Line Method. Then, we have, what is called, the Sum-of-Years Method, the Declining-Balance Method, and the Sinking-Fund Method. So, these four methods are, what we are going to be talking about, in the next few slides.

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**Straight line method**

Cost of the fixed capital is evenly spread over the life of the equipment

Annual depreciation charge in year  $t$ ,  $d_t$  can be expressed as:  $d_t = \frac{P-S}{N}$

where  $P$  is the initial cost &  $S$  is the estimated salvage value after  $N$  years

Book value at year  $t$ ,  $B_t$  is given by:  $B_t = P - \sum_{i=0}^{t-1} d_i$

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As far as, the Straight-Line Method is concerned, it considers that, the cost of the fixed capital is evenly spread, over the entire life of the equipment. What it means is, that the annual depreciation charged in a year T, which is given as DT, can be expressed as P - S upon N, where P is the initial cost, S is the estimated salvage value of the equipment, after N years.

And, this means, that as far as the book value, at year T is concerned, which is given as BT, is nothing but, P minus, the sum of all the depreciation, which has happened till that point in time. Essentially, what we are doing is, we are saying that, we started this value, which is P, we go to S, over N years, and the depreciation every year, is nothing but P - S upon N.

And, the book value, which starts at this point, will be nothing but, this value, minus, all this depreciation, which has taken place, till that point in time. Till such time as, at the end of N years, all this depreciation, has already happened, and we have come to the salvage value of this equipment. So, that is the simplest form of, understanding depreciation, the Straight-Line Method.

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**Sum-of-years method**

**Most of the depreciation associated with an asset is recognized in first few years than at later stages**

**Annual depreciation charge in year t,  $d_t$  is expressed as:**

$$d_t = \frac{N - t + 1}{\sum_{i=1}^N i} * (P - S)$$

**Where P is the initial cost, S is the estimated salvage value after N years**

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Let us try to complicate the matters a little bit, and try to see, how the Sum-of-Years Method works. In this method, most of the depreciation associated with an asset is recognised, in the first few years, and not at the later stages. Meaning thereby, that an annual depreciation charged, in the year T, DT, which is the kind of terminology, which we used in the previous slide as well, is given by this formula.

This formula will become easier to understand, once we see a numerical example. And here also, P is the initial cost, S is the estimated salvage value, after N years. One thing, we must remember that, we start at P, and we land up at S. This total depreciation, does not change. In principle, by and large, this total depreciation has to remain constant. And, that is something, which we must keep at the back of our minds.

Whether or not, this change is linear, whether it is something like this, whether it goes something like this, whichever way it goes, the total change, by and large, in principle, should remain the same. That is something, which we should keep at the back of our mind. But, I am going to violate this principle, in the next method itself, perhaps. But, in principle here, as far as these two methods are concerned, the total depreciation has to be the same.

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**Double declining balance method**

- Depreciation is calculated on the basis of instantaneous book value
- Rate of depreciation is taken as  $2/N$

Annual depreciation charge in year  $t$ ,  $d_t$  can be expressed as:  $d_t = \left(\frac{2}{N}\right) * (B_{t-1})$

Book value of a given year is calculated as:  $B_t = B_{t-1} - d_t$

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Now, let us come to the Double Declining-Balance Method, where the depreciation is calculated, on the basis of the instantaneous book value, and not on the difference between, the book value, and the salvage value, and so on. And, the rate of depreciation, is taken as 2 by N, where N is the service life of the equipment.

And, the annual depreciation charged, in this case, can be expressed as, 2 by N times, the book value of the asset, at the start of that particular year. So, in year T, we take the book value at, T – 1. And, the book value at the end of the year, can be calculated as, the previous book value, minus, obviously the depreciation, which has taken place, in that year.

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**Sinking fund method**

- This method works in terms of sinking fund factor.
- A fixed sum is set aside every year, and taken to be invested throughout the life of the asset (attracts interest), such that the accumulated amount sums to the original purchase price less its salvage value.

$0.302 + 0.302 + 0.302 + \dots + \text{Int} = 1$   
 $i = 10\%$   
 $n = 3$   
 $\frac{0.302}{(1.1)^t}$

$$\text{EPSFDF}(A/F, i, n) = \frac{i}{(1+i)^n - 1}$$

A = depreciation expense  
 F = initial cost – salvage value  
 n = useful life  
 i = annual interest rate

**Equal payment sinking fund deposit factor (EPSFDF)**

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Now, let us come to the Sinking-Fund Method, where a fixed sum is set aside every year, and taken to be invested, throughout the life of the asset. And, it attracts interest, such that, the accumulated amount, totals to the original purchase price, less its salvage value. So, basically, what we are saying is, that the amount of funds, that are set aside, as far as, depreciation expenses are concerned, they attract interest, for the remaining part of the service life. That is something, which would become obvious, and more clear, when we look at an example.

This is something, which we had actually done earlier, in the Equal Payment Sinking Fund Deposit Factor Method, where we said that well, given an F, what should be an annualised A, in a manner that, over a period of N years, if the rate of interest was I, this A should grow to F. So, this is something, which is known to us, by this formula. That is, I divided by  $1 + I$  to the power of  $N - 1$ . So, if we take a pack of the envelope calculation, we will take I to be 10%, and the N to be, let us say, 3 years.

Then, this fact alone, will turn out to be, 0.1 divided by 1.1 to the power of  $3 - 1$ , which will turn out to be, 0.302. So basically, what it means is that, if we want a unit F, that is, this F was to be 1, and year N was 3, the 10% was the rate of interest that is applied, then this is A should just be, 0.302. Effectively, what this meaning is, that this  $0.302 + 0.302 + 0.302 +$  all the interest, that accumulates in this, is what is going to give us, this value of 1, at the end of the service life. So, that is the principle of the Sinking-Fund Method.

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**Illustrative example**

Consider an asset with an initial and salvage values of INR 9 lakhs and INR 70,000, respectively, and a service life of five years. Tabulate changes in the book value of the asset over time using

- Linear depreciation
- Sum of digits method of depreciation
- Double declining balance method of depreciation
- Sinking fund method of depreciation (assume annual compounding interest rate of 10%)

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Now, let us look at an illustrative example, which will probably clarify a few things. Considered, an asset with an initial and salvage values of 9 Lakhs, and 70,000 respectively, and a service life of 5 years. Tabulate the changes, in the book value of the asset over time, using the four methods that you have done, Linear Depreciation, Sum of Digits, Double Declining Balance, and Sinking-Fund Method, assuming an annual compounding rate of 10%.

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**Linear depreciation**

Year (t)	Linear			
	BV <sub>o</sub>	k	d <sub>t</sub>	BV <sub>c</sub>
1	900	1/5	166	734
2	734	1/5	166	568
3	568	1/5	166	402
4	402	1/5	166	236
5	236	1/5	166	70

$$\frac{900 - 70}{5} = 166$$

All values in thousands

BV<sub>o</sub> indicates opening book value  
 k indicates the factor of depreciation  
 d<sub>t</sub> indicates the depreciation in year t  
 BV<sub>c</sub> indicates closing book value

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So basically, what we are doing is, we are starting with 900,000, that is 9 Lakhs, going to a value of 70,000. And, this service life here is, 5 years. So, what is being asked is, that how do we calculate, or what will be the different values of DT, for years 1, 2, 3, 4 and 5, if we were to use the four methods, that we have discussed. Not only the DT, but also the book value associated with it.

And, the book value is obviously nothing but, the original book value, minus, the entire depreciation, which has happened, till that point in time. Now, coming to linear depreciation, which is the Straight-Line Method. If we look at this, we started with 900, we go to 70, what is our K. K is the factor of depreciation. Over a period of 5 years, if 900 is the original value, 70 is the salvage value, and we divide this by 5, what we will get is, 166. That is, 830 here, divided by 5, that is what is giving you, 166.

So, 166 is the constant depreciation, which is happening. 1/5th is coming from the fact that, we have 5 in the denominator, and 1/5th is the total depreciation, any given year. So, if that happens, then the book value is, 900 – 166, which is this much. We bring this value here, start with this, subtract this, we come here, and so on, till at the end of 5 years, we come to the salvage value of 70,000.

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**Sum-of-years method**

Year (t)	SOYD			
	BV <sub>o</sub>	k	d <sub>t</sub>	BV <sub>c</sub>
1	900	5/15	277	623
2	623	4/15	221	402
3	402	3/15	166	236
4	236	2/15	111	125
5	125	1/15	55	70

Sum of years = 5 + 4 + 3 + 2 + 1 = 15

$d_t = \frac{N - t + 1}{\sum_{i=1}^N i} * (P - S)$

BV<sub>o</sub> indicates opening book value  
 k indicates the factor of depreciation  
 d<sub>t</sub> indicates the depreciation in year t  
 BV<sub>c</sub> indicates closing book value

All values in thousands      166

Now, let us try to see, what happens, as far as the, Sum-of-Years Method is concerned. As far as the Sum-of-Years Method is concerned, how it works is that, we add all these here. For this case, we are talking of 5 years of service life, so the sum of years is 15. And, as far as the K is concerned, which is the factor of depreciation, it varies from 5, 4, 3, 2 and 1. And, the depreciation, that is happening in a given year is, 5 by 15.

That is, 5 upon, the sum of years, of the total depreciation that should happen. And, the total depreciation that should happen is, 900 – 70, which is 830. So, this does not change. Now, with this not changing, what will happen is that, in the first year itself, we will have a factor

of 5 by 15, which is 1/3rd. So, we will have, 1/3rd of the total depreciation, which is 277, happening in the, first year itself.

Which means that, the book value at the end of the first year would be, 900 – 277, which is 623. Bring that, 623 here. The next year, the factor becomes, 4 by 15. And, the depreciation for that year reduces, the book value goes here. You continue to do this exercise, till such time, as you get the salvage value to be 70, at the end of year 5. So, we can see from this, as far as the linear depreciation is concerned, it was 166 throughout.

Now, what is happening here is that, instead of this 166 throughout, it is 277, 221, 166, 111, and 55. So basically, the Sum-of-Years Method, is giving you a lot of depreciation, in the initial part, and very little depreciation, as far as, the latter part is concerned. There are advantages in book keeping, as far as this model is concerned. And, that is something, which we will talk about later, perhaps in this course.

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**Double declining balance method**

Year (t)	DDB			
	BV <sub>o</sub>	k	d <sub>t</sub>	BV <sub>c</sub>
1	900	2/5	360	540
2	540	2/5	216	324
3	324	2/5	130	194
4	194	2/5	78	116
5	116	2/5	46	70

**All values in thousands**

$N=5$        $d_t = \left(\frac{2}{N}\right) * (B_{t-1})$       40%

Where N and B are useful life & book value

BV<sub>o</sub> indicates opening book value  
 k indicates the factor of depreciation  
 d<sub>t</sub> indicates the depreciation in year t  
 BV<sub>c</sub> indicates closing book value

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Now, coming to the Double Declining-Balance Method, where we said that, the depreciation that happens, in a given year, is 2 by N times, the book value, not the salvage value, which the book value that we are talking about. And, in that case, what happens in this particular example is that, we start with 900, we have 2/5 as the factor. This 5 is coming from the fact that, my N is equal to 5, in this particular case. And, which means that, we are basically operating, 40% of the initial book value, would be the depreciation for that particular year.

And, if that happens, the depreciation will be, 0.4 times 900, which is 360 here, which will give you this book value. Apply this 0.4, on this 540, and get this depreciation, continue to do this exercise, till you land up with 70. Please remember, that in this case, may be the examples and the numbers were chosen such that, this book value at the end of year 5, is indeed turning out to be, the same as the salvage value, which was originally estimated.

But, in this particular method, that is the Double Declining-Balance Method, since we are actually not considering this 70, or the salvage value in our calculations to begin with, there is a possibility that, this salvage value, and the book value, at the end of the service life, may not match. That is something, which I am leaving to you, to think about it. We will possibly try to do a small example, if we can. And, let us move, forward.

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**Sinking fund method**

Year (t)	Sinking fund				
	BV <sub>o</sub>	A	I <sub>t</sub>	d <sub>t</sub>	BV <sub>c</sub>
1	900	136	0	136	764
2	764	136	13.6	149.6	614.4
3	614.4	136	28.5	164.5	449.8
4	449.8	136	44.9	181.0	268.8
5	268.8	136	63.0	199.1	70

$EPSFDF(A/F, i, n) = \frac{i}{(1+i)^n - 1}$

$F = 900 - 70 = 830$   
 $i = 10\%$  and  $n = 5$

All values in thousands  
 $136 \times 5 + 9\% \rightarrow 830$

**BV<sub>o</sub>** indicates opening book value  
**A** indicates fixed depreciation  
**d<sub>t</sub>** indicates effective depreciation in year t (A+I<sub>t</sub>)  
**I<sub>t</sub>** indicates the accumulated interest in year t  
**BV<sub>c</sub>** indicates closing book value

Yearly interest rate is i for a period of n years  
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Now, coming to the Sinking-Fund Method, here is the example, that we have done. What we have is, that finally we want, 900 – 70, which is 830. So, my F here is, 830. I is given to be 10. N is 5. And therefore, if I use these numbers, I is equal to 10, and N is equal to 5, the factor here will turn out to be, 0.1638. Now, this is the factor that you can, of course in this particular case, you can probably do it with a calculator. But again, you can always go back to the tables, and see this number.

Now, once you have this 0.1638, and given the fact that, 830 is what you need, and not a unit value. Therefore, what will be the A, for 830. It will be, 0.1638 multiplied by 830, which is 136. So, now this 136, is what is your A. That is, if you set aside, all these 136, for a period of 5 years, they will grow to 830. What you effectively saying is that, 136 into 5, plus, the

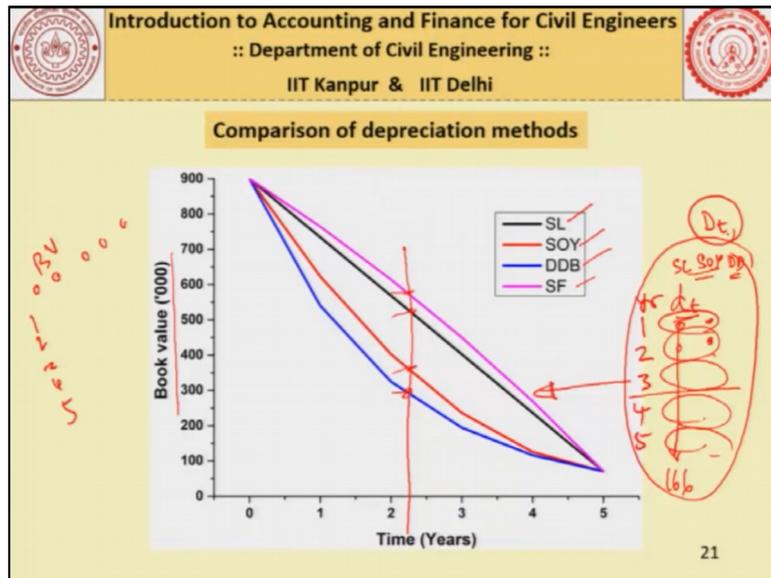
interest that you get, this will be 830. So, that is something, which we need to establish. Now, let us try to understand, how it really works.

So, if we keep removing 136, putting it into a pool, as I called it, there will be an interest associated with it. And, these are the interest values. I am leaving it to you, to calculate those interest values. And, you will find that, at the rate of 10%. Since, this is the value that you set aside, it will attract some interest. And, then again, you set aside 136, that will attract some more interest, and so on. So, if you do that kind of a calculation, this is the book value.

So, what this table really showing you is, that A, that is, this column, is showing you, the fixed depreciation. That is, this value here. And then, I indicate the accumulated interest, in the year T. And, as more and more funds, keep getting transported in to that pool, you see that, the interest is also going up. It is not only going up, by 13.6, and 13.6, but a small amount, which is higher than 13.6. Because, the previous 136, is also attracting interest, for the second year, and the third year, and so on, and so forth.

So, this is the accumulated interest, in the year T. And, this DT, is the effective depreciation, in the year T, which is nothing but, the sum of, this plus this. Now, once you do that, then you get to the book value, which is the, original book value minus the DT. And, once you do that computation, you can always come up with, the final salvage value, or we can calculate the book values, at different points in time.

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If you do this, and then try to plot, the Straight-Line Method, or the Sum-of-Years Method, or the Double Declining, or the Sinking-Fund Methods, and try to plot, how the book value changes. This is what, you will get. What it shows is that, depending on the method that you choose, you may get book values, which are quite different. The other side of the coin is, that you can always create a table, which says that, okay, if I have year 1, 2, 3, 4 and 5, what is the DT.

Which is, the depreciation, for that particular year, using the different methods. That is, using the Straight-Line Method, using the Sum-of-Years Method, using the Double Decline, and so on. So, these numbers, we have already calculated. For example, for the straight line, all across here, we had the number of 166. Similarly, you can write these numbers down, for the Sum-of-Years Method, or the Double Decline Method, and you will see that, the amounts of the depreciation, which is happening in these cases, for different years, is different.

And therefore, so will be the total amount of depreciation, incurred or accounted, for at any point in time. And, this can be coupled, a similar table, instead of the depreciation, can be calculated for the book value. That is, for the different time periods, 1, 2, 3, 4 and 5, what is the book value, using method 1, 2, 3, 4 and 5, whatever the methods are. And, this is what has been, represented to you graphically. This has been left to you, as an assignment. You try to create the table, and understand this picture, a little better.

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- Companies often use Double Declining Balance (DDB) method as the rate of depreciation is very high.
- Sometimes, the book value at the end of the useful life may not be equal to the salvage value that was assumed initially.
- This may result in a situation, where the company may have to pay additional taxes, if the actual salvage value is higher than the initial assumption.

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Now, coming to a more realistic situation, companies often use, the Double Declining-Balance Method, as the rate of depreciation is very high. Sometimes, the book value at the end of the useful life, may not be equal to the salvage value, that was initially assumed. Now, if that happens, there could be situations, as far as taxation is concerned, and the company may have to pay additional taxes.

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**Problem in using DDB method**

Year	Depreciation (DDB)	Book Value
0	-	1000
1	400	600
2	240	360
3	144	216
4	86.4	129.6
5	51.8	77.8 > salvage value

Initial Value = 1000  
 Salvage Value = 0  
 Service Life = 5 years

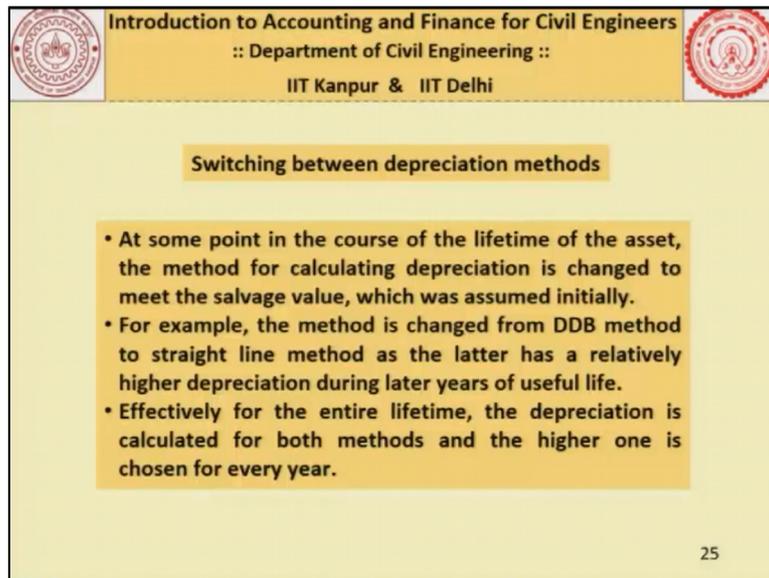
This results in a situation, where the company may have to pay additional taxes, as the actual salvage value is higher than the initial assumption.

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Now, let me explain this, with a small example. That, if we have an initial value of, let us say, 1000, salvage value of zero, service life of 5 years, using the double decline method, what we are saying is that, since it is 5 years, we are talking of  $2/5$ , which is equal to 0.4. So, 0.4 would be the factor, that will operate. And, this will become 400, when we come to this, it will become 240, and so on and so forth if we do that, finally the book value here, is turning out to be, 77.8.

That is,  $129.6 - 51.8$  is,  $77.8$ . This value is not zero. In fact, one thing we should remember is that, if we are using double decline, it will never go to zero. It will always retain, a finite value. And now, how do we handle, this is something, which we will probably have to think. Of course, this results in a situation, where the company may have to pay additional taxes, as the actual salvage value is higher than, the initial assumption.

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**Switching between depreciation methods**

- At some point in the course of the lifetime of the asset, the method for calculating depreciation is changed to meet the salvage value, which was assumed initially.
- For example, the method is changed from DDB method to straight line method as the latter has a relatively higher depreciation during later years of useful life.
- Effectively for the entire lifetime, the depreciation is calculated for both methods and the higher one is chosen for every year.

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Now, as far as the paradox of having different salvage values, at the end of the service life is concerned, that is sometimes resolved using, switching between depreciation methods. Now, what the switching means is that, at some point in the course of the lifetime of the asset, the method for calculating the depreciation is changed, to meet the salvage value, which was initially assumed.

So, this is a matter of working backwards, to some extent, and trying to ensure, that the salvage value initially assumed, is not different from, what is actually obtained, at the end of the service life. For example, the method is changed, from the DDB, to the Straight-Line Method, as the latter has a relatively high depreciation, during the later years of useful life. Effectively, for the entire lifetime, the depreciation is calculated, for both methods. And, the higher one is chosen, for a given year.

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Illustration (continued..)				
Year	Depreciation (DDB) (1)	Depreciation (SL) (2)	Selected Dep. = Maximum(1, 2)	Book Value
0	-	-	-	1000
1	400	200	400	600
2	240	150	240	360
3	144	120	144	216
4	86.4	108	108	108
5	51.8	108	108	0 (= Salvage Value)

P-S  
N

Switching is done in the fourth year

It should be noted that depreciation in a given year for both the methods is to be calculated based on the book value of the preceding year and the remaining service year

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As an illustration, if you do the same example, that you start with 1000, and we want to go to zero, at the end of 5 years. We calculate the depreciation using, DDB as the first method. And, we calculate the depreciation, using the Straight-Line Method. So, as far as the Straight-Line Method is concerned, we will be talking of,  $P - S$  upon  $N$ , that is something, which we had discussed.

Now, as far as this particular example is concerned, what we will do is, once we have this 400, the Straight-Line Method gives me only 200, because that is,  $1000 - 0$  upon 5. We use the higher of the two, which is 400, and the book value becomes 600. Now, on this 600, we operate 40%, and we operate the Straight-Line Method. That is, this number, is not the same as, 200.

So, this is only 150, because it is 600. And, now the remaining service life is, only 4 years. Therefore, 600 divided by 4, gives me 150. Again, we take the maximum of the two, 240, this becomes our book value. Repeat this exercise. This becomes the book value. But, now coming to the 4th year, this gives me only 86.4, whereas this is giving me a 108. So, choose this, and we get a book value of 108. Again, this value is higher than, this here.

Use this value, and we get the salvage value, to be zero. So, this is how we assume, that the book value that we get at the end of the service life, is not different from the salvage value, that we initially assumed. So, as far as this example is concerned, we have switched, from the DDB to Straight Line, in the 4th year. So, depending on the numbers, that are given, the switching could be happening, at different points in time.

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Total depreciation for equipment at site

Consider a site which uses the following equipment for one year

Equipment	Initial value (lakhs)	Salvage value (lakhs)	Service life (years)	Age*
1	100	0	4	3
2	500	50	9	10
3	300	60	6	5

\* : of equipment or the how long ago it was procured

What is the total depreciation due at that site? •  
Carry out the computations using linear and sum of years methods

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Now, as far as, the total equipment depreciation, at a particular site is concerned, the construction site, does not necessarily use, just one equipment. It could use, several equipment. And then, what we have to determine is, what is the kind of equipment cost, that should be charged, as far as, that site is concerned. So, what we should be paying, at least from that particular project, is the total depreciation, that happens for all the equipment, at that site.

Now, if we take an example, if this site uses, let us say, 3 equipment, 1, 2 and 3, which have these initial values, the salvage values, and the service lives are given, and age at which, this equipment's have been made available to the site. Now, this is 3, 10 and 5. And, the question is, what is the total depreciation due, at that site. Carry out the computations, using the Linear and Sum-of-Years Methods. So, the Sum-of-Years Method, or the Linear Method, is a matter of detail.

What we have to really see is, how much is the depreciation, to be charged at that site. Now, what we notice is, that this equipment, and this equipment, are in the last year of their useful service life. The useful service life is, 4 and 6 here, and, they are already 3 years and 5 years old, when they are brought to the site. However, in the case of Equipment-2, the useful service life is 9 years, and it is already past that.

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Equipments 1 & 3 are in their last year of service life, whereas the service life of equipment-2 has been reached before the operating year. Therefore, the performance of equipment-2 is a bonus. Hence, total depreciation in the operating year is given by

**Linear method**       $= \frac{(100 - 0)}{4} + \frac{(300 - 60)}{6} = 65 \text{ lakhs}$

**Sum of year method**

$\left[ \frac{1}{1+2+3+4} \cdot (100 - 0) \right] + \left[ \frac{1}{1+2+3+4+5+6} \cdot (300 - 60) \right] = 21.4 \text{ lakhs}$

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And therefore, as far as depreciation is concerned, we need to calculate, as follows. If it was the linear method, for Equipment-1, Equipment-3, it is 100 - 0 by 4, 300 - 60 by 6, we get a total of 65 Lakhs. As far as, the Sum-of-Years Method is concerned. This numerator is coming to be 1, because it is in the last year of its service life. Similarly, here also, it is 1, because it is in the last year of its service life. Of course, the service life here was, 6 years.

So, if you do this calculation, we find that, the total depreciation due is 21.4, as against 65. Of course, as far as, the Equipment-2 is concerned, its use at the site, is basically a bonus, because the equipment has already served, its service life. Now, so far, we have talked about, a service life. And, the depreciation being, related only to, the service life. Is there any other way, that we can count depreciation, as far as, construction equipment is concerned? Yes. The answer is, yes.

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**Unit-of-production depreciation**

- Sometimes, accounting for depreciation on an asset is more closely related to its use than time.
- The method may be used for construction equipment that had very heavy use in some years, and very light use during other years.

**Unit-of-production depreciation in an year =**  $\frac{\text{Production in the given year}}{\text{Total life - time capacity}} \times (P - S)$

**Where P is the initial cost and S is the estimated salvage value**

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That can be based on the, Unit of Production Method, Unit of Production depreciation, basically, accounts for the fact, that an equipment may not be able to work, beyond a certain point, if it has been used, for a certain amount of work. Basically, sometimes, accounting for depreciation of an asset, is more closely related to its use, than time

And, the method may be used for construction equipment, that has very heavy use, in some years, and very light use, during others. In that case, the Unit of Production depreciation, in any given year, is basically the production in the given year, divided by the total life, minus, the time capacity, into P – S, where P is the initial cost, and S is the estimated salvage value. This will become clear, if we take a simple example.

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**Illustration**

An excavator has an initial cost of INR 20 lakhs, and its useful life ends after excavating 50,000 m<sup>3</sup> of earthwork. The salvage value at that point is estimated to be INR 2 lakhs. What are the yearly depreciation expenses of the equipment in a project, if the construction schedule calls for 8,000 m<sup>3</sup> of excavation as follows:

Year	Estimated excavation (m <sup>3</sup> )
1	3000
2	2000
3	1800
4	1200

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If you talk of an excavator, which has an initial cost of 20 Lakhs, and its useful life ends, after excavating, 50,000 cubic metres of earth work. The salvage value at that point, is estimated to be, 2 Lakhs. And, what are the yearly depreciation expense, of the equipment in a project, if the construction schedule calls for, 8,000 cubic metres of excavation, as given below.

So, we are talking, in terms of excavation, which is up to 8,000 cubic metres, spread over 4 years, and, the useful life is, not in terms of time, but in terms of 50,000 cubic metres. Of course, the initial value, and the salvage values, are given as usual.

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Depreciation cost per unit excavation =  $\frac{(20 - 2) \text{ lakhs}}{50000 \text{ m}^3} = \text{INR } 36 \text{ per m}^3$

Year	Estimated excavation (m <sup>3</sup> )	Depreciation (INR)
1	3000	108000
2	2000	72000
3	1800	64800
4	1200	43200

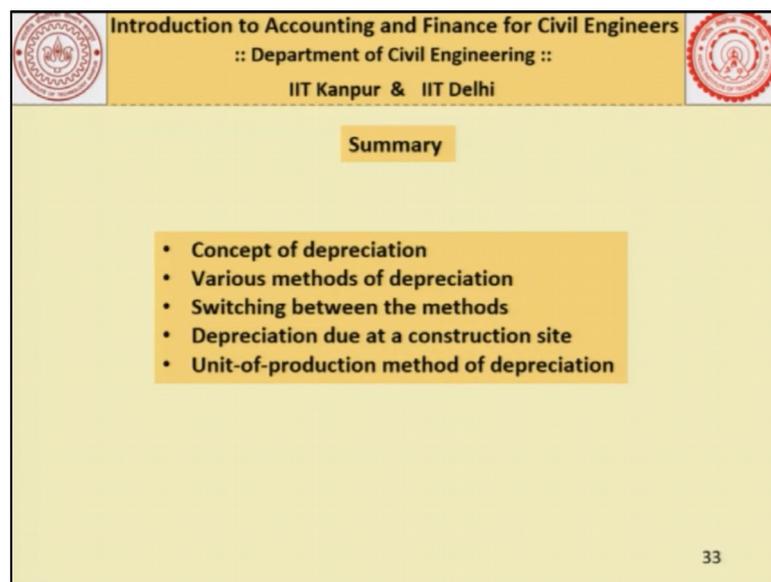
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So, in this kind of a situation, the depreciation cost, per unit of excavation can be taken as, 36 Rupees per cubic metre. Now, if that is taken, then we know that, for these amounts of

excavation, for which this equipment is being used, then we can calculate the depreciation, in terms of INR, for any given year.

So, this is just another alternate method of, trying to understand depreciation, not only in terms of time, but also in terms of the usage. That is, the units for which, the particular equipment has been used. Now, with this, let me come to a summary of, what we have been talking about today.

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Summary

- Concept of depreciation
- Various methods of depreciation
- Switching between the methods
- Depreciation due at a construction site
- Unit-of-production method of depreciation

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We talked of, the concept of depreciation. We talked of, the different methods, that are used, or the morals. We talked of, switching between the different methods. We talked of, how to calculate the total depreciation, due at a construction site, which uses multiple equipment. And, we also had a quick look at the, unit of production method of depreciation, which is slightly different from the, other viewpoint, which is largely related to time. So, in this method, we were trying to talk about, the actual use of this equipment.

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Now, with this, we come to a close of our discussion today. And, this is the list of some of the books, that you might find useful. And, I look forward to seeing you again, in a later lecture. Thank you.