Fire Protection, Services and Maintenance Management of Building
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Lecture – 40
Estimation of repair cycle

So, if you recollect we were looking at estimating you know in related to maintenance management.

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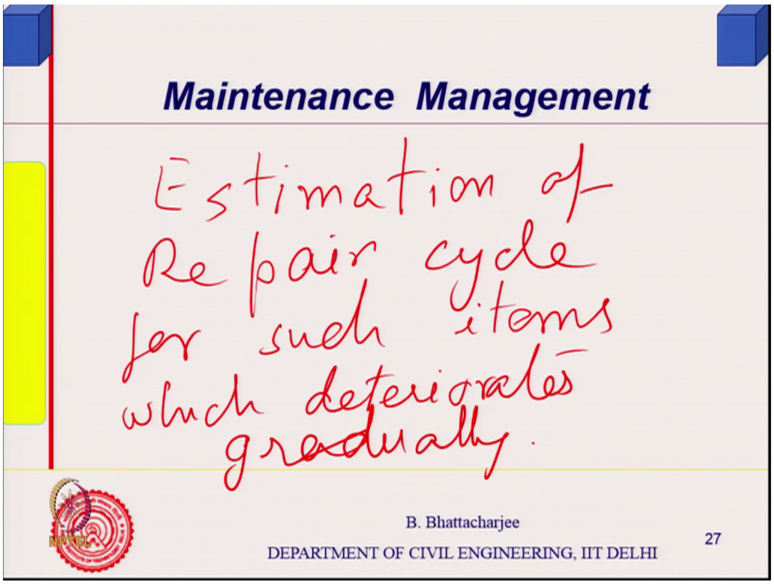

Estimating the repair cycle; estimation of repair cycle for such items or systems you can say which deteriorates gradually. For example, roof covering system; roof covering system you know the roof covering system would be made of tiles quite often in North India or even elsewhere also in the other part of the India also so where you have lime terracing top there is a cover. This top cover deteriorates with time, because it is exposed to rain, thermal cycles, and if it is accessible maybe sometime human activity as well. But that is not much, main is a it gets you know rain and exposed to rain and thermal cycles etcetera, etcetera.

So, in such once basically the deterioration you would see, we talk in terms of 5 early term in maintenance management. Yearly of course, we do yearly budgeting yearly maintenance we will see that kind of you know steps that we will take. But we talk in terms of 5 year, because you will not see the process is so slow it is not very fast it is not like many of the mechanical system where there is lot of wear and tear where you have lot of wear and tear moving parts there you might see much faster. So here it is 5 yearly time term.

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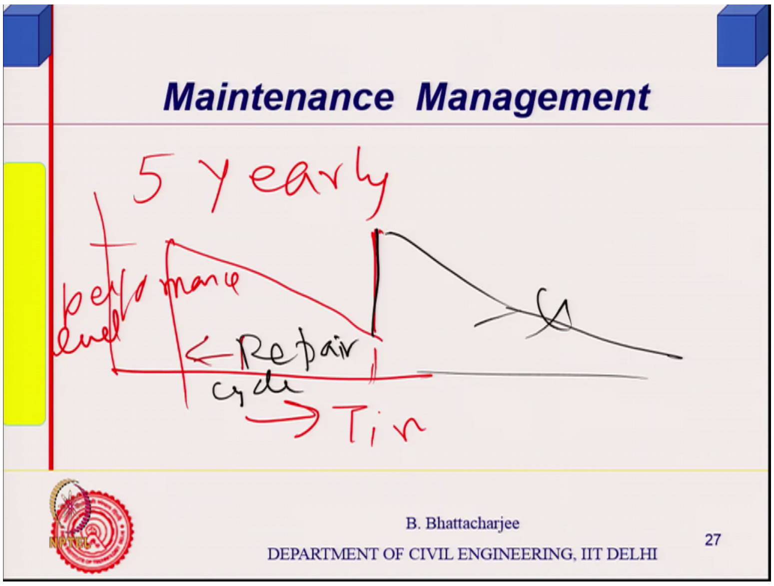

so it deteriorates slowly possible every 5 yearly 5 yearly deteriorates you know we look at and then it deteriorates slowly and when time comes so that that curve if you recall you know its level you know like the performance level; performance level performance level it will come down slowly with time then you store it back to its original state or maybe even better.

If it is better performance level performance level might be with a better material might depends upon we are looking at trying to find out this time repair cycle. So, repair cycle is this is our repair cycle, so this is our repair cycle, this is our repair cycle; repair cycle is this, repair cycle: this is what we are trying to find out. Now you might repair it and might even do it a better manner, so that it actually does not deteriorates so, fast, but at the moment we are not interested in this part of it, all that we want to find out is repair cycle.

If I had a mathematical model available, if I knew the rate of deterioration it think should have been much easier. Supposing I knew that rate (Refer Time: 03:50), but then is this kind of system which is actually system not even individual material. So there, is a there is a problem, problem in the sense that it has to be based on your observation and empirically you have to find out.

So, you have to collect data or record the data. That is why it is very important in building maintenance management estate maintenance management one is to keep the data, when you have done what.

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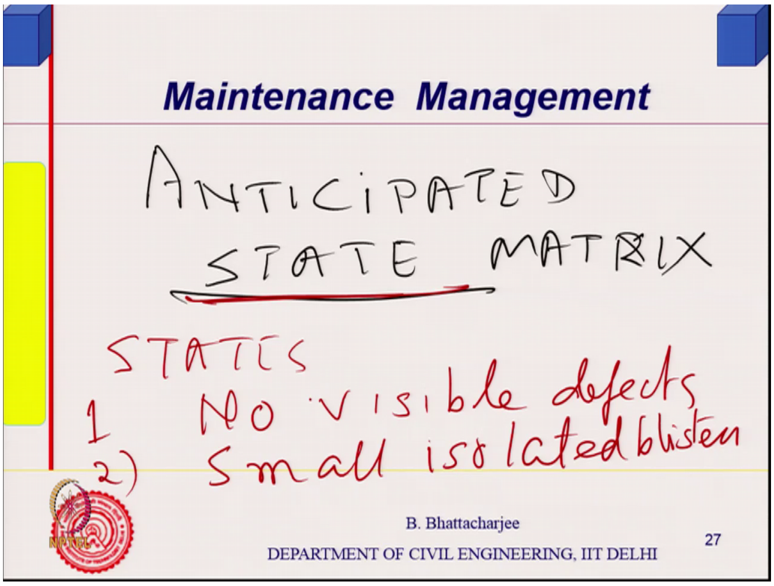

So, we define something called anticipated state matrix if you remember we talked about that: anticipated state matrix or state matrix that is what we tried to find out state matrix. And this will also come from first data. Therefore, first you should define the state; first you define the first you should define the state itself; state itself first you should define the state itself state. So, first state you know you can even give a code to it number to it.

For example states and its description right, so this is anticipated actually state if I may say. So, number 1 states if I say number 1 it is you know designation or its identification number no visible defect. 2, as I was mentioning in the last class small isolated blisters etcetera. You know large area covered under blisters and then maybe something cascading effect right, lot of water seepage marks inside, etcetera, etcetera.

So you can define the states in this manner, now I did not go into further because it will vary from element to element. For let us say the same thing I can do for possibly a flooring industrial flooring right or places where I like to have possibly there will be some spillover something of that kind.

So, what you will find is there might you one small patch of floor has gone after some time the seconds no visible defects then there is isolated you know isolated exposure of the lower course the top has gone and then large area they extent that also we can talk about. So, this is how you can define the states in various cases. The example that we are taking is of roof covering. Now simultaneously what you know to also remedial action required and cost.

So, in the same table you might then say no visible defect remedial action nil, cost is 0. So, small isolated location even still you can say remedial action nil and the cost is 0. But then, this is now over some larger area extent is slightly more you might cover the extent also here, of course one of the ways is doing it in more elaborate way the defect state the defect then extent large small etcetera also you can quantify that is that is you know more detail.

Somewhere I might show you later on related to condition assessment of structural system I might tell you about the same also. So, states are there and their remedial action and cost involved that you might talk about. So if you look at this is an example of a roof covering system.

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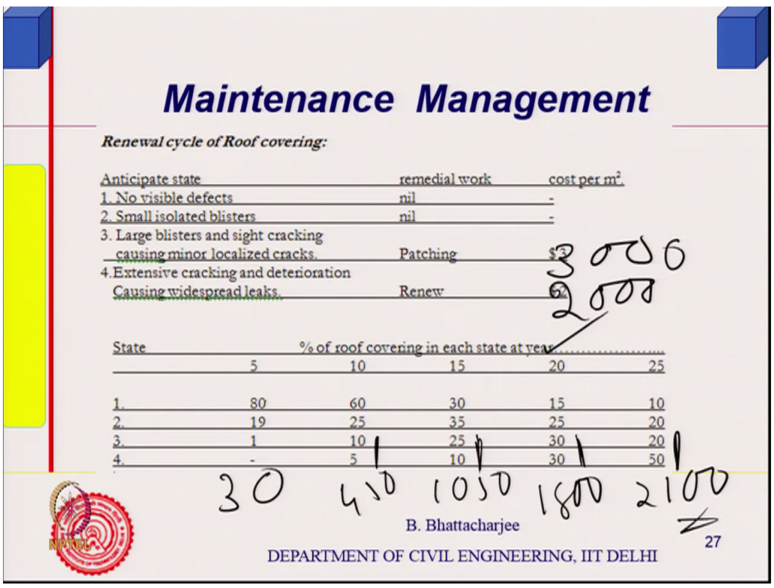

Anticipated state 1 no visible defects remedial action cost per meter square 0 you know then second one again some isolated blister, large blisters cost is there patching cost. So, if there are large blisters, but it is only in some places you might do what is called patch repair those area. Now, I will give an example of its easy to give an example of IIT estates if you look at it; construction would have gone in by stages. So, you know let us say let us say residential areas or hostels, hostels would be better because some you might be.

Now, if you look at the boys hostel particularly you will find Shivalik Vindhyachal they look similar they would come out at together. Then there are 5 more hostels starting form Jwalamukhi to Nilgiri they all look similar therefore, they are clubbed in one group they would have come up in the same time and when I look at the roof covering system, I take all of these areas survey all of them and then large blisters in many one of them; right in all the all the roofs. And if you see the residential you will find many two storey building came at that point of time; in the east campus and sometime later on in 78 there are number of them came into west campus as well number similar.

So, we can group all this similar type of houses together in one go. And then what we are saying is we record obviously, and if past record is available then we say isolated blisters in one building little another building little. So, you do what you do patch repair, because this little the cost then patch repair, but if it is a large scale then you have to remove it. You know if it is also resulted in some sort of exposure of the lower level lot of lot of rain penetration is occurring then you have to do in all in one go.

So, cost for each one would be recorded also, also would be known. Now the point that I want to make here is that you know related to the cost part of it.

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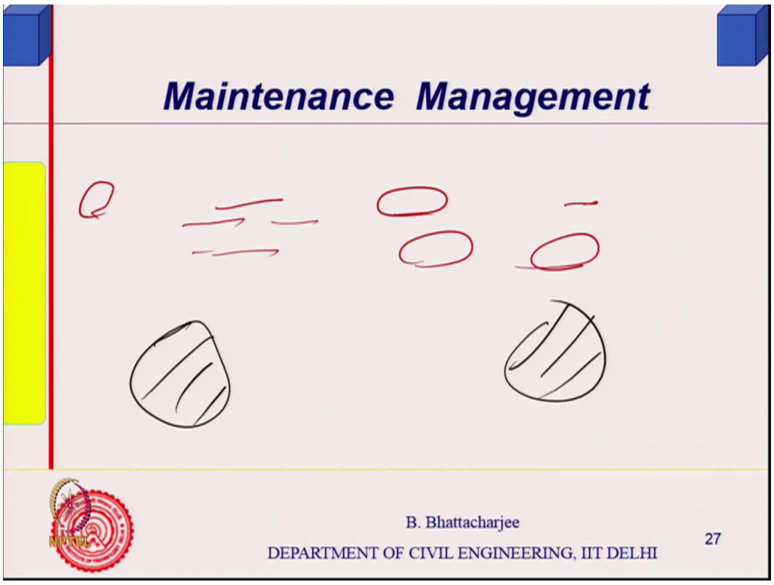

When you do one patch repair small area; when you do for small areas; small areas you do it for you know smaller areas you do it patch. So, every time you will have the people will come if it is a roof covering people will have to go to the roof, if there is an excess available fine otherwise ladder and such system bring their whole thing, maybe they are going to put in some kind of a some sort of specific you know finishing layer or replace the tiles.

So, every building they will be setting up and even if it is the same contractor goes from one building to the another, to another and so one so forth. That is you know and then there is a little bit of work can comes back which means that wastage of plenty of wastage of time and they will be charging every time for setting up the thing and this year you do it next year you do a little bit of patch repair. So, these costs are usually patch repair costs are usually higher per unit area right. But if you do give the contract in one go to a you know agency so you do the whole floor I mean hold roof or maybe all six roofs six hostels then it will turn out to be per unit area wise it will turn out to be cheaper that is the philosophy.

So, if you plan it properly you can actually do all of them in one go. And that is what we are trying to find out what is the repair cycle, if you have constructed x you know like 19 let us say 1970, and I know the life is 25 years. So, 1995 to 2000 I should have done all the in one go, if I can find the life; let us see how do we find the life.

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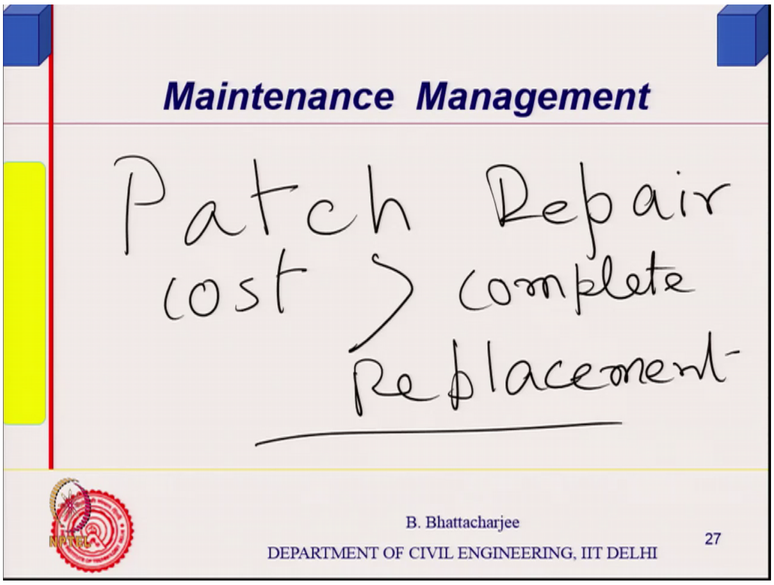

So, philosophy is that patch repair cost, spelling wrong; cost is higher than replacement; complete replacement right. So, you are anticipated state matrix now will have time on one side right an; I mean you know rows will be for time. And first column will be the state's; first column will be the states and each time how much percentage of the area is seen in that state that that is what would be. So this is the philosophy; and let us see how we arrive at this.

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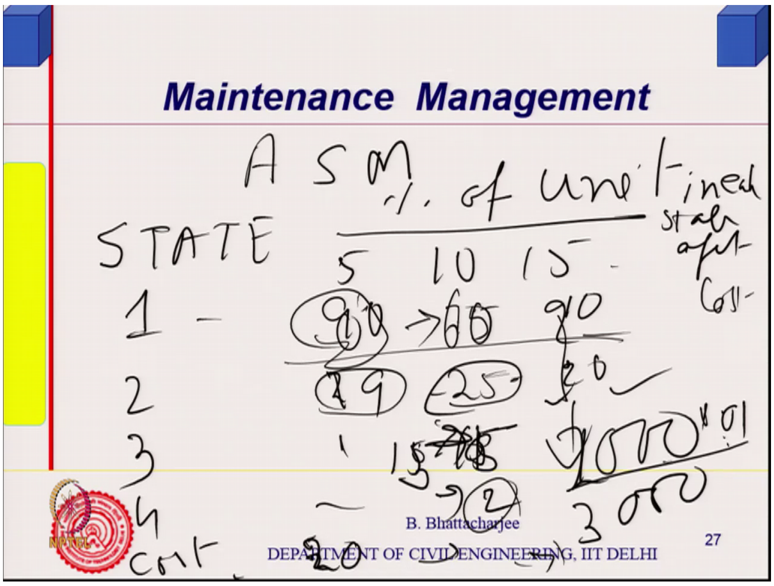

So, my anticipated state matrix let me call it like this I do it like the state 1 2 3 4 etcetera, I have defined now I have defined the states now. And then this is a percentage of area or unit I can say percentage of area or unit in each state after 5 years, 10 years, 15 years, etcetera, etcetera. So, after 5 years maybe 90 percent or 80 percent will be in state 1 right 80 percent maybe 20 or 20 you know 19-18 percent in state 2 maybe 1 percent might show its in state 3 just is an example, but this record has to be kept.

So, if this is kept let us say not in one agency, but many places this will help you in modelling right. If it is not available at the moment and you are starting for the first time not records are available good guess works can also be done actually or experience of people can be, so it can be utilized. So, then they will be (Refer Time: 14:00). Similarly 10 years this will now reduced this might reduced to 75, because state 1 is no visible or 70 or 60 maybe, this will this might increase to maybe 25, this will definitely increase there will be there will be increased this, this will be little bit of increase in fourth state also.

And as you go further, so then you find out the cost implication, here the cost is 0 first case 5 years every you know their cost implication after first five, so you have a cost at the bottom. And the cost implication you find out cost will be practical you will not be any cost involved 5 years, because this remedial measure for this is nil even this is nil; at most you will have 1 percent of the cost.

So, what you can do is you can actually find out what is the cost implication, because it will be if the cost is given as let us say just for the sake of it 1000 rupees for the; I am just taking it you know 1000 rupees per square metre or maybe 2000 rupees per square metre for complete replacement, cost for patch work might be around 3000 rupees right cost of this will be around 3000 rupees.

So, what you do here you will do patchwork of 1 percent so multiplied this by 0.01. So, cost here after 5 years will be you know 1 percent I said so 10 no 20 per metre square cost; per metre square approximately per meters you know like the total cost overall on an average, because 2000 rupees per metre square plus only 1 percent will be affected. So, as if my effective 20 into the total area so total area I am not taking into account so 20.

Next year, this will increase and next year next 5 years 15 years it will still increase. A time will come supposing this as now going to 60 years so 25 years and maybe you know 5 year. So, how much does it make; 25 30 another you know 5 or 10 no 15 just let me for the sake of understanding let me put here 16 25 15 or you know maybe because probability state we will see that probability part of it let me take it as 12 or 13; 13 and 2 here, because some small area might show even significant distress.

So the cost then would be to a you know 35, because this also I will do patch repair only 2 percent is in real bad shape I will still go and do the patch repair, so this should be how much 25 40 percent. So, 40 into now 20 40 percent this was only 1 percent here 40 into sorry this is now 15, 15 into 20; because this also no remedial action 15 into 20 would be now 10 to 100 300 rupees; 300 rupees right.

So, the when this becomes 10 percent or something somewhere or 20 percent this is another 20 percent and this become 60 percent; the cost of this one will go to how much 2000 into.

Student: 60 divided by 100.

Which means 0.6 so 0.6 into how much it will become 3000; sorry I multiplying the wrong one 3000 rupees. So, this first one would have been 30 this is the replacement cost this is the patch cost which is higher. So, 3000 into 1 percent first 5 years 30 rupees when it is 15 percent it goes to 450 rupees, if it goes to 60 percent then it will go to 180 rupees and if it goes to 70 percent this is 2000 not sorry 60 percent means 1800; 1800 and 17 percent means 2100. So, when it goes you know 2100 it is not worthwhile to do this patch repair you should actually do complete replacement.

So, you study this data and when you find that your patch repair cost is same or more then the replacement cost you replace, the whole thing even something good that also will get replace. Because, if you do patch repair next 5 year later those one which you have not done repair they will actually become bad.

So, you replace them in one go that is the philosophy that is how we find out what is the deterioration level right. In structural system we will see its slightly different. Structural systems acceptable it is important serviceability limits. You know it cost is an issue, but more importantly even if the you know cost maybe slightly higher or you know cost is secondary first suppose in there is a crack people will not accept it people will not feel safe. So, serviceability limit comes into picture, here we do it in this kind of economic way.

So, now I can look into the slide that I had it is the same thing, but since it is not clearly; you can look at it when you have this slides you can see. So, this I was saying 3000 rupees this I was saying as 2000 rupees right. So, if you see the cost implications then you can see this will have 80 19 1; you know at best you will do some sort of 1 into 3000 will be 30 rupees.

Student: 1 percentage

So 1 divided by 100. So 30 rupees only if you come to this you find 15; 15 into this 450.

Student: Further we are going to add the 2.

No.

Student: Only for.

No but 10 plus 5 even the state 4 also you would need patching; state 4 is localised; state 4 is bad condition, but is localised at the moment ok. So, I will still do patching only when it comes to 35 35 into 3000 is how much, 35 into 3000.

Student: 10.

1050 right, 1050 and then 60 into 3000 is 1800 and 70 into 3000 2100 obviously, I had say that I will do it because next year if you do it will be costlier than 2000. So, do not wait for that because 70 percent has gone in not acceptable states really. So here itself you do the complete renewal of all the buildings total area that is under you. So, you know like as giving the examples of those hostel similar looking hostels from Jwalamukhi to Nilgiri.

Now, it will at different locations when I am looking at even bad condition this will be at different locations not in 1 hostel every hostel will not have 30 percent its not be uniform they will be at different location. Therefore, if it is less still I will do patchwork you know do an extensive repair work, but patch work cost would be similar sort of. But when it is out of those 6 hostels 6 or 6 or 6 7 hostels 6 hostels total about 30 percent area requires extensive repair, and another 30 percent requires somewhat removal of the tiles and things like that I would rather go for doing everything in one go. So, that is the kind of approach, so my life then I decided that it will be 20 years of life for this one right.

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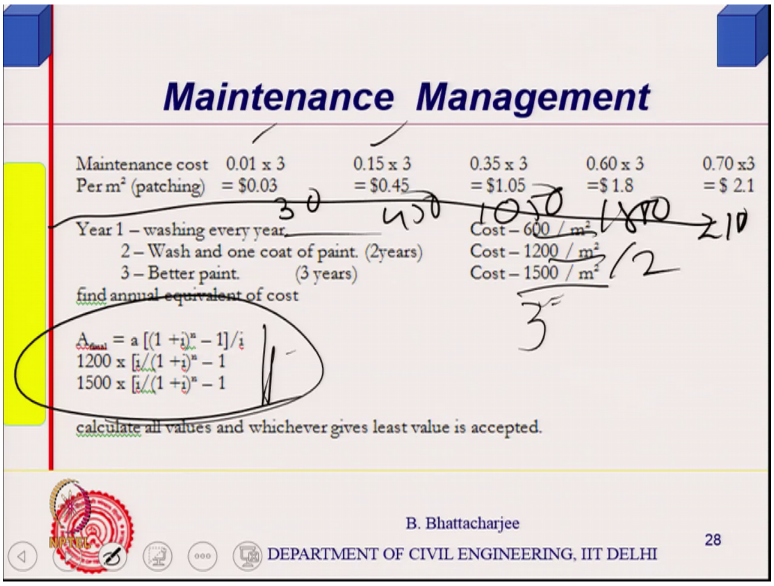

So, the costing is done in the next one, costing is done in the next one; you know this is what I have already done it. So, per metre square cost you can find out this will come as 2100, this comes as 1800, this come as 1050, this comes as 450, this comes as 30 you know this already I have done.

Student: Why are we can at the end of 25 years?

Yeah.

Student: Then we can do the replacement why are we.

No, but actually with 60 in between I am not very sure in between actually you know already 60 percent is gone to such a state I will do one earlier. You know 1800 I could have done 1800 possibly, but then I have to do somewhere in between if I have do match it 2000 case know. So, possibly a better judgemental decision will be why leave 60 percent in bad state replace everything out you know it is judgemental essentially. So, it will little we are doing slightly earlier then it exceeds 2000 alright.

Now, there could be other kind of situations where you have say external painting. Now you see the external painting let us say another case of external painting let me call it. The external painting let us do let me look it external painting let me look at it external painting scenario where did it go, right. So, external painting scenario let us say now you see from architectural requirement generally I as I mention, if the constructions are done at different time particularly of larger areas, group of areas, groups of buildings. Depending upon type of you know occupancy say if it is residential then I will be talking in terms of neighbourhood right, because which we mentioned earlier neighbourhood actually.

If it is let us say hospital it has got a functional use there are different components for some of the lager hostel like all India institute of medical sciences. Delhi if you see it, you will find it has got different departments or units if I may call them which are buildings actually. So, that everyone has got you know OPD has got its own function, the operation theatre building has got its own function, the wards have their own function, so it is a complex sort of thing.

Now what happens is when it is planned planning is done in a given way and if it is done in a very systematic way traffic movement would be minimized, the look aesthetic part and then functional issues. For example, OPD should be close to the external you know road. So, that entry is straight away emergency OPD is there you know that kind of things so interfacing or interrelationship between different spaces are taken into account right.

And this can be modelled sometime I might have mentioned even mathematically you can minimise the traffic flow and you know implication cost implication are normal. Now, look wise generally there is a philosophy; look wise there is a philosophy. So you would not like to change the look, because unless you understand that philosophy and deliberately knowing that philosophy you do it. During a external painting just for the sake of painting is not the best thing to do, because it is looking ugly paint something whatever you feel like that is not right. Right thing would be understand the philosophy that the initial architecture is because as they grow old 10 to 12 go towards heritage.

Today Lutyens Delhi which is about 100 you know at best 100 plus 1000 20 years old even not 100, because capital was shifted in 1911 and they started building those things later on 1930 mainly would have come. But today you call them heritage building you do not want to change then you want to keep that legacy the culture, the history, because you know it tells us also it educates us first educates us basic legers idea. So, that is to be kept, so something becomes heritage so therefore, one would not like to change things.

Now if you want to maintain the same one simple washing might be a good job do washing. So, one of your options could be wash it every year, so that dirt does not accumulate, but it will depend upon climatic situation; dust you know whether you know industrial I mean microclimate as well because industrial pollution come and making it dirty etcetera, etcetera there are issued like that.

So, one options could be simply washing. There could be a second option depending upon the situation you only 2 yearly you do something do not do yearly washing 2 yearly you do possibly some coating; washing and coating maybe or maybe there is an option do it 3 yearly. Now, but they keep the philosophy same architectural look same everything same that is the fundamental requirement or functional requirement that should remain same. Now if you have such options then you have to find out the cost of each one. So, cost of doing yearly obviously, let us say is something again let us put it as you know some values some values I can put in. Now, if you cost it 2 yearly the cost will increase, but then you have to increase proportionally right.

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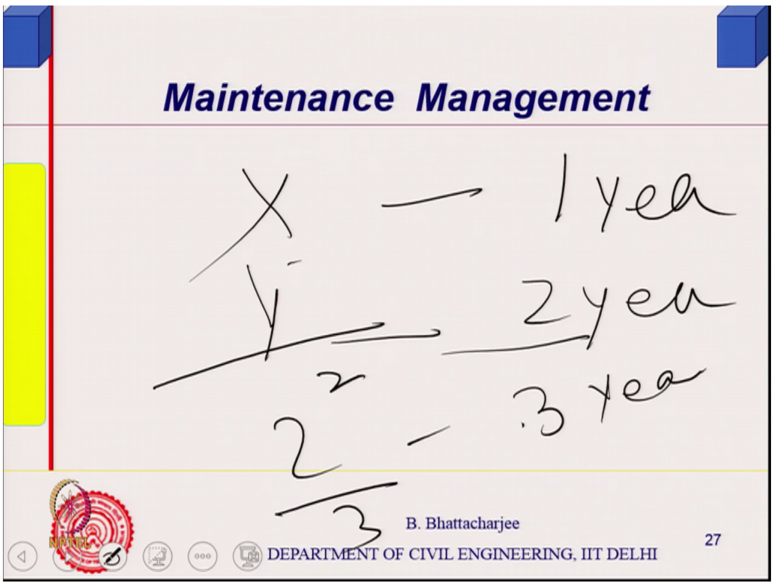

So, if it is x y this is 1 year cost, y 2 yearly cost and z maybe 3 yearly or 5 yearly whatever it is. So what I will do; I one way is to simply find out average cost and whichever is least you choose that. Because this you will do every 3 year this you will be doing this you will be doing every 2 years and this you will be doing every 1 year.

So, this is you know a simple model, but a slightly complicated not complicated slightly more realistic one can think of think it bring in time value of money right, as I said you know time value of money means engineering economy. So, as I said that your simple average is possible, but time value of money means 100 rupees today.

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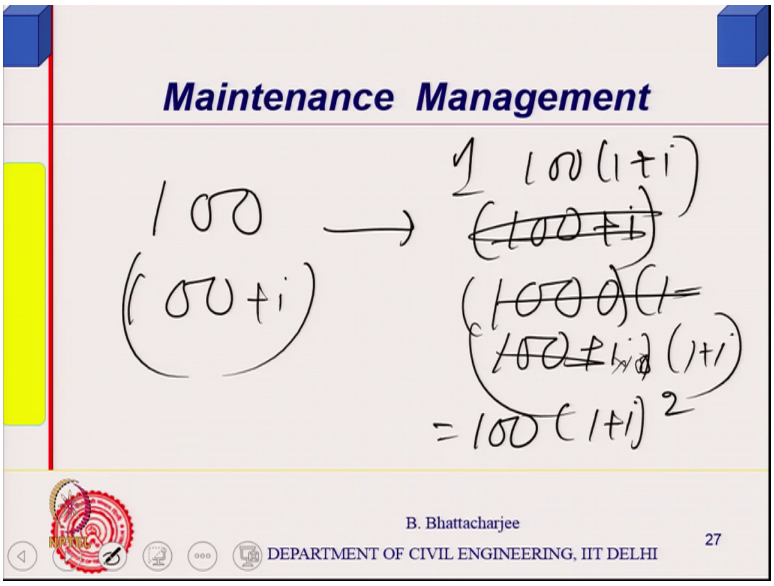

After 1 year it will be 100 plus i if the interest rate is i and 100 plus i, today will become 100 plus i into 1 plus i again 100 sorry 100 100 plus i into 1 plus i again right. So, this becomes 100 into 1 plus i square so 3 years. Therefore, the money that you are spending after 3 years is effectively actually less today.

Student: Sir, you will get 100 plus 100 out.

100 plus.

Student: 100 of i of 100.

I of 100 i, i of 100 i of 100 that is right; i mean basically it will be 100 plus 100 into 1 plus i 100 into 1 plus i that is what simple writing and this is 100 into 1 plus i square and so on and so forth. So therefore, because even if I put it to the bank straight away 4.5 percent savings account they will give me interest.

So therefore, I should value the money that might because they will invest somewhere get the return much higher than that and bank issue savings account even. So therefore, I must value by at some interest rate and it is compounding interest is done, and there in engineering economic situation we account do the accounting at the end of the year financial year. So, you sum of all the money that you spend of the whole year or received and put it at the end of year so we talk in terms of EOY; at the end of year right.

So, if I take that into account the money that has been spent 3 years later money that has been spent 3 years later current present value of that money would be simply you know 3 years later I have spend that money.

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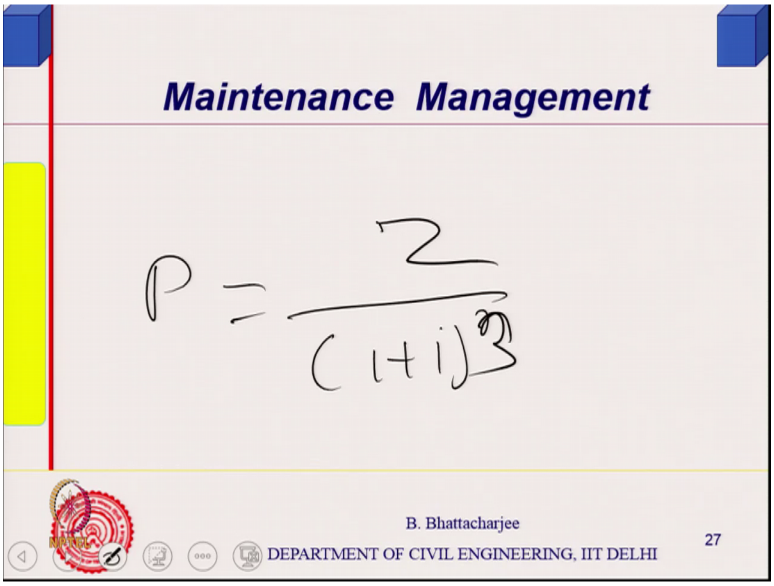

So, I was saying the z divided by 1 plus i to the power 3 in this case n equals to 3 number of years is 3. So, I can compare the present value of each of them and whichever is least that I should be choosing this is one way of comparing. There is another way of the same one I will just little bit quickly not going into the engineering economics part of it, but engineering economics should be brought in actually here.

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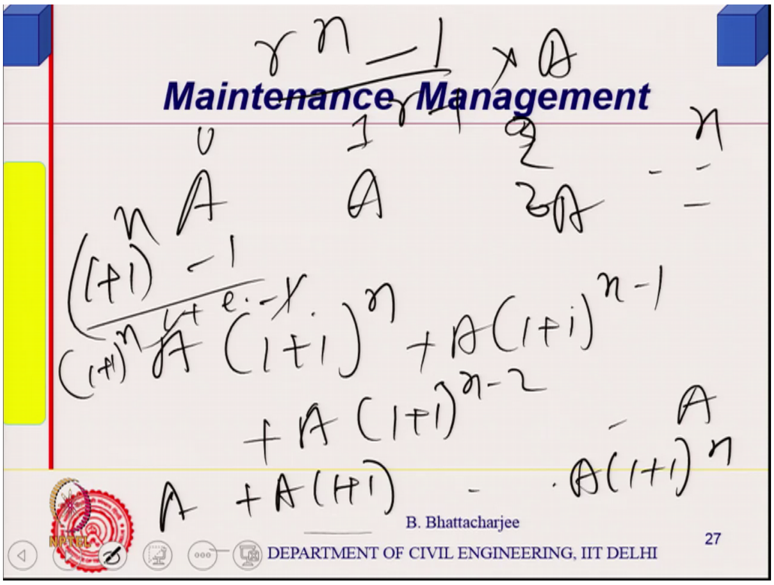

Supposing just for the sake of understanding, supposing I spend A or deposit A in the bank, now and then deposit again A after 1 year 0 1 1 2 you know 2 3 A A A for n years what will be its feature sum or present sum that I can find out. Since it is n year right now I have put in A it will become future sum will 1 plus i to the power n this will become A into 1 plus i to the power n minus 1, next one will be A into 1 plus i to the power n minus 2 and last one will be A only A.

So, you can see it is a GP series this is geometrical progression series I mean if I write it in the reverse order A plus A into 1 plus i etcetera, etcetera last one will be A plus 1 plus i to the power right. So, there is 0 1 2 n plus one terms actually in this case n plus 1 term right or if you know whichever way.

So, actually you can find out the GP series right geometrical progression series. So, is basically A into r to the power n minus 1 the common ratio divided by r you know r minus 1 if r is the r is the common ratio. So, common ratio here is 1 plus i to the power 1 plus i common ratio is here 1 plus i right. So, common ratio here is 1 plus i to i and so it is r to the power n minus 1 divided by r minus 1 into A remember that right its fine GP series. So, 1 plus i to the power n minus 1 divided by 1 plus i minus 1, so it will become i so future sum is this and its present one if I want to find out divided this by 1 plus i to the power n.

So, if I spend A A A A for you know right now or after first year I have started let us say up to n minus 1 n you know n minus oneth n terms total n terms starting from 0. I can find out what is called present worth of an equal payment series ever year you are paying same you must be doing it in high your projects as well or you know building construction management of course, you will be doing. So, one can actually resort to this sort of engineering economics calculation to find out the present worth future sum or if you know the present worth, what we call capital recovery you can find out every year how much or what is called sinking fund factor how much I should put in. So, that I get future so much this is all you can find out by doing a little bit of manipulation; I am not going to details of this.

But one can take that sort of situation into account. So then you can find out say for example, one wash in 600 rupees 1200 1500 rupees you simply divided by 3 this comes 5 if you divide by 2 this comes 600 same; so this is will be the best option if 3 yearly I do and if the cost is 1500 rupees per meter square you know just hypothetical sample that I have taken divide by 3 comes 500. And if take time value of money obviously, if you spend later its effect now, is less because 1 plus i to the power n it will only favour spending later if we take interest straight into account it will. So, present worth you can find out and this is you can compare and whichever gives you best you can choose.

So, this is another way of finding out the periodicity. Let us say of external painting or internal painting or something of that kind if you have options available alternative selection of alternatives.