Fire Protection, Services and Maintenance Management of Building
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Lecture – 42
Lamp replacement

So, if we continue with that, you know then mortality curve for lamps looks something like this.

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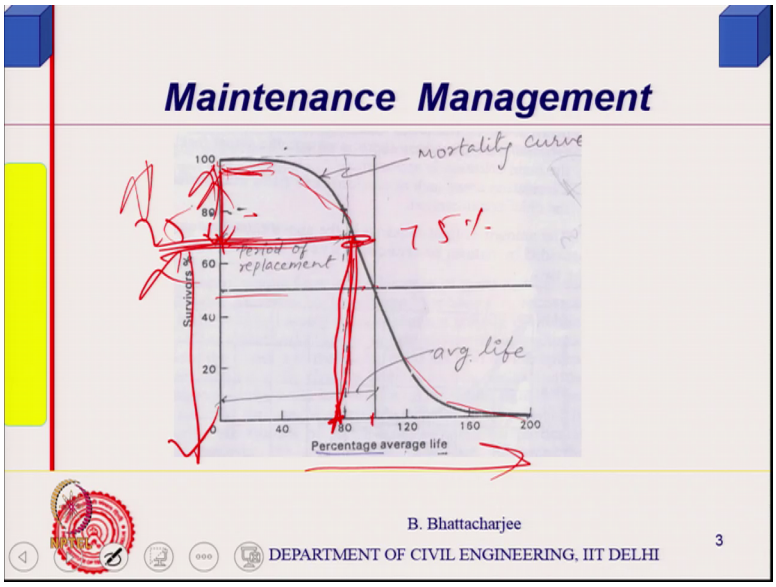

We plot percentage of the sorry we plot percentage average life and this side percentage survivor. So, these are you know manufacturers find out from their tests experiments and all that. So, at the moment, first the starting point you will have 100 percent life. Then, as the time passes, average life is defined as that time when survivor is 50 percent right, 50 percent is survivor, 50 percent is failed, 50 percent is survivor 50 percent has failed.

So, typically the curve is something like this. Initially, the failure rate is very slow. Then, suddenly the failure rate increases and once it increases, then you know it goes at a very fast rate. Because, this slope you can see if and then again last at the end, few lamps will last for longer period of time you know. So, is complementary S curve actually 100 percent surviving in the beginning slowly, there is a failure and then rate increases and suddenly of lamp starts many lamps starts failing, but few lamps will survive for very long period of time right.

Basically, cumulative you know distribution related to that kind of scenarios involved you know one complementary S curve. So, we will define the average live as life is that one where 50 percent of the lamps are surviving. Now, then one can find out what is economical do. I wait for every lamp to fail and then replace as and when they fail or I do a bulk replacement at some point of time when you have large number of lamps, you know I can do a bulk replacement when large I have large number of lamps right and that might turn out to be cheaper, that might turn out to be cheaper.

Why because, when you do a repair as and when it fails, the cost is higher every time you have to you know the time is lot of time is wasted, every time you have to call the people engaged in repair work. They will set up do the repair and then again go away. So, the time spent per lamp is much higher. So, therefore, cost is higher. Now, one part is the constable lamp itself other is a labour cost. So, labour cost is usually higher cost of the lamp will remain same since something similar which I said about the roof covering repair.

So, essentially the cost will be same. So, let us see. So, we call it spot replacement or bulk replacement spot replacement or bulk replacement. So, spot replacement is that when I am replacing whenever there is a failure.

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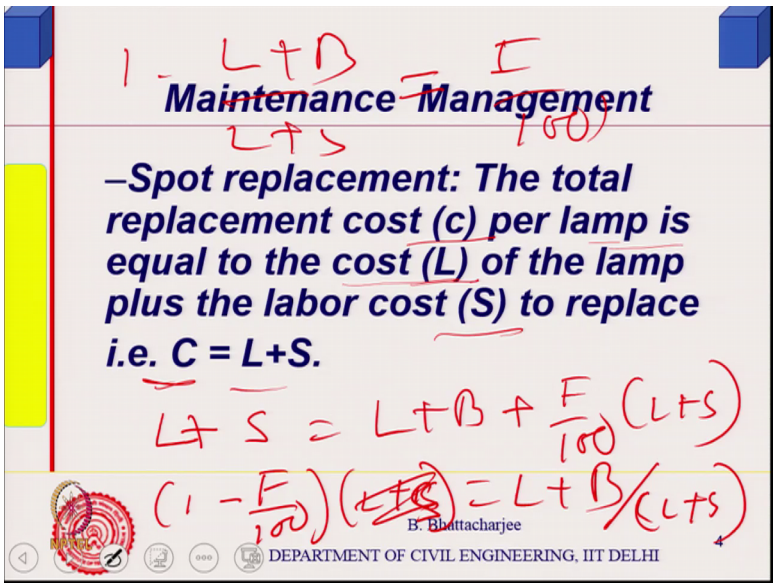

So, the total replacement cost will be C per lamp. Let us say cost of lamp is C and you know cost total cost C lamp is equals to cost of the lamp and cost of spot replacement

right. So, C is the total cost which is L plus S; L is the cost of the single lamp, S is the spot replacement cost you know, essentially labour whatever it is if you have bulk replacement cost, then the objective is to avoid the costly random. You know, use of labour force involved in replacing lamps individually that is the idea because, randomly if you call them, labour cost is higher.

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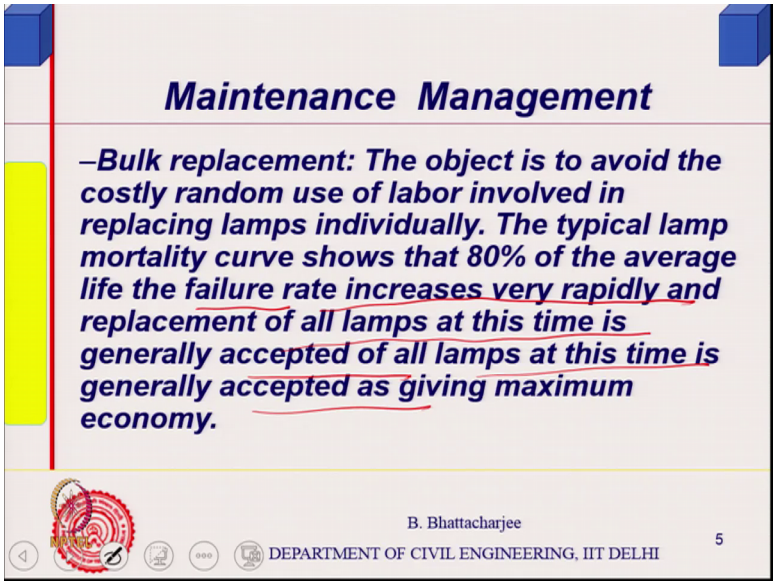

So, mortality curve would show that after 80 percent average life you know the average failure rate increases very rapidly. That is what as mentioning and you know it is possibly generally accepted that all lamp at this time generally you know maximum if I want to find out the economy possibility 80 or 75 percent of the survivor when there is a maybe I replaced all of them, let us see how it is.

So, we define as I said spot replacement C is spot replacement C is equals to L plus S. Now, what about the bulk replacement? This will be also L plus per lamp. This is per lamp you know, this is S per lamp and this a per lamp.

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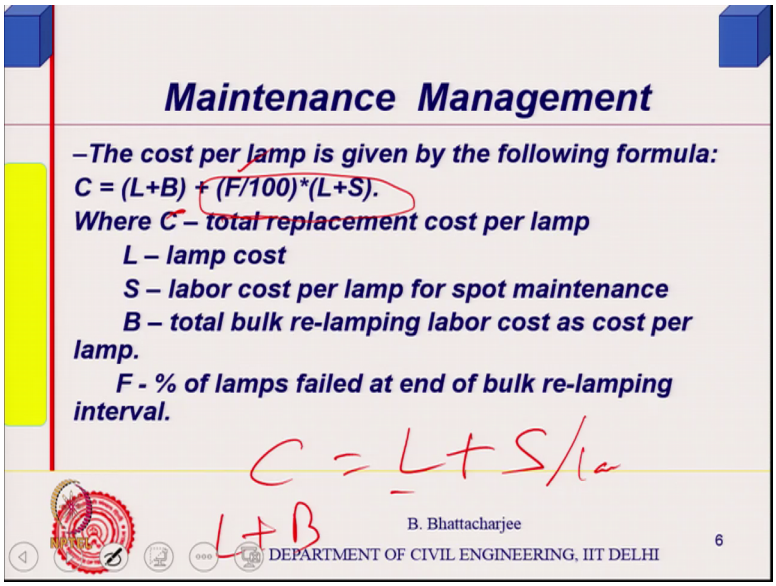

Similarly, cost for bulk replacement cost would be L plus B because B is the bulk replacement cost per lamp which will be smaller than S which will be smaller than S because, now set up cost etcetera is single time somebody come some you know some agency comes starts from one end and just replaces them but, this one thing happening because I will not bulk replacement. I do that certain periodicity. So, then part of them part of them part of the lamp the fraction that fails between the period of repair.

Let us say, that is F because I am talking terms of percentage survivors. So, F fraction F percentage fails between 2 cycles of complete replacement bulk replacement then this F would actually mean that I have to do spot replacement for them. So, when I am doing bulk replacement, I cannot avoid spot replacement completely because you know some of them I will have to replace, some of them I will have to replace spot replacement I will have to do. I cannot avoid bulk replacement. Even if I do, I cannot avoid spot replacement completely between 2 periods of complete replacement bulk replacement. I have to do some spot replacement.

Let that percentage be F. So, F divided by 100 into L plus S because that is spot replacement cost per lamp that will be the total. So, cost of bulk replacement will be this. And therefore, I can find out what is the value of F corresponding to what is the value of F corresponding to you know what is the value of F corresponding to the decision that bulk replacement is cheaper. So, what I do? I equate this.

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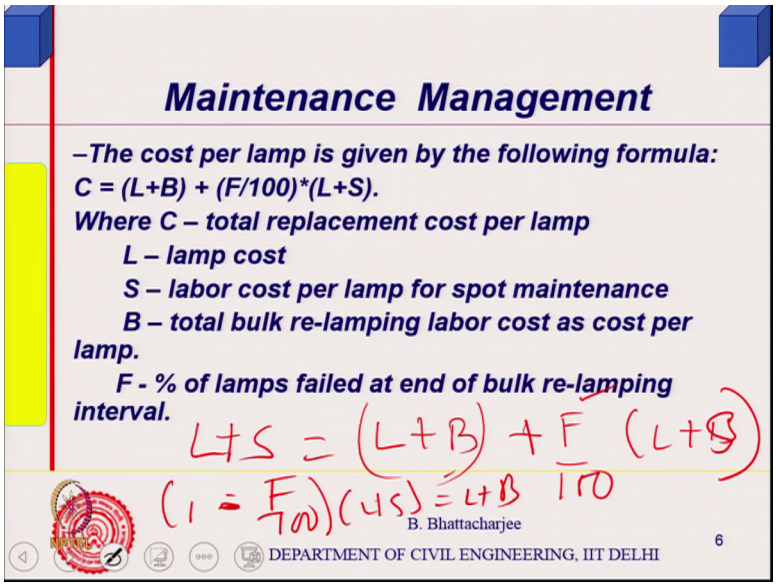

So, I simply equate this. I simply equate this L plus S if this is same as L plus B plus F by 100 into L plus S, then I go for you know this should be less or equals to. So, limiting case let me take B as equal and find out the value of f. So, F would work out if F is in percentage F would work out right, F would work out L plus you know L plus yes I can bring the term this side. So, I have 1 minus F by 100 into L plus S must because to L plus B. I bring it on this side L plus S is common into 1 minus F by 100 uses algebra ok. I think it is ok. So, you can find out that you know L plus S.

So, it is essentially I will right it like this L plus S is equals to L plus B plus F by 100 into L plus S because that is the cost of bulk replacement and when it is the same well or this is less, I can take a decision right. So, what I do is, this if I it will be 1 minus F by 100 into L plus S is equals to L plus B. In other words, 1 minus F by 100 is equals to L S by L plus b. So, this I cancel out this is L plus S. So, this you know this or I can get an expression for F simply Expression for F will be from this expression for F will be I can get an expression for F from this 1 minus F by 100 it was.

So, both sides if I subtract 1 or if I take it to the it other side. So, I get 1 minus 1 minus L plus B divided by L plus S is equals to F by 100 and this is nothing but L will cancel out. So, I will have. So, I will get an expression of this in this manner. Let me see just write it somewhere. So, let me erase this out portion erase this portion out. So, I will get an

expression of this kind simply I will get an expression of this kind, I will get an expression L plus S minus L minus B divided by L plus S is equals to F by 100.

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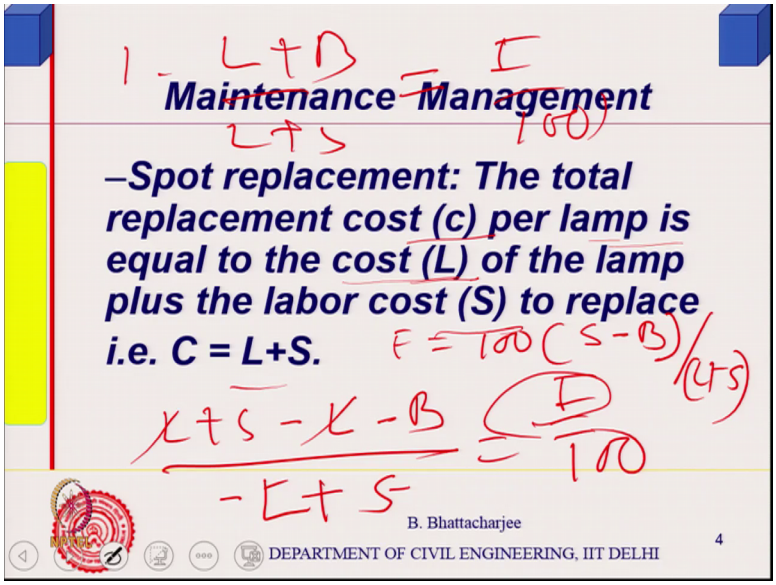

So, this cancels out. So, S minus B is B divided by L plus s. So, F is equals to 100 into S minus B divided by L plus S. So, this difference actually how much is the difference between S and B that will dictate when do I do. So, once I have found out F ones out I have found out F. Let us say find out F is equals to 20 percent right F is equals to 20 percent. So, I can go back to this graph I can go back to. So, F let us say is 20 percent or 15 percent or whatever it is. So, I can go back to this graph, let us say this is this is my you know this is F is this much and what I found out this 25 percent or something like this.

Let us say, in this particular case. So, percentage F is the percentage failed fraction fail percentage fail. So, 1 minus F or 100 minus F is the percentage survival. So, percentage survivor I know is here corresponding to this what is the life of the you know percentage of average life at which I should do bulk replacement I can find out. So, I can find out.

So, for examples is 80 percent. So, if you know 25 I mean this is this is this is how much this is 80 it. So, maybe 75 percent you know this one is 25 percent. I have found out corresponding to that it will show that I should do actually a bulk replacement at around 80 percent of the average life.

So, even lamps are good, but still I might simply replace them because, after that the rate of failure will be fast and I have to possibly call people every now and then and it would have both ways that to be indirect cost involved also particularly in a factory the indirect cost will be very high. Why? Because, production might get affected maybe it is in a hospital that can be serious problem.

So, depending upon the occupancy type or otherwise I might decide to actually do a bulk replacement even taking into what is called disruption cost into account indirect cost into account. So, bulk replacement that is what and if you plan then plan only this time this you can do. So, replacement policies are to be planned and not based on just emergency somebody calls you things are not ok. You start repairing; that is not the best way do things right ok. So, that is the example. Now, how do you find it out? Actually, how do you find it out?

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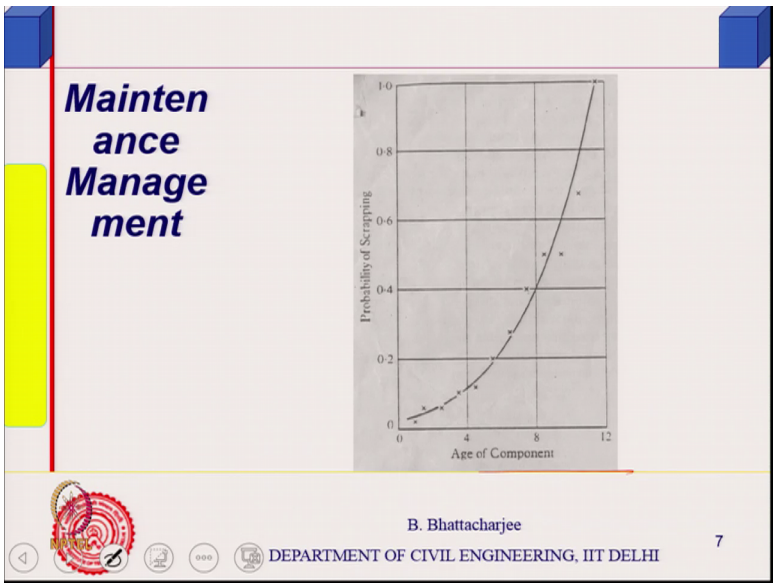

For that, you have to actually find out the percentage survivor right and you might find you know age. So, percentage scrapped if you have no other percentage in some other for some many other items say you know precast lamp poles they have longer life we are not talking about 1 year 2-year life sometime it is much longer.

Precast lamp poles you might find there. They start once, they start falling once they start giving up you know cracks coming or something many of them will start showing cracks and we go to or might we have bulk replacement tap washer tap washer you know in a

large area number of taps are there. I will say you will find that fuel replaced all of them. Suddenly, initially fuel fail, then suddenly all starts failing. So, there can be several other situations where mortality curves are similar to the lamp mortality curve.

I show you one module, but you can look into other modules also, but the data should be available. We do not have this kind of data from any server situation. You have to actually you know weight find out where you can apply this modules but, this modules can be applied and you can find out the renewal cycle.

So, how do you find it out? For example, if I know the percentage, how do I find out? First, I find out today I have put in x amount in service I call that 100 percent how much is the percentage of surviving after 1 year, then how much of the percentage of that surviving next year and next year and next year and next year. If this data is available, I can find out average life for lamp. They do experiments in the lab.

Well, the water is subjected to high voltage as long as a failure mode remain same. You can use rules what is called you know there are there are there are there are cumulative damage theories you know. So, you can from that cumulative damage, you can count at high voltage.

So, you can actually find it out. There are ways of finding out. We will not looking into that right now, but some cases where it is for a long period of time you find out percentage has been scrapped after 1 year how much percentage has been scrapped after 2 years. So, average life you find out might work out after 7, 8 or 11, 12 years.

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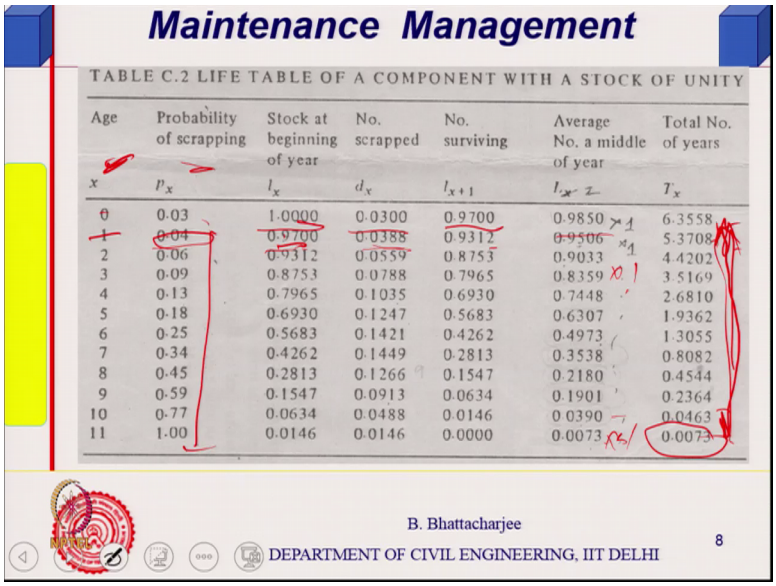

So, you might generate a table of this form which will show that edge this column is edge 0 that is starting point and between you know percentage scrapping after. So, starting point is 1 0 fraction 100 percent and numbers scrapped is 0.0103 percentage of fraction. You can talk about survival is 0.97; so, probability of scrapping. Therefore, is 0 3 because out of 100 you know only 0 3 has been scrapped next year 97 remains to start with then you find out that some 0 3 8 8 you know certain percentage has been number scrapped survivor is this. So, probability of scrapping again because it will be now on 97 percent 0.97.

So, 0.97 0.3 038 or something else scrapped, at 100 how much it is? So, this probabilities you can find out and you might find everything has been scrapped after 11 years also. So, if you form it in a tabular form, you can find out the you know this is this was 100 percent here or 97 survive average survived on this year would be 1.97 divided by 2 because in the beginning of the year 100 percent was there end of the year 97 percent was there.

So, on an average 100 and some half of that 1.97 or 100 and 97 divided by 2 which comes out to be how much 98 5 0 that is the average survival on that year.

It could be the 1 year or 5 year even depending upon the situation, but 1 yearly situations are what is our concern usually. So, average survival on that year was between the 2 starting one end 97. So, average is in between similarly starting 97 and then survive 93

point you know survive it is 90.931 to so, average how many survived on that year that you can find out. So, if you sum up this average you will get the you know average multiplied by year that many average year average into 1.

So, if you sum this up this cumulative is the sum right not this cumulative was not the sum. So, from backward you can go on cumulating for last 2 years survival was cumulative sum was 0.073 plus point you know 3 9. So, it will be you can add this up and cumulate from this side right cumulate from this side and you will find out that basically, what you are doing is this one survived 11 years 0.03 survived 11 years 0.04 survived 10 years right; so, this server. So, if you sum this up cumulate this anyway this gives you the average life because this multiplied by one this multiplied by 1 that is the average life.

So, if you sum it that gives you the average life. So, average total number you know years average life you can find out. So, actually most of them many of them survive till 11 years average how many how much they have survive survived that you can find out like cumulative back.

So, in case of such once where your data available you can actually find out the average life or plot even the mortality curve where 50 percent survive that would be your average life and use the same. So, lamp is usually for shorter period of time earlier lamps would have been 6 months, may be the life would have been of that order now the life is increased. But still, similar concepts can be applied and it can be applied many places where the failure consequence of failure is very serious or their financial implications and also you can predict the renewal.

So, we have I have shown you couple of modules; one have shown in the modules of roof covering have shown you the modules of painting external or internal. I have shown you the case of replacement of let us say flooring and now lamp replacement or some other replacement where let us say the electric post or something the similar kind. So, you can actually find out the renewal cycle of many items in the building, but for that, you have to keep the data you have to maintain the data and record it over a long period of time and that system should be get increased recording system should be increased right ok.

So, once you have done that, then I can plan my maintenance. Once I have done that, I can plan my maintenance actually right. So, main thing is when I do such kind of bulk replacement, I get actually cost saving right.

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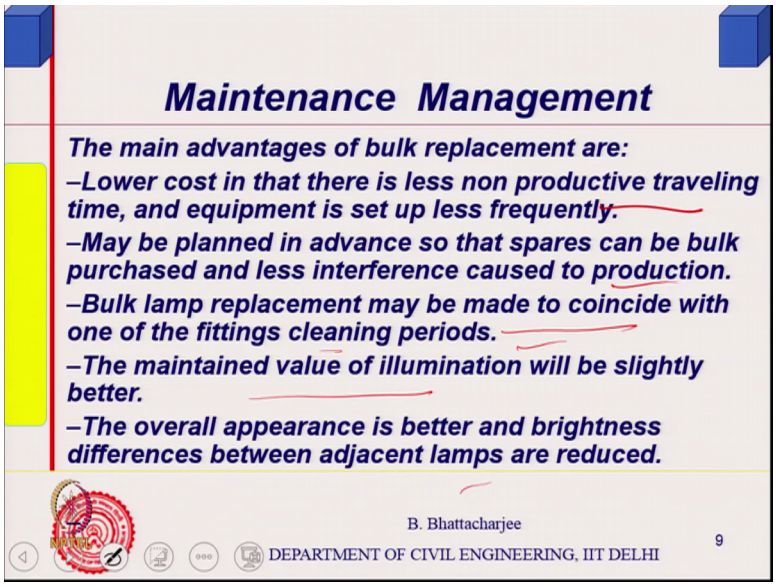

Lower cost in that there is less non-productive travelling time the equipment is set ups less frequency frequently. So, your cost of equipment setting up or equipment hiring time would be less, may be planned in advance. So, that if you for example, it would be a good idea to do lot of maintenance during summer vacation; hostel maintenance in summer vacation because, the students would not be there or if you know the lean period in a hotel, not the season. So, you can or in a some sort of a maintenance you know you can coincide with other maintenance. For example, machine maintenance is required you might coincide with that kind of thing.

So, planning is possible may coincide with one of the you know fittings cleaning etcetera. The value of illumination also will be higher in case of lamp maintenance because, you are replacing them with the new ones. The overall appearance in better etcetera etcetera and this goes for every other you know such renewal you know right.

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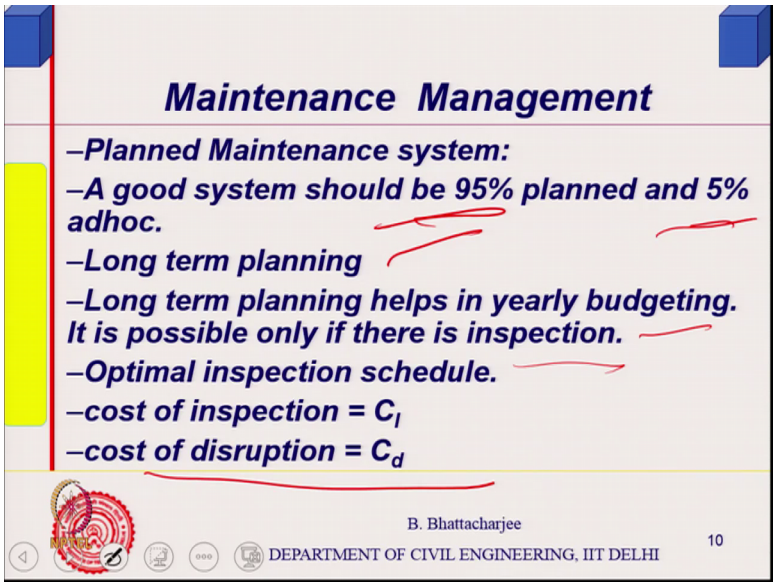

So, therefore, I can when I have decided on renewal cycles of many items and got a cost profile. Then, in such situation what I can do? I can actually plan my maintenance system rather than keeping it emergency on the basis of emergency which will be costlier.

Then, it would be economic a best maintenance system will plan around 95 percent and we can do that actually and 5 percent is left adopt to you cannot avoid a adhoc in such system you cannot avoid a adhoc if you see even if you are doing budgeting for let us say you know laboratory budgets or even national budgets many a times you have some cost called planned cost, then you have got some expenditure which are every year they recur recurring expenditure and then you have contingency in the recurring expenditure.

Now, the recurring expenditure which is contingency where you include actually that should be something like 5 percent of the total or something is a lump sum you can dispute because you might have actually been able to a kind of keep a track of them or data of them you know data's are available data is available for many years that ok. Typically, this is the percentage of cost of the non-planned items. So, best would be 5 percent a adhoc and I got to do long term planning right and it does help me yearly budgeting.

And it is also you know, but then it need needs inspection I must do an inspection to verify my planned the you know verify my planning I would have planned it. So, it

should be I should be able to verify my planning right that what I have planned is going on well alright because sometimes it may happens.

So, cost of inspection is important and inspection cost saves your saves your repair cost sometime inspection cost saves your repair cost sometime in that context or even otherwise in the context of maintenance one cost is very important cost of disruption. This module, I am talk about is important because I am also involving now cost of disruption disruption cost right, cost of disruption cost you see if you are doing inspection you will be actually disturbing the function or activity. So, therefore, there is a cost of disruption involved in many places this is happen. So, cost of disruption is involved let us I will come to this little bit later.

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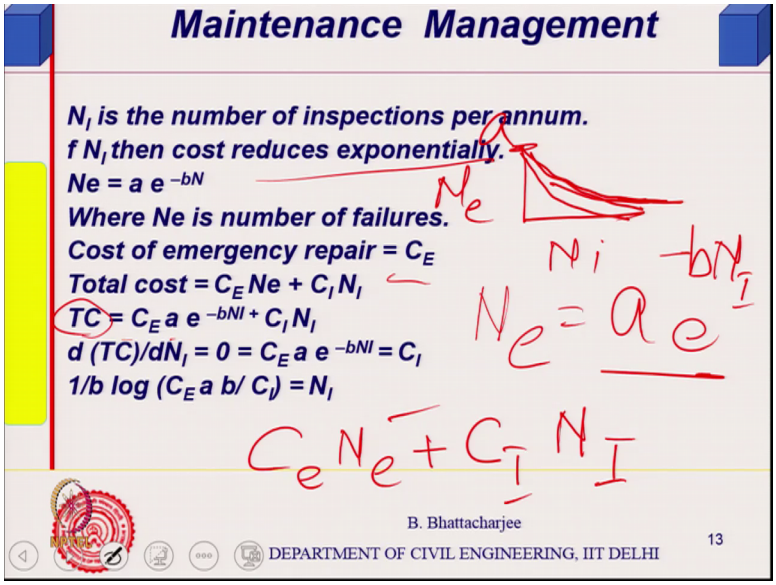

Let us look at this module first. Then, I will come to those things diagrams that I have talked about. I want to find out what should be a number of inspections on certain things. Let us say, it is per annum, but it could be for 5 year also for some other item.

So, this cost reduces exponentially you know if I increase the number of cost of emergency repair or number of emergency calls, if N is the number of emergency call it is seen that if I do inspection, this should be N i, where N i is the number of inspection. If I do more number inspection less will be my number of emergency calls. For example, you know electrical system let us say right. So, if the periodically check the short circuiting and things like that why there is you know somebody check them.

Then failure would be relatively less and more inspection you do this tends to this number of emergency calls tends to reduced down exponentially. So, it is something like this you know when I have possibly 0 inspection there is something like this you know 0 inspection; so, N i versus N e. So, this is a right. So, when N i is equals to 0 these equals to N is equal to a and then it reduces in this manner when it sorry it will not be it will be a synthetic. So, as N tends to infinity this will go to 0 this will a synthetic to x axis. So, this will show in this manner.

So, N is the number of emergency failure and supposing my cost of emergency repairs is C then my total cost will depend upon C e N e plus cost of inspection into number of inspection and any can be replaced by this formula.

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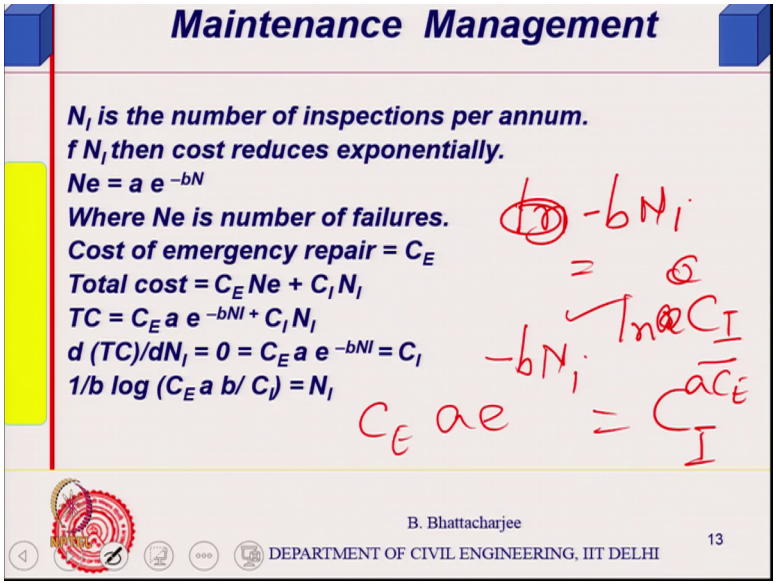

So, that is what I have done C a b to the power b N i C a N i and then minimum. What is the max optimal number of inspection? Simply differentiate this total cost with respect to N i and you will find that it comes out to be you know if I differentiate this, then it will come out to be C e a e to the power minus b N i is equals to C i inspection cost you know.

So, therefore, I can find out N i simply by taking you know like e to the power b N or if I take L N L N both sides. So, b b N i will be equals to C L N of C i by you know L N of a C i or no L N of a C, am I right? Let me just do it again, write it clearly for you, write it

clearly for you yeah. So, what I am trying to say is e C is the total cost is to see the total cost is.

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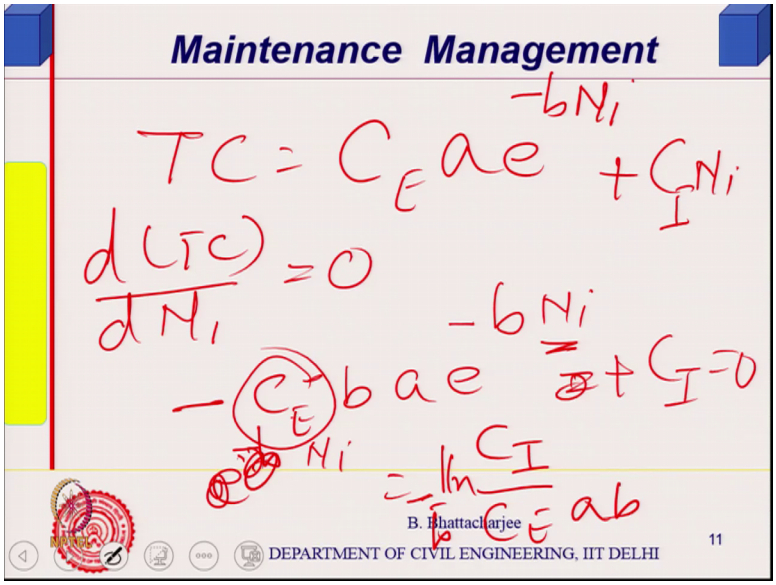

Cost of emergency which is a e to the power minus b N i plus cost of inspection into N i. Take differentiate this with respect to d N i put equals to then you get minus C e b right, am I right? B a e to the power minus b N i is equals to or plus C i is equals to 0.

So, you can find out N i then which will be you know which will be e e to the power minus b N i will be equals to C i by C e a b, am I right. So, if there is that take L N of both sides you will get minus 1 by b L N this equal to N i. So, N i is equals to minus you know 1 by b i C i by C i C e a b. So, one can find out the optimal number of inspection required which will make it cheaper. Now, you can add this one you might add this C e might also include what is called as disruption caused because emergency suddenly you stop the activity, there will be disruption cost and this formula is given here.

So, this formula is given here minus 1 by b minus 1 by b log C a b etcetera is equals to N i. So, one can one can obtain this you know. So, one can obtain this is it correct or is something wrong b N I. So, L N b N i N i will be this by that is right. So, this the formula ok. So, one can obtain the one can obtain the optimal number of inspection required one can obtain the optimum number of inspection required. Similar sort of situations can come in many other places where you bring in the annual cost of repair annual consequential cost that is your disruption cost then replacement cost.

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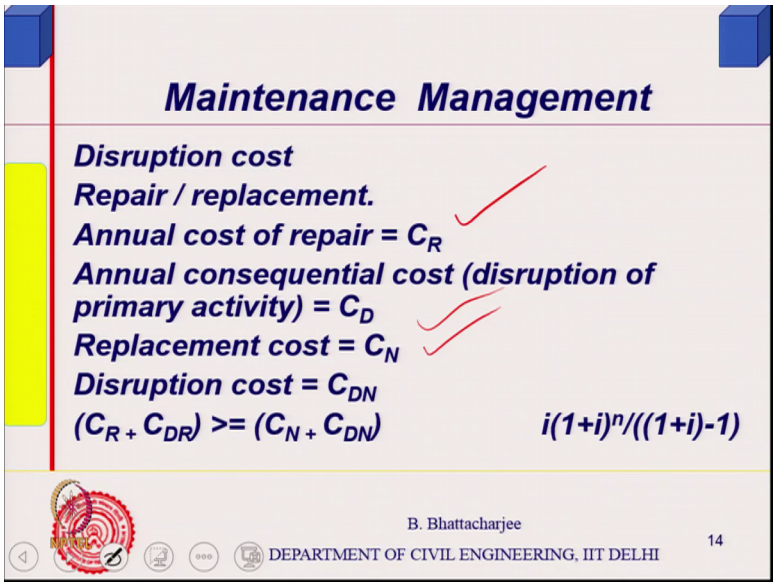

So, actually you can model find out the total cost for alternative like we did it for bulk replacement or for this one number inspection. So, you can actually find out the total cost should be equated and then differentiate if required to find out the number of inspection.

So, disruption cost one may take into account right ok. So, that is what it is. So, would now alright. So, do you have any question related to this? Otherwise, we look into the inspection role of inspection in the overall maintenance case right. So, do you have some question will answer otherwise may be maybe I will take 2 minutes to explain this to diagram and then will bring. So, if you role of inspection is here.

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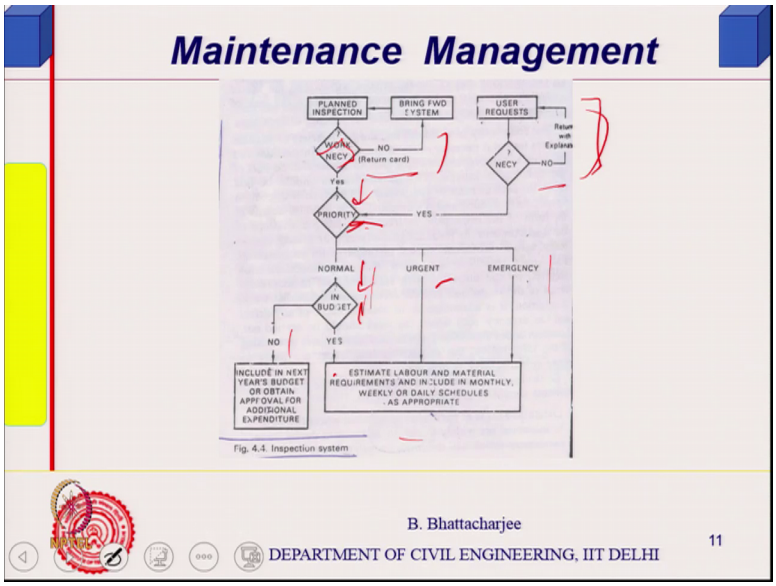

Basically, I have a 5 yearly plan or 60 years plan I have talked about in that there is 5 yearly plan. Inspection has to be done every year before budgeting, the purpose is to see whatever I have planned from 5 yearly long term plan is this deterioration has actually occurred or is that the condition is gone bad. If it is gone bad, then I must be doing repair. Otherwise, I may delay it for the next year.

So, when I do yearly budgeting before the time that must be inspection. So, what I do? I first find out I have a planned inspection. Then, I find out for each of this item that I expect that there will be some problem whether work is necessary or not.

So, that is the decision box what necessary. If it is yes, then I find out what is priority and if it is priority is normal, then you know I would like to do it in whether there is a budget is within the budget or not again a decision box. If it is within the budget, then I will go on doing it in the overall plan you know and if it is priorities urgent, then I have to put it in monthly plan. That is, quickly next month I should do and if I find it emergency, then maybe I have to do tomorrow or in a week's time.

So, even you know inspection you do you see the time during which month of the year March or April you know march your April it would be financial year starts whether you like to do it in December if it is something you can do in house, but emergency because your workforce should be meant only for emergency works otherwise you would be

giving it to contractor. So, if you are giving to contractor or agencies because you it is not worthwhile to maintain a large work force for work which is not continuous right.

So, if you planned already planned most of the things you will outsource them give it to agencies from time to time, but when you going to give it that will be decided by you if it is outside the budget then no leave for the next year because it may not be then emergency it may also happen that you know if it is not work is not necessary you keep it that next year I will have again inspect it sometime you can take the users request also.

When you are doing inspection because user has requested and you my say if you just check whether is necessary make a decision if it is necessary put it find out the priority if it is not necessary send back to the user say that will do it sometime later on at the moment you not doing it. So, during inspection period you can take it and then how you can actually these inspection lies in over scheme of things. So, yearly inspection is a must you know yearly I said, but certain things you can even do inspection more than once in a year if the cost is you know you find the inspection your optimising the cost.

Emergency number of energy emergency calls are reduced sometime you might do it more than that. So, therefore, role of inspection we have defined and then maintenance management will have 2 things.

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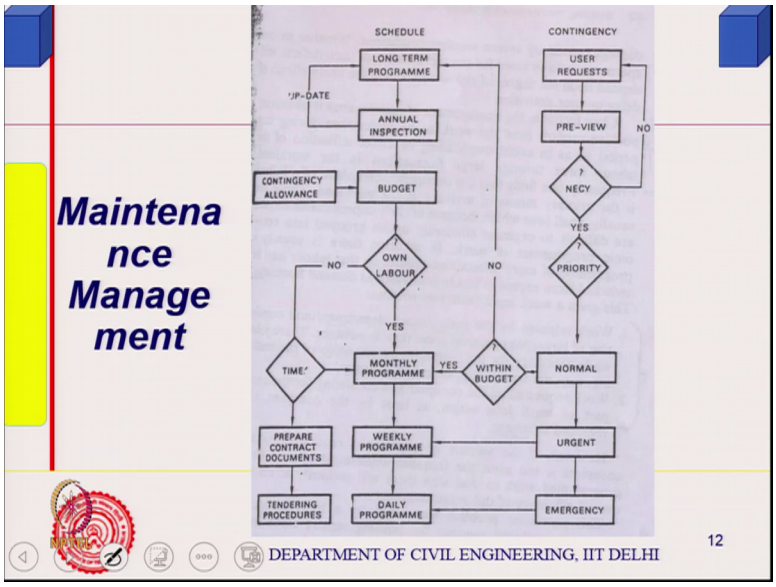

Therefore, that is what we have understood and will break up to this 2 things one a large chunk will be planned and a small chunk will be unplanned based on users requests something like that. So, first one we call it schedule maintenance because I will schedule them.

Second one I call it contingency or adapt maintenance which will be based on users request largely or you know anything what emergency happens. So, the scheduled maintenance will have long term program right in the beginning I found out the cost profile and I know every 5 year you know I found out the renewal cycle.

So, between these 5 years what I am going to do that is a long term one then from long term to yearly planning right annual planning and that how much I would be spending this year would depend upon annual inspection and then from there I do the budget for that particular year I do the budget.

But in the budget, I must keep some provision for contingency that is what you normally do some provision for you know contingency that we will have to do alright and then you find out even if it is within budget this year I would you like to do to your own men own manpower or give it to contract if I have sufficient time available. That means, I can start this work maybe in sometime 3 4 months later. I have time for giving it to contract, then I give it to outside agencies because I may not have that much of staff I do my staff planning also in this kind of basis.

If I done maintenance planning properly then staff planning also I can do. So, that is what the thing then if it is something very emergency type time is not available from my inspection I found out that I have to see whether I do it in monthly program weekly programme if it is urgent to within monthly program if it is emergency within weekly programme right or then daily program and so on similarly I take users request also in between.

So, I keep some provision for you just request and then in there you know I find what is whether is necessary if it is not necessary put it back to the user saying that will do it sometime later on find out priority normal do it in the whole year urgent do it next you know within months you plan it and emergency my do it into weekly and daily program. So, that is the overall scheme of maintenance you know scheduled maintenance or planned maintenance scheme right.