Fire Protection, Services and Maintenance Management of Building

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Lecture – 36
Life cycle cost and basics of building maintenance

So, we will look into now building maintenance management as you know I just mentioned in the last class; so some of those issues then we talking about is.

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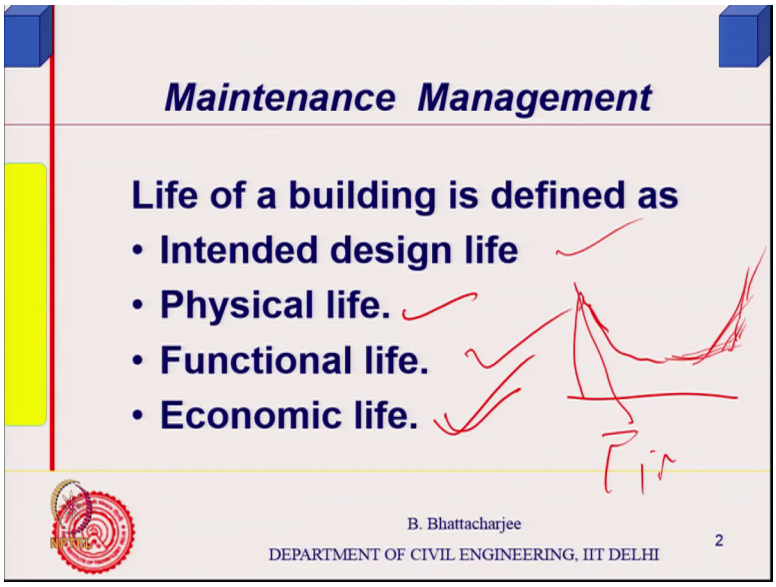

This is related to actually maintenance management of not; you know usually when we talk of maintenance management of building is not a single one it is buildings. Number of them may be in form of a state or single building large building whatever it is it can be even go up to this. So, in this context what is important is life of the building; life of the building. Now how do you define life of an inanimate object. You know building is an inanimate object.

So, while living beings they have actually if defined sub you know demarcation between life and death. So, you can say that this is life and then you can talk in terms of expected or life expectancy and so and so forth. But unit comes to inanimate object like buildings it depends upon the context you are talking of right.

So, something we defined called intended design life. That is your intention at the initial stage beginnings right. So, intended design life is when you are actually constructing a building or this is true for any other structure, you expect that it should have a; you know it should have a functional service life of so many years of structures part of it.

So, you talk in terms of intended design life right. So, intended design life is generally used in the structural design concept quite often. For example, you would possibly think in terms of 50 years time period of the wind or that the wind that will come once in lifetime right. So, this is more of notional so that is intended design life is what is your intention.

So, for bridge it may be much higher 100 years or something of that kind the intended design life. So, during the design stage, whatever is the life you have actually conceived or thought of that is what is intended design life. Really physical life would be much much higher, because physically it might last much longer. You can actually do maintenance you can repair it and you can continue for practically infinite life.

So, physical life will be infinite unless there are something kind of an accidental overloading because, of largely because of natural disaster or something of that kind. Not accidentally natural disaster oriented overloading which we have not really emphasized during the design and or accidental overloading due to human activity or similar sort of thing.

Otherwise physical life would be very long. Deterioration do takes place and that requires repair to be done. So, for example, a bridge might have some kind of deterioration; so, which requires that you should be repairing it. And once you repair it can bring it back to the same level as much as possible, but then there something called functional life. For example, if it was a you know 2 lane bridge, you know some of you are from transportation 2 lane bridge. Now you think that this is not right I want to you know it should be 6 lane bridge or something like that.

So, it is functional life of that 2 link 2 lane bridge will be; what you might even abandon it and started constructing a new bridge. Similarly building functional life in building is of course, very important because occupancy type changes, functions of buildings depends upon occupancy type. So, it if it was let us say you know all essentially, you know many of them you would see that actually they were possibly status earlier. Now,

that got converted into shopping malls. Or there are various examples where actually they were residential once upon a time say, Chandni Chowk in Delhi. They were all residential, you know the those may be 100 150 years back Shah Jahanabad right.

But then with that went off let say mid of a 20th century and so on. You know after independence, you know what they have done is; they have converted the ground floor into shops and top ones are residential mixed occupancy. So, functional function changes occurred right, many other cases it would be similar building remains same, but it is functions change. So, functional life might change depending upon the situation. And economic life is related to cost of maintenance. This is this is very quickly evident in case of mechanical systems where there is a lot of volunteer. What happens is; see if you look at the such kind of you know machines or similar sort of thing.

Initially you will have some slightly high maintenance requirement because things are not working properly, maybe little bit of servicing is needed as you know in case of your car there are free service 3, 4, 5 initially. And you do it much less periodicity then compared to a regular service which you will be doing little later on which is on kilometre or yearly basis or 6 months or time basis you know either way.

So, initially maintenance requirement is high, but then maintenance really come down after certain period of time. So, which time actually maintenance will come down, maintenance comes down. And then it is more or less same and then we will start failing 1or 2 parts will starts failing initially which you replace. And in the long run when every parts have lasts you know is leaped it is life by enlarge many parts starts failing together. So, it has got a cascading effect so maintenance cost will tend to increase beyond a point maintenance cost will tend to increase. So, when maintenance cost increases a time comes when if you do an economic analysis.

It is not worth while maintaining it anymore because cost of maintenance is higher than, cost of maintenance is higher than anyone you know economically you can justify 2 alternative to be compared. One is to keep on maintaining the same equipment or machine other is to have a new one. So, you can have an economic comparison alternative comparison and find it is better. So, that is related to economic life economic life. So, you see the life's are quiet, you know life's can be quite different depending upon the context. Of course, in structural system we talk in terms of what is called

service life of a elements. Generally, elements essentially not the whole structure or building as a whole service type. Or you can say not only one can say service life of building is likely time during which it will be in service the building will be in service right.

Likely time I mean expected service life you can talk in terms of which will be the sort of expected time during which it will be in service. For elements we talk in terms of service life and that one is essentially related to failure of you know like reaching a serviceability limit. So, in case of modern design as you know it might be true for all buildings, building structural elements are otherwise. Even you know elements in payment and things like that, you talk in terms of one is the kind of a structure you know mechanics oriented failure collapse or similar sort of thing. And mechanical failure other is a functional failure or some serviceability limit failure.

So, serviceability limit failure means in case of structural elements it is lot of cracks or deflection or such thing you know. So, if I know a time when an element will be which is it will exhibit, it is reaches it is serviceable to elements say exhibit a crack right an acceptable crack. Then what I will do I will repair or replace that element. So, that is not whole structure or building I will not do anything, but repair the locally repair that particular element or replace it.

So, that service life of that particular element so if this you know this is the context. So, when it talk of maintenance is always related to the life, because during whatever life or intended life you want to maintain it that should be done, right in the planning stages itself. It has got it is implication, it has got it is implication in economic terms let us see what it is.

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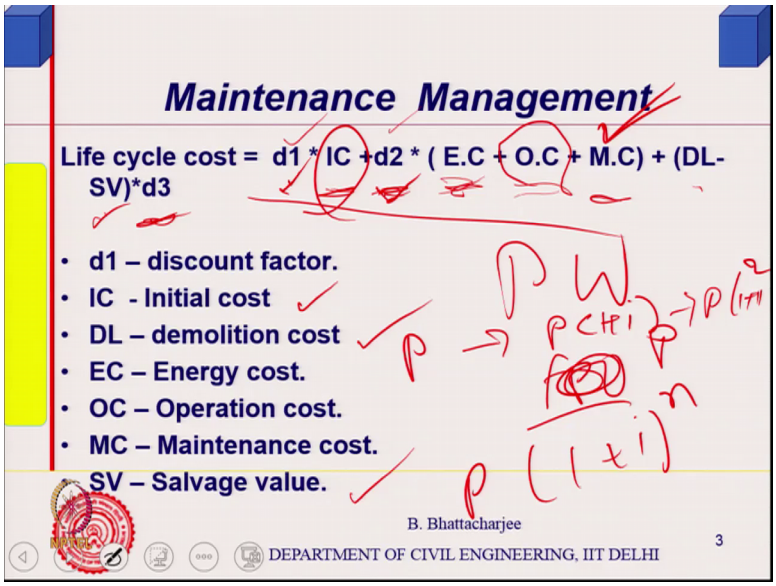

So, one has to look into life cycle cost then you know in life cycle cost maintenance will come into picture. Now, you might put something by design right in the beginning, which you know that I will go and replacing it every year. You know you might have a choice or something which you might like to replace it once in 5 years. So, that decision right in the beginning you would like to make.

Now, the once which you will be replacing every year it will be cheaper possibly. The one which you will like to replace of once in 5 years it will be relatively costlier. So, when you look into maintenance situation you would look into because maintenance will be doing during it is service period during it is you know intended design like period. So, therefore, life cycle cost is what is what ne should look into. And in life cycle cost if you see the components of life cycle cost initial cost, initial cost, I call it IC. This is in buildings energy cost is very important in many buildings many functional building right energy cost is very important.

Because there is a huge amount say you know academic buildings, lecture theatre, complex or something if it is air conditioner is running. So, you know energy cost will be pretty high. There is a operation cost which in buildings which would include actually, you know cost to go to pay to the municipal authorities and similar ones. Also for maintaining the systems, like your lift system, water supply system you incur certain amount of cost.

So, therefore, the operation cost and then is the maintenance cost. So, maintenance cost is any anything you know I will define what is maintenance. So, anything related to that definition of maintenance that would be maintenance cost. The other one is demolition cost, there can be demolition cost involved there is the demolition cost involved at the end of it is life. And then minus something you are able to salvage out of this.

Supposing you demolish a building you might get all some elements which can be you can sell. So, that salvage value so DL minus SV. And these are discount factor because initial cost is in the beginning; at the time of construction and design you actually spend that money. While maintenance cost is yearly, you know maintenance cost is yearly right? Next year and next and next or may be 5 yearly you can you can make it that way and then this is at the end of the life

So, therefore, they all occur at different time in the life of the building or building systems different type time. And therefore, you must bring them into same time frame, and that would do taking interest rate into account what is called time value of money. The concept of time value of money which is used in all engineering economics analysis of the kind that society that we are in.

If you if I invest 100 rupees today, I should get 100 plus I rupees you know next year. And then 100 I next year I should be getting 100 plus I into 1 plus I, because you know the factor would be 1 plus I compounding every year. So, any amount today it would fetch me that amount multiplied by 1 plus I right. So, that is time value of money. So, you have several discount factor so depending upon what you know you have something called present what. So, you can bring all the money that you will be spending later on to the current time frame that is S equivalent of money, because if I put that maintenance cost for every year I want to get.

So, what I will do; I might put a kind of a money right now, and withdraw every year x x x or MC amount you know MC amount I am saying out of c or sum total of this every year. So, then the value the amount that I am putting today is actually present worth of the all the maintenance cost. Similarly, what will be happening at the end of it is life, that is supposing it was 100 rupees today it is value will be 100 divided by 1 plus I to the power n, because after one-year value of you know the value of our P, we call it P if it is

P now after one year it will be P into 1 plus i. Then after 2 years it will be p into 1 plus i square and after n years it will be P into 1 plus i 2 the power n.

So, that is the future sum of P today. So, if I know the future some divide it by 1 plus i to the power n I get the present 1. So, everything I can convert into present 1 in that case D 1 will be equals to 1. Rest will be multiplied by sum factor and this factor as simply I have done is 1 by 1 plus i to the power n. This we can derive and I will go to much better thing I will recur it.

So, sometime whenever I will recur I will come into this. So, this is called equal payment series capital recovery factor. You know it is a factor to take account of the interested you will you will just do this little bit. If you have done a course on finance or economics construction economics or finance, then you will have gone through in detail in this kind of things. So, these discounting factor are required, that is how we define life cycle cost. So, life cycle cost should be minimized in a way.

Today concepts are there in everything you try to look at life cycle analysis right. It is you know it is true for any infrastructure system building or other infrastructure as well. So, you try to do life cycle analysis even in terms of life cycle carbon emission, life cycle energy, life cycle you know everything life cycle environmental impact and so on everywhere you have life cycle.

So, life cycle cost is important, and role maintenance cost comes here maintenance cost come here. So, you might spend a little bit more here to see that this is less may be this is beneficial this is economy. Compare life cycle cost and that will tell you what kind of decision you want to take at the initial phase. So, that is economic in implication. Now, let us we can now you can define this; maintenance you can define maintenance.

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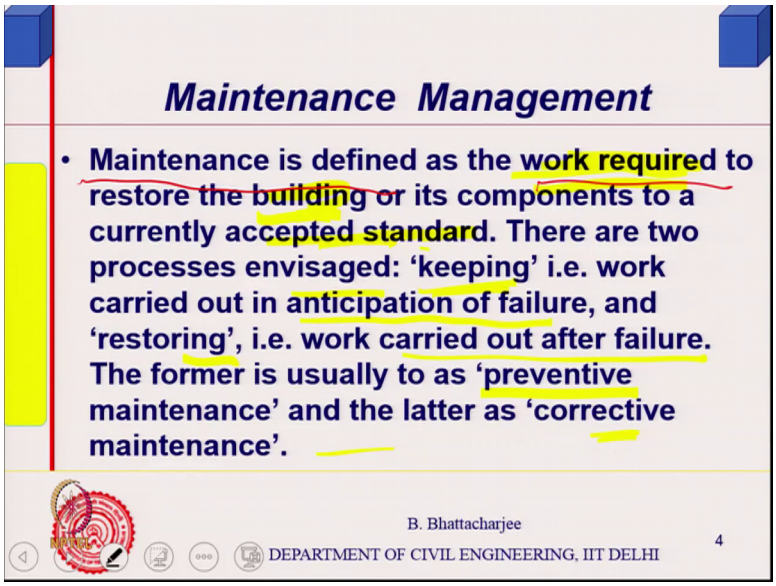

So, what is maintenance in term context of building; it is defined as a work required to restore the building or it is component to a currently acceptable standard. So, we are talking in terms of restoring what it means it was there originally whatever it was there. Obviously I will restore it to it is original level, but current standard. So, standard might have changed, standard change even in other situations standard change. For example, the standards on earthquake design of building keeps on changing. Earthquake design of structure keeps on changing, new perception risk perception increases changes and therefore, you change the code so currently acceptable standard.

But in building it is slightly more complicated. It is not such kind of codified standards, but taste of people will also come. Standard means standard of living here right, not only standard from safety point of view or otherwise, but also standard of living. For example, people feel you know today you go you do not find the floor finish that you get today. It will be all 4 tiles many of the even you know middle income group MIG buildings. You will find that it is all floors are all different then what it used to be say 20 30 years back or various fixtures, various features of you know plumbing system or plumbing services. You will find that they have all changed. So, it is a change of taste. So, we are talking of standard means standard of living. We are also talking of standard of living.

So, currently acceptable standard so maintenance is related to work required to restore a building to it is component to an acceptable standard. There are 2 process envisaged

keeping you know. So, you know restoring means keeping that is work carried out in anticipation of failure right, and restoring the work carried out after failure is also there. So, one is if you anticipate the failure you will keep the maintenance will also actually include keeping it at the right position; that means, you might do a predefined predetermined places. You know even nothing has gone wrong you might do a maintenance. Apparently nothing has gone wrong, but it should not go wrong therefore, you might do maintenance which is preventive maintenance. In machines they do it very often for example, electrical services you are talking of the other day transformers they will if it is oil cool change it is oil. Every yearly they will have a shutdown will change the transformer oil this is there for almost many system it is there.

So, it is preventive maintenance right you schedule it of course, properly. So, that is keeping it in right kind of condition. And if you do it after failure then you will have to bring it back to state so that is actually restoring. So, this is preventive and later and later is corrective maintenance. So, these are some terminologies which might go and it will you know it will go into our discussions every now and then you know. So, we will we will see that when it comes actually.

So, may this must be understood that maintenance is in case of buildings, maintenance is the work required to you know allow it to all work required to keep it is functional performance to an acceptable currently acceptable standard, terminologies are important, currently acceptable standard. And standard here we mean not necessarily the codes which we civil engineers all understand. But even living standard currently acceptable, living standard of the same might be the same person, same group, same economic group, but many things should have changed; styles would have changed in the upper level, but in the lower levels the modern materials, you know one would like to replace then load replace in the same one, but this happens elsewhere also.

For example, you know even other infrastructures this happens sometimes. Where there is a maintenance importance of maintenance is there. So, this is one issue other I said is preventive and corrective. So, our building maintenance involved both preventive as well as corrective. In fact, you would like to as much as preventive then corrective right. So, 2 parts therefore, preventive part means planned right.

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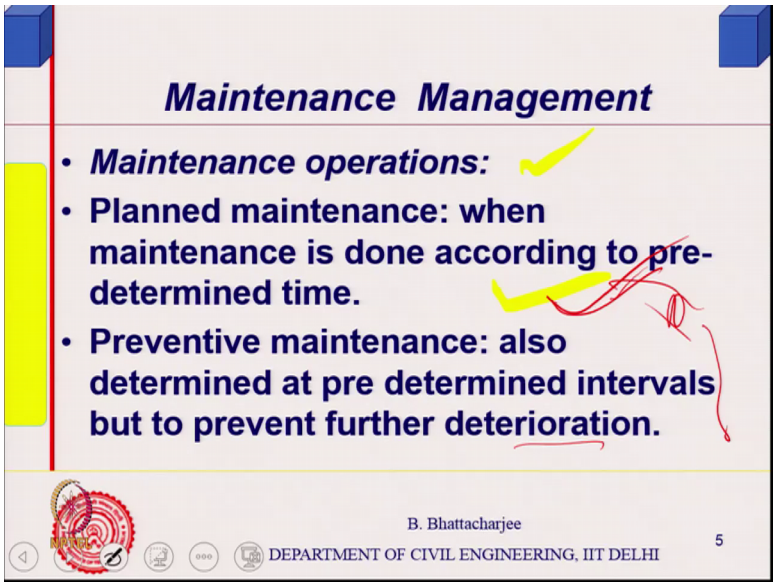

So, planned maintenance so part of it will be planned preventive will involve part plan. So, according to predetermined time so you actually fix up the time right and also determines predetermines internal, but this will this is not necessarily related to deterioration, you do preventive maintenance. But, you know the preventive maintenance goes, planned and preventive maintenance I mean; planned maintenance will involve a lot of preventive maintenance of that featured deterioration do not occur. So, building maintenance involves this.

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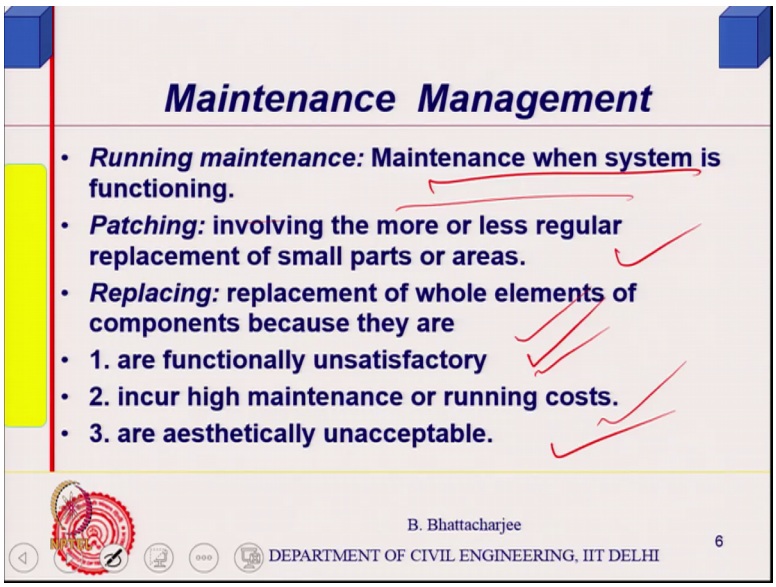

And running maintenance is some other kind of terminologies not in release building maintenance scenario unless an industrial building. When your production is running everything is running when you do that; so that is what it maintenance system is. You know when system is functioning if you do a maintenance then it is running maintenance all right ok. Other terminology is patching patch work which is important, this will be relatively important in our case. Patch work repair requires removal of small parts or small area. Doing maintenance in small area not complete thing complete thing; replacement means you replace that complete one.

So, say example wise patch work means I find that you know a floor, some damages in the floor. I mean extreme case that is an industrial flooring right, where abrasion can occur; the crane, crawler cranes or other cranes they move heavy loading machine is move. You might find that some portion the flooring has cracked right or disintegrated.

So what you do; you just remove and the repair is done in road very often. Where black toppings in some places the pot holes have come and you will just do patching this is patching, but supposing I decide to replace the whole of the floor because there are number of patches have come. So many patches has come that the cost of patch repair possible would be more than replacing it in one go.

We will see that economics little bit later on; in that case I do complete replacement. So, replacement is complete thing patch means localize small right. So, replacement is a whole elements of components because they are functionally unsatisfactory. Not necessarily that there has been damaged, but functionally unsatisfactory not able to performance his functions.

For example, you know this room, if you look at it flooring is timber tiles. Essentially meant for acoustic reasons you know foot fall noise control, there should not be foot fall noise if somebody is walking in so since it is a studio. Now supposing here is become lose in couple of places. So, then noise would be there so it is a functional failure. Although you know otherwise no problem there is no difficulty in walking, but it will make noise. So, there is a functional like failure. So, functionally unsatisfactory incur high maintenance or running costs.

Now, supposing too many patches starts coming, this year I do replace next year I find lot more patches are coming. Then I possibly maintenance cost will become too high. So,

I might replace them we will see that and then except are you know aesthetically unacceptable if it looks ugly. Some cases it can happen that nothing has gone wrong, but I do not like it I just do not look it or it is not up to the standard of the current, you know current flooring standard from my level I do not like it.

So, I just change it so replacement can go because of all this cases, that there is functionally it is not performing. What it is not you know maintenance cost may become high or it is aesthetically unacceptable right. So, this is some of the definition preservation.

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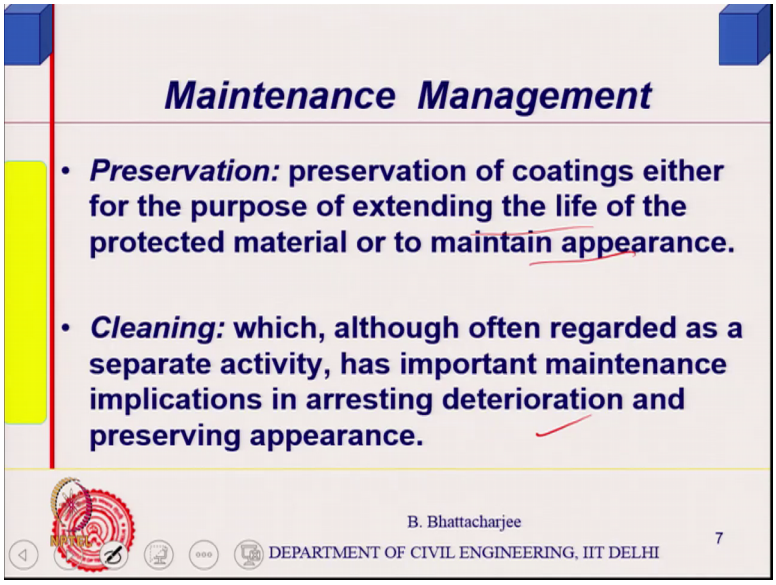

Preservation is related to actually you know sort of a heritage structures you preserve, or even in our case preservation you do is coatings or other 2. So, that since the deterioration do not occur you to preserve you do you know. So, this is what is coatings either purpose for extending a life or protecting it right, or to maintain the appearances also that is preservation. Cleaning is essentially essential is all though sometime it might be a actually treated as a separate activity. For example, daily washing, cleaning etcetera the floors and such things. Well it is usually taken as a separate activity, but certain cleaning is also required or related to maintenance right.

So, because deterioration might you know it is it is cleaning for example, drain pipe, gutters so which rain water comes in. Now if you do a maintenance before the monsoon season, it will ensure that there will be no; you know the water accumulation will not be

there, otherwise it can lead to water accumulation somewhere inside the pipe and overloading leakage of the pipe or if there is the water accumulation of the ceiling roof level itself. It might cause in case of water into the structural elements of the roof system.

First, you know the top level, the finishing elements, thermal insulation element and then structural elements and it might actually initiate corrosion process. So, therefore, you would like to cleaning becomes sometime as a part of maintenance one, but daily cleaning the floor cleaning keeping it look wise good and no dirt free and things like that. That is although can be considered as a part of maintenance work, but this is sometimes it is treated separately. There is the separate to you know agency it might be doing it. But maintaining meaning is also necessary for maintenance of element otherwise they will look you know they can lead to deterioration and such things so that is other aspects.

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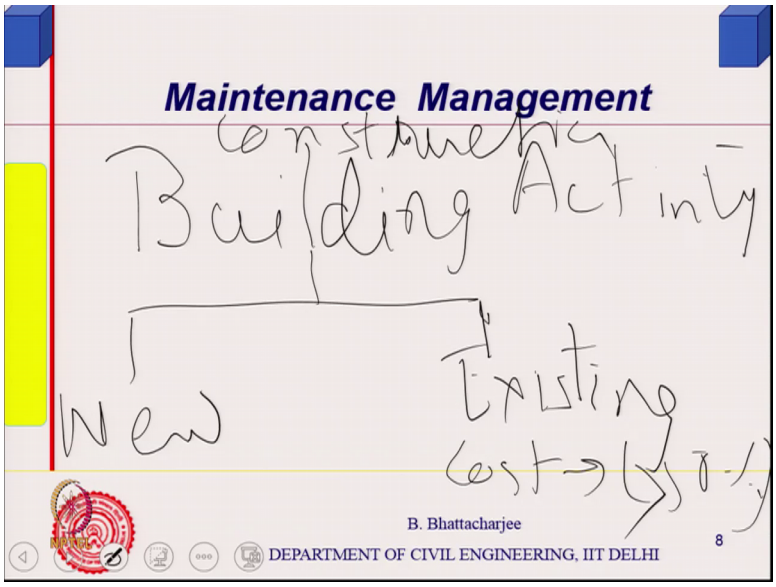

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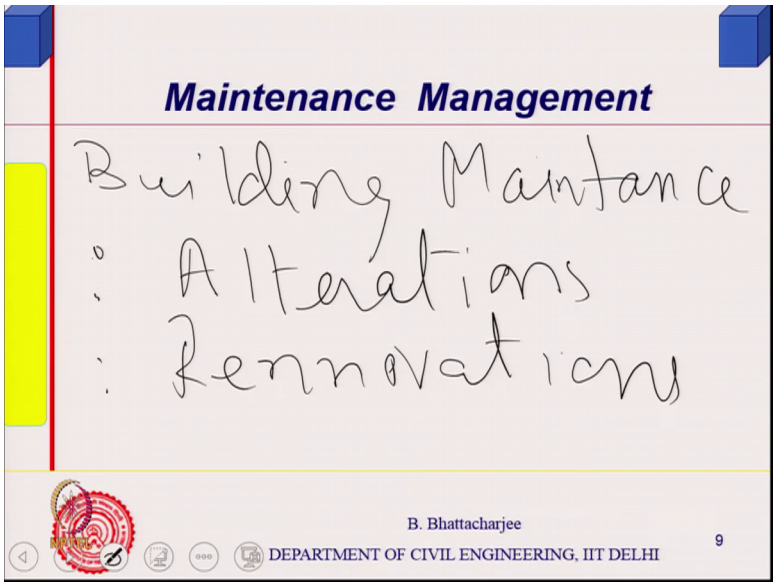

Now, this diagram I think I might; yeah right it is something like this, you know something like this same thing building activity, if I look at it building activity I will have building activity.

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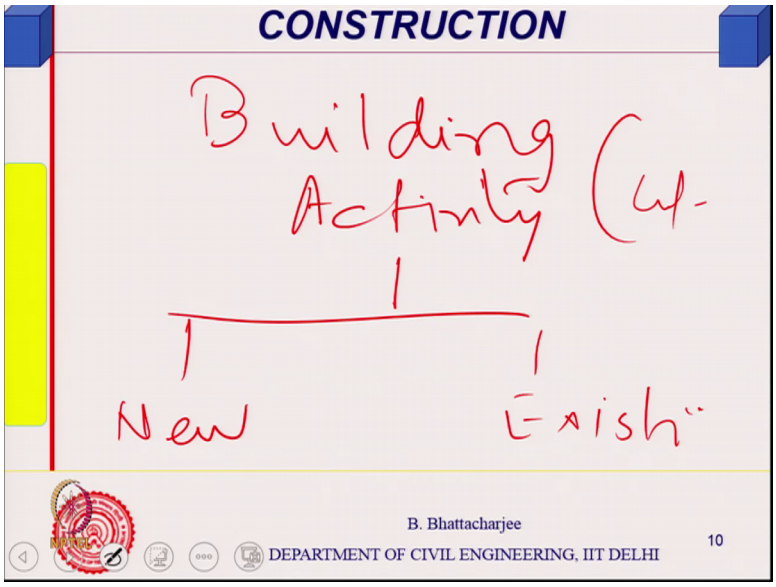

That is what I calling it building activity, just trying to do it again right. If you look at it new one existing I have a better slide for this next slide will be better, new one existing right. So, building activity then I can say construction new construction and existing construction right. So, this is what is there in the next slide next slide it is this.

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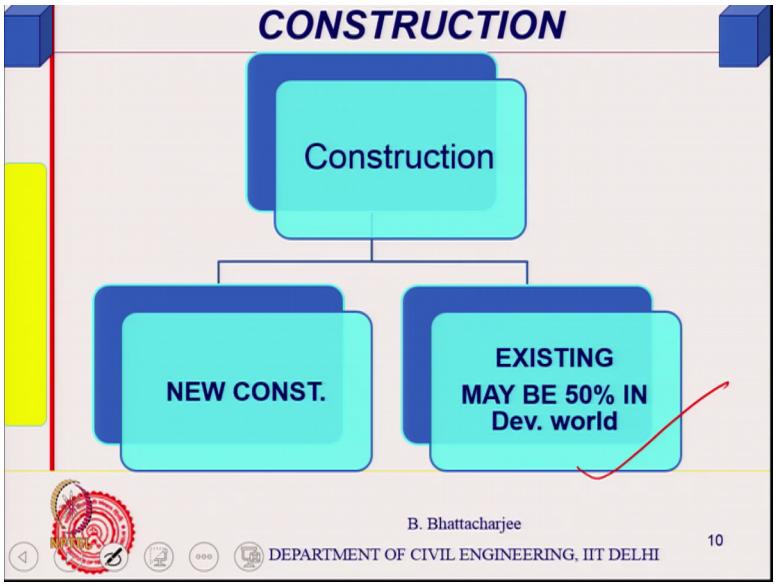

Construction, new construction an existing construction I mean; this is what I was calling as building activity. Now new construction and existing construction both are included in the construction or building activities or whatever you call it and existing maybe 50 percent in many cases. Maintenance you know where the infrastructure development it is already done for example, you know we have been talking about housing for all for many many years and still talking about it.

Now, developed countries have all such things have actually as occurred, you know there is. Or in even you know countries like china where last 20 30 years they have possibly done all kind of infrastructure development. So, in such countries now it is only the maintenance. New constructions are only demolition and new construction.

Otherwise relatively so, this cost is more than 50 percent; in many many places including in India also it might be close to 50 percent because many of them are deteriorating and so on so forth. So, existing building cost of repair maintenance then repair. And demolition and you know that might actually this is the importance of maintenance activity. The cost involved is quite large quite large right ok. So this is one thing, now then this is this is alteration and renovations some definitions we require.

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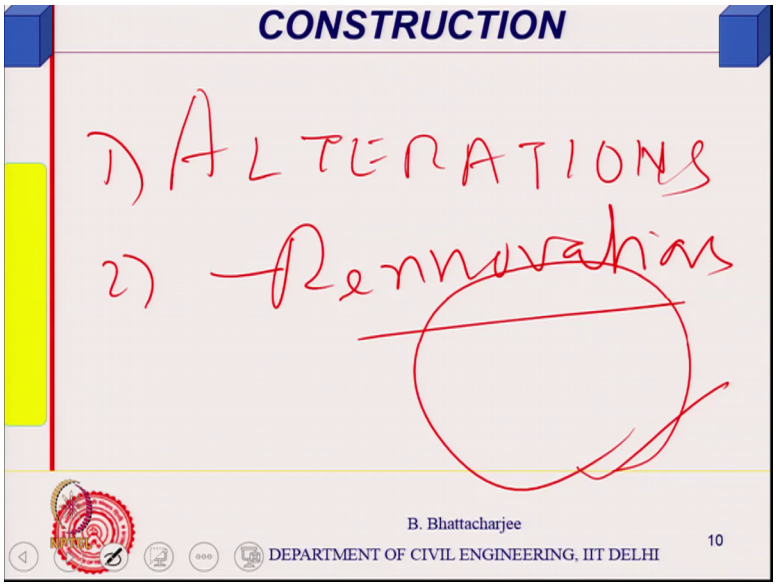

Alterations 1 and Renovation certain Definitions, alteration means you are altering the spaces you know you do quite of a in office you do quite of an alterations. What you do like the for example, you know civil engineering department office. Generally, you have the office scattering to all academic activities. You know various academic activities student interaction through to the faculties, administration rather. And then the possibly the administrative head is sitting, there may be sometime a committee room meeting room etcetera.

Now, quite often what you do you want to you have now increase number of people number faculties have increased. So, you want to increase the size of the meeting room, what you do you alter. The office but becomes smaller because the computers have come you do not need do not need bigger tables different tables so this is alteration.

Area wise you know you are changing alteration, it is not a measure maintenance it is actually alteration is not really maintenance, but you do quite often. Sometime this becomes done by maintenance department or not sometime almost all the time alteration is done by right. Renovation is the other terminology will define them renovation just we will stop right now and the questions from you. Renovations renovation is also related to alteration renovate it to some requirement right.

Which is not necessarily you know basically giving a new fit to both of them. Alteration is giving you fit renovations you might add also something renovate it you know such suitable function requirement so this is what it is.

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So, we will define some of those definition like Repair, Rehabilitation, Retrofit renovations you have defined alterations you have defined we will define this.