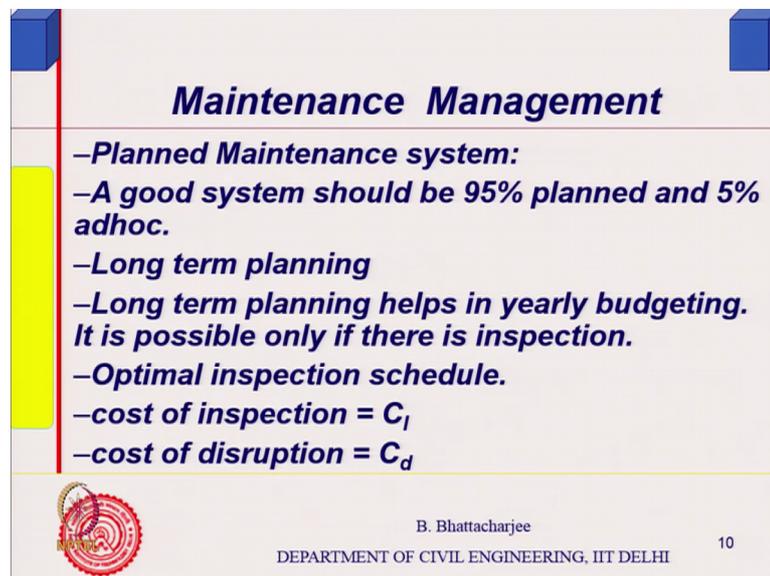


Fire Protection, Services and Maintenance Management of Building
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Lecture - 43
Building inspection, Planned and Ad-hoc maintenance

So, continuing from what we have done, basically finding out the periodicity of replacement you can actually plan the maintenance right. But, one thing is integral part is the inspection.

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Maintenance Management

- Planned Maintenance system:**
- A good system should be 95% planned and 5% adhoc.**
- Long term planning**
- Long term planning helps in yearly budgeting. It is possible only if there is inspection.**
- Optimal inspection schedule.**
- cost of inspection = C_i**
- cost of disruption = C_d**

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So, planned maintenance should be 95 or good maintenance system will be 95 percent plan, 5 percent should be based on contingency or what you call ad hoc. So, we have 3 levels of planning that is what I think I was mentioned in the last class at the end. Long term planning which will be for 5 years or right in the beginning you do it. Then yearly planning middle time and there are short term planning. Then we looked into certain models actually right.

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Maintenance Management

The main advantages of bulk replacement are:

- Lower cost in that there is less non productive traveling time, and equipment is set up less frequently.
- May be planned in advance so that spares can be bulk purchased and less interference caused to production.
- Bulk lamp replacement may be made to coincide with one of the fittings cleaning periods.
- The maintained value of illumination will be slightly better.
- The overall appearance is better and brightness differences between adjacent lamps are reduced.

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So, always replacement models we looked into a number of them.

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And we also said that you need actually there are some disruption cost involved, because if you do inspection or if you do any kind of you know like pre planned maintenance work sometime there could be disruption. So, while you are trying to find out replacement analysis and all that disruption cost should be taken into account.

Now, then this is what where we look into the role of inspection in the overall; planned inspection in overall planned maintenance system. So, you do inspection every year, so

you might do inspection let us say if it is your financial year starts from April to let us say march then. You might do an inspection somewhere in January and February. To identify what is the work that is necessary this year which would have come from long term plan because you know every 5 yearly you may have to do certain amount of renewal work.

So, we have actually developed what is called maintenance profile. Every 5 yearly which you know between 5 to 10 years which items will be renewed completely replaced, which items will be you know partially replaced or whatever it is, that is what we have seen for large estate this will work out very easily. So, you do an inspection to find out whether this year you need it. Although, it is within 0 to 5 years from long term planning or 5 to 10 years or 10 to 15 years, whether this current year which might be 13th year or twelfth year, whether you need that or not that is inspection will give you first that.

So, once we have looked into visually you know applies the situation might do a small instrumental also. For example, you might have like to see if there is some places where you cannot see. You might use of instruments some you know instruments depending upon of course, the kind of buildings. For example, in a very important building you might do good lot of instrumental survey. To see that things are which are likely to deteriorate and things like that.

So, by doing a survey inspection you find out what is the work that would be necessary this year, if it is within then the next point would be. So, first you will see that whether it is work is necessary, if it is necessary then you have to also decide the priority. Some items when you are gone to inspection you might find that it is very urgent to be done. So therefore, you decide the priority if it is normal urgent or emergency. First you find out whether work is necessary not necessary then put it back for the next year's inspection right. Some time you know not necessary work necessary put in the next years inspection again.

If it is necessary, yes see the priority and then normal urgent frequent you know emergency. So, emergency you will do it weekly basis, urgent you might do monthly basis, and if it is normal then see whether you can outsource it to a contractor or something like that. So, planned inspection is a must for planned maintenance system

right. In the meantime, you can also keep some users request some leverage or some question for users request.

So, if the users request has come over the years may be which are long term type of emergencies will come anyway everyday or every week. So, then you say if it is necessary then put it back, because they might say that is you do external painting right that. So, you can even keep that put together for the whole year or you know some sort of planning within some inspection schedule if you have. So, you check whether it is necessary, if it is not necessary you think that it can be done later on send it back to the users say we will check it later on.

If you think it is necessary see whether again the priority whether you know it is emergency situation, urgent or normal and following the same manner. So, this is inspection is a must now cost of inspection; what is the frequency of inspection we have looked into a model related to that also. What we said is if you increase the number of inspection there will be reduction in emergency call. So, if you know the cost of emergency and cost of inspection, then total cost you can find out sum total of number of emergency calls multiplied by cost of emergency per calls plus inspection and number of inspection. And we have actually had a model I think last class we discussed about that right.

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Maintenance Management

*N_i is the number of inspections per annum.
f N_i , then cost reduces exponentially.*

$N_e = a e^{-bN}$

Where N_e is number of failures.

Cost of emergency repair = C_E

Total cost = $C_E N_e + C_I N_i$

$TC = C_E a e^{-bN_i} + C_I N_i$

$d(TC)/dN_i = 0 = C_E a e^{-bN_i} = C_I$

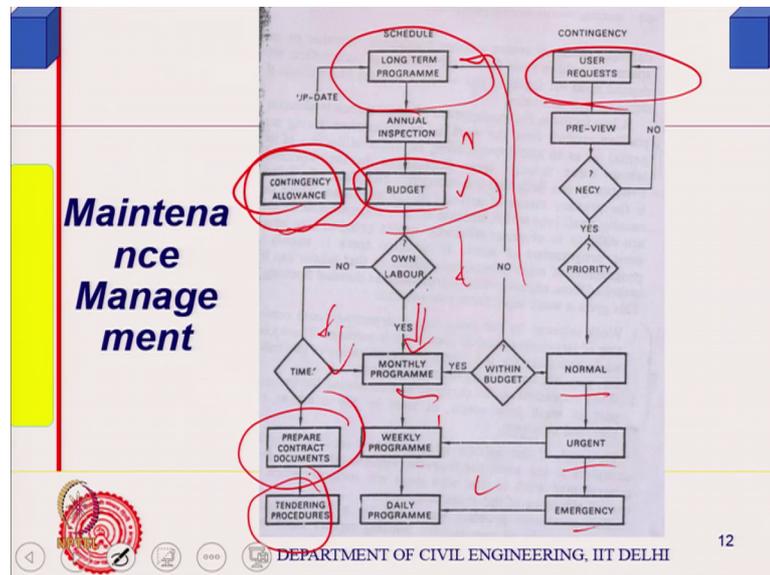
$1/b \log(C_E a b/ C_I) = N_i$

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So, this is the model that we talked about I think we did discussed this. So, we will not I am not going to this, but the point that I was trying to mention was that planned maintenance system we divided into 2 parts.

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One you call as schedule maintenance another is contingency. Now schedule maintenance is the plan part of it which will pre schedule them; contingency is what comes as emergency situation you know suddenly some request comes when you talk about that. So, it generally emergency or contingency generated from users request and scheduled come from long term program.

So, I have every 5 years program as I said 0 to 60 years, 0 to 5, 5 to 10, 10 to 15, etcetera, etcetera for each building. And for a given estate every building if I have the records. So, I do not know I know at which year it is. So, what is what I am supposed to do this particular year maybe I have already planned that I will be doing replacement of the internal wiring of some 10 houses, you know 10 set of houses. And maybe some other 10 houses I have been looking at the roof covering because their age is about 20 25 years.

Now, if I am I am at the 22nd year for a particular set of buildings; then I might find although I said that 20 to 25 years I will do all renewal only a part of them will require renewal. So, from long term I find out what is what will be done this year early planning you know. So, long term program from that annual inspection both generates my plan for

this year. Because, I do the annual inspection and say out of those 10, 5 I will do this year may be 7, I will do next year and so on 0. You know twentieth to 25th year I should do the roof cover covering replacement, but all I will not doing this year; I will be doing you know. So, it would be distributed over a period of time that is what we have seen.

So, first in a annual inspection and long term plan from that my work comes. I up to date my long term plan through annual inspection, then do the budgeting for the year. So, in the budgeting I must keep some provision for contingency. That means, I know over the years if I have actually seen how much percentage is the contingency, then I can keep that much provision in the budget. You know that is what normally done even other things also when you are doing planning.

For example: even if in your office if you are doing a planning in your office which could be design office itself. You will have sudden recurring cost which you know. For example, air conditioning air conditioners or you know like your papers. So, every year how much money goes on paper that you know? These are basically recurring and contingency sort of like either you can of course, paper purchase you can always planned. But I am saying some of them you know; although they are they come as and when suddenly somebody says that cartridges are down or something like that you know all the printer cartridges are to be.

So, you can actually replace them in bulk again bulk replacement policy you can adapt. But supposing certain contingency is also might come, because you between 2 bulk replacement you might require certain number of immediate replacement. So, you know how much percentage it would be. So, actually how much contingency allowance you should be putting that you know, usually it should not be too large. Then the budgeting you do for this year. Then you have to decide this year if I am doing the budgeting whether I will be doing by own or I have time. And I will put it to the contractor or outsource the housing.

So, if it is own labour then of course, it will be put into monthly and daily or weekly. You know weekly program or daily program depending of course, their priority, where if it is normal obviously I will put it in monthly. If I am doing by own, because I will maintain my work force also to a minimal level depending upon how much of the work which I

can you know kind of some, you know the workload has to be sustained; for the throughout the year and year after year.

Only those works you know those works which you can do yourself you will do yourself otherwise you will be outsourcing it. So, if the time has to be also so, outsourcing would be in that you need some time because you have a tendering procedure etcetera, etcetera. So, then if the time is available prepare contract documents, tendering procedure etcetera, etcetera. If it is no time or even otherwise you decide your workforce will otherwise be sitting idle. So you want to do or you have actually planned certain types of work to be done by yourself, then see whether you can put it in the monthly program, weekly program or daily program, depending upon of course, their priorities normal urgent or emergency.

Now if it is not within budget then put it back to next year. Now if it is not within budget what does it mean it means actually that; you see you have already done 60 years of planning. So, you know how much money you need in your budgeting for long term budgeting you have already done. So, even if the provision is not available here which means that it possibly is not an important work, may I can delay it possibly. So, put it to the long term plan and next year I will do it.

Now, since you have already kept some provision for contingencies obviously there will be users request coming on emergency basis. In that case or what cannot be taken care of by plan for example, I said between 2 bulk replacement, you will still require some spot replacement. So, those are taken care of by users request. Check if the users request comes whether you look at it you check it. If it is necessary, fine go ahead find out the priority and normal urgent or emergency etcetera, etcetera.

For example, user might request I need an internal painting right, I need an internal painting. Now you check by doing quick inspection well we have done it last year you do not need this year. Straight away you can find it out then you know you can put send it back, but you think it is necessary it is only you know cycle, near the cycle maybe it might have gone back. Now if it is internal painting it can you can delay it so it should not put it into emergency, but something which is you know like quite; like it can have effect, it can have hygienic effect or it can like the primary activity of the organisation.

Then you might think that is urgent or something might be even emergency. So, that is how overall maintenance planning is done.

Student: (Refer Time: 13:11).

Yes, this is we have to do it in emergency and so on. So, similar so therefore, what we have identified we have identified 2 components in the planned maintenance system one we call as schedule maintenance, another is contingency maintenance. Schedule maintenance takes care of all the planned items and contingency is what I cannot cover by scheduled maintenance you know planned maintenance.

In the schedule maintenance what I do? I bring it from long term planning then check look into the annual inspection. So, these are actually part of large estate maintenance system. That means, you must schedule you should play plan right in the beginning. You know every year there is a particular time when you say ok, you inspect there should be a team which should be inspecting all your facilities, and give you updated situation. So, that is you know maintenance work, in civil maintenance work can also be planned. Normally it should you know good maintenance system, should have as high as planned part than some emergency or schedule part you know so that is what it is right.

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Planned maintenance	Ad-hoc maintenance
1. Jobs can be grouped ✓	1. Isolated locations ✓
2. Large scale ✓	2. Small scale. ✓
3. High value jobs ✓	3. Low value jobs. ✓
4. Predictable (nature of job) ✓	4. Unpredictable ✓
5. Less % loss of time ✓	5. High % loss of time ✓
6. Less access difficulties ✓	6. Access difficulties. ✓
7. High volume of materials. ✓	7. Low volume of materials. ✓
8. Low administrative cost. ✓	8. High administrative cost. ✓
9. Control is possible for time, cost ✓	9. Difficult to control time, cost ✓

So, therefore, advantages of planned maintenance the schedule part of it. You can group many jobs; you can group the jobs right. For example, you know nearby facilities you

can just say that you do this, do this you can group the jobs or type of depending upon type of building. But if it is ad hoc or emergency type then it will be isolated location, today this place next day somewhere else. This will be large scale this will be small scale; obviously high value jobs in the sense that you will give a bulk. So, here each job is low value, but finally we will be doing the same thing.

Here, those ones which are predictable that is what you will take it and in this one you have decided not to do predictable you know so, but. So, only unpredictable thing should be taken in the ad hoc part. Percentage loss time will be much less in case of planned maintenance high percentage loss time in this one access difficulties this is also there, because you know permissions you have to enter you have to take possibly; you will have to take permission or ask the user. This will have difficulties this will have less difficulties. So therefore, high volume of material, low volume of material you can plan it even the storage cost will be lesser.

Administrative cost, possible time and cost high administrative cost difficult to control time and cost. So obviously, this should be costly this should be relatively cheaper. That is why you tend to keep 95 percent as high as 90-95 percent to the planned system, then only a small portion should be adopted. Therefore, economic and socially acceptable balance between these 2 are necessary.

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Maintenance Management

–The maintenance plan must therefore strike an economic and socially acceptable balance between the operation of two complementary and interacting systems – Schedule system and Contingency system.

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The slide features a blue header with the title 'Maintenance Management'. Below the title is a large yellow rectangular area containing the main text. At the bottom, there is a footer with the presenter's name 'B. Bhattacharjee', the department name 'DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI', and the slide number '16'. On the left side of the footer, there are several small circular icons, including a red one with a gear and a white one with a play button.

And they are complementary you cannot avoid emergency or ad hoc maintenance system, contingency system you cannot avoid right, but try to keep it at the minimum so that is what we have seen.

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Maintenance Management

Schedule system:

This covers items which tend to deteriorate at a more or less uniform rate and which do not have a high degree of urgency. The procedure take the following forms:

Scheduling work to be carried out at predetermined times. This applies where the incidence of failure can be predicted with some accuracy or where the periods are fixed by statute or contract, e.g. the terms in a lease requiring painting to be undertaken at fixed intervals.

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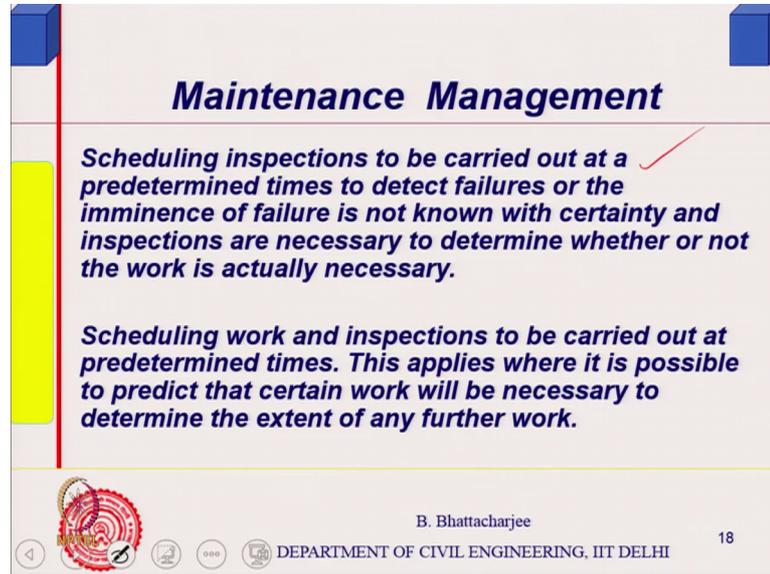
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So, which items you will take in schedule system. Well, predictability is there even in planned maintenance everything you cannot take in schedule; there will be some in the contingency maintenance. So, which tend to deteriorate at a more or less uniform rate and which do not have a degree of urgency. If you have urgency, then you have to put into. So, we have actually classified items into different classes, we have item we have classified items into different classes. So, those items where I can predict or I can actually find out a replacement cycle, repair cycle replacement cycle. Where I am able to find out that after 20 years I need replacement or you know major change or renewal. In the then those items I will put it in schedule system such that; I will be carrying out the work at predetermined times.

So, incidence of failure can be predicted accurately or somewhere I can fix the periods for example, external painting I will say- I will do it every 3 years or every 5 years or every 7 years. You know guarantee time is given to me 7 years or something like that I will do it every 7 years or something like that. So, if the periodicity I can actually estimate; somewhere through deterioration somewhere by frequency based. In that case I will do those items in the schedule system right.

So, it can also be contractual for example, in the lease you have decided you will keep it every yearly external painting will be done or something like that.

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Maintenance Management

Scheduling inspections to be carried out at a predetermined times to detect failures or the imminence of failure is not known with certainty and inspections are necessary to determine whether or not the work is actually necessary.

Scheduling work and inspections to be carried out at predetermined times. This applies where it is possible to predict that certain work will be necessary to determine the extent of any further work.

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So, second thing is inspection is a must for planned maintenance system. So, you know you can identify the defects and where you can actually imminence of failure, you can identify you will put them schedule where you cannot identify the; you cannot predict. So even through inspection right so inspection through inspection actually those one which you can predict you will put in schedule, which I still after that I cannot predict they will go into contingency system like; sudden leakage of pipes something like that.

Although the inspection might tell me there is you know there is some problem. For example, if the rusting is occurred on the pipeline, or something of that kind or the some damages, that by inspection I should be able to find out ok. So, essentially where I can predict the work, I will put them in schedule where I cannot predict the deterioration or the time of my repair I will put them in contingency.

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Maintenance Management

–Contingency system:
This entails a policy of waiting until a complaint is received from the user before taking action. If the frequencies and types of complaint are analysed, procedures for dealing with remedial work can be planned even though the timing is uncertain. That is, the direct labor force can be sized and manned to deal with the predicted workload and materials kept in store for the more common repairs.

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So, this is you know waiting till the complaint comes this is basically those ones till the complaint comes and users has to be relied on this. So, what you can do is even then if you are seen last year's complaint, how many complaints came last year? After doing planning how many complaints came last year or previous year. So, if you have over the years on an average basis how many complaints came of a given type and what is the cost involved, if you can predict that then it is quantum can be predicted. Although, the actual job you may not be able to predict, but the quantum the amount of work or amount of money, finance needed for that for every year that you can predict.

So, that is you know you put that. So, this is what you put into the contingency system. So, which should be preferably done through direct labor force, because your own labor force suddenly something emergency comes you cannot hire somebody time is no you do not have time. So, it should be direct labor force or if there are even if you outsource it give it to such an agency which is available all the time to you. You know you call them and they will come in the night, but then they would be charging high, because they will also have surplus work or something like that. You know unless they are able to give work force work to the work force all the time.

So, best you know it is basically such work should be taken care of by direct labor force. This works you know you find out your labor force which is required to sustain, you know labor force which you can actually for you know have a sustain workload on emergency basis; that also you can find out if you see periodically if you look at the data yearly data then you can actually find it out.

So, a preferably contingency works are done by direct labor force and overall workload you can predict right? And also materials etcetera you can keep it in a store for the common repairs and such things like that.

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Maintenance Management

A necessary feature of this system is the need to introduce a delay period between the receipt of the request and the actual execution of the work.

The main difference between schedule and contingency maintenance is that the lead time, i.e. time between notification and execution, is greater for schedule maintenance.

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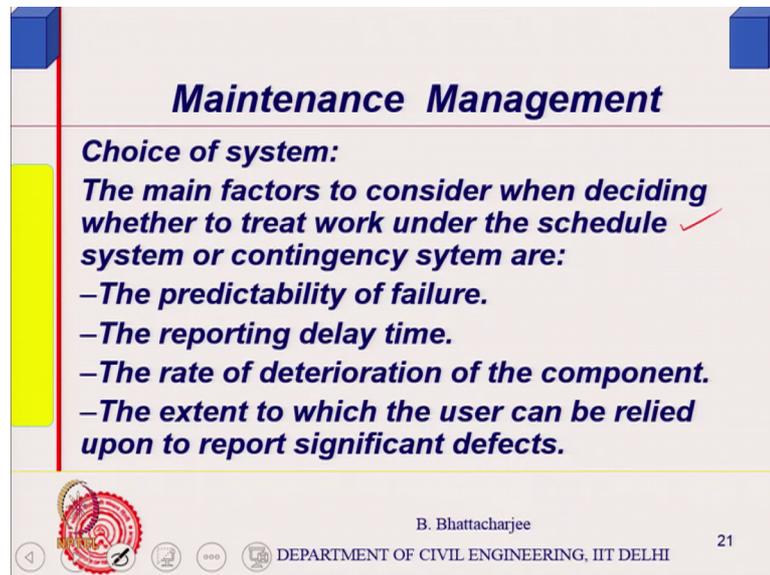
So, basically that is what is your contingency and schedule system differences. How much time diff gap you can give? If you cannot give a time gap between the complaint you have got it between the time, you have actually identified that there is a or you have come to know that there is a problem; to the time when you can do the repair. If the time gap available is less, then it will go to contingency if I can delay this work a little bit then I will put it into schedule maintenance you know.

When I have come to know about that particular type of activity or repair work has to be undertaken. If I can delay if there is a delay available first identifying there is a problem. So, from the time of identification supposing I identify at this time, supposing this is time axis at this time I have identified and one case is that ok. After identification I have sufficient time to yes, sufficient I mean I can delay it because it will not have other implications. No cascading effect of other defects or stop my function or something of that kind.

Then I can put it into the schedule system, but if it is to be done immediately then you better do it by contingency system. So, it is essentially the delay period this is called delay period right. So, main difference between schedule and contingency maintenance

is that lead time. That is the time available between notification and actual execution. So, if this is greater than I put it in schedule maintenance, if this time available would be short then I put it in contingency.

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Maintenance Management

Choice of system:
The main factors to consider when deciding whether to treat work under the schedule system or contingency system are:

- **The predictability of failure.**
- **The reporting delay time.**
- **The rate of deterioration of the component.**
- **The extent to which the user can be relied upon to report significant defects.**

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So, the main factors while deciding whether a work should schedule system or contingency predictability of failure, reporting delay time sometime I may not be able to even know when there is the actual defect has got initiated. I will come to know about it much later; in such situation you cannot put it to schedule system, because the delay period would be less. So, rate of deterioration of the component that should be known. And if it is, if you cannot rely on user then you have to be on schedule system on your inspection. If sudden complaints are there whenever user says I can do it I can put it them point into contingency system also, but idea is to maximize the plan minimise the contingency part.

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Maintenance Management

Factors influencing Delay time:

- Safety considerations. ✓
- User satisfaction. ✓
- Effect of failure on the primary activities of the organization. ✓
- Dispersion of job situations. ✓
- Cost growth. ✓
- Misuse of property. ✓

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So, sometime safety might be affected, user satisfaction is also the other issue if you delay it users will be unhappy. And primary activity of the something you do not do. Primary activity of the organisation might be affected. Second thing is if I can you know delay this job so I can you know the sites could be dispart sites. I might decide I can delay this job, but I will do it all of them together.

If there are some more complaints from a similar places or you know if not compliant might I might group, the jobs together. So, this is dispersion of job situation is important. Cost growth sometime you do not do it cost will increase, cost of maintenance will increase and of course sometime misuse of property can also happen.

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Maintenance Management

Programming Problems:

- The small scale and diversity of a large proportion of total workload.*
- The need to determine the best work sequence for a large number of interlocking tasks involving several trades.*
- The uncertain work content.*
- The dispersal of sites.*
- Interruptions to the normal progress of the work.*
- Irregularity of user requests and the extremely short lead time for executing emergency repairs.*

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So, this is how we should actually, but then there is problem involved because, as I said that building maintenance management system or building maintenance or building as a system, large number of buildings I am talking of. I am talking about single building maintenance it is large number buildings we are talking about, large number of buildings in an estate. Generally, that would be the case usually whether it is like even if your office. If it is a small office one thing, but office might have been you know it must be on rent. So, there were the owner might have number of offices similar offices in the vicinity.

So, we are talking about similar sort of situations. So, in such ones number of items are too many. I said there will be civil items, there will be electrical items, there will be mechanical and trades people involved might be carpenter, the fitter you know even mason. So, trades are also very different many different trades come in they you know kind of interlocking activity.

For example, I can give an example of a fixing of a let us say night latch door lock right, in a board timber board door right door. So, suppose you want to fix it first the carpenter will have to make the hole. The latch will penetrate into the work I mean masonry work into the masonry work. So, you have to actually some mason will have to come and create that space for the latches to go. Then the fitting will be done by a fitter, lock opening and you know it will be done by a fitter.

Now, you see the sequence of operation; first carpenters operation. May be part of it is then masons work I mean if somebody is expert in all of them that is a different issue, but usually I am giving simple example there will be more complex one. Then there little bit of masons work, then fitter comes in he fixes it up checks that is working fine right. Maybe carpenters work is repair required again. Finally, mason will come and do the plaster and things like that. So, this is all interlocking activity not a single you know it is not that I come finish and go away.

Even when an electrical rewiring is done first masons work is required. Then you know conduct will be placed the electrical electric electrical electrician should actually fix those. So, there are interlocking activities actually which is involving different trades and different types of items. So, with this kind of small, but the quantity is small. In this classroom in a classroom you might have about 2 doors or 3 doors. Maybe you know some lamps maybe some lamps and fix are some 20 25 of them.

So, you can see that small items, but number of them. The item is not a big one as opposed to let us say you know an industrial scenario, let say thermal power plant now will have a huge turbine single item. Although, turbine itself will lot of chemical items and electrical items involved into that, but what I am saying in buildings there are too many items. Building as a system will have too many items, comparison let us say another infrastructure facility bridges much less; much much less number of items actually and similar kind.

Here the too many trades too many number of items so it is not easy to actually you know plan this work. So, there is a planning difficulties there the need to determine. So, therefore, you have to decide the best work sequence, otherwise your mason will just remain idle, mason will be idle once the carpenter has finish the work. So, if you can do some work sequence with several such works grouped together that would be best.

Then uncertain work content that is also there sometime. Dispersal of sites from one site here, and next day another site; for example, if you have maintenance depo is possibly start from here. You know from the depo goes there it does the repair comes back again then there is another site goes there. So, dispersal of site is there these are all other problem and some time user might not allowed to do the work. Users for example, ac

servicing of let us say all the rooms in office rooms in block 4, right? The office occupant so I am not available right now.

So this is also like normal problems of the work because the classroom is not available forget it. No, one servicing now you do it sometime later on Saturday or Sunday you know this something of that kind. So, there this kind of issues involved. And if you are relying on user sequence then there is irregularity, it cannot be you know it will not be periodic. So, all these issues are involved in planning the maintenance work.

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Maintenance Management

Planned Inspection:

Purpose:

1. Preparing the schedule of facilities to be maintained at present and their current condition.
2. Detecting deviations from standard and faults and their reasons.
3. Ascertaining extent of damage and their remedial measures.
4. Checking the correctness of past repairs.

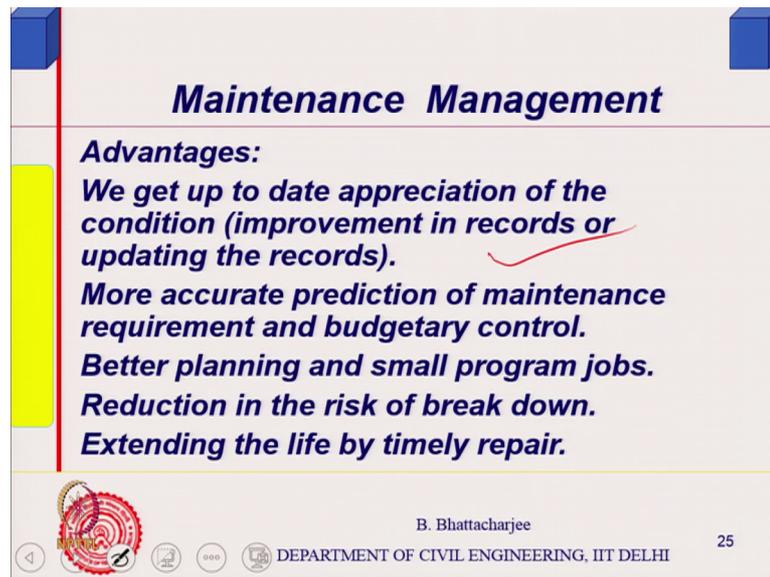
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And therefore, this is not an easy job, but still it can be done and do as much as possible put it to the plan some will be obviously you know not everything you can plan.

So, this is what is there and planned inspection is a part of planned maintenance that is what I have said. And if you look at what is the purpose preparing the scheduling facilities to maintain in the present. At present first you find out which I should be doing maintenance this year and it is current condition. If there is a deviation from the standard that I check and extent of damage and their remedial measures, and if the past repairs are been done correctly or not that also I check through inspection right. So, basic advantage is you get up to date appreciation of the condition right.

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Maintenance Management

Advantages:

- We get up to date appreciation of the condition (improvement in records or updating the records).***
- More accurate prediction of maintenance requirement and budgetary control.***
- Better planning and small program jobs.***
- Reduction in the risk of break down.***
- Extending the life by timely repair.***

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And it should be actually today it is very easy to keep a track of everything and record them actually. And keep a kind of a track of it, because it is all you know we have all computer based. So, you recording is very easy you record it and store it, but people should have the right idea that we want to do a scientific building maintenance management system so it is all possible to do that.

And that would allow you to actually save lot your money because you can control. So, more accurate prediction of maintenance requirement, budgetary control is possible, better planning of small jobs that would be there. And risk of break down reduces because we have seen that number of emergency calls reduces exponentially if you are doing in increasing the number of inspection. So, this also increases the life also right. So, inspection is part of planned maintenance system.

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Maintenance Management

–Inspection is important part of planned maintenance.

Group the elements on the basis of

- a. Location.*
- b. periodicity of inspection.*

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We can group them location wise and based on periodicity of inspection etcetera, etcetera.