Building Materials and Construction
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Module - 10
Lecture - 6
Walls: Defects and Durability

In the last lecture of this module on walls and masonry, we shall look into some defects. Some of the defects and issues related to durability of and walls in general.

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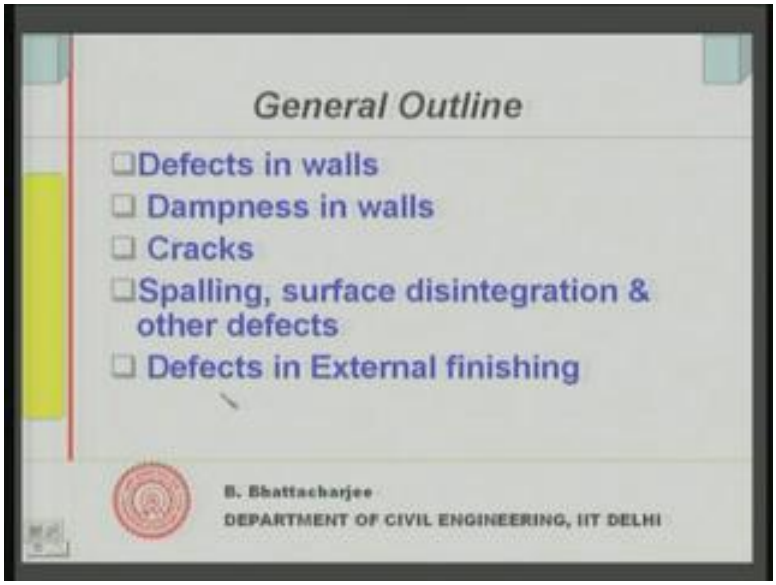

Therefore, outline of our lecture today, would be defects in walls. First we will look into some of the defects in walls and these defects include: dampness, cracks, spalling, surface disintegration and other defects and some defects in external finishing. So, that is what we will look into. So, let us look into what is the kind of possible defects.

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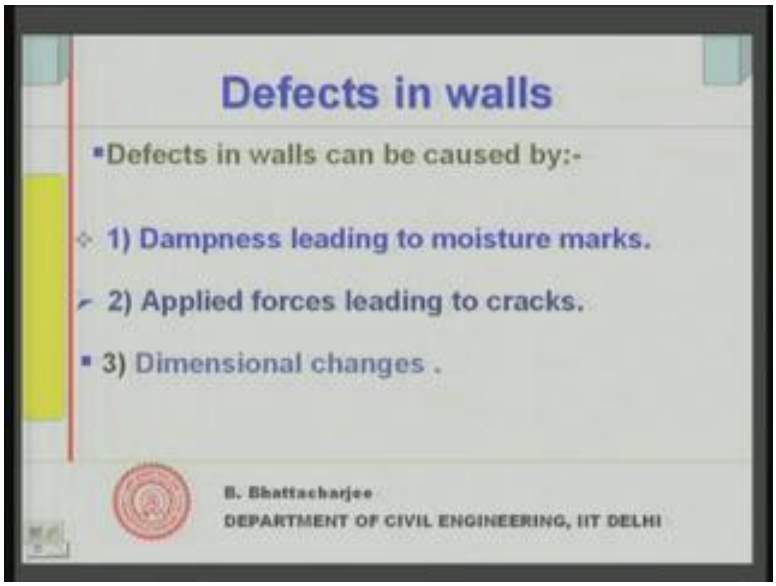

In fact, defects in walls can be caused by I mean they can be actually classified into 3 types of varieties right. All the defects broadly of course 1 can classify, of course there is no sharp line of demarcation, still 1 can possibly classify them into causes can be classified you know they could be caused by 3 possible things. Now, first 1 and the most common is dampness leading to moisture marks. Normally that is what 1 would have observed.

Dampness is a very common defects or problems durability related problems in masonry walls and masonry structures in general, in buildings in general that is very common. And then that leads to certain additional things like it is moisture in that can lead to deterioration of concrete. We have seen that between corrosion and so on, which require moisture. So, therefore, in buildings dampness is a major problem. We will try to you know devote some time for this issue.

Then of course, cracks. Now, crack is essentially related to forces. So, you apply forces leading to cracks, some sort of forces, forgetting about special cases like heavy wind, very high wind effect or wind loading or exceptionally sudden say high earthquake or seismic loading. In an otherwise cracks can come and we are looking into those issues. Note of those high loading or accidentally high loading, this way I am not looking, but normally cracks can come into structures walls and masonry structures and we are looking into those.

And some dimensional changes that actually sometimes lead to crack or sometimes some other kind of defect local cracks and things like that spalling of brick and so on so forth. So, some of this we will look into. So, that is how we look into actually right. So, first let us look into crack, I mean dampness.

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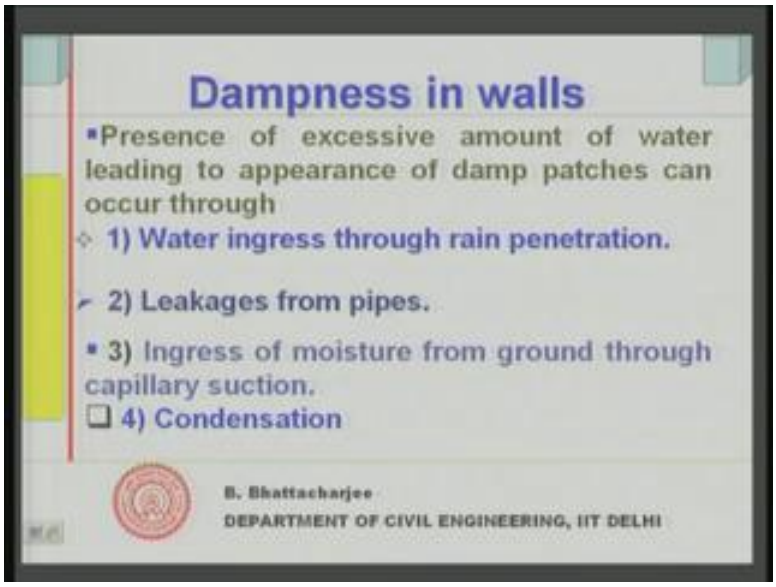

So, dampness in walls is presence of excessive amount of water leading to appearance of damp patches, you know that is what is dampness? So, what is it actually dampness means; there will be excess water then that should be, after all water is always present there. In fact, in most of the cementious material you know it was chemically combined water and the water is a part of the system itself absorbed water. Some amount of water can be absorbed water as well or mechanically held, but that may not create that may not give rise to dampness. We may not feel like any water it cannot give.

So, when this moisture content becomes excess and kind of it gives us an appearance that there is a presence of damp patch there. That is what we call as dampness otherwise, moisture presence of moisture may not be dampness all the time, because after all chemically combined waters are always there in many of the cementious material. In bricks also absorbed water could be there a little bit, but it may not be a problem in terms of dampness, dampness means; that you must have of damp patches.

And this can be caused through water ingress from pain penetration. This is 1 major cause. Some time rain penetration, penetration from the rain. And then it can be due to

leakages from pipes, pipes leakages you know excess water coming in from there. Then it can be due to ingress of water from ground to capillary suction. This is very important, because you see ground contains water, ground water is always present and you know most of this masonry materials they are capillary porous, their absorption is much higher.

The amount of absorption can be 10 12 percent and of course, the maximum amount is fixed in the 24 hours standard absorption is fixed and we have seen that absorption is a property which is important as far as brick is concerned. But brick generally normal bricks ordinary bricks they would be capillary porous and they would allow moisture to come into them through capillary action and there can be rise of dampness rising dampness could be present there due to capillary from ground. So, this is 1 situation.

And, then this situation: the last situation that we are talking of condensation. It is not very common in India, usually occurs in such places where there are cold climate outside climate is cold. In fact, it would look something like this, because we will not discuss much about it. So, let us just discuss right away something about it.

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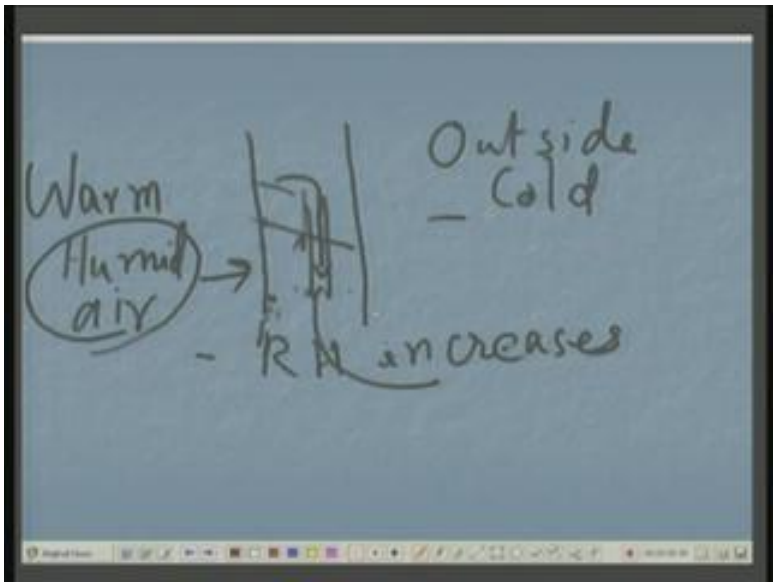

It can be something like this you know; you have the wall and outside is cold. This is outside and is cold. So, cold actually condition is cold. This side is warm. This side is warm condition. So, this surface is cold. So, when humid air you know air containing moisture vapor humid air, travels towards this direction and reaches touches the cold surface touches the cold surface.

Now, you know the humid air means; there is some amount of moisture vapor present in the air and capacity of air to hold on to the moisture, thus a function of the temperature itself. So, we talk in terms of relative humidity. Relative humidity is nothing, but it is the ratio of the amount of moisture present in the air divided by the saturation moisture content at that particular temperature, expressed in kg per kg weight of mass of dry air. Moisture content in air is expressed in terms of kg per kg mass of dry air. So, that is relative humidity.

So, when you have relative humidity, amount of saturation moisture content it is a function of temperature. And as the temperature reduces, the amount of water the air can hold or the saturation moisture content becomes less. So, when suddenly it comes in contact with the cold surface or somewhere in between let us say; if I have a cavity wall or something, somewhere you know in between also within the wall somewhere in comes in contact with the cold surface or it becomes cold, its saturation moisture content reduces, thereby its relative humidity will increase.

So, R H will become relative humidity increases. So, as relative humidity increases, it may so happen that, it reaches the saturation moisture content and still the temperature is lower. That means the moisture present in the air, is more than the amount of moisture, the air can hold at that particular temperature. What will happen at that stage? Condensation; The excess moisture will condensate. This can happen with a solid wall and then there is a problem, then you can see moisture patches. It can happen within a solid wall and you can see moisture patches.

If it happens within a cavity wall, of course cavity wall has the advantage, because in the cavity wall it will be brain cavity. It can happen in surface also in some clay cases as we shall see. So, condensation is that kind of a phenomena, where by actually it work as mostly in when inside condition is warm and outside condition is relatively cold. So, warm air coming in contact with some where its temperature is getting reduced and the due point as we say that means, the saturation it moisture content becomes saturation. Moisture content the due point has been reached.

Now, below this temperature, if the temperature is reduced further, the amount of moisture present in the air will be more than the saturation moisture content and then vapor will be condensing. So, condensation is that kind of phenomena. It can lead to

dampness in buildings, especially in cold countries where it is maintained warm. But this can also occur in some part of northern part Himachal Pradesh etcetera of India as well right. So, this is the fourth issue, fourth type of reason why dampness cannot occur right.

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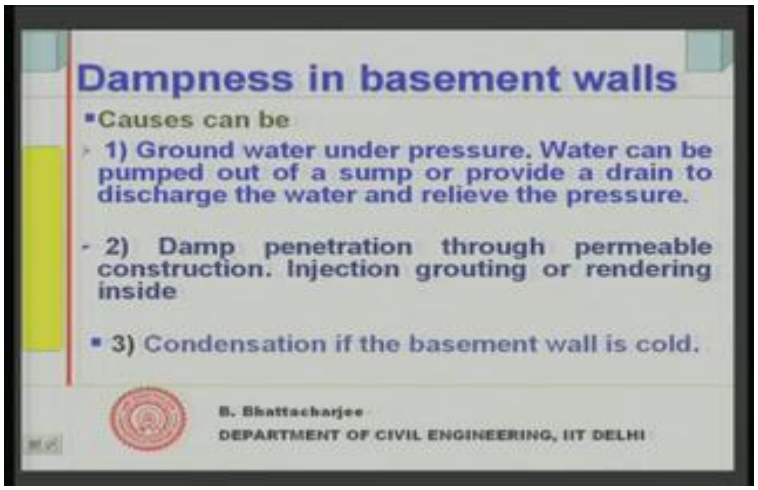

Now, let us see causes for ground water, you know dampness in basement walls let us see dampness in basement wall right. This can occur when ground water is under pressure, very high ground water pressure. If it is there, then basement you know basement you must be aware of what is a basement, a basement would be like you have this is your ground level let us say and you have construction here right. So, this is the basement level, here basement wall is there. Now, we can have dampness here, dampness can be here can be absorbed here. This can happen if there is excess pressure. You know the water pressure water head here is excess pressure of the ground water is there, then this might result in pushing through the permeable wall. This even happens sometime in concrete wall as well. Usually basement walls will be as we see and it happens to those also, not necessarily masonry, but is happens to concrete as well and if this is this can show signs of dampness here.

Now, if such dampness signs have been shown or even high amount of water is coming down, it will depend upon what is a function of the basement, what are you doing in the basement? If you can tolerate some amount of water in the basement, then you can create a sump and from there you can pump it out right, otherwise you can even construct drains here such that, such kind of filtering system so that water percolates into the drain provides slope and it is actually it is drained out. It could be one of the reasons.

The other thing could be make this system impervious as impervious is possible. Make this system impervious as impervious as possible by various kind of means like; putting injection or chemicals inside which will block the pores, because it is it can only come through if it is permeable, if it is if there is a permeation possible through this then only it can come. So, you actually densify this or reduce down this permeability. Some time you can give treatment here. So, these are the kind of remedial measures that would be available, but there is no 1 remedial to depend upon case to case.

So, damp penetration through permeable construction that is what happens an injection grouting or rendering inside. Rendering is nothing, but some kind of a plaster thick plaster. But that is not a very best solution, you know the rendering although is mentioned it is not a very best solution, because you provide a rendering to the inner surface. You are providing rendering to the inner surface like here, but moisture; that means, will penetrate up to this. Moisture will penetrate up to this portion straightaway which means that, it will if air is also present unless we saturated all the time it is unlike to be saturated all the time. It will be only saturated for some period of time, but after that it will be partially saturated.

Anyway it can be dried up unless there is continuous moisture supply from outside, which normally would not be the case, because ground water level would rise only during possibly the rainy season, then it will go down.

So, there is a situation of wetting drain possible which means that it will be wet saturated for certain period of time and dry for certain period of time. So, if that is the situation, then what will happen the all the deterioration process in a reinforce concrete structure, if it is reinforce concrete then this can take place. So, in a reinforced concrete situation, providing rendering here may not be a very good solution, because it can cause it can attack all those internal reinforcement also. So, internal rendering could be the other solutions.

And condensation in the basement wall is possible when it is cold. If it is warm inside and cold outside, then condensation. That is what is explained; what is condensation is just explained. So, it can happen that way right. So, dampness in basement wall we have looked into. Let us look into dampness near ground.

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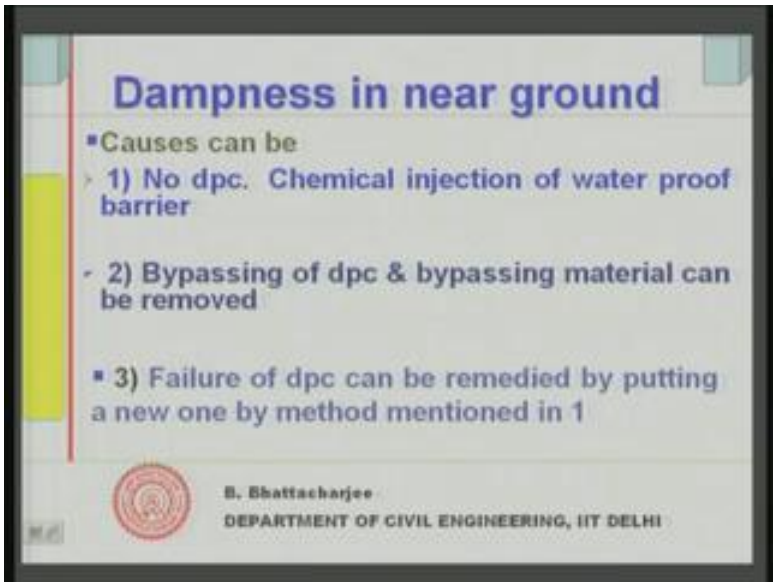

Now, if you see dampness near ground, this can be caused by no dpc. You know to avoid we said that bricks are capillary porous. So, what you do, you know rather I will show it in a diagram. Bricks are capillary porous to ensure that the ground water or capillary rise do not take place through the brick wall, you provide damping force at the climp level. That means, just above the any soil level just above any soil level. So, whatever and usually it has been bituminous treat. There can be varieties of chemical treatments today possible. Earlier it was all bituminous treatment water proof treatment, which will not allow capillary water to rise through and that is called a damp proof. It is provided all through the wall through the cross section to the whole periphery you know through all the walls in the building, so above the just above the as we shall see now.

First thing: so rising dampness is possible or near the ground it could be due to rising dampness. Now, if such a thing is happening that could be one thing could be that there is no dpc. So, if there is no dpc well or dpc is there it has failed or there could be situation by passing of the dpc. We will see the by passing of the dpc, but there can be failure of the dpc, dpc has got damaged. It has now walking pretty old and it is not worth. So, in such both the situations what you can do; you can actually try to provide the kind of a water proof.

Now, such thing can be done through chemical injection. Not very best method, but this can be done through chemical injections. Various chemical injections, such that you

create an effectively impervious layer within the break level of the dpc the level of the right. So, chemical injections of the kind which will be usually in liquid form high viscous liquid form, which when you know like when enters inside solidifies in the long run, because either the solvent evaporates or the chemical reaction or curing take place by which the liquid which has entered that actually solidifies. Usually the second type is likely to be there most often.

So, it will solidify, it has to solidify with injected in the liquid form enters into the brick and then it solidifies. There are various kind of construction chemicals in this connections and chemical injection techniques can be used. Well, if the by passing of dpc takes place just as an example.

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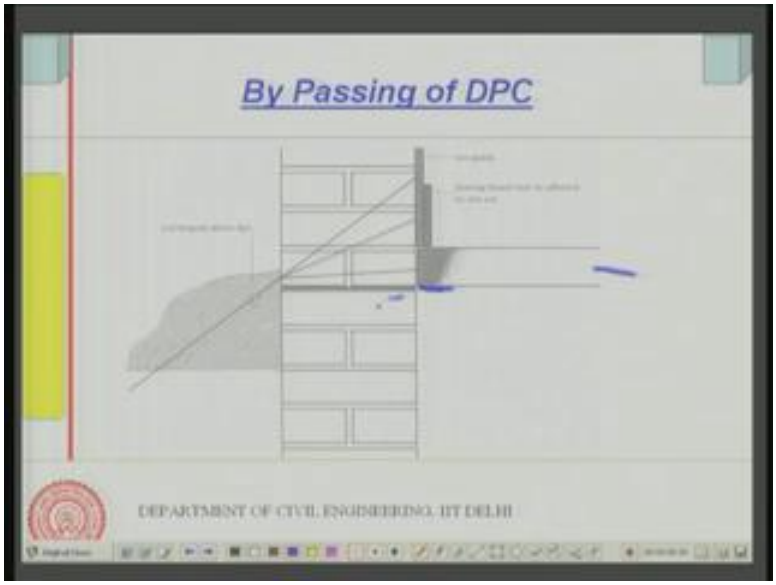

These are example of by passing of dpc. This can happen. This example shows how by passing of dpc can take place right. For example this is your damp proof course, this is the level of your damp proof coarse right and this is your flow level all over. So, through the wall this is the flow level. This is the flow level and you can see you see this is your damp proof coarse and this is just below the clink level you provide so that soil is here. So, now soil from soil no nothing can enter inside, just above the any soil level. No soil level should be there.

Now, supposing what you have done 1 would have possibly hipped up soil around. This could be 1 situation. There could be many reasons, you know similar by passing the dpc.

So, the dpc should not be bypassed. Now, supposing a heap of soil has been put here like this, then the moisture will enter through this. And this moisture will then travel by capillary rise and you are going to see wet patches here right. So, if there is some board or something, if there is some board skating board is there that might be affected, it is a timber 1 it might be affected due to this and even through the moisture will penetrate. So, this is what is by passing of dpc.

Now, what is the solution to such situation? If by passing of dpc is taking place then remove this soil. You know people what they do sometime they create possible planted some small gardens outside the building and this situations are quite often absorbed. So, when this is happened this original clinch level much above the original clinch level you are putting some soil and that soil absorbs moisture. So, what you got to do; just simply remove this portion ensure that no soil is there above the dpc. There can be several other situations also in cavity walls and so on. That similar skating of dpc may take place right or by passing of the dpc may take place.

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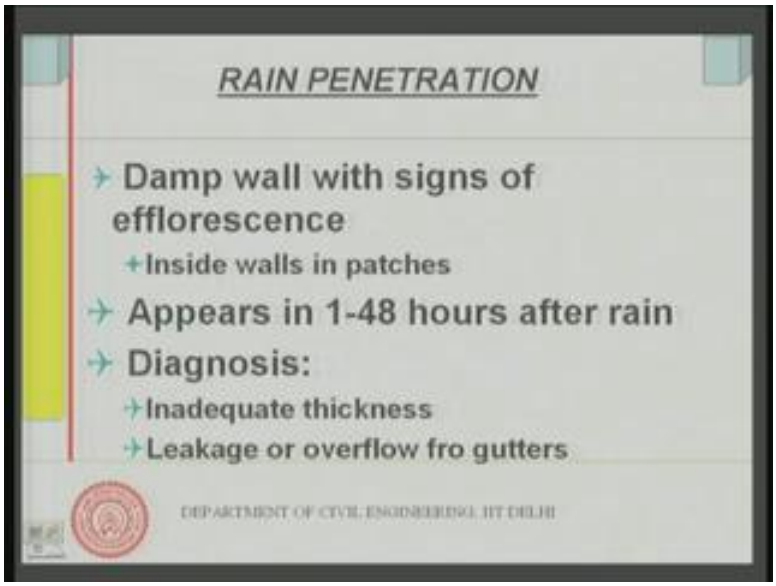

Rain penetration: so we have seen some cases like ground water capillary rise situation which I mentioned out of the 4 things, condensation I have discussed a little bit. In fact, I have started the reverse order. First I discussed the condensation basement also is related to condensation. Then we discussed about capillary rise situation. Now, let us look at the

rain penetration. If it is you know what does rain penetration do? It will find damp wall with signs of efflorescence after you know after the rain.

If the rain penetration is taking place we remember efflorescence we of course, discussed about efflorescence again today a little bit. It is a kind of, you know it is not a major durability problem. Efflorescence is nothing, the soluble salts because moisture enters into the wall. The moisture evaporates from the surface, upto the surface is the salts, but the moisture itself will evaporate right, liquid water will become vapor and then it will evaporate leaving the salts at the surface.

So, you get patches, white patches marks of patches and this must be quite common in many places in walls. Most of you might have even observed in many places, if this is a usual phenomenon. So, damp walls with signs of efflorescence and usually inside walls in patches; that is what we will see. And normally they will appear just after the rain 1 to 48 hours after rain. You know infective sea this occurs after dampness is absorbed more after the rain. It is also way to actually diagnose what is the cause.

For example you can see the periodicity of a appearance of the dampness. If it is there all the time the moisture source is also there all the time. If it is there only for certain period of time, then it dries off leaving its mass then it means that, during that you know the period the moisture was it was in the moisture source was there. So, rain if it is rain penetration, then you will see just it after the moisture marks or wet situation you will see most after almost after the rainfall or 1 to 48 hours rain it will appear.

And then this could be because of inadequate thickness and leakage overflow from the rain water drain pipes the gutters. So, inadequate thickness could be 1 of the reasons. Now, IS 20 I or IS code 1905 it gives little bit of rain penetration. In SP 20 is a commentary on that particular code. It gives you some guidelines in tabular form. So, inadequate thickness is the issue what has been dealt in. And what are the condition where you should have what kind of thickness has been suggested. We look into that just.

Thickness the basic principle is very simple. I have mentioned to you earlier sometime that, the principle is something like this. You know this principle is something like this.

You have the wall let us say I mean you have the wall right for the section and rain water will come through this right. Rain water first of course, it is here. Usually when rain force vertically there is also a wind velocity and there is a terminology called driving rain, driving rain index and that index is nothing, but the product of the rainfall intensity in millimeter multiplied by the wind velocity, you know it is something velocity is an index. Velocity multiplied by the rain fall intensity.

Now so, usually there is a horizontal component of the velocity, because the velocity will be horizontal thrust. So, there will be some horizontal flux of the water at this surface. Now, this will result in what. Moisture content profile if you draw it, supposing I draw the moisture content profile, I allow high moisture content here, moisture front if I call it, it will go on entering like this. After some time moisture front will enter further and then it will enter further.

Now, the idea is that if the rainfall continues for long periods of time, moisture front will advance within the wall from the exposed side to the unexposed side. But rain does not continue for very long period. In any place at best it may continue for its intensity maximum intensity of this will get reduced down say it continues for few hours. Now, in this process what will happen? Moisture front will advance, but after that rain stops. So, when the rain stops drying starts.

Now, thickness should be sufficient such that, by the time the moisture you know the moisture rain stops, the moisture front should not advance to the inner surface. I have I think I have mentioned it earlier. I am repeating it again. The thickness should be sufficiently large such that, we can look into more details of the same thing.

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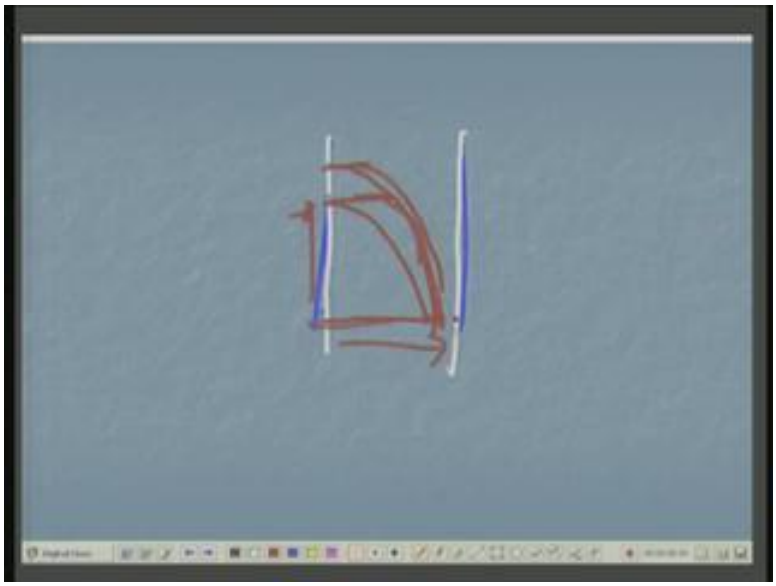

Thickness should be sufficiently large. This thickness should be sufficiently large such that, the wet front. If this is the moisture front you know there is a moisture content, what I am saying this is a moisture content value and this is the thickness x axis is the thickness. Moisture content value here the moisture content is 0. So, after some period it has increased like this, then further the rain continues may be it will be something like this. May be it is saturated here. May be it will not increase here, but it will increase here, so saturated it has been saturated. But the moisture front should not reach at this point. Thickness should be sufficiently large such that, the moisture front does not reach here. That is 1 of the way of protecting against protecting against protecting the rain penetration.

So, inadequate thickness if it is there that can be rain penetrated, but quite often it is something else is happening; either the rain water is accumulating on to the roof top, the gutter is blocked or you know it is there is some kind of over flow that is taking place or some other leakage from the rain water. That is how the rain water penetration can take place.

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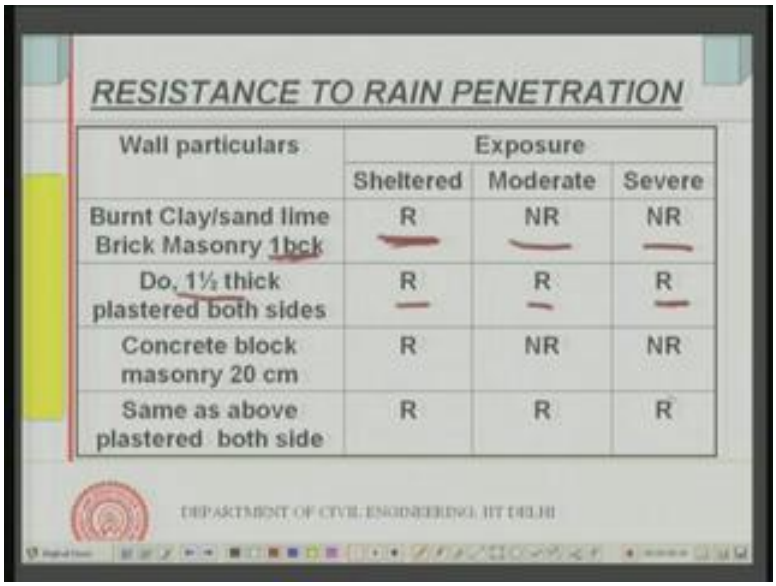

Now, the code gives you this sort of a table; resistance towards rain penetration. The table has got as you can see particulars of the wall, wall particulars. Then it gives you different types of walls. Say burnt clay and limes brick you know let us say burnt clay or sand lime bricks masonry 1 brick thick wall and cluster. Then it recommends if it is only 1 brick thick wall 1 brick thick wall its only 1 brick thick wall. If it is sheltered there is no rainfall then it is recommended for recommended.

If it is moderate or severe it is not recommended, because thickness is not sufficient. I do not have even a plaster here. Simply 1 brick thick wall. So, it should be only partition wall or within the limit. You know that is what it is. Similarly, same brick clay brick plastered on both sides if you have and you have 1 and half inch 1 and half thick brick, then it is recommended everywhere. 1 brick thick means something like 225 millimeter or so. And no plaster then this is in various very severe rain conditions it is known, but if it is 1 and half brick thick and you have plaster on the both sides, then this is sufficient and it is recommended even in most severe rainfall condition.

Similarly, there are many others in the code table, you can look into the code table, but I am just trying to give you the whole idea and a basis of it. Concrete block masonry 20 centimeter. Concrete block masonry let us say twenty centimeter without any plaster on any side then it is recommended here sheltered, but not recommended and not recommended in moderate or severe rainfall. That means if you are using a north east

either of these cases is not really recommended in north east where the rainfall is very very high intensity or driving rain index will also be very, very high. Same is above, but you have plastered on both sides then it is recommended.

So, code gives you more details about the same, but we are not really right now interested in the details. We are just trying to look into further you know. So, 1 can look back into code refer back on to the code.

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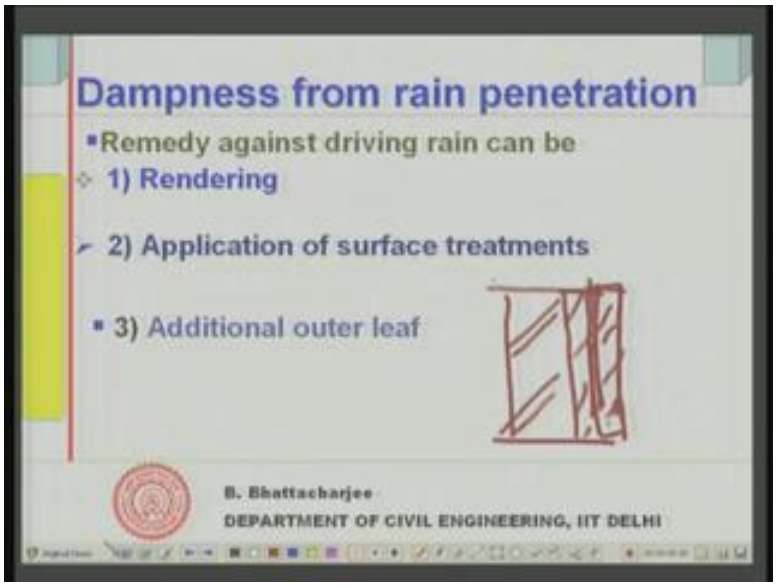

Remedy against driving rain they can be rendering, increase the thickness. Rendering means plastering increase the thickness. So, we put a kind of render on the external surface, this will give you. You can give some sort of a application of surface treatments. I will just discuss this surface treatments. Application of certain types of surface treatments you can give and this surface treatments are you know include 1 of them it includes rendering as well, but you cannot certain coating, but they would be costly. So, you have to use a possibly if it is penetration we need not use anything, because it is costly situation. So, the cost has to be same, but all the types of surface treatment possible both on masonry and concrete. You can provide an additional outer leaf. What I mean by additional outer leaf is that, you have already the wall right. This is your wall, already existing wall. You provide an outer leaf, but this would serve also good purpose for condensation in cold climate, but here of course, this end is of course, that sort of or

even it should be just rendering or outer portion of the wall, you can increase that. So, that could be one of the solutions. Let us see the surface treatment.

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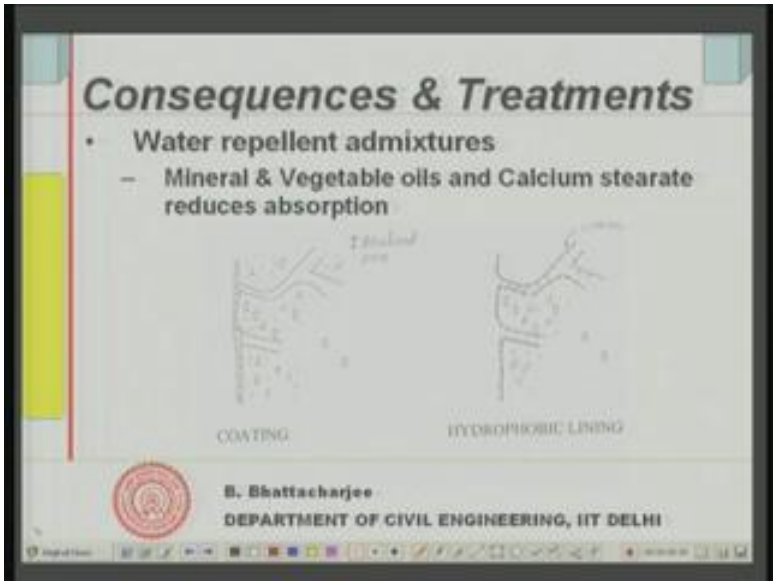

These are the kind of … Well in concrete if it is concrete of course, 1 can use water repellent admixtures. I mentioned it water proofing compounds. You know even in mortar you can use this. That is what I mentioned, but these admixtures which are there they are mineral and vegetable oils of calcium stearate and that reduces absorption. I mentioned to you earlier also in connection with the concrete and they can be added to the plaster or in concrete surface if this is there, then in additives you can use.

But the surface treatments which are there, there are 4 types of surface treatments which can be used on masonry, but even used in concrete. Some of them are costly and used in masonry therefore, they are used very judiciously you know just like that, because cost is an important issue. Like coating is one of the ways; you know you just provide a coating, because in all this mortar concrete or bricks you know masonry they are all porous. So, these are your pores let us say these are your pores. So, if you put a coating very fine coating, it will depend upon the situation. Fine coating can be 600 or 300 micron thick epoxy coating which will be costly, but you have to see. Coating could be one the solutions, but remember coating will not allow anything to come out. No moisture vapor can come out. Coating could be one of the situations.

There is something called hydrophobing lining. Now, this lining what does it do; you know they go and these are silicon for example, silicon treatment, silicon treatment. Various kinds of silicon compounds are there details of course, not part of our discussion the moment, but let me introduce this. What it does; you know water is a wetting liquid, It is something like this. Water is a wetting liquid; it would just drop water it will spread all over the place, because its contact angle with most of the solid is considered to be 0.

If you have markery on the other hand, then it will just form sort of you know it will not spread. It is not wetting because its contact angle. This is the contact angle is more than 90 degree, contact angle with the solid. So, therefore, if you want to force markery into such pores, you need pressure whereas, water goes on its own by capillary suction. Silicon treatment or surface lining treatment are those ones, what they do is they change the surface characteristic. They go into this 1, you know the lining as you can say in the pores and they actually change the surface characteristics. Like wax for example, if you put wax on to this surface.

If you put wax on to this surface you know, if you put wax on to this surface like you put wax treatment then you put water, it is not going to spread. So, that is what this treatment does. It is a liquid actually which will penetrate into and then forms a changes of surface characteristics in such a manner that, the what is called contact angle changes and therefore, water cannot penetrate, but vapor can of course, come out. So, that is what is one of the other kinds of surface treatment.

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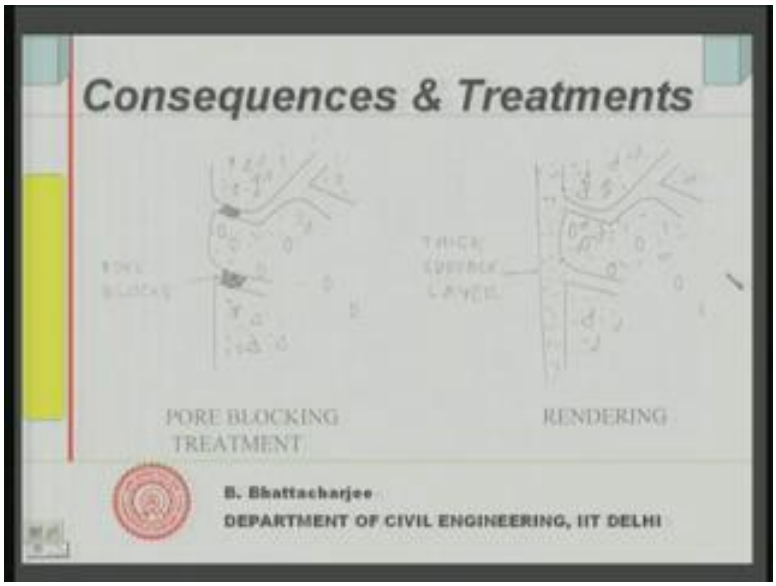

Two other kind of surface treatments are blocking treatment, but that is usually for concrete, not for in motors, but not in bricks. These ones go into the concrete system and reacts with calcium hydroxide in case of motors cementious system and that will block the pores there. So, it will block, this is called pore blockers right. This is called pore blockers. There are several sort of crystalline pore blocking treatments available. Again details we will discuss. It is more to us concrete rather than brick. Motors of course, same thing you will get. These 2 systems are relatively costly.

Rendering is that I was mentioning all the time this is nothing but a thick layer. We put a mortar layer. You can put all varieties of kinds of mortar layers today. Polymer modified mortar or ordinary mortar cement concrete cement mortar 1 can put rendering and this will also not you know provide resistance against rain penetration. This surface treatment can be possibly in case of brick masonry putting this the most you know cheapest way. How do I diagnose the dampness problem?

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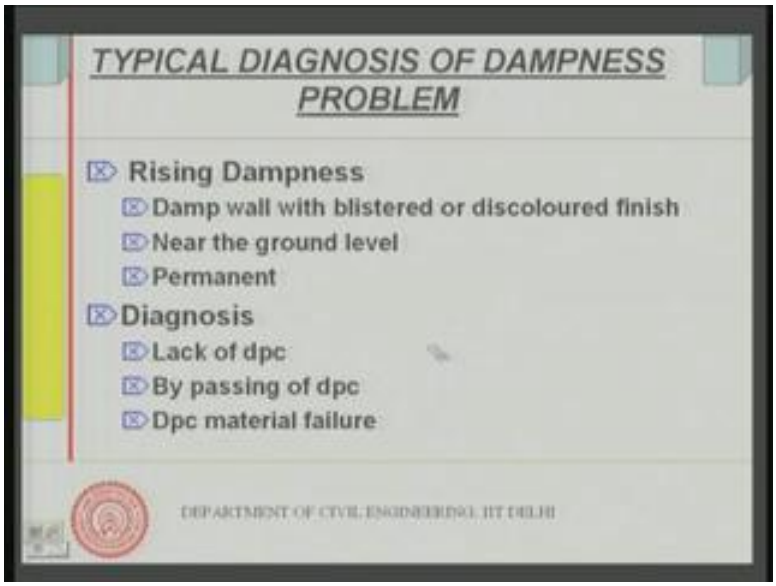

Damp wall with blistered or discolored finish near the ground level or permanent, what is it. Rising dampness would give rise to damp wall with blistered or discolored finish near ground level usually and they are permanent. They do not go away unless you have removed the soil or wherever it is coming from right. So, that is raising dampness. Lack of dpc I said by passing of dpc or dpc material failure. So, this rising dampness can be diagonizing this 1.

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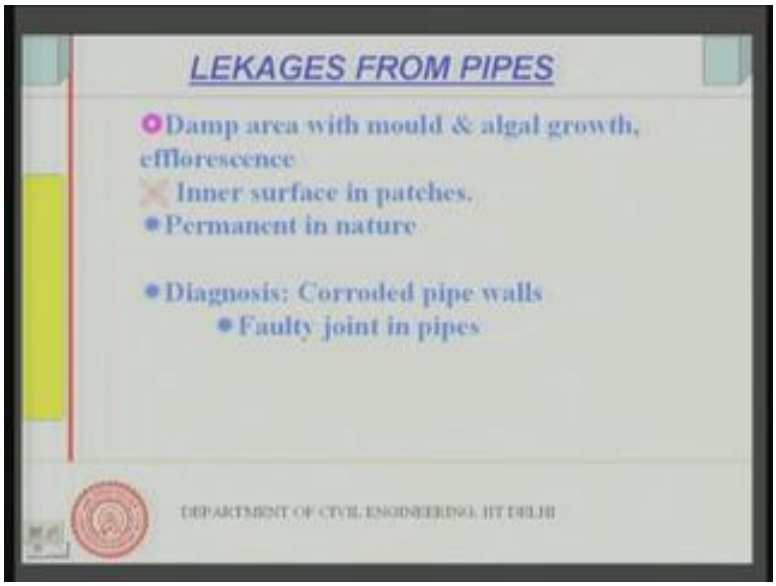

Rain penetration I have already mentioned that it is 48 hours 1 to 48 hours the after the rain it will come. If it is leakages from the pipe that also you can find out, because it would also depend upon the usage of the leakage pipes you know. Supposing it is a waste water pipe right waste water pipe and then some people have people who occupied it they left this place for some period of time, we will see that it has … Whenever the pipes are being used then you will find a wetting is there. When the pipes are not in use so you can stoop pipes, use of this pipe temporarily to see whether the dampness really prevails.

If it does then; that means, it is coming from this I mean it is not from the pipe. So, but normally 1 would also because a proximity to the pipe have also to be there, which is a judgmental and experience and a little bit of trial and error to arrive at what is the cause of that.

Now, if it is leakage from the pipe, you will find damp area and mould and algal growth will take place, some efflorescence also you will see, this mould and algal growth with all kind of dampness. Inner surface in patches you will see and permanent in nature generally, because pipes are used most of the time. Corroded pipes or faulty joints. This is the 2 reasons why pipes leakages takes place. So, you have remedy simply rectify the pipe. If it is joints rectify the joints. It is corroded pipe replace them. There is no other solution, but diagnosis is very important. I said 4 causes main type of causes are there.

If you can diagnose the cause then solving is not a problem. Quite often what is done is when it is faulty joint pipe the major reason, you will find that, even if you relaid your pipe it still might be leaking, because the joints have been faulty.

If one has to do the testing also, new pipes once laid that should be tested as per the IS recommendation under full pressure or whatever it is or smoke if it is a waste pipe and so on.So, whatever is the Indian standard recommendation although this is not part of our discussion, but testing has to be done, because this leads to quite often the dampness in walls and other places and you know dampness has got a cascading effect in or structural element. So, if you do not attend it may increase your cost of repair or rectification more. So, that is very important 1 has to be you know alert about this. How do we investigate dampness?

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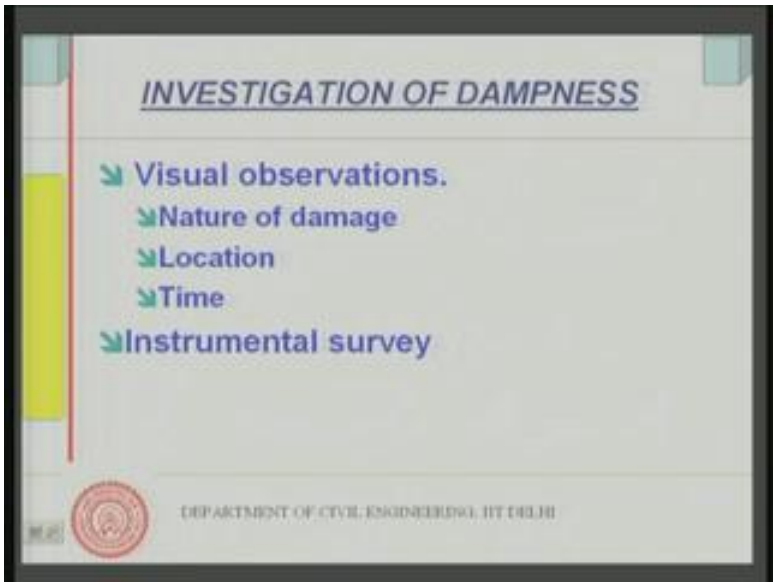

Visual observation then look at nature of damage, location, time, because I said you have to see that pattern. And some time instrumental surveys also possible, because there are moisture meter, several other techniques are there. We are not going to discuss this at the moment. So, that is what it is about the …

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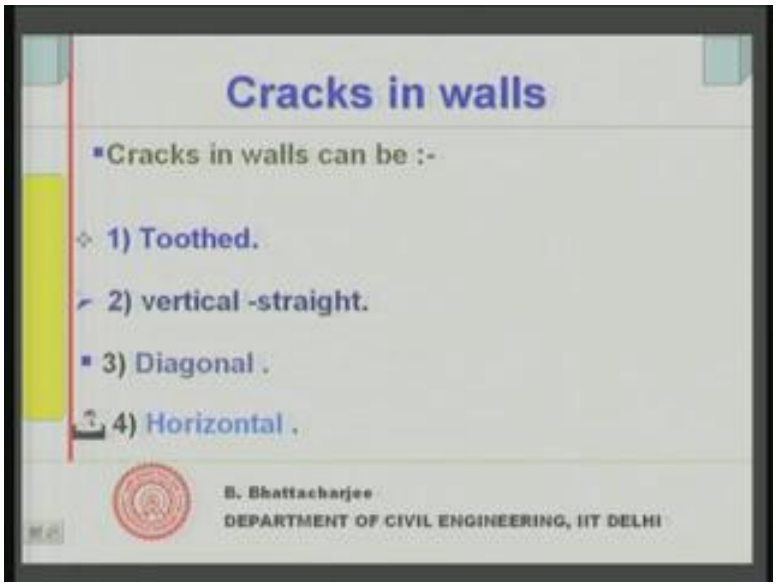

Next look into the cracks in walls. Cracks in wall can be of 4 types. Toothed; will see what is a toothed crack and even cracks mostly come from some sort of force application. It may be load some sort of force application. Vertical and straight, diagonal and then horizontal cracks. We will try to discuss several reasons and there are varieties many things involved in this. We will try to just look into how the cracks look like and 1 possible case is in each of them.

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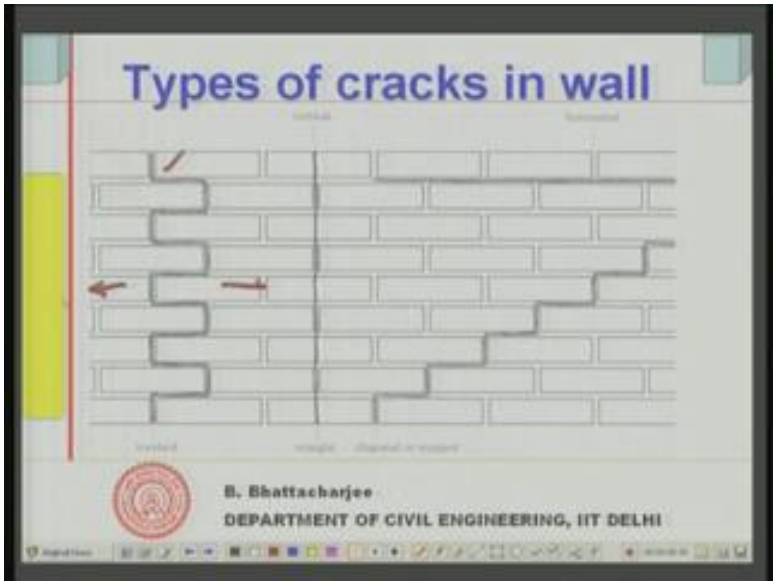

Now, this diagram will tell you all the types of cracks right. For example, when I said toothed, you know this is a toothed crack. This will look like this, usually the cracks in brick masonry comes through the joints because that is the weakest link we have told you earlier and therefore, you will find cracks come like this. This is a toothed crack you know it is getting separated along this direction.

A vertical crack can also come, but such vertical cracks even pass through the brick also. Such vertical cracks toothed or vertical, these are vertical cracks. This is straight vertical straight. So, it has also passed through the brick as well. Some cases it may not. Horizontal cracks usually through the mortar joints and then diagonal cracks will pass. So, these are the types of cracks normally visible in brick masonry walls and let us see what can cause.

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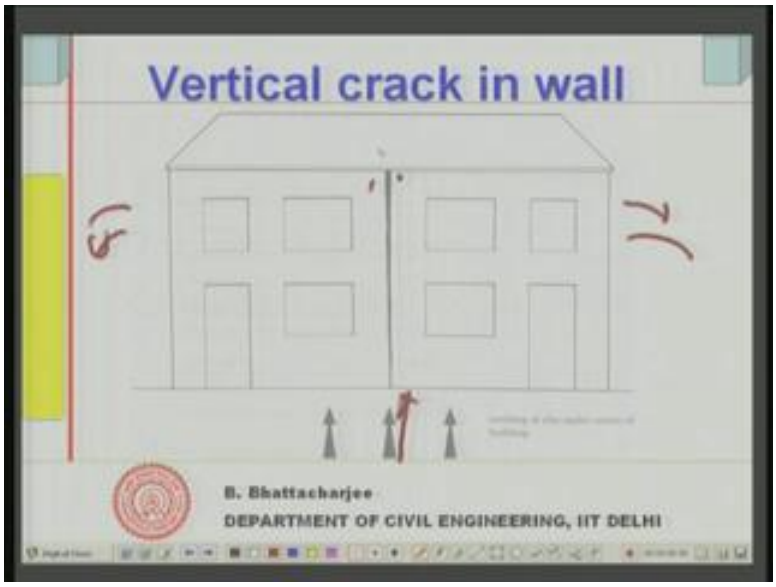

Some examples; there can be several causes and it will depend upon it will meet diagnosis looking at the situations. There can be several causes several thing resulting in several causes resulting in, I have just taken 1 or 2 cases. For example, for vertical cases sort of or swelling of the clay under you know centre of the building. This can result in crack formation like this. This can result in crack formation of this form. You see wide crack here less. What is happening? It is separating out. There is a force vertically vertical force like this which is causing it to separate out in this direction and separate out in this direction. Separate out in these 2 directions.

So, you have wider width of the crack here, lesser width here and this will be through and through breaking the bricks as well. Vertical, just as an example of vertical bricks. Now, why does this happen? Possibly you have a clay material which was dry and possibly of moisture came in and swell down. It became the moisture variation in the clay could have resulted in this right. So, swelling of the clay has taken place and these are … This is an example of a vertical crack. Let us see some other diagonal cracks involved.

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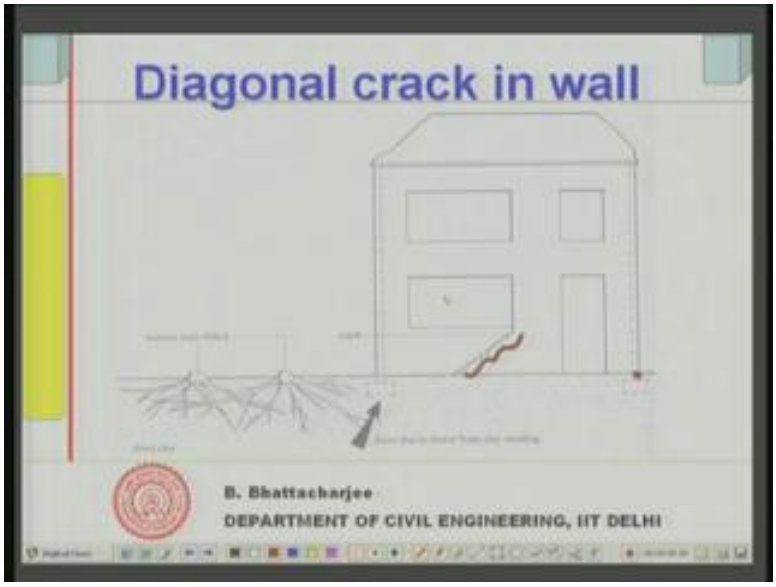

And this can also again the example that I have taken is also from the soil, from the forces due to the soil. Now, supposing the trees they were there, they would maintain the moisture it was cut. So, this tree actually they have you know. So, trees have been fell. These were holding on to the moisture. This will dry of them. Once it is failed it will dry. Next time if the drying can results in shrinkages. So, force due to then when moisture comes in then it can it is only 1 side not below not at the centre, but at the corner there can be healing force if, actually moisture comes in later on.

So, when this becomes this dried clay this moisture comes in it starts heaving and try to push it this side, it will result in sort of diagonal. You know it is actually trying to rotate about this point you know it is trying to rotate about this point. So, this is therefore, shear acting like this and this will result in diagonal crack. This is 1 example. There can be

several reasons. Usually they are related to foundation or soil related matter usually, but there can be other causes which lead to diagonal as well as vertical cracks.

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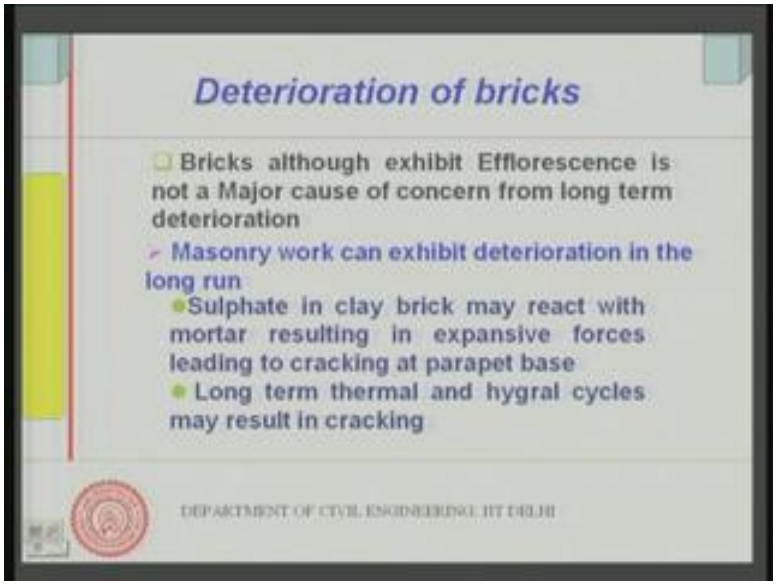

Now, let us look at horizontal cracks and before that just looks into you know what kind of deterioration process goes on bricks. We have talked about this efflorescence quite a bit, but we have also said that there is a not a major cause of concern from long term deterioration point of view. But sometime, sometimes salt crystallization may have a little bit of problem. The florescence gives you a look problem.

But the more major problem is sulphate in the clay brick may react with the mortar, resulting in expansive forces leading to cracking at various levels. This is 1 of the causes which lead to various kind of cracking. For example, cracking at several sort of situation even in the finishing. Then long term longer thermal and hygral cycles may also result in cracking. Thermal expansion differential thermal expansion on window top sometime results in horizontal cracking. These 2 causes can …

Now, I have taken a example of this say real life example. Just above the window level lintel level you know the level of the window, the differential expansion and contraction due to thermal can result, but I have taken the example of this and let us see that example.

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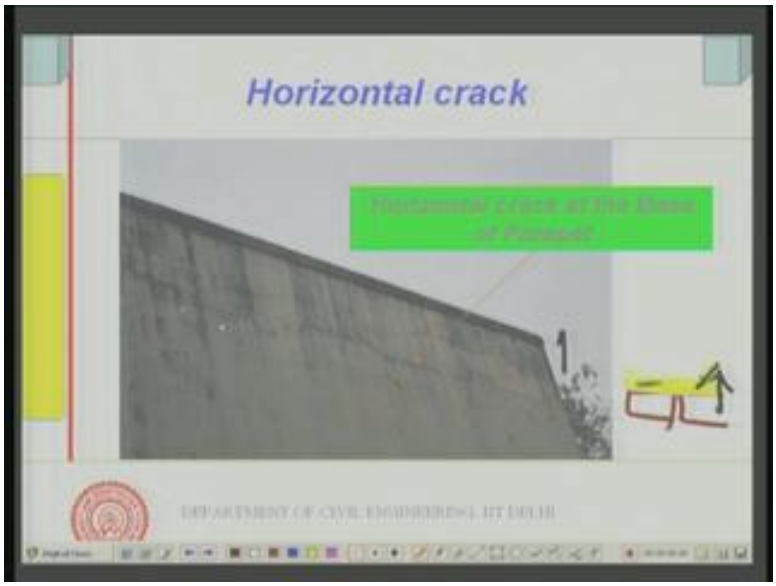

These are real life situation. You can see in many cases in old buildings parapet wall, along the parapet there is a crack. This is due to usually due to sulphate. What happens Sulphate present if it is present in brick, quite often they are present in soluble form and they come out over the long period of time and react with the mortar; cement tricalcium aluminate in the cementious portion of the mortar and then these results in fringed formation which you know.

So, when such a fringed formation is taking place, it may you know along the mortar line of the mortar for example, this is your brick let us say, this is your brick and over this you have let us say there is a mortar joint over this is let us say is the mortar right. This mortar sulphate comes in here and this expands. So, if this is expanding anything on top or free side would actually there will be a upward pressure exerted by this. Then the upward pressure exerted by this. Any expansion here would exert after pressure. And in case of parapet wall at its base what happens is there is a separation to it, because sulphate attack sulphate attacking the mortar causes expansion and this expansion pushes up this particular 1 upward and a crack develops. So, this is 1 example. There can be several other possible cases, but 1 has to diagnose accordingly.

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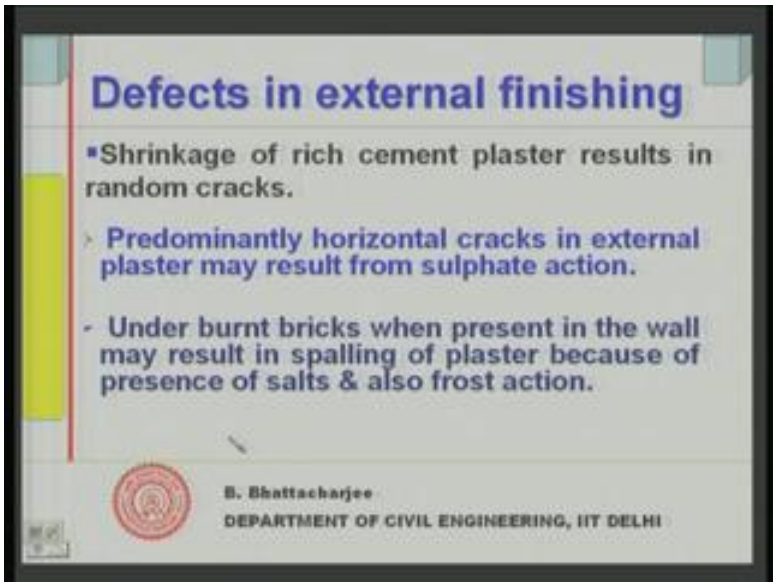

We will look into some of the defects in external finishing. This is very common; shrinkage of rich cement plaster results in random cracks. Now, these cracks would look like this you know this cracks would look something like this. If this is your wall you will find cracks are in, there is no single pattern or something. They are in all directions, random cracks formation right. They can be of all kinds. So, such kind of shrinkage cracks in the cement plaster, especially the rich 1; 1 is to 3 very rich and the curing has not been done properly. So, this results in shrinkage and shrinkage cracks they do not have any pattern.

Now, one of the ways of avoiding this of course, these days you have got various kind of fibres, say polyester or polypropylene fibres, which you can add to the mortar and they can reduce down your cracks, but cheaper way would be you know this also is a solution all right, but 1 has to see. Preferably do not use a very rich plaster, it should not be very rich and second issue is the curing part of it. The curing has to be undertaken and thorough curing must be there. So, that is what is. And it is continue for the appropriate period of time. So, if that is done, normally these cracks will not appear right.

So, usually for rich cement plaster, the remedial measure is; obviously, related to this. In plaster, predominantly horizontal cracks after certain period of time could be result of sulphate action. In such case, what 1 has to do is look into the sulphate content soluble sulphate content in bricks; that means, you find out you know subject possibly is the

brick to water for a long period of time distilled water something. Find out the try the solution out test the solution out is there sulphate present in that. Such sulphate when present, can come in contact with the cement of the plaster. And then or even to the mortar it might react with the mortar joints between the brick and when mortar joint is trying to expand it will actually result in horizontal. Generally their patterns are something like this.

This we will find if this is your wall you will find everywhere, many places you will find, but all horizontal cracks need not be because of this reason, this is one of the examples of horizontal cracks can be there. One has to diagnize in detail looking at it you know case by case basis 1 has to diagnize, but this could be one of the thing.

This is called line there is something called line blow result in plaster and something called line blow that I thing I am coming later on, but there is something under brick under burnt bricks can result in result in spalling of plaster, because of presence of salt and usually in frost action. Sometime you know this is of course, spalling I mean spalling of plaster is not a very common thing in any situation, but it can happen because of the sulphate action. I will come to that sometime later on.

But frost action can result in presence of salts if they are there and if they are expansive in nature within the brick pores, let us say the form they are expansive in nature that can cause spalling of the plaster. Spalling of the plaster will occur when there is some expansive forces within the brick itself. So, when moisture comes in some salts crystal some sort of crystallization takes place and this even this can be also happen because of the sulphate present in the brick wall. In the long run first it will form cracks, then it can cause such expansion that it actually spalls out.

Frost action can do that because of frost also causes expansion. So, complete plaster can spall of because of this sort of situation when there is expansive forces within the brick.

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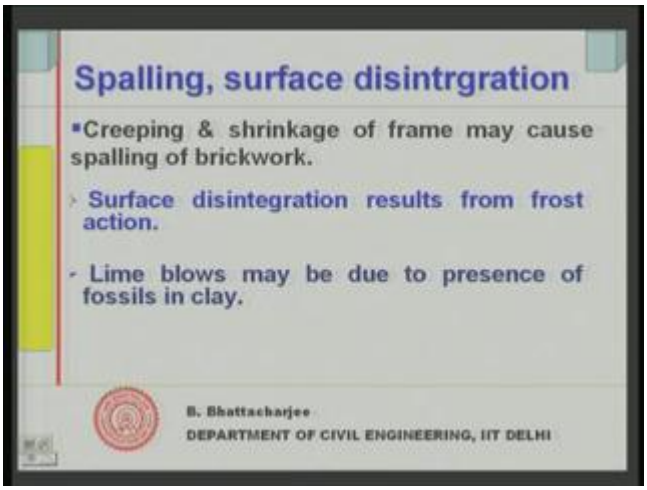

This is interesting situation. Spalling of brick wall, this can occur if it is in a frame structure. This is your RCC let us say RCC frame and you have this occurs usually in infilled walls and you have brick masonry wall here right. So, this is your brick masonry wall inside and such situation spalling of concrete can occur when the shrinkage and shrinkage of excessive shrinkage and creep of this 1. So, in the long run long term shrinkage and creep may result in sometimes spalling, because this is shrinking which in other words it will actually exert a kind of compressive forces to the brick wall. And this compressive forces if the brick is not strong enough to resist a brick wall it is not strong enough to resist this compressive forces, spalling can be observed from this portion.

So, this can be one of the reasons while spalling is. Surface disintegration usually results from frost action of exposed brickwork. When I have exposed brickwork, again not very common in Indian situation, but when I have exposed brickwork you know something like this the bricks are exposed brickworks Then what can happen is; this is your exposed brickwork because of frost can this is the mortar. This is the mortar portion. This portion is the mortar portion mortar portion is here mortar portion is here. So, this is the brick face and moisture can penetrate.

Moisture can penetrate inside this. Moisture can penetrate. Moisture can penetrate inside this. Moisture can penetrate inside this. Moisture can penetrate inside this and during the cold season if this freezes. So, that will cause expansive forces here and this will result in actually disintegration of the bricks. So, after sometime what are you going to see is; you are going to see you know this was the original situation.

This was the original situation and after sometime what you see is this. So, this portion of the brick some portion of the brick from outside will be actually spalling. Some portion of the brick from outside actually you know in the mortar some portion of the brick in the mortar you may find that this has to be disintegrate and comes out in flakes comes out in flakes.

So, that could be due to frost action, but again this is not very common in Indian situation right. Lime blows is the other 1 data has to. What is lime blows? You see if you have fossil in the clay in brick making right, fossils in the clay in brick making bones and things like that which actually while burning I mean they do not get grinded. If you are grinding the clay of course, they can be grind into lime.

There is essentially some sort of you know unsoundness associated with the lime free lime sort of situation. So, what will happen if you have fossils in the clay, this clay when you try to mixing grind it somewhat it does not get fully grinded, but if it is there in the system in sort of probable format, you would have used it in the molding and what will happen they become lump of lime calcium oxide, remain as lump of lime within the brick right.

And in future when moisture comes in contact there will be expansion, there will be heaving forces. There will be expansion, because calcium you know it will become slaked lime it will try to temp to become something like that. It will absorb moisture in expanding volume. And when this does that is called lime blow and that would cause disintegration of the brick itself.

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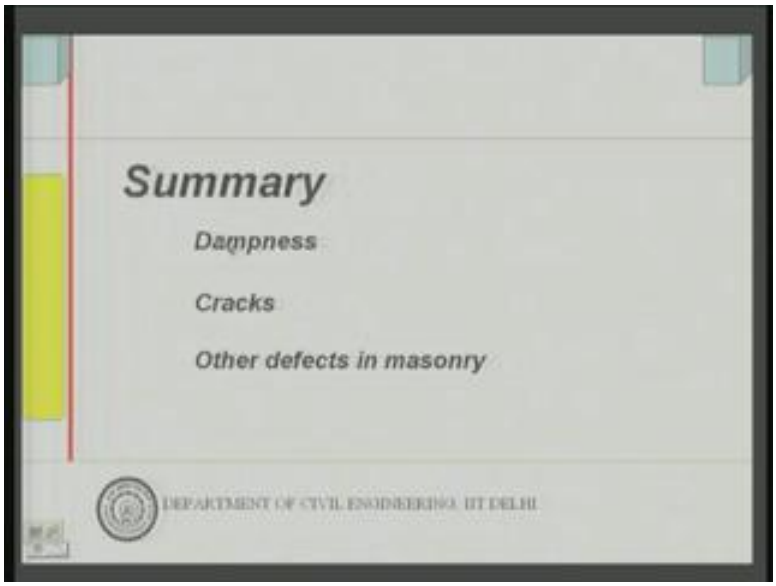

So, therefore, some of the defects we have been able to cover in this discussion; cracks and other kind of defects.

Dampness first we have discussed dampness and we have tried to look into what are the possible causes of dampness of course, they defects we have classified in this terms. Dampness cracks and other defects in masonry and we looked into dampness we tried to classify them. Classify the dampness in terms of causes that gives rise to dampness say rain water could be 1 of the causes. Capillary rise could be the other and then condensation could be the other 1 and leakage of pipes.

And, then we tried to see you know rising dampness, what could be the diagnosis of such problem if it is available and how fast we investigate or look into it. Let us say where you would like to find them mostly. We will mostly find them near the ground as you have seen and they can occur because of the some sort of either the dpc is not there, dpc is not working it has failed or you did not bypass. That is what we have seen in case of rising dampness.

Then we have seen the other rain penetration. We have also looked into the to avoid rain penetration. And then we have seen condensation etcetera to understand condensation, how it causes dampness and also looked into leakage of pipe and rain penetration situations right. Then we looked into cracks, but remember these cracks as we have seen

they are not, we just looked into a few of them. You said that, we said they can be vertical cracks due to soil heaving at the bottom, they can be diagonal cracks.

If the soil pressure which causes foundation, heaving takes place at 1 of the corners of the building, then it results in diagonal cracking. The diagonal cracks can also come if somewhere settlement of the foundation is taking place. Instead of the heaving on 1 side if, there is a settlement on the other side and nothing happens on this side, then there can be diagonal cracking formation. And then the horizontal cracks which are mostly results of outside the sulphate or similar attacks right, crystal formation and expansion taking place at the bottom joint resulting in resulting in sort of vertical pressure, which separates out of the horizontal mortar joints.

And then we have looked into also the finishing, defects in finishing which can result in cracking quite often. They can be due to shrinkage and surface treatment rain water penetration treatment also we are going to, so in the other defects that we have mentioned. So, I think with this we actually finish our discussion on masonry and walls in general in this module. So, walls and masonry, mostly we have covered masonry and thrust was mostly to brick masonry. But 1 point I would like to mention here which we will discuss later on is that, we have also discussion focused mostly on brick masonry and brick clay bricks are the most common used 1. Sometime we look into this end of our discussion; 1 of those vast discussion is sustainable construction.

Now, clay is clay concrete and clay they are they consume a lot of energy, very high embedded energy content they provide into the building. Steel of course, is a highly energy considered material, but then the amount of steel used in building is relatively small of concrete and brick clay brick, they have a lot of energy contained in them. So, energy already is sustainable point of view, clay brick is not a very good proposition which I have mentioned earlier and we shall see this issue later on. So, I think with this we can finish off our discussion on brick masonry under module 6. And next we will look into module 10 and discussion on bricks we can conclude. And next we will look into the other module.

Thank you.