

Architectural Conservation and Historic Preservation
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Lecture - 22
Causes of Decay in Cultural Property (Contd.)

We have been discussing about the Causes of Decay of Cultural Property and in that case we have in our last lecture we have discuss basically the problems due to the gravity and the due to the sunlight and other problems and we started with the rain. How the rain in different forms the can cause a problem, so we will continue with that.

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Common threats to historic structures and sites

External Causes of decay in buildings Rain

"Faulty disposal of rainwater is the most frequent cause of deterioration in ancient masonry"

- Rainwater washing against the surface of a structure will gradually wear it away
 - Mortar and porous masonry are particularly vulnerable
- Rainwater penetration into the individual materials of the structure causes more damage through:
 - Salt crystallisation
 - Continual wetting and drying
 - The action of frost and ice

<http://cinw.s3.amazonaws.com/wp-content/uploads/2013/06/WhyBldgsDecayWebsiteVers.pdf>

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So, if you remember we say the faulty disposal of rain water is the most frequent causes of deterioration and they can wash against the surfaces and specially if you some porous building materials like break and certain kinds of stone then it is a problem. And rain water penetration of the individual materials of the structure cause more damage though. I also give in some of the reference which I have been. So, I mention the Salt crystallization, Continual wetting and drying and the action of a frost and ice.

So, we will discuss the three independently what are this issues actually. As I say that is not only one aspect or one factor which causes the problem there are many other things combine which causes some of the basic issues.

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Common threats to historic structures and sites

External Causes of decay in buildings

Rain

Penetrating rain

rain penetration causes

- timber components to rot and insect attack
- damage of embedded structural timber

The slide features two photographs on the right side. The left photograph shows a view looking up at a wooden ceiling with visible decay and insect damage. The right photograph shows a close-up of a wooden beam and its connection to a masonry wall, showing signs of rot and structural weakening.

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Now, let us see the external causes of decay: the penetrating rain. The rain penetration causes the timber components to rot and insect attack. So as you can see that this is again in Narajole, this is a place where you can see that. This is some of the roof damage which has happened, the flat tiles which are there and there are the timber post and the beam and the rafters which are there and because of the salt the water penetration through the roof.

These are the timber elements and not only they are causing the rot of that, this also causes a very good environment for the insect that are very different type of insect. This is also a Narajole the one of the roof of that. You can see that how, what type of damage has been happening. There are the timber, lines and other things where the major problems.

And this is also the major issue in that where the timber beams are actually resting within the masonry, this places are getting affected due to the water penetration and this rotting of the timber and that is ultimately will cause a structural problem to the entire structure and roof may collapse because damage of the embedded structural timber. So, these are one after another it happens as a subsequent things and if it is not taken care of initially the it can be very seivour.

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Common threats to historic structures and sites

External Causes of decay in buildings
Rain & Moisture

- Change in relative humidity in the air
 - Damage to interior
 - Moss and fungus growth

The slide features three photographs: the top one shows two people working on a wall with a ladder; the bottom left shows a dark, arched interior space; the bottom right shows a stone relief sculpture.

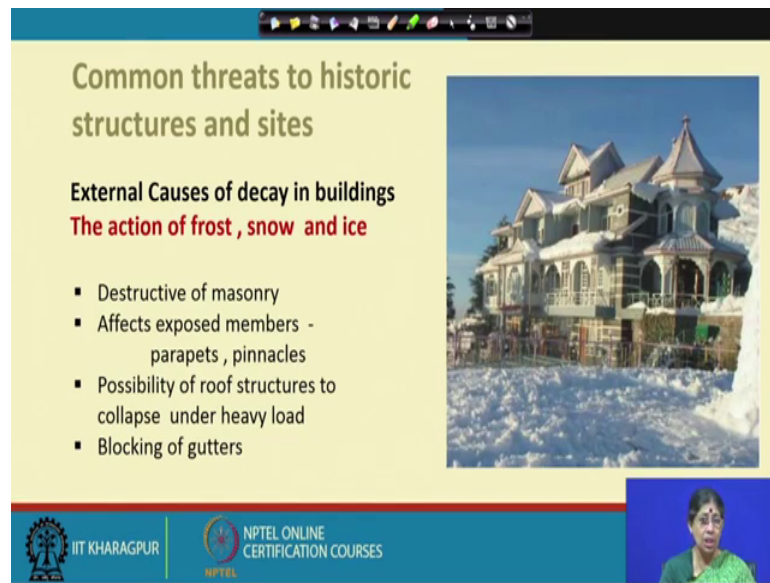
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The external cause of that rain and moisture because the rain also the humidity and other thing (Refer Time: 03:06) It is not only those type of structure and the other elements, but also damage to the interiors sorry there is a spelling mistake. So, there is an interior which has happened and the moss and fungus growth also causes because of that. And as you can see that this is Shantiniketan Vishwa Bharati where there are the morals, the wall paintings which are under desaturation and due to the dampness and other aspect and the moisture content, these has got damage and deteriorated over the time and group of artist restoring that.

This is again a small temple of flat roof temple in West Midnapore where you can see the not only the penetration of rain is causing a problem of the seaviour crack at the wall, is also is causing a problem lot of the moss and fungus and also the raising darkness which is causing a problem. And this is also a small temple where it is there in the small relief is there. Is very important element of this type of temples, very strong European influence where you can see the moss and fungus and other thing; which all cause due to the rain and the humidity and the moisture contain.

So, and this damage is happening is one by one all related that if it is not taken care it and becomes a very good environment for the moss and fungus to growth and there are variety of moss and fungus, the biological causes which gets ideal environment to grow in certain environment.

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Common threats to historic structures and sites

External Causes of decay in buildings
The action of frost, snow and ice

- Destructive of masonry
- Affects exposed members - parapets, pinnacles
- Possibility of roof structures to collapse under heavy load
- Blocking of gutters

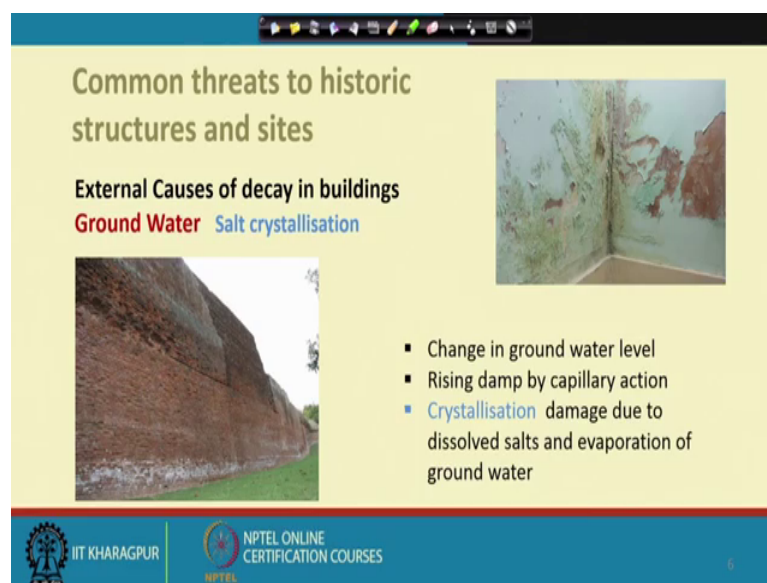
The slide features a photograph of a large, ornate historic building with multiple gables and turrets, completely covered in a thick layer of snow. The building is set against a clear blue sky. The slide is part of an NPTEL presentation from IIT Kharagpur.

So, this is some of the issues which happen due to the rain accumulating rain or the due to the raise in the humidity. The other problem which is also related to the wall specially in the cool climate; the action of frost, snow and ice. As you know that many many places this causes a seivour thing. Even India is a vast country there are areas where we have very high degree of this snow accumulation.

This is Shimla, as you can see that there is a lot of snow has accumulated on the sloping roof and if that is not structurally sound this also can cause an extra load and can cause a seivour structural problem; it can sort of the cause destruction to the masonry itself. It also effects the members of the parapet and pinnacles. As you can see that all of these are the these are problem it can cause because of the heavy sheets of a snow which can cause a problem and possibility of the roof structure to collapse under heavy load these in addition to the water seepage and other issues, moisture moisture penetration.

These also and of course, the flow of the water; as I say the all the gutters and pipes can get blocked. Due to the snow and this temperature drop of the temperature this has to be taken care of there. Now, and as I say the blocking of the gutters; this are the very very seivour things. So, depending on the climate, depending on the likelihood of some things happening and depending on material one has to understand that what are the likely causes of decay in a particular scenario.



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Common threats to historic structures and sites

External Causes of decay in buildings

Ground Water **Salt crystallisation**



- Change in ground water level
- Rising damp by capillary action
- **Crystallisation** damage due to dissolved salts and evaporation of ground water

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Now, also I say that this salt crystallization. Now then there is a ground water, ground water can happen because of the accumulation of water or basically the high ground water level and if the ground water contains the salt either the salt can come with the ground water or the salt may be there in the building the some of the bricks though because of the material it has been there it can be a high accumulation of the salt.

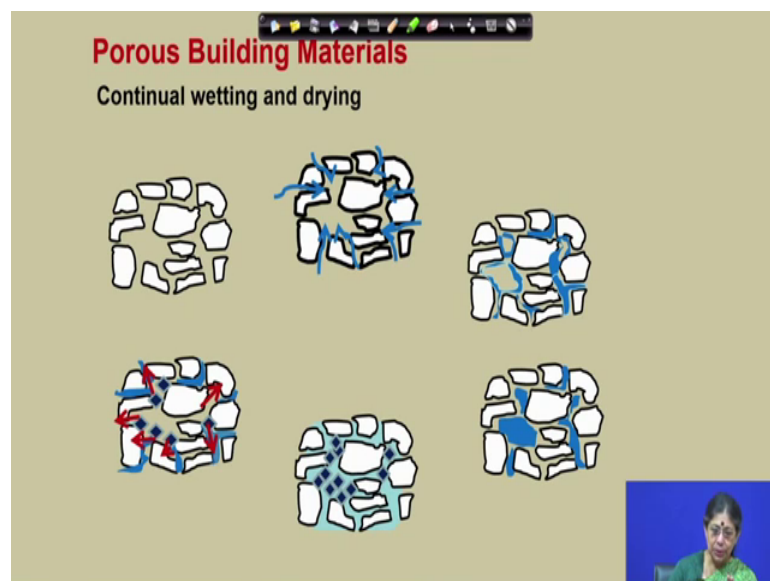
So, now when the salt comes in the thing the salt crystallization is one of the major things of the porous building materials. You can see that this is not Bengal that the salt crystallization has happened and you can see the clearly the marks which is happened when the salt is coming out. And here you can see this falling of the plaster because there is a rising dampness and along with the salt crystallization which is happening. Now as I say the salt crystallization can happen due to the change in the ground water level, due to the rising damp by capillary action and due to the crystallization is damage due to dissolve salts and evaporation of the ground water. So, what should one do about these things. So, generally what is that one is that to be stopped the ground water in ground into that.

And especially the porous building material acts as a capillary. The pores in the porous building material and they sort of sucks the water and along with that if the salts comes when the if the subsequent dry season, when the water sort of sort of the fabric is dried up; then the salt dissolves salts come out and they accumulate on the surface. One of the measure we generally taken is to make a damp proof course, and if you say already a

structure is there. So, there are ways how to insert a damp roof course in a historic structure this is one. But one thing is sure that generally sometimes the mistakes which is done is to this type of a salt crystallization. The surfaces are covered with some sort of paint or something or some time tiles are given to cover that and that is something which must neither be done.

Because it here actually the fabric is breathing out and if that the process of breathing out is stopped, then what happens is that it goes further up; it goes further up. So, one should not stop that the, that the possibility of the water which is within the fabric to come out of the surface. And that and then of course, if it is lot of these it coming out very regularly then of inserting the damp roof course, and others are there. But never cover the surface with a sort of some paint or some materials which stops or does not allow the water which is within the fabric to come out this is absolutely important to remember.

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Now, let us see what is happening, this example that this is when there the places where there is a days of heavy rainfall and then there is a drying period. So, there is a continual drying and wetting there is a cycle of drying and wetting happens. And in a porous material what happens is that the water tries to fill up the pores and with the water there can be the dissolve salt, which may be with the water, dissolve in the water or may be within the material. Now what happens as we can see that when the water comes there it

will be followed by drying period, when the water tries to recede away, but this salt particles they try to sort of crystallize.

And these repeated cycling and the wetting and the drying period that is something we have to see. Why the movement of the water through the pores, maintaining the movement of water through the pores is so important. For example, we see that what are the process that in these case? What is happened that there are pores? These are the different depending on what material details; there can be a small pores, there can be the large pores, there can be a combination of large pores and the small pores.

So, as we can see that when there is a rain the wetting period the water is coming through the pores and as I say know that capillary action what happen; the smaller the diameter of the pore, the higher the water can go into a more the water can go into a due to a capillary action. In the larger pores the in grace is much slower and so, you see that in the wetting period the water comes and then the water tries to fill up the smaller pores and the larger pores. That is what is happening here.

So, when the, that is the wetting period and then it fills up all the pores generally if the rain continues for a longer time. Then this is the wetting period what we see, but this wetting period is actually so, this is the wetting period and then it will be followed by the drying period when the for few days there would not be any rain.

What happens is that water is there and then what you see is the salt which is dissolve, either it is a part of material or in the water. This dissolve salts try to crystallize and fill ups the pores. Now in the drying period what happens, the water recites from the pores and these crystals they remain within the pores and they will like to come out of along with the water and they generally come out and then try to get deposited on that.

And this is those white salt like things what you have seen on the surface of the wall and that is not bad because still one can, it causes some problem to the fabric, but still it can be washed, it can be cleaned and it is actually not if it does not remain within the fabric, then it is not much of a problem. That is why to allow the water to come out is absolutely important.

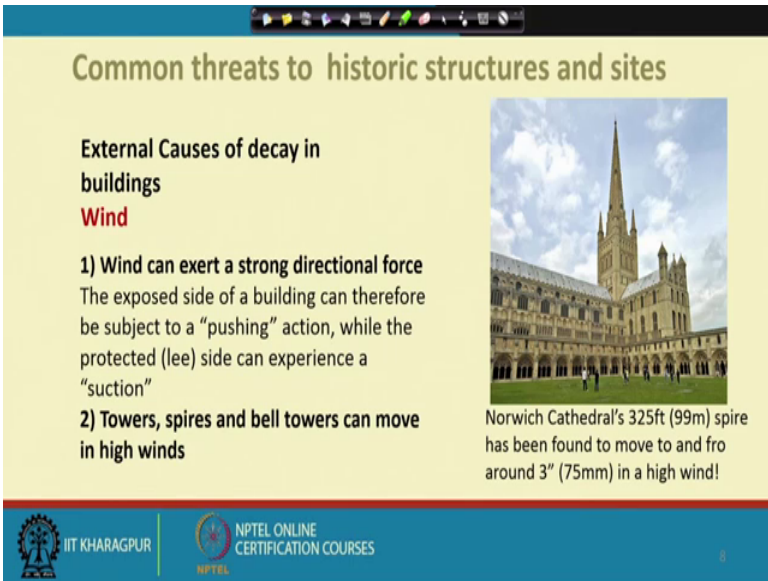
Now, what happens that in a case that this crystals becomes so big that they sort of blocks the narrow pores and they do not allow the water which is accumulated inside to

come out. Then what happens? It causes sort of a pressure to the internal sort of the material, thrust happens and that causes a cracking of the building. So, if the crystals are not allowed to come out and other.

So, as we say the insertion of damp roof course, is definitely needed the making a proper drainage system around the structure is important. So that there is no water accumulation, cleaning of the gutters and the making a proper drainage system, draining out the water, making sort of a clean protection. These are all very important steps and along with that before the rain starts, that that seeing that that there is no blockage of the water.

And so, these are some of the important things this continual wetting and drying period. Specially where there are heavy rains for continuous few days and followed by a drying period and if there is a salt in material or in the water dissolve salt, then this type of problem happen. This is what is called the salt crystallization damage.

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Common threats to historic structures and sites

External Causes of decay in buildings

Wind

- 1) Wind can exert a strong directional force
The exposed side of a building can therefore be subject to a “pushing” action, while the protected (lee) side can experience a “suction”
- 2) Towers, spires and bell towers can move in high winds

Norwich Cathedral's 325ft (99m) spire has been found to move to and fro around 3" (75mm) in a high wind!

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Now, dissolve in the water or they there is a salt content in the material porous building material and if this is combined with the wind, it can cause some other seaviour problem we will see that. But so, we are coming to next natural cause which is the wind. Now wind as such I am come to the water moisture problem later on, but wind as such can exert a strong directional force. The exposed side of a building can therefore be subject to pushing action and while the protected lee side can experience a suction. So, there is a

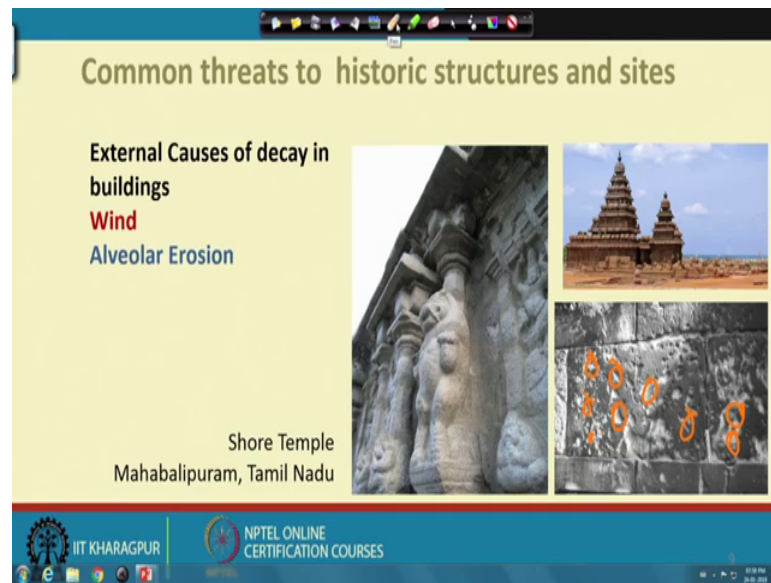
difference between the protected side; the lee side and the windward side. This can be differently seen like the sun; the sun which is more exposed to the sun and which is very drying up and cool down to very very drastically, will have a different type of a problem where is the other side of the building which is or the fabric which is cooling down very slowly that probably will not happen.

So, one has to also understand this phenomena. So, this one that wind creates a problem and specially the towers, spires and bell towers which also can move in the high winds, these are very good example Norwich Cathedral, you can see that in England. There is a 99 meters spire which has been found to move to and fro almost 3 inches or 75 millimetre in a high wind. It was actually moving and it is a very important case because at one time the movement and the deterioration of the spire stone was such that that the authority decided to take down this spire and it is a burned filled which are referring a lot.

He was appointed as the architect of that conservation project. He says that when I went up to the there is a lot of writing and he is also spoken on various occasion that when he went up he could feel the spire moving, but what he did is that rather than tiring down, he talk to the structural engineers another. He decided to put the stainless steel wire and also in addition consolidation and some of the replacement of damage stone and because of that the original spire is still there. It is moving, but just the moving is not bad. It it gives strength so that even the movement.

So, one has to understand even high structures or high rise parts or elements or component of a structure, it can be it can create a problem. And always not necessary to demolish that but there are ways to find. So, this is a very important case where there problem of the spire actually happen due to the wind load.

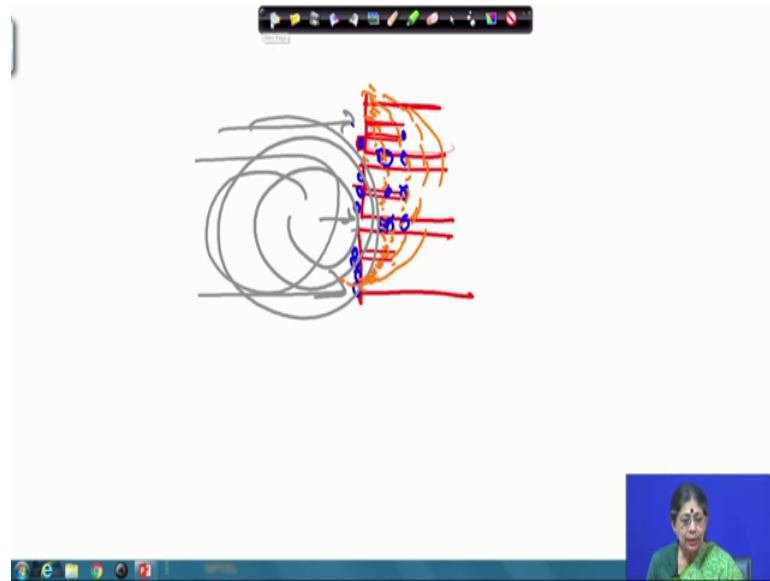
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I come back to the that the water moisture problem which is talking about the Alveolar Erosion where, it is dangerous more dangerous than the salt crystallization damage and which we will we are many of the places which specially near the sea shore and porous building material is Alveolar Erosion happens.

This is the shore temple in Mabalipuram, as you can see that the most of the features is they are blurred and other and what happen is that where the wind, the salinity, the moisture all of this combine and the direction of the force of the wind, winds speed is so high that it actually causes the Alveolar Erosion. When the Alveolar Erosion happen, this is something what happens like; this is the pop mark on the building fabric and the, this looses. Now, let us see that what really is actually the Alveolar Erosion? What happens?

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Now let us see that let us say the porous building material. So, let us say these are the bricks and I am also almost accelerating this part. So, between the bricks there are these sort of a joints and these actually are the areas or the through which and apart from that within the break also there will be the fine sort of a capillaries through which the water is likely to come out. Now what happens is that in that case if there is a salt within the water this salt will like to sort of come out of the if they come out on the surface, if they come out on the surface then as we say the I mean of course emphasizing a lot is out of scale, but they will deposit and they can be washed away.

But when there is a heavy wind that for example, there is a the very high sort of a wind is coming and hitting the surface which happens in the Mabalipuram in (Refer Time: 19:30). Then what happens is that before this salt can come out of the surface, this salt actually gets even before it is coming out of the surface, when it remains within the surface they at the it gets dried up.

Now water is sucked out and because a such a high speed high speed of wind is happening and so what happens is that this crystals rather than coming out the water cannot come out and it is getting dried up very quickly at a very high rate. So, the crystals actually remain within the material within the pores or within the joints of the material. And because there is that a they remain there. So, what happens is that that at a certain time this sort of this surface they become a sort of a separates from that and it is

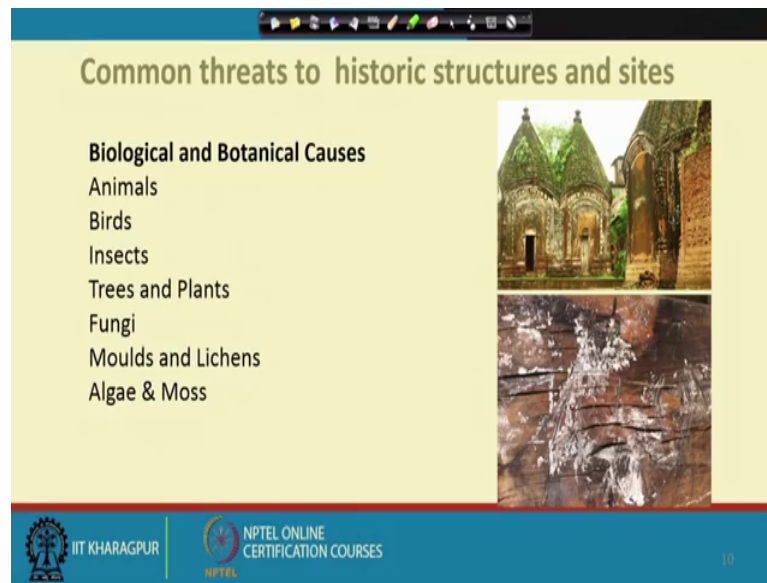
falls off. I mean it is actually in scale if you see the pop mark is happen. So, this actually falls out and there is a sort of a hole, local hole happens. And when this local holes happens, what happens is that that there is a local a d current which forms which is much faster and this when this local AD current is formed, it again does not allow the the further water to come out and there will deposit further inside of the surfaces.

So, that happens is that in that case the surface actually then the next layer is that the surface will get sort of a damage and this sort of a progresses and then we will see that because of the local AD current and a very high speed then gradually we see the sort of a holes developed in the surfaces. So, this is call Alveolar Erosion. Alveolar Erosion means holes and erosion. This is quite dangerous because as I say as you have seen that because of that that this type of the holes and what this type of a pop marks whole surface happens because the salt remains within the fabric.

So, this is something which is sort of a problem. And now the question is that how you sort of take care of that? Then the idea is that you have to sort of the see that the speed of the wind becomes less. So, here is a sort of give a carton. What is the carton in case in mabalipuram? And many other cases, the barrier is formed, in this case the cashew nut trees these trees are been planted.

So, that the wind which is coming it actually the speed is getting reduced and then of course, along with that the insertion of damp roof course, or reducing the salt draining way the salt from the structure all these are very important. So, this is the what I said teh salt crystallization damage and the Alveolar Erosion. As I say the Alveolar Erosion is much more dangerous it affects the material (Refer Time: 22:49) that this cannot be sort of a rectified until and unless you change the change the stones which is definitely.

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Common threats to historic structures and sites

Biological and Botanical Causes

- Animals
- Birds
- Insects
- Trees and Plants
- Fungi
- Moulds and Lichens
- Algae & Moss

The slide features two photographs on the right side. The top photograph shows a historic stone building with significant green moss and algae growth on its roof and walls. The bottom photograph is a close-up of a stone surface heavily covered with white, fuzzy mould or lichen growth.

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The next one and which is the biological and the botanical causes; as you have seen in the some of the cases that how in very rain fall area and other the different things which are important at. So, in the biological botanical cause which is our next aspects. The animals, different types of animals and the problems associated with them. These are also causes a lot of problem. The birds, the bats a W in the historical structure and of course, we cannot stop them. We have to see the, that how to reduce the damage or how to stop them because there also society which are also very concerned about the animal protection.

So, we have to see a balance and we will see that what type of damage happens. The insects different types insects depending on a particular whether condition or a particular type of material. These also the problems area; the trees and the plants is if not taken care of in very initial stage. This actually can be a very disasters for a historical structure. The fungi different types of fungi and different types of moulds; there are thousands of species of moulds and lichens, each has it is own habitat and own sort of an environment we stay. Like their different food habit. That they eat on a different survive on the different type of environment.

So, that is why we need actually the people who specializes, who know the behaviour of different types of moulds and lichens, until unless we have a clear understanding that we

cannot really investigate or take precautionary measures, the different types of algae and the moss.

There are so many species which are there. And these are very important to understand what are the reasons for their decay and other things and as you can see that this is Maluti which is a terracotta temples in Jharkhand; border of West Bengal and Jharkhand, the more than 100 terracotta temples are there and you can see that the what type of damages happened due to this biological aspects of the moss and fungus and as I said the depending on what material and they also a variation of fungus and various algae and the moss and as their habitants.

So, it is very important to take the expert advice for that what again the while cleaning that one has to be also very careful because it should not affect the material in a negative way it maintain. So, this is the holistic approach one should take care of that. So, we will take that those aspects into our next lecture, that where we will talk in detail about the various biological and botanical causes and what type of broadly what type of damage and decay that cause to our historical structures.