Disaster Recovery and Build Back Better
Prof. Ram Sateesh Pasupuleti
Department of Architecture and Planning
Indian Institute of Technology - Roorkee

Lecture - 10
Rock Shelters at Risk

Welcome to the course 'disaster recovery and build back better'. My name is Ram Sateesh. I am an assistant, Department of Architecture and Planning, Indian Institute of Technology, Roorkee. Today, I am going to discuss about a heritage component, how it is subjected to risk and how one can analyze from a very multi-disciplinary perspective and also how the conservation plan works along with the risk management plan.

So, this is about rock shelters at risk; and in the whole world if we look at the ancient man's shelter, the very basic form of shelter is the caves, you know the cave dwellings and the rock shelters. And different parts of the world still carry some evidences that how the earlier man have lived and some images of their paintings, there have been some images of their nomadic or pastoral life or hunting life you know.

So, these are all some learnings of how the today's generation can also learn from our historical records and the anthropological aspect of human life.

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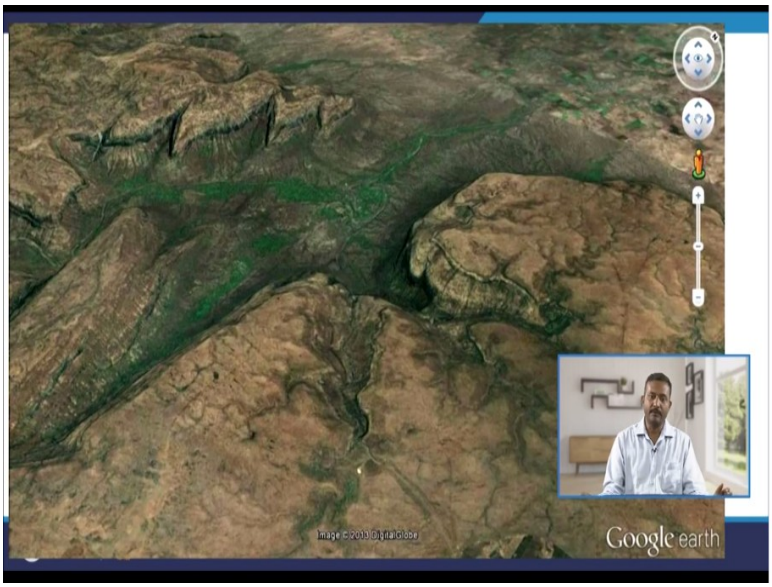

So, when you see at this image, I am not talking about as an historian, I am not talking about as an architect, I am talking from a risk perspective, how this heritage component subjected

to risk and how one can look at from a multidisciplinary perspective. So, when you look at this image, obviously one can notice that there has been some kind of liquid, lava or something which has been flown around this region and it has got settled down.

And that is how from the Google Earth map you can see that the whole gradients and the slopes and aspects which are formed by the way it has been cool down. And then you can see some cliff kind of environment here and a valley sort of thing. If you go little closer, the same cliffs, it looks like this where there is mountains around it, a very plateau sort of mountains.

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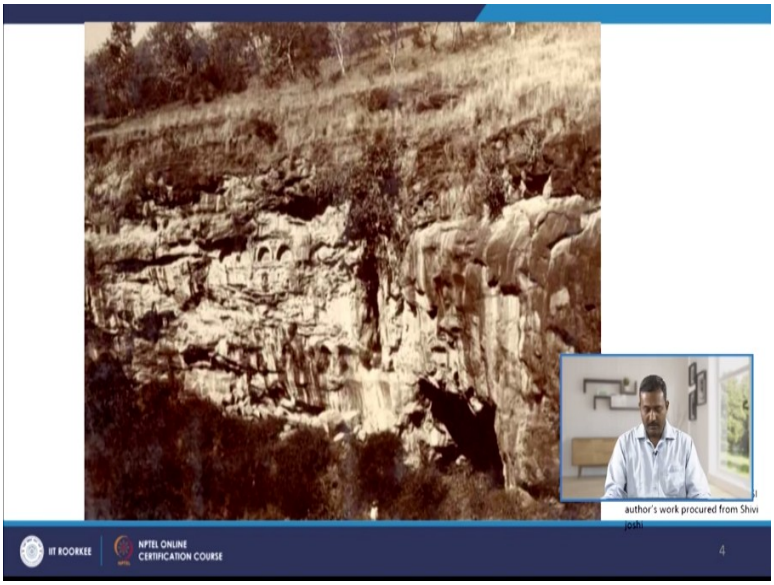

And if you go further closer and this is what we can see the Pitalkhora caves. This is in the Western Ghats in the Satmala range of the Western Ghats in Maharashtra state of India and in fact I want to give a credit of two important people like this is most of the information this has been from the source of Prabhakar Nandagopal. That time he was a superintending archaeologist in the Archaeological Survey of India.

And his work has been, he has been working on this projects and also Deshpande's work, so this I have able to procure from Shivi Joshi's, who was my student earlier in SPA Bhopal. So, many of the photographs and many of the details which I am learning from their work, Dr. Nandhagopal's work. And what you could see is the cave dweller settlement, and in fact this was also a kind of excavation site where people realize that there has been a human settlement here.

And in this, you can find many nomadic tribes you know roaming around and one is it is also just not only in the name proximity but they do travel.

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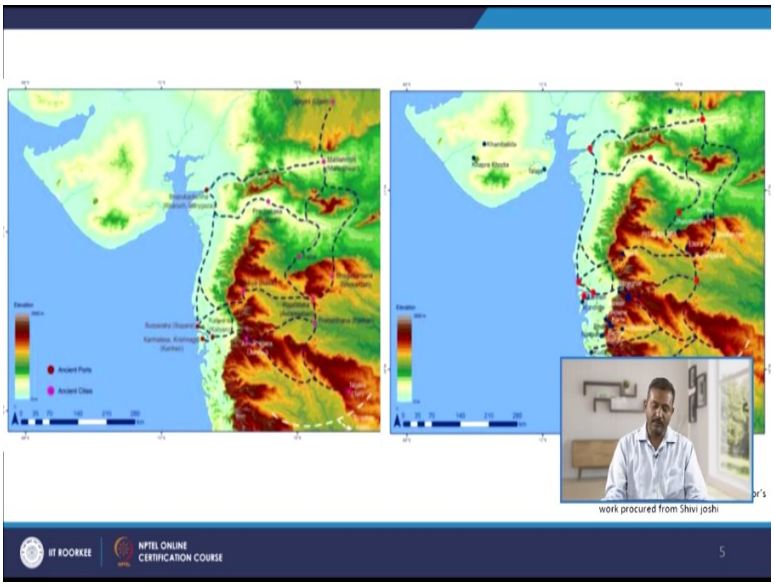

If you look at their networks, the trade networks, it goes back to Mahishmati, it goes back to Ujjain, it goes back to Bhimbetka in Madhya Pradesh you know, so Ellora, Ajanta. So, like that there has been a network how people have traveled and migrated and settled in different parts of central and the western part of India and also their expansion in the port cities like you know on the western side of the port cities how they have settled down.

And you can see some similarities of how these cave dwellings have some similarities in the African continent as well as in the South American continent, some kind of similar depictions of how man has lived.

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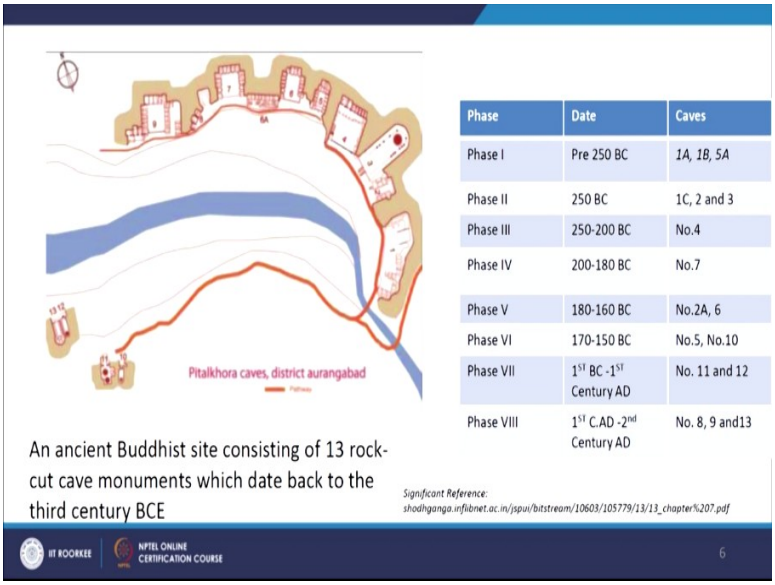

So, this is the layout of a Buddhist site which is a Pitalkhora caves which is in the district of Aurangabad. Now, initially these sites goes back to almost pre 250 BC which is almost to the 3rd century BC as well and they are not done. If you look at there are about 13 caves which has been discovered in the excavation process and some of them have been discovered much later and some were discovered in the beginning.

And if you look at the phase wise, and what you are able to see here is the cave numbers which has been written on 1, 2, 3, 4, 5, 6, 7, 9 and 6a and on the bottom side you have 10, 11 and 12 and 13. There is also they are not the same form, they are not of the same alignment like you can see from number 3 which is a kind of Chaitya sort of thing and here again in 13 as well you can see a kind of Chaityas and Viharas for Buddhist style.

And whereas where we talked about number 1 which is of a very rudimentary stage of a cave which is about dates back to pre 250 BC and then the phase II which talks about the 1c and 2 and 3 which is a smaller one and the third one is a kind of a Chaitya which is an elongated corridor. So, that is again goes back to 250 BC's whereas number 4 which is supposed a huge square base which is between 250 to 200 BC's.

Whereas in 7 which has a similar, which has again a smaller components, smaller compartments around it and that is dating back to phase 4 which is about 200, 280 BC and similarly you have number 6 and 2a, they are all again getting back 180 to 160 BC and if you come like that number 11 and 12 where you can see on the bottom side on the other side of

the caves, you can see that they have dates back to first century BC and first century AD as well.

And number 8, 9 this also again goes back to 13 which is more refined stage in the second century AD. So, this is how it took almost about from pre 250 BC onwards till the 2nd century AD. So, that is a kind of timeline of how these cave dwellings have been developed in this region in the Satmala range of Western Ghats in Maharashtra. Now, how do they able to figure out this process.

You know there have been evidences, there has been some iconographist who have studied how their paintings were done, how the symbolic representations on their pillars, who have donated it, when it was donated. So, there has been a linguistic understanding, there has been an artistic understanding in it, and you know the style interpretation of it. Now, for example when we talk about how they have identified.

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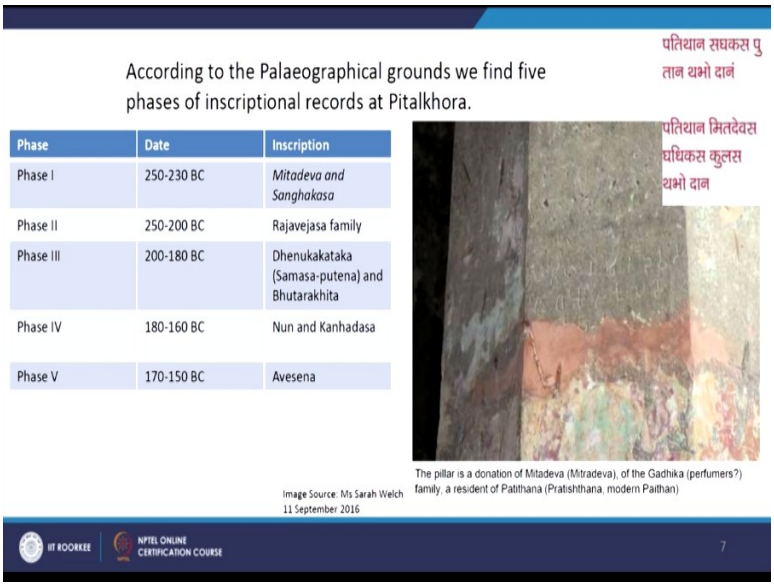

On the right-hand side in the photograph, you can see some small text which has been written in either Pali or and this is saying that the pillar is the donation of Mitadeva which is a Mitradeva of the Gadhika family, a resident of Patithana which is Pratishthana the modern Python. So, it says, these inscriptions are telling actually about who is the family who have donated to the construction the pillar, so which means and from where they belong to.

So, all this process has been become a very rich evidence to know that what kind of families used to live around, how they are connected, what kind of time they were talking about and

like that if you look at the phases, we find nearly 5 phases of inscriptional records at the Pitalkhora. One is the Mitadeva and Sanghakasa, Rajavejasa family, Dhenukakataka and Bhutarakhita and whereas phase IV it talks about Nun and Kanhadasa and phase V Avesena.

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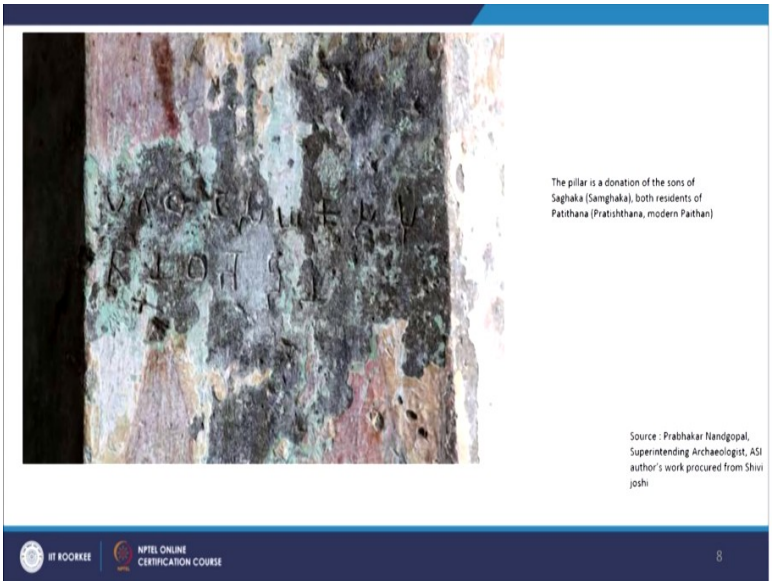

So, this is how some of the evidences and similar to this you can see that this is also donated by the Saghaka both the residence of Patithana.

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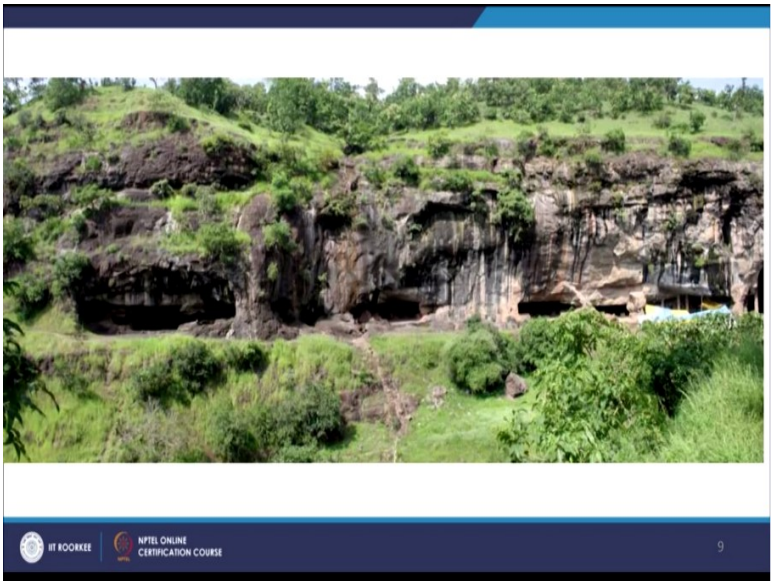

And if you look at the panoramic view of the whole caves, what you can see is small small caves which are actually located in a very linear pattern and has been embedded under this mountain Big Mound which has been covered.

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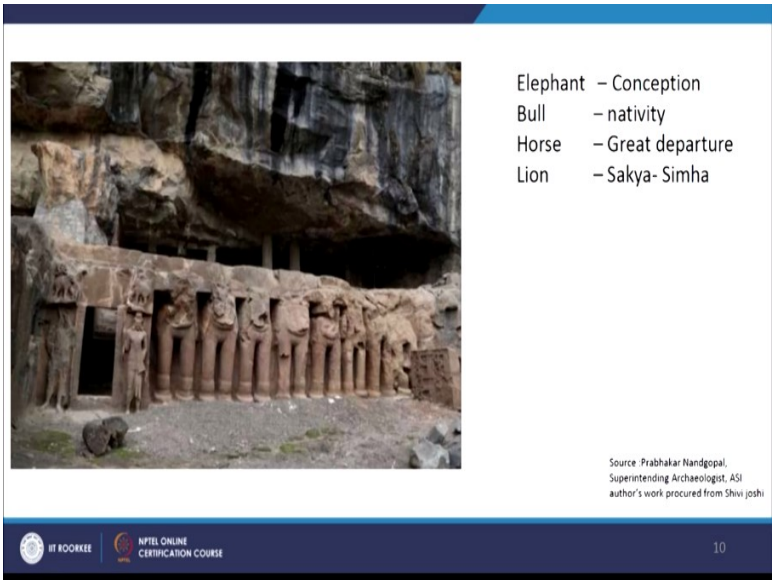

And there are also some iconographic aspects of science and symbolic aspects of it where you can find some sculpture as well where in their time elephant is referred to the conception, bull is referred to nativity, horse is referred to great departure, lion is referred to Sakya and Simha you know. So, like that there are some different meanings associated to these symbolic expressions.

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In the Buddhism, one of the important phase we talk about the Mahayana phase of Buddhism at Pitalkhora. It is also the paintings which also depict with the time like if you see the left-hand side one which actually both of them they are talking about the paintings of the Mahayana phase were drawn where the caves were occupied by the followers for the Mahayana sect.

But you can see the time difference, the style of Buddha, both of them are talking about the Buddha's where it is the hairstyle have been different, and their artistic style is also very different. In fact, some point of the time people also used to make it, this is a kind of Pitalkhora style of hairstyle you know, these are all some representative skills which has been developed through time.

Now, this is a brief about the caves and their historic aspect like the Buddhist sects and how they have been represented, but then I will also touch upon the geotechnical aspects of it, the geomorphological aspects of it.

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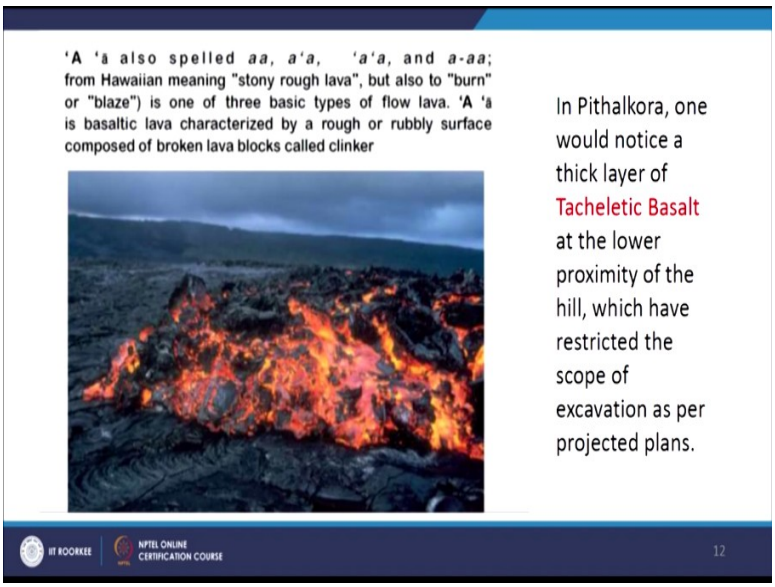

Now, in Pitalkhora we actually notice a very thick layer of Tacheletic Basalt at the lower proximity of the hill, which have restricted the scope of excavation as per projected plans because you know this is about this Basalt which actually sometimes it becomes a very soft material when keeps making an excavation it breaks into the pieces you know, that is how there is a chance that the evidence will also be losing, we will be losing some evidence.

Like now what you see here is a kind of lava where we talk about the 'Aa' which is the basaltic lava which is characterized by a rough or a rubbly surface and these lava blocks also we actually extract the clinker from this kind of rough and rubbly surface lava is called 'Aa'.

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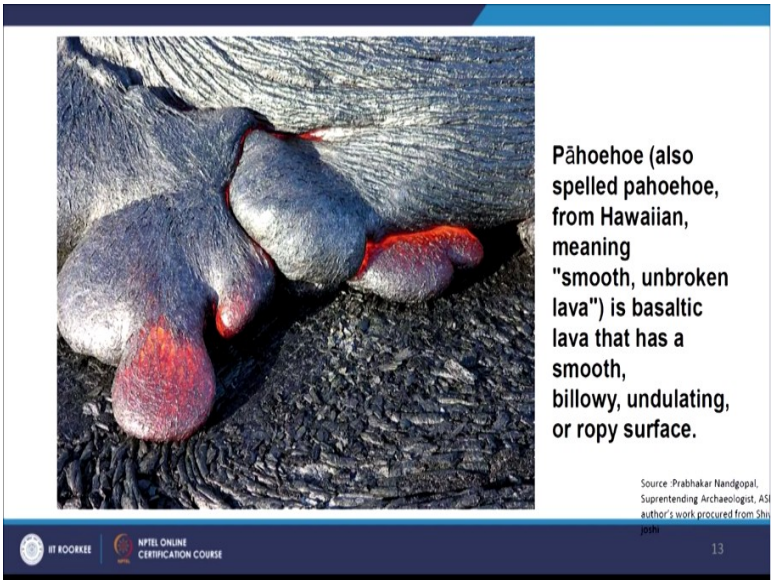

This is a very smooth surface which is unbroken lava is also a basaltic lava that has a very smooth, billowy, undulating or a ropy surface and this is called a Pahoehoe and this is a Hawaiian meaning which is called smooth and unbroken lava, it just floats in a very smooth liquid like you know when the mercury starts flowing down.

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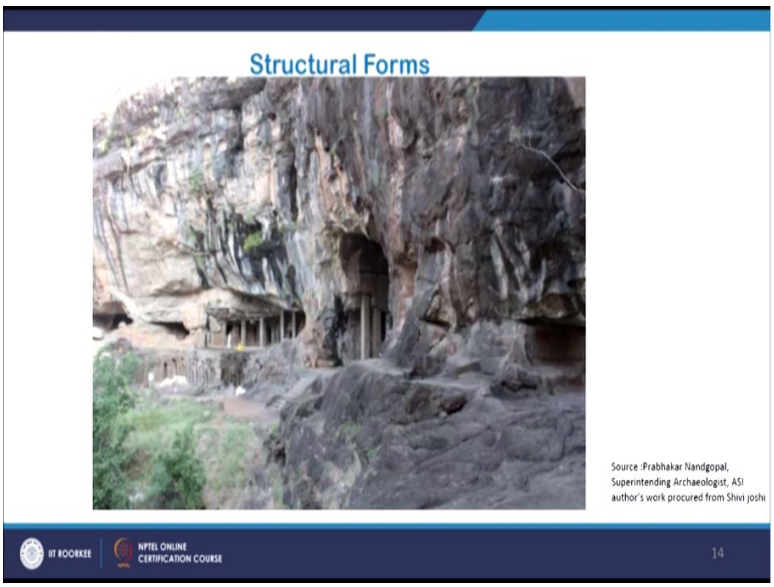

When these kind of molten lava gets cooled up that is where it develops the structural forms whether structural joints are developed and some hollow spaces are also developed and this is where the hollow spaces becomes eventually man have made his shelters.

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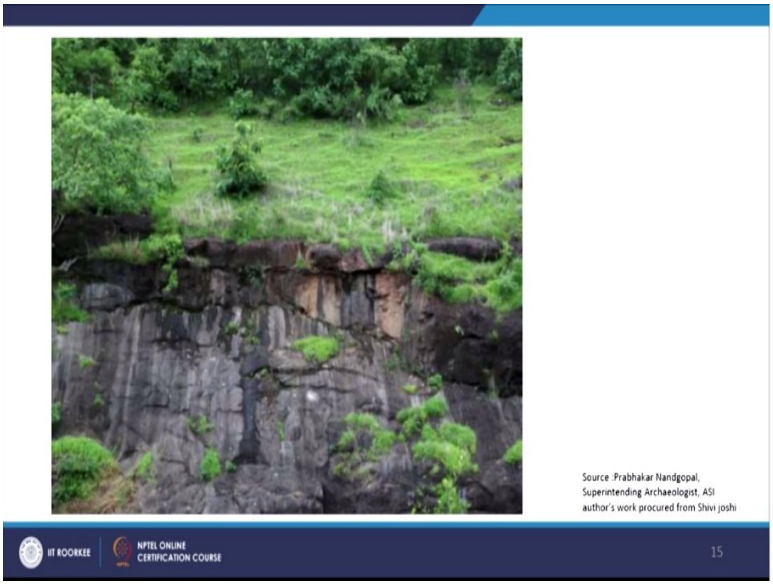

Now, what we can see is the layers of the horizontal layers of one over the another. So, these layers also talks about these beds which are talking about, so a set of lava have come down and gradually another set of lava and the by the time it cools down the another set came, another set came. So, this is how this horizontal layer started developing one over the another.

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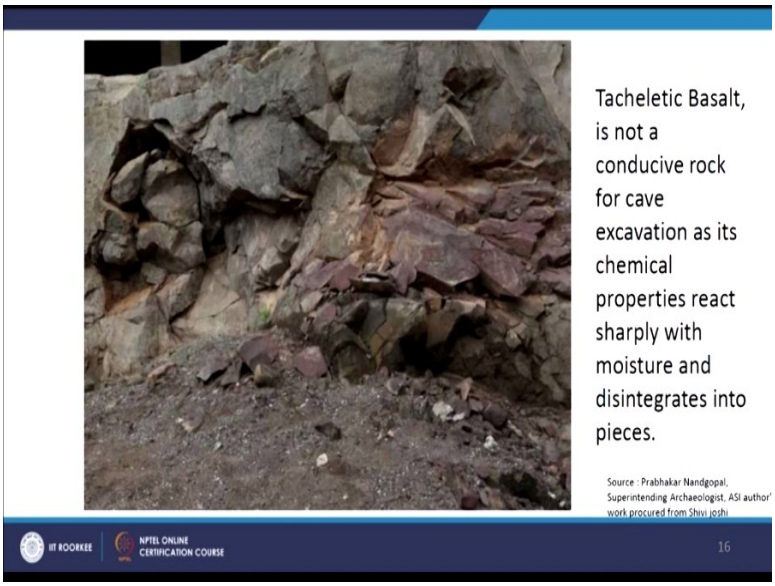

And this Tacheletic Basalt which is not a conducive rock for cave excavation as its chemical properties react sharply with moisture and disintegrate into pieces. The moment you are making an excavation process, it gradually brokes into small wedge-shaped pieces you know, that is one of the important aspect in the excavation challenges and excavation challenge especially with this kind of material.

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This is another form we talk about the ropy structure, so that is where this is again a Pahoehoe sort of thing which actually twist into a trend of ropy format.

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And you can see also as time passes on the spheroidal weathering takes place because this layers on the top layers keeps coming like a chip by chip and this is again in a spheroidal manner, this is called spheroidal weathering.

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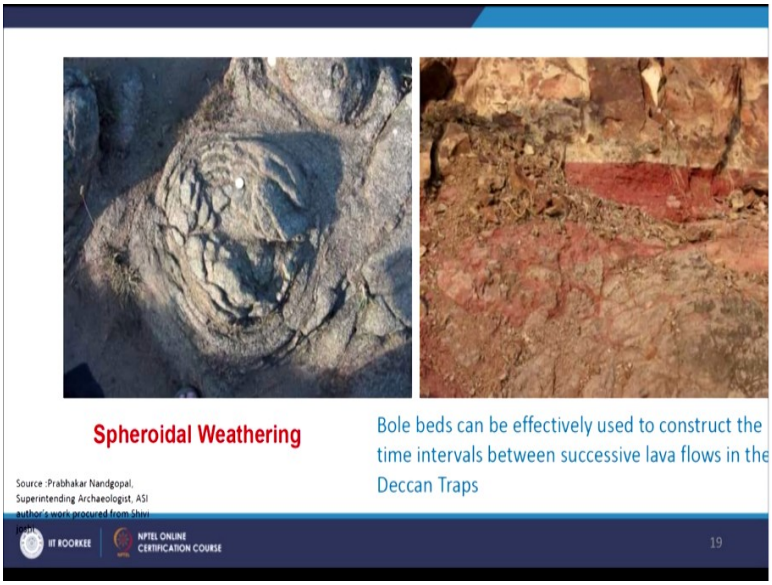

And on the left-hand side, you see an example of how the whole rock formation and because of the weathering aspect how it chips down. On the right-hand side what you see is a kind of Bole beds which is actually look at the time intervals of how these successive lava flows have been trapped in the Deccan Trap you know.

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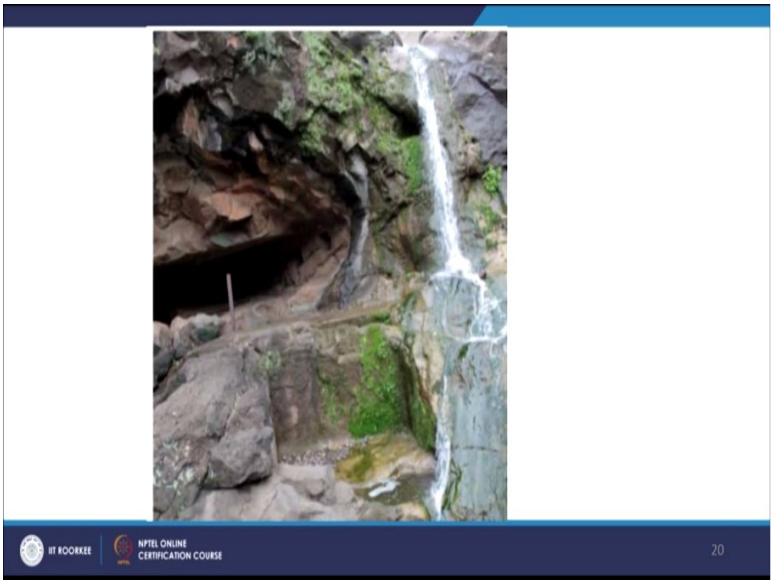

And as the time passed on obviously there has been some water bodies, small waterfalls or they keep channeling it as per the slope and the gradient which has been a natural form. But then it has been there for ages and until people have discovered no one have realized it, and it has been there since many decades. Now, things are the water is following and the seepage has started within the caves and this is one aspect.

Now, what they did was the archaeologists team they have actually mapped down, they have actually documented the whole set of caves including the analysis of the cracks this is where they talk about a geological mapping of the ceiling of the caves and this is one of the Chaitya where they have documented where are the cracks coming into it, what are the categories, they have classified the categories of the risk.

So, depending on the nature of the crack and from the stable to the most unstable level, so that is how they leveled crack category 1, 2, 3, 4, 5 and that is where they classified and categorize these risk aspects and similarly this is again, they again categorize with what are the different aspects of the risk.

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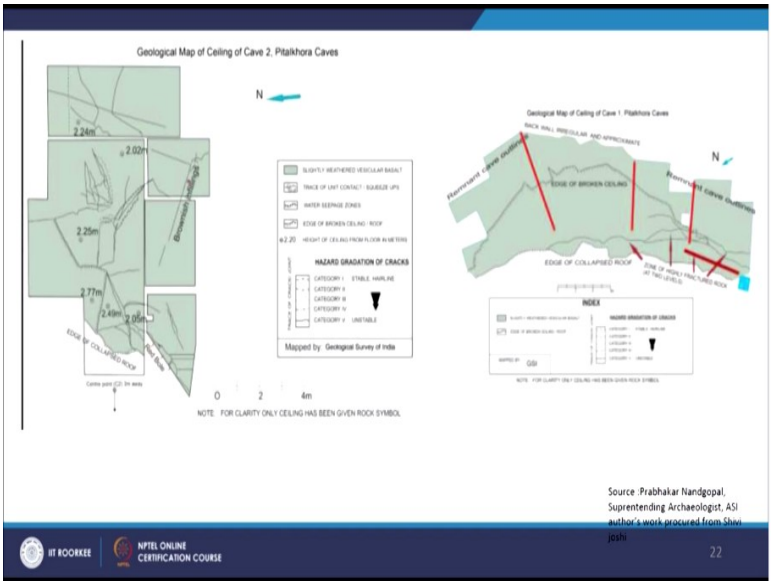

One is the slightly weathered vesicular basalt and also water seepage zones which are more of this dotted aspects of it and where the edge of the broken ceiling you know the roof, and this is where they try to again classify all these aspects and also where the cracks are also appearing continuously not only in a horizontal in the ceiling level but throughout the cave structure, how this vertical cracks are also coming up.

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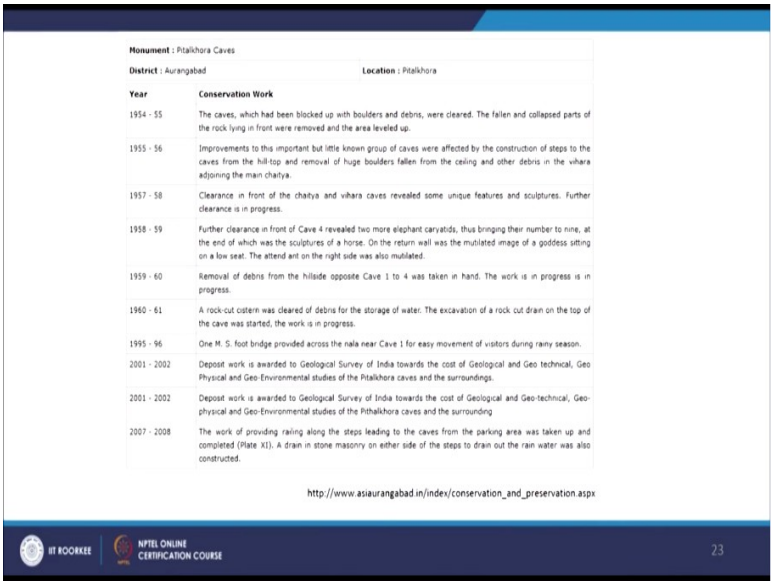

Monument : Pitalkhora Caves

District : Aurangabad **Location :** Pitalkhora

Year	Conservation Work
1954 - 55	The caves, which had been blocked up with boulders and debris, were cleared. The fallen and collapsed parts of the rock lying in front were removed and the area leveled up.
1955 - 56	Improvements to this important but little known group of caves were affected by the construction of steps to the caves from the hill-top and removal of huge boulders fallen from the ceiling and other debris in the vihara adjoining the main chaitya.
1957 - 58	Clearance in front of the chaitya and vihara caves revealed some unique features and sculptures. Further clearance is in progress.
1958 - 59	Further clearance in front of Cave 4 revealed two more elephant caryatids, thus bringing their number to nine, at the end of which was the sculptures of a horse. On the return wall was the mutilated image of a goddess sitting on a low seat. The attend ant on the right side was also mutilated.
1959 - 60	Removal of debris from the hillside opposite Cave 1 to 4 was taken in hand. The work is in progress is in progress.
1960 - 61	A rock-cut cistern was cleared of debris for the storage of water. The excavation of a rock cut drain on the top of the cave was started, the work is in progress.
1995 - 96	One M. S. foot bridge provided across the nala near Cave 1 for easy movement of visitors during rainy season.
2001 - 2002	Deposit work is awarded to Geological Survey of India towards the cost of Geological and Geo technical, Geo Physical and Geo-Environmental studies of the Pitalkhora caves and the surroundings.
2001 - 2002	Deposit work is awarded to Geological Survey of India towards the cost of Geological and Geo-technical, Geo-physical and Geo-Environmental studies of the Pithalkhora caves and the surrounding
2007 - 2008	The work of providing railing along the steps leading to the caves from the parking area was taken up and completed (Plate XI). A drain in stone masonry on either side of the steps to drain out the rain water was also constructed.

http://www.asiaurangabad.in/index/conservation_and_preservation.aspx

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And after having this, I showed you only a small set of analysis of how one have able to document all these caves and how they were able to map down from a spatial point of it and analyze what are the root causes for it, where are the material aspects into it, where are the water seepage issues, whereas the ceiling has been broken down or if there is the pillars have been broken down, whether the floor aspect which has been chipping out because of weathering aspects or during rainy season what kind of impacts it is having.

So, all these documentations have been done. So, but then when you look at the set of activities which has been taken as a part of the conservation plan from 1954 to 2008 you see a huge span of time but then a very limited work what we can see but then one has to understand, it is not a regular building project, it is a conservation project.

So, it normally takes time because even analyzing to make a small scaffolding how to do it is also a big task you know because you might destroy the evidence like in 1954-55 this has been completely blocked up to the big boulders and debris. They have started clearing it, and then there are already some fallen and collapsed parts of rock lying in front were removed and the area has been leveled up.

And in 1955-56, so has been very little known group of caves were affected by the construction of steps to the caves from hilltop and removal of huge boulders fallen from the ceiling and other debris in the Vihara adjoining the main Chaitya. So, in 57 and 58, clearance in front of the Chaitya and Vihara caves reveal some unique features and sculptures that is where I showed you the lion and bull, the horses.

And in 58-59, there is again cave 4 revealed two more elephant caryatides, and like that one by one they started discovering, and they started and they again in 1959-60 by this time it is almost 6 years to even taking the debris from the hillside opposite cave 1 to 4 you know that is how it is a six-year project only just to clear the debris. And whereas in 60-61 a rock-cut cistern was cleared of debris for the storage of water and the excavation of rock-cut drain on the top of the cave was started the work.

So, in that way they started the cistern as well as the water storage and 1995, this is where they started about a mild-steel footbridge because the tourists start pumping down and in order to channel them without destroying the evidence that is where they try to keep some kind of access. Whereas there also in 2001 onwards, the deposit work is awarded to GSI Geological Survey of India towards the cost of geological and geotechnical and geophysical and geoenvironmental studies of the Pitalkhora caves and the surroundings.

Whereas here it is not only that how a set of activities are related to, there is a different dimension of technicality comes into it. Now, it is not a story of a conservation architect, it is not only a task but how this analysis works with the geotechnical and the geoenvironmental studies also collaborate in it because they becomes the base now in order to understand the impact aspects of this kind of case that is risk aspect. Now, inside the caves following all these analysis what kind of modifications has been done?

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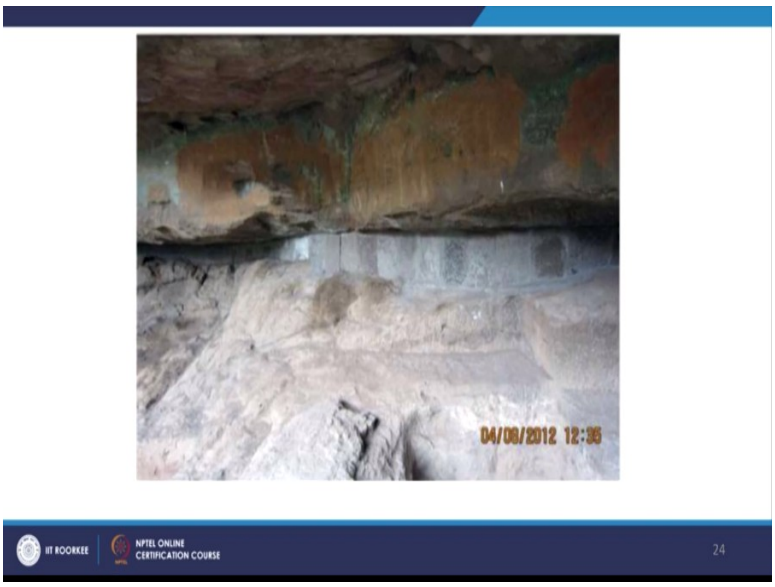

So, now you can see that they have started looking at how the edges of the roof and the structure of the vertical aspect and the roof aspect are merging that is a lot of damage have occurred, and there might be a chance that it might collapse at any time. So, that is where they started giving some kind of support system at the edges so that there is a you know the balance of the structure as well.

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Also, what you can see here is whatever the columns they already have and now retrofitting them and giving a kind of support to the ceiling as well.

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So, now you can see the scaffolding process because in the scaffolding process is a very important task because you do not need to like in a normal building project you hit the wall, you puncher it and then you try to keep a support system, but here in conservation project, it

does not work like that, you have to because each and every evidence is much more important significant and it is very critical to understand that.

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So, this is how the restoration process has been done. And on the flooring part you know because there has been some times, it has been chipped out so that is where they start making some kind of flooring restoration has been done.

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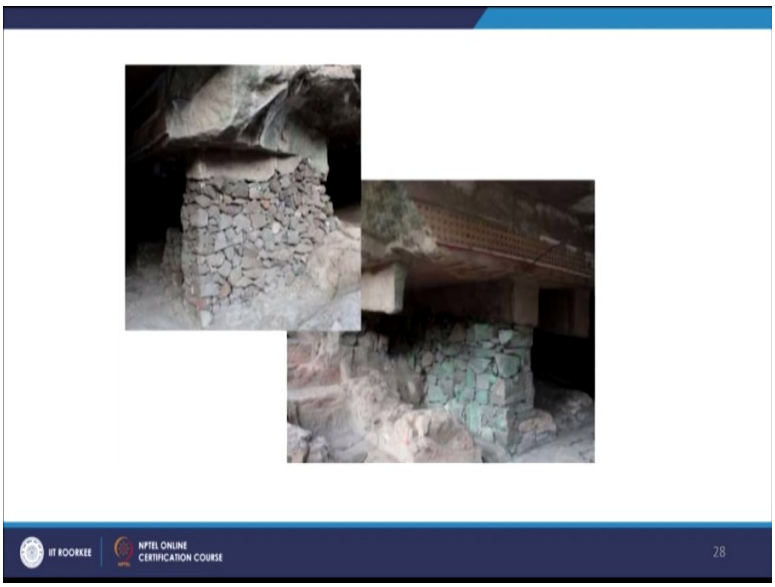

And similarly, they also given some support systems where there has been cracks and there is a possibility that this may not bear the load after some time that is where they started giving some kind of huge rubble masonry wall, not masonry, it is a kind of dry stone wall which they have able to give a little support on that. So, without giving any additional material or a render to it but just keeping as a stone wall.

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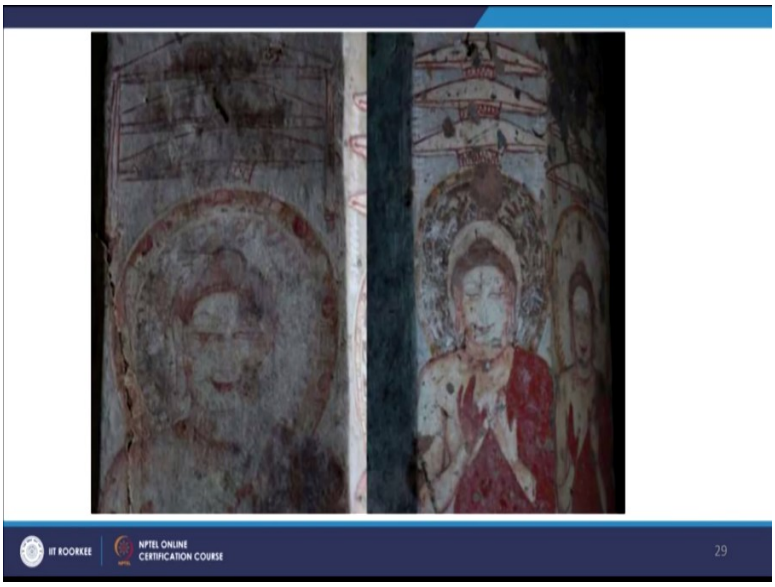

Also, the paintings are most important elements that is where they keeps check to the risk. So, how to restore these paintings that is one of the biggest challenge and that is where you have to work out with the people from chemistry, with people from archaeologists because you need to see that there is a material scientists could also be involved in it, how we can actually protect them is very important.

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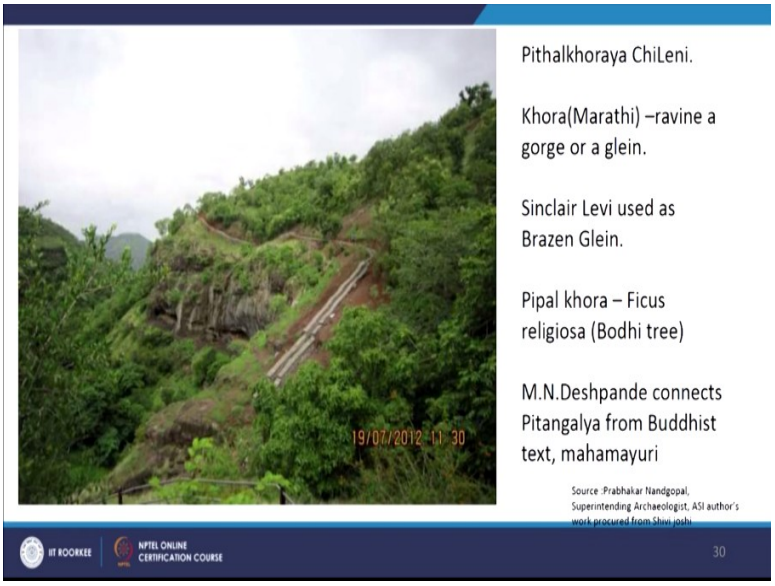

Now, what you can see is a small canal, but after having a thorough understanding of the topographic aspects and after having a understanding of where the water seepages are coming, they understood the root cause of the water is not just not in the cave, it is somewhere beyond the mountain. So, then they started making a kind of channel you know how to divert this water so that at least it can protect the water seepage in the caves.

So, this is, it could be a very small intervention, but then a thorough analysis has to be done in order to protect these heritage structures. In fact, one of the scholar who actually worked on this particular structures M.N. Deshpande, and where there has been many names of this Pitalkhora, Pithalkhoraya ChiLeni, Khora, is a ravine, a gorge or a glein and Sinclair Levi which is a Brazen Glein, Pipal Khora which is Ficus religiosa which is a Bodhi tree which reflected the Buddhism.

And you know that is how a lot of disciplines come together and they work on this assessment of the risk as well, also the conservation but how you manage it is also an important aspect. I hope this helps you.

Thank you very much.