International Studies in Vernacular Architecture
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Lecture 06
Stone as a Vernacular Resource Material

Welcome to the course International Studies in Vernacular Architecture. Today, we are going to talk about stone as a vernacular resource material. When I was a student of architecture, my very first interaction with the stone buildings was somewhere in 2002, when I was actually doing my fieldwork in Gujarat, earthquake affected areas.

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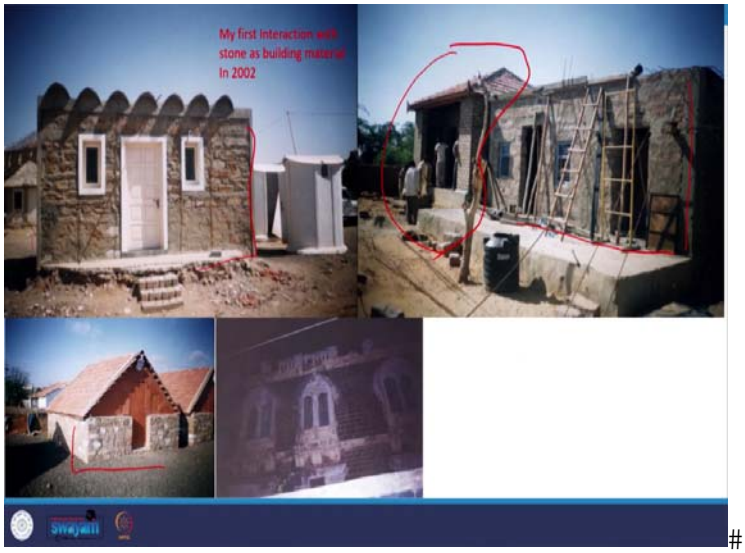

And this is where I actually got interacted with one of the very interesting example that when different NGOs has given a new housing with the compressed stabilized blocks, but I could see the communities have started building on their own, just adjacent to it with the help of a stone as a building material.

And I could see that various agencies came forward to come up with alternative technologies for integrating various different techniques like for example, they have the ferro cement channels over the stone constructions, they have the temporary rehabilitation structures, and including many efforts have been done in the historic architectural conservation projects. So, that is how, with my little understanding over there, and then I started interacting with various works done by various architects.

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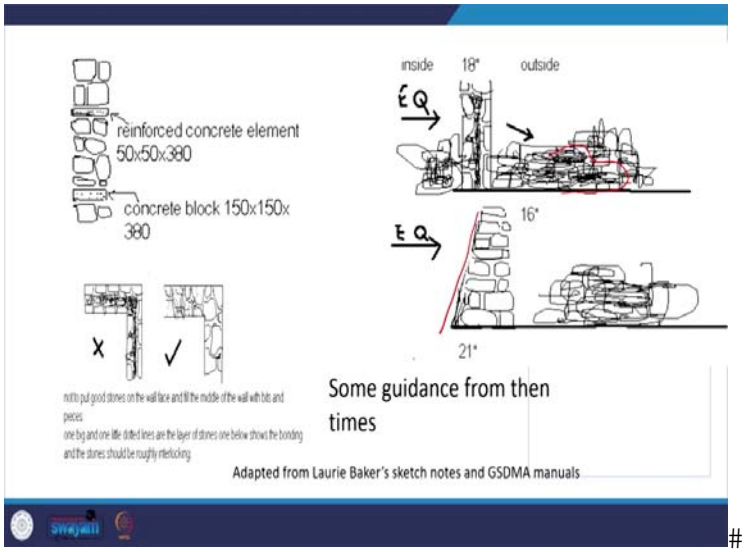

And one of the very initial my understanding of this stone construction was Laurie Baker's handbook, where he talked about when his work in Chamoli where he talked about how to construct with stone and how not to construct with stone, what are the effective ways of their bonding, how the filling technique and how we have to taper the surfaces because when if you make it straight in terms of earthquake-prone areas, it may fall inside the house where it may affect the people. And whereas if you taper it, you know it will have certain resistance.

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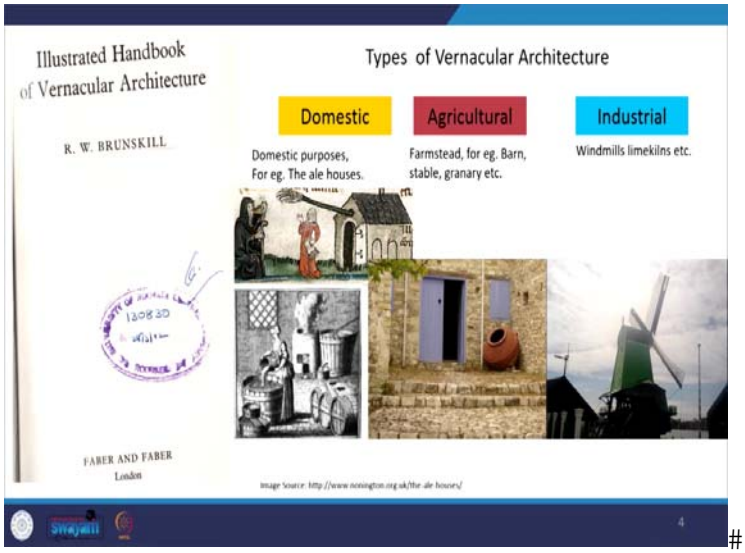

And relating it to in the context of vernacular architecture, Burnskill's work on the illustrated handbook of vernacular architecture where he classifies the types of vernacular architecture into domestic, agricultural and industrial. So, where we talk about the domestic purposes

were the kinds of ale houses, which conserves the community, the agricultural, where we have the barn houses to stabilize the granaries and the industrial, which talks about the limekilns and the windmills which is the producing part of it.

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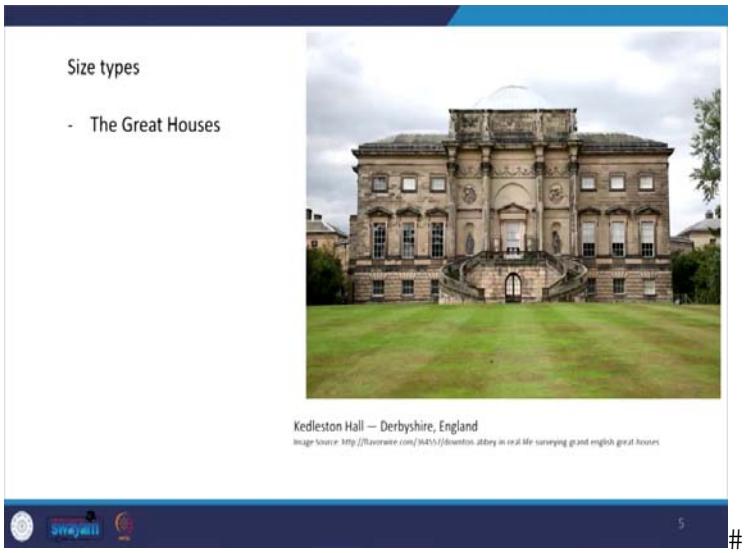

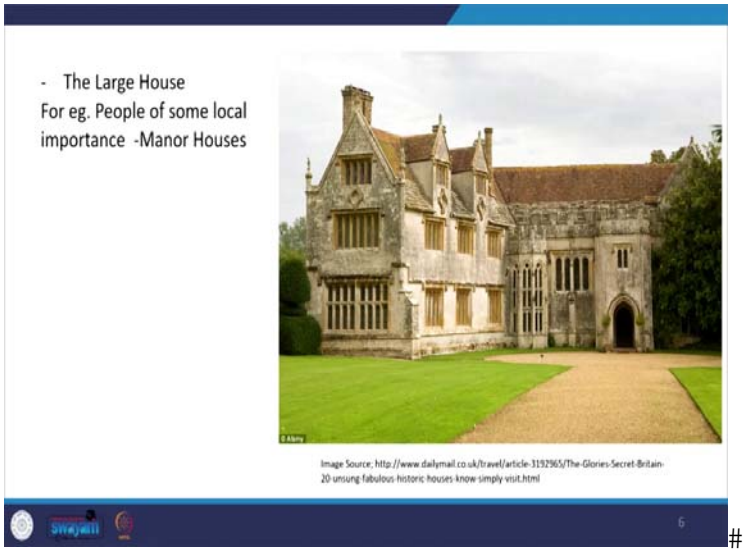

So, in terms of the size also, you have these, especially in the English context, the great houses and the large houses, which were the people of some local importance like the Manor Houses.

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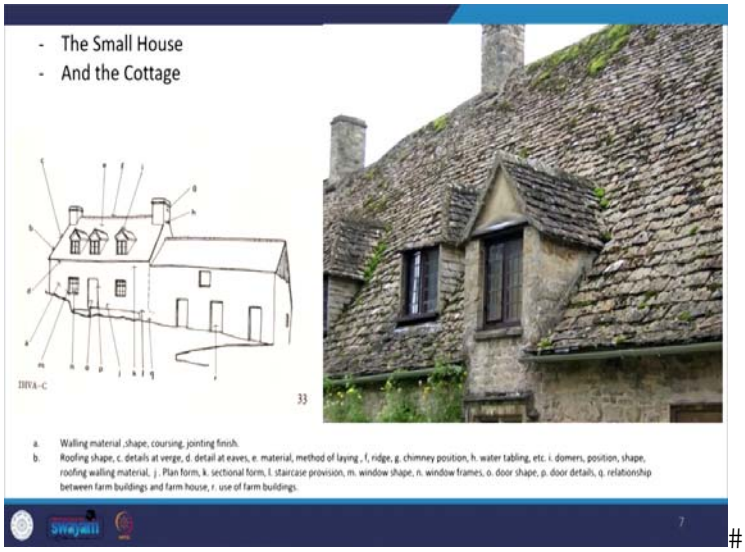

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And similarly, the small and the cottage houses where you can see on our way to Dartmoor, we could able to find many of these cottage houses where even the roof was made with the slates, whether the dormer window everything is made with the slates because that is the locally available material.

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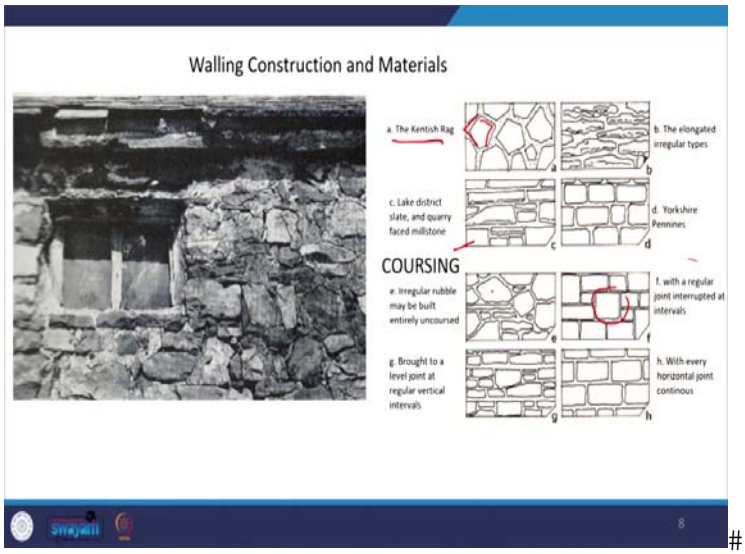

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Let me brief you about a few techniques of wall construction materials, and what are the technical terminology adopted in these techniques. So, one is the Kentish Rag, like you can see, there is the polygonal shaped stones which are placed and then that is how the Kentish Rag is made. And you have this lake district, when especially near the Manchester where you have this lake district slate you know that is.

And you have these are irregular rubble masonry and how it is coursed and uncoursed and at the same time the kind of joint, see that this is a process where with the irregular joint interrupted at intervals, so in that way, the bonding also makes an important aspect on the aesthetic part of the wall. So, whether it is random rubble masonry, where it is a coursed rubble masonry, the type of coursing it has done.

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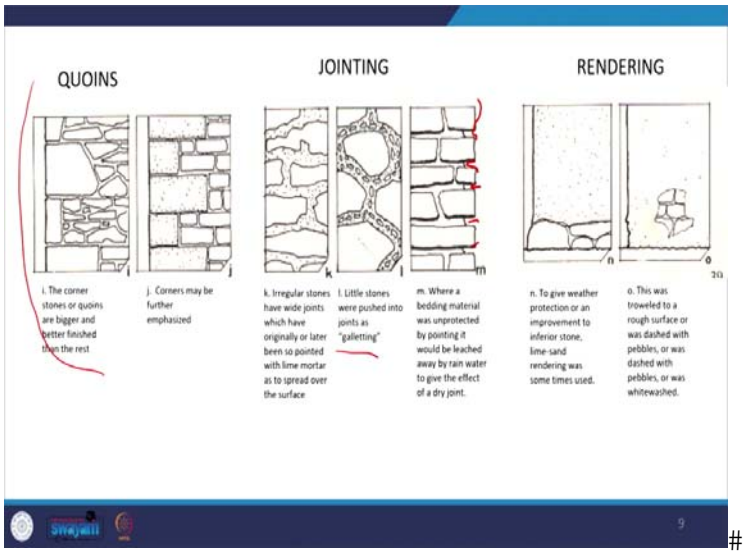

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And especially in the corners, you this we can find in many places like where the corner stones or the quoins are much bigger in size, because that gives more stability and it gives better finish and because the corners are emphasized. Similarly, in terms of jointing, how the irregular stones have very wide joints, and they can be pointed with the lime mortar or to spread over the surface.

And this is a technique which we talk about the little stones were pushed into these joints, that is where we call it as a galletting technique. And similarly, where a bedded material was unpredicted by pointing it will be leached away by rainwater to give the effect of a dry joint. So, there are rendering processes where we use different types of lime sand rendering has been applied on the exterior and the interior surfaces. Also, there are certain process where we actually use certain pebbles and also the whitewashes.

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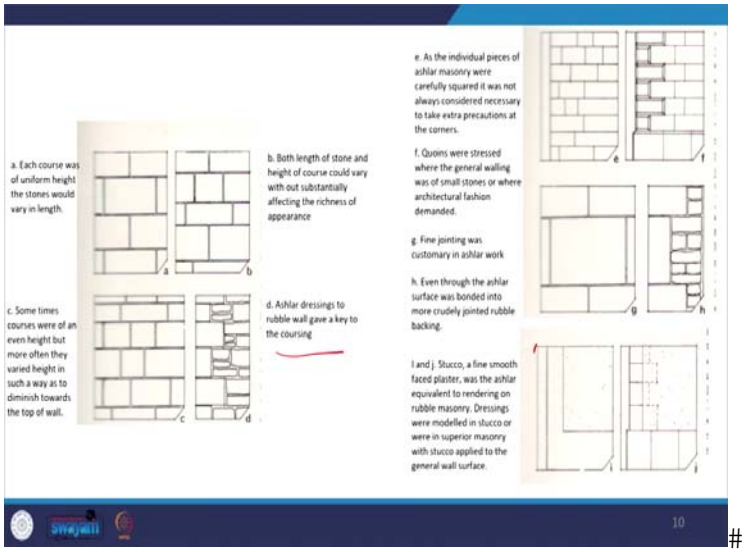

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Similarly, we have these the coursing process, how the ashlar dressings, we have these cornerstones and they follow a particular pattern, so this is how there is different techniques of how we can actually use these stones, and it actually brings an effective aesthetic outcome.

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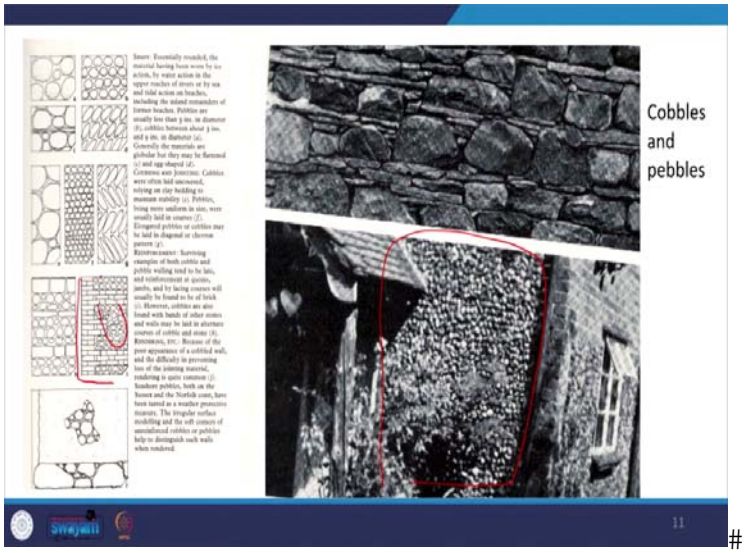

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Similarly, we talk about the cobbles and pebbles where we have mostly found these in 3 inches, the cobbles about 3 inches to the 9 inches in diameter. And whereas these are mostly in an egg shape, because they might have been found in any other riverbeds and they may be shaped it later, but you can see this whole wall facade was completely built decorated with the stones.

And here you can see that the different ways how these pebbles have been arranged in a systematic order like you can see here both the integration of a flat stones and the cobbles and pebbles have been arranged so that there is designed composition could be formulated in order to bring a certain aesthetic patterns.

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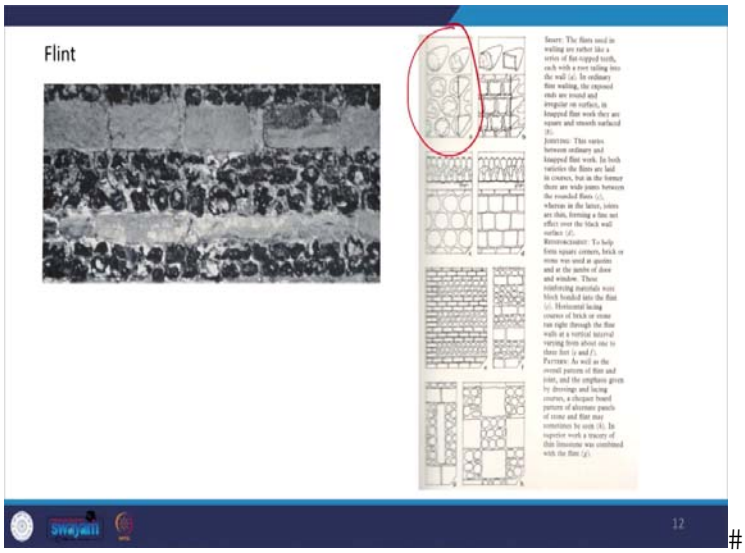

This again, flints we call, and the flints basically are the walling material, they are basically kind of a flat top teeth shaped stones and which the root is tailing into the wall, so, that is where you can actually see here. And so, this is how they actually follow different bands, like, when we are using a smaller structures, we actually follow horizontal bands, because that actually gives a kind of bonding to the whole wall structure.

On a similar note, Brunskill have also come up with an technique on how to document these vernacular buildings, when we are actually doing a county or village or anything, what is the easiest way to document how we can develop a particular standardized process.

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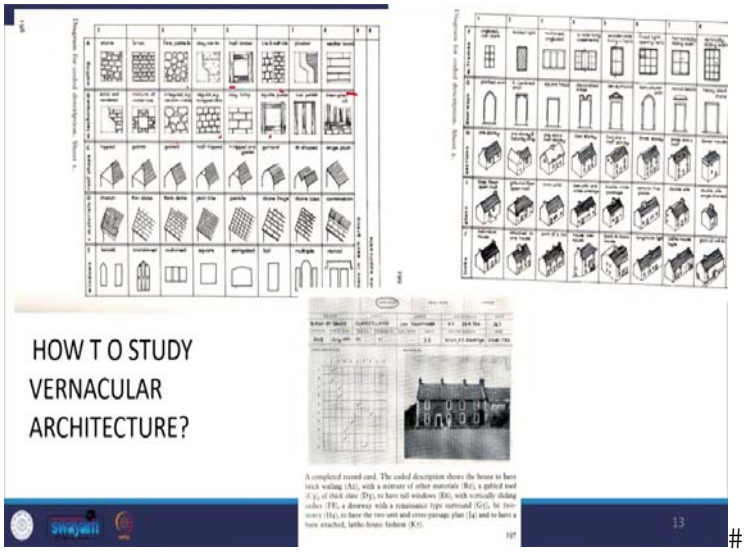

So, what he did was once we do a Reiki survey of any particular area, we develop this as what are the walling material available in that place, what are the weathering technologies, what are the roof shapes it has, so, you prepare a template of this. So, whenever you go and study a particular building, it will be easy for you to take up.

And let us say for example, you have the photograph of this particular thing and the address the appropriate location of that and the orientation. So, once if you have this background template with you, so it is easy for you to prepare a code for that. The coded description here it talks about a brick walling which is referred to A2 with a mixture of other materials, a gable roof, a thick slate to have a tall windows with vertical sliding sashes, a doorway with a renaissance type.

So, like that it actually covers the whole component of the built form in a systematic order. So, this is how the coded sheet could be recorded in older times.

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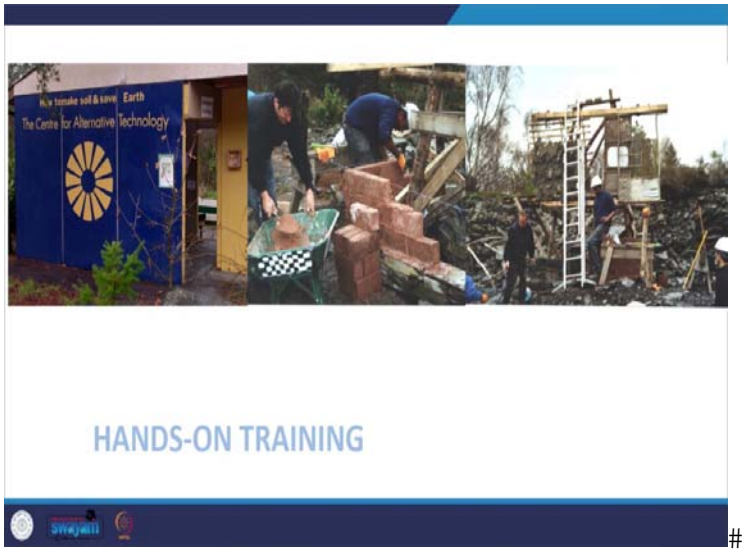

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And in terms of the education purpose, that is where I personally have learned that hands on training for students is very important when I was a student training with the center of alternative technology, where we were working with the stones, how we can create even a sliding window with the stones and how we can drill the stones?

What are the characteristics of stones? So unless we touch that we do not know the weight of the stone and how we can process it. And this is how my interaction with the stone and when it comes to the design aspects or when we come to how stone is pursued from a larger context.

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When we were studying in the Lefkara we have encountered the whole historic code is completely built with stone whether it is local houses, whether it is the restaurants, whether it is the public buildings, anything, even the roads are paved with the stone. So, the newer generation are actually facing certain difficulties in order to maintain this and how they are not finding comfortable with these tools so that is where a serious issue with the generational understanding of stone as a vernacular material.

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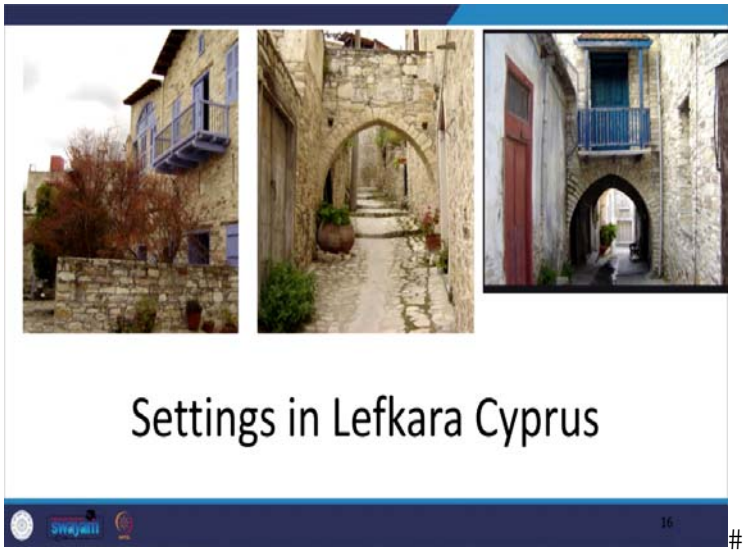

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So, this is how what we see even today in Lefkara, that all these streets are completely made out to build with the stone.

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But same that the Turkish part of Cyprus, where if you go to the other part of Cyprus, which is part of the Turkish TRNC in Lefkosa, where you can see on gurney you can see many of these buildings are built with the stone. And here you can see the galletting techniques also and we have in of course it is very relevant even in the Himachal Pradesh where we have this the GD bar construction cities built within a wooden frame and the stone is built within that, composed within that.

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So, as a part of my work experiences I had happen to work on certain newer constructions which are part of the restoration projects and where we have to really work with this stone masonry as an outcome, but integrating with the modern timber frame buildings where the interior complete interior has worked with the modern timber frame and the exterior because in order to address with the local guidelines of the Heritage considerations, so, this is where stone plays an important role in terms of aesthetics are not controlled with its locality.

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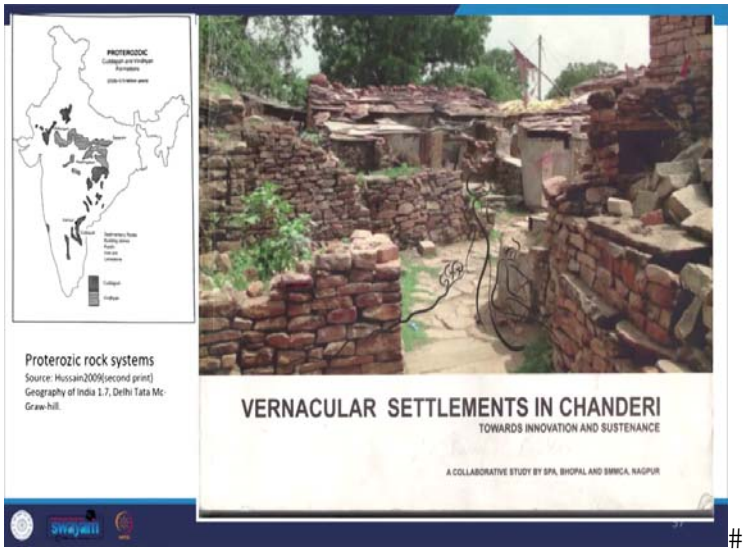

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And from an academic perspective when I was working in SPA Bhopal and I was we were coordinating studio with document with the students of architecture where we have taken them to the villages in Chanderi. And they have composed the whole documentation and this book was published by the SPA Bhopal press.

So, there we can actually see why do these villages exist in this part of the belt because we have to understand the geomorphological dimension of that this Kadapa stone or any proterozic type of formations is evident in this part of the region and that is where we are not talking about a small village, but if we look at the larger scale, and this is how these villages have existed, and they are all built with the stone because of the natural availability of the local material.

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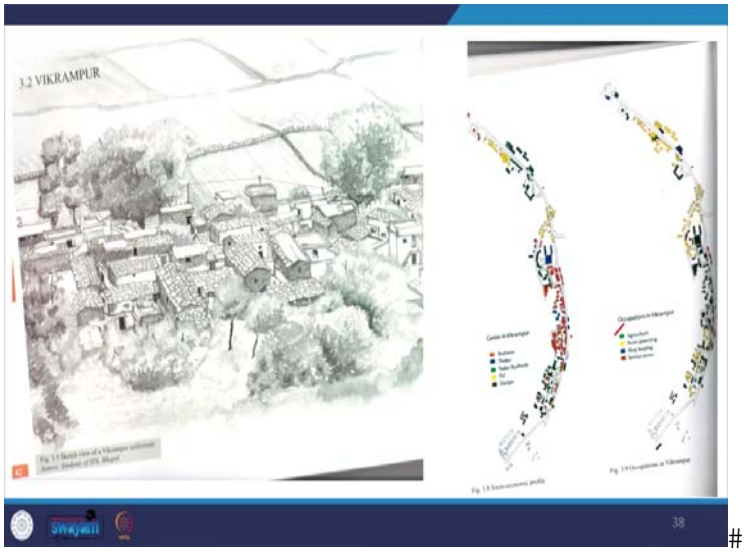

And that is how the some of the villages I would like to show you that how the whole villages are built, including the wall, the roof, everything is built with the stone.

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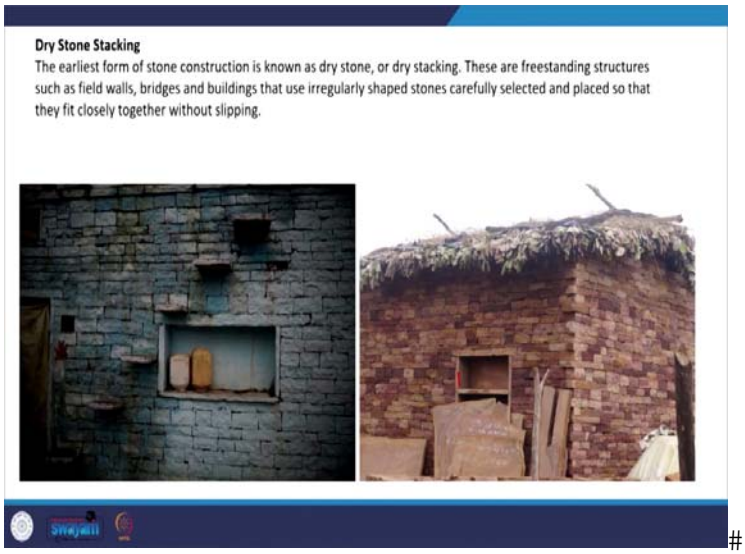

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So, you can see the dry-stone stacking, they do not use any mortar or anything, will self-load itself is a component and with that only the create the steps the cantilever steps, the create the windows, the create the doors, and the create the roofing materials. And the locals know much details about what kind of the slab they can use for the roof element, what kind of the element they can use as a beam, what kind of stone material they can use it for the normal wall purpose.

So, by looking at their grain, but by looking at their texture, by looking at the quality of it, the locals were able to judge all these things and the whole village even till today they are constructing with the same process.

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So, here are some photographs even the first floor they have G+1 floor completely made out of stone.

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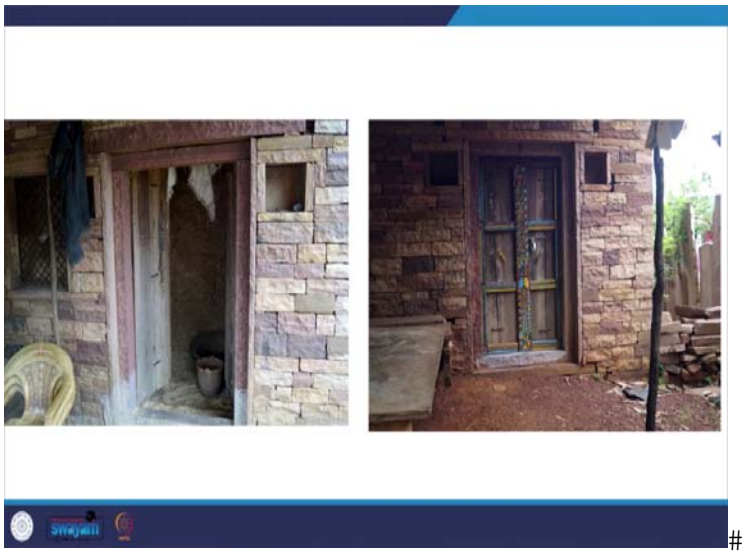

And entrance is how the jams were created, how they have these cultural aspects, how they create an entrances, and the lintels, the completely stone lintels.

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And the renders, they are also like for they want to construct a cattle shed then they created for the thermal comfort purposely created they rendered the whole wall.

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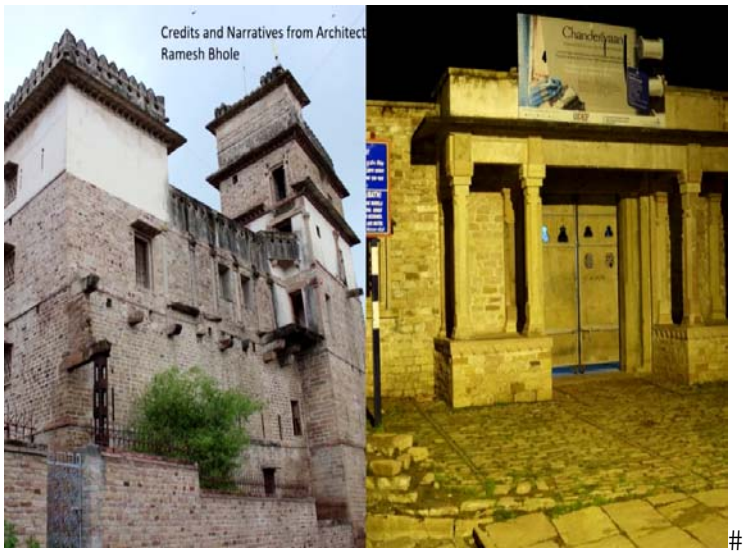
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So, that way, we can see that the local knowledge plays an important role. In the same place in the Chanderi Raja Rani Mahal, where architects Ramesh Bhole, when he was working with INTACH he worked with the conservation of this Raja Rani Mahal and he explained us what are the difficulties in the conservation process especially one with the recent building codes, which does not match with the historic elements like for example, you have the staircase, how we have to keep it, what height we have to keep. So, in that way, there is always a challenges with the present code and the conservation process.

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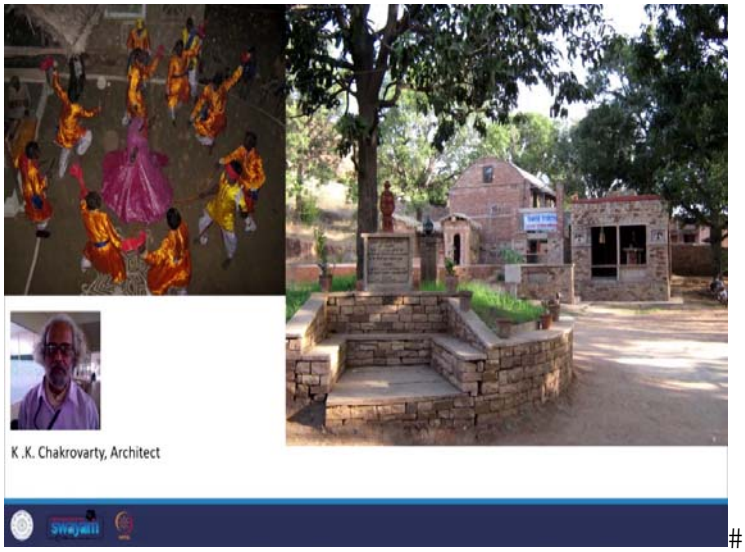

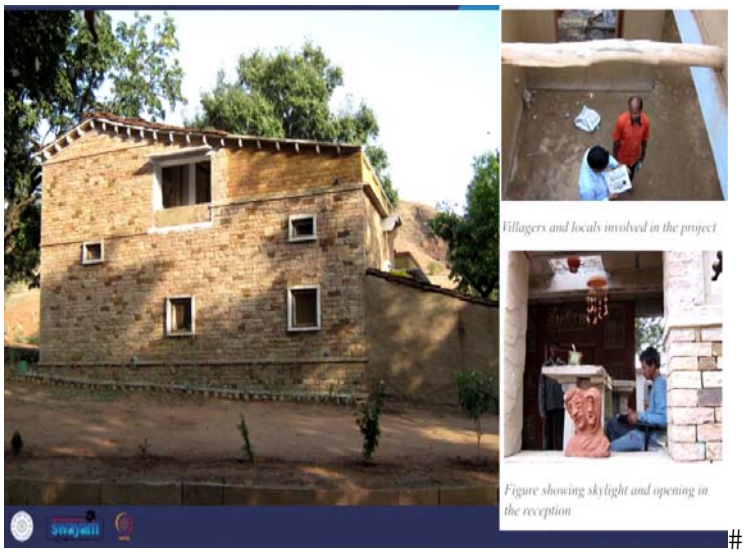

So, there is another architect, K. K. Chakrovarty, who actually worked on this Amrai resort project, where in fact, this is one challenging project, I could say, Amrai is the kind of local dance which the men performs this particular performs and he has taken that as an inspiration and he negotiated with the government authorities to bring the stone as a local material and this resort was built, including the walled and even the structures he come up with these smaller window sizes, engage the community in the process.

And very interestingly, there is no formal drawings of that everything is made on the site with the help of the villagers, where the villagers were involved, how they want to create the receptions, how they want to create the rooms, so, all these processes.

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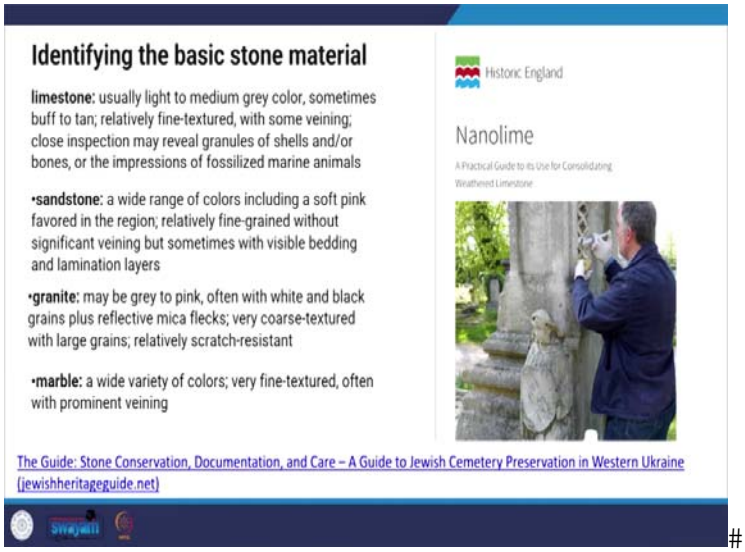

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So, these are a few examples, but then when it comes to the investigation of the stone material, first of all, we need to really understand what is the stone we are talking about, are we talking about the limestone, are we talking about the sandstone, granite and the marble. So, when we talk about the limestone, it has certain biological processes, it could be through the coral reef process or certain organisms which has produced this process.

Whereas in the sandstone it is again, bigger rocks where it transforms into the sandstone. So, that is how we really need to understand what part of the stone what kind of stone we are going to deal with in any of the project. So, I am giving a reference of some of the Jewish cemetery preservation in Western Ukraine, the link is provided, so you can actually go through that.

And there is another document which I would like to refer is the Historic England, the Nanolime process, how we can use this consolidated weathered limestone process.

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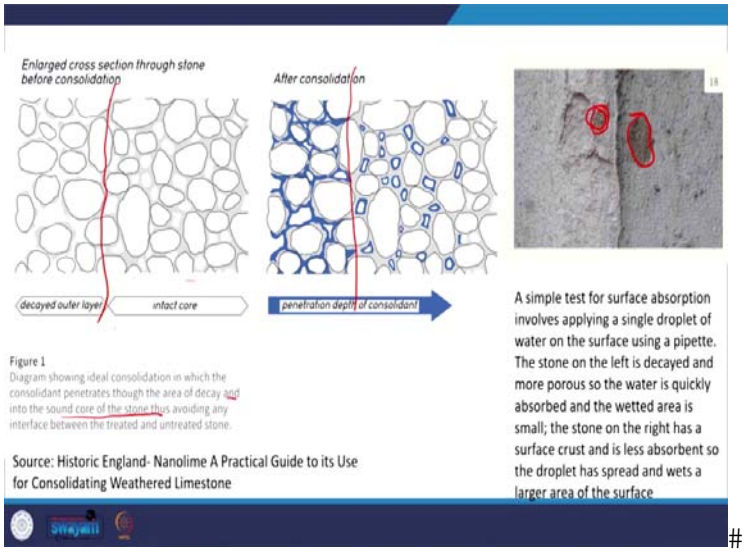

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So, in that document, what they actually talked about is how the exterior layer, like, when it gets decayed, what happens when it gets decayed and there is a big difference, what you can actually see from the decayed outer layer with the intact core, because here this can in this process, you can actually see that the consolidates penetrates to the area of decay and into the sound core of the stone thus avoiding any interface between treated and untreated zone.

Here it can have a chance of greater penetration, because once it is decayed, it can absorb the things. So, there are many other tests, I am just giving an understanding on one type of tests like we have the surface absorption test. So, here you can see there is you put a single droplet of water on the surface using the pipette and you can see these two varies because on the stone on the left is decayed and it is become more porous.

So, the water is absorbed into it and the wetted area is very small. So, whereas in the right it has a surface crust and is less absorbent, so the droplet has spread and wets a larger area of the surface. So, these are different types of tests one can actually consider in evaluating what kind of stone and what is the property, what is the present status of it. So, what is Nano Lime?

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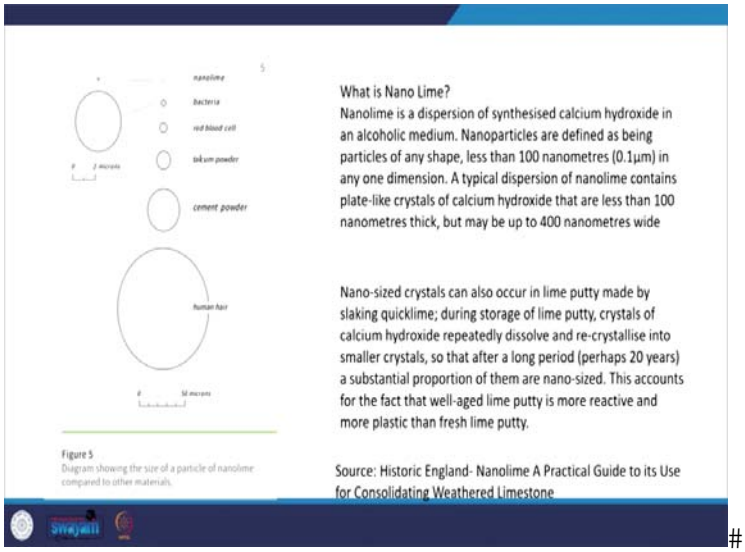

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Here we talked about the Nano Lime is a dispersion of synthesized calcium hydroxide in an alcoholic medium. So, these nano particles we consider the human hair and the cement powder, you can see the proportion of it, it actually is a particle of any shape which is less than 100 nanometers. So, it is even lesser the size of the bacteria.

So, this is how you can actually relate with what is the size of these nano lime because why this is very important in the conservation process. Because they occur in the lime putty and the slaking quick lime and they can repeatedly dissolve and recrystallized into smaller crystals. So, after about 20 years, a substantial proportion of them are nano sized, there is a process of how these are produced.

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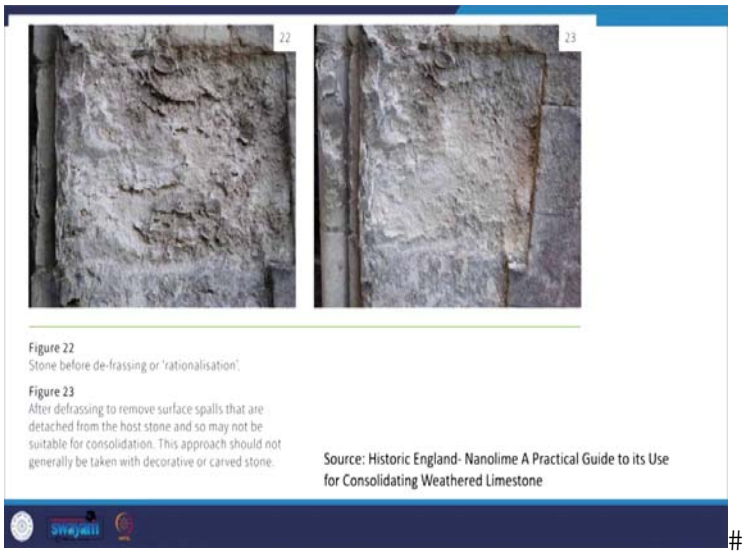

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And so, how do we apply these treatments? The very first part of is the defrassing or the rationalization. So, once we have to remove the surface spalls, and we have to see is there any biological component, is there any salts which are affecting the stones, so we have to first clearly take out those things. And especially, we have to be again careful, we cannot take the same approach in a decorative or a carved stone, because it completely takes the whole aesthetic nature of it.

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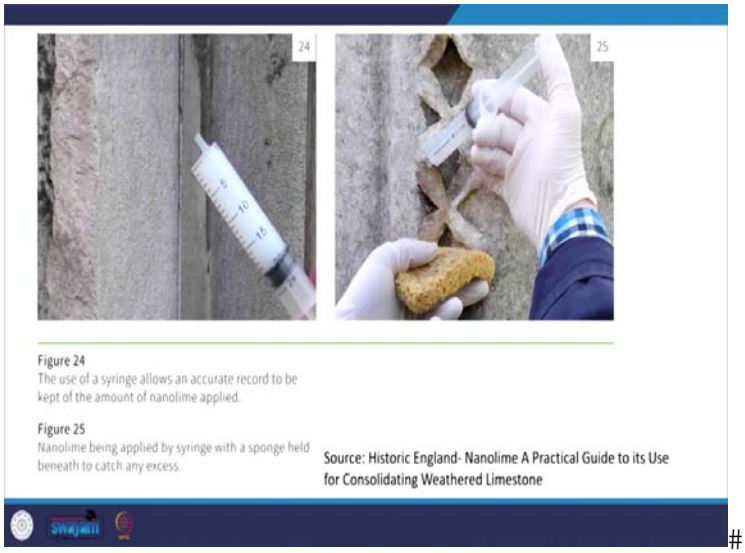

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So, this is the very first step and then we also have to consider what are the biological ingredients in it, because tomorrow, it may affect further. So, we may have to really treat that fast and clean that then we can actually use these nano lime, either there are three processes that we can apply by spray, we can apply by the syringe, so, like that, we know, if we apply through the syringe, what happens we know what kind of quantity we are actually giving it. So, similarly the excess part could be collected with the sponge process. So, this is the way it should be meticulously carried out.

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So, I am just telling an example of this process of nano lime, but there are many other techniques where which people follow and there are many methods which still under the investigation, where there are different scientific and technological tools are available to understand what kind of decay what is the nature of the decay and before understanding not only the nature, we have to understand what is the root cause of that process.

And in the same conservation subject, I would like to show you a case of restoring a small house in Syria, the Syrian architect Ghieth Alwarah. He is currently a PhD scholar in Indian Institute of Technology and Civic Design Lab. So, I am there showing trying to show his one of his work, how he restored dilapidated stone building in Besin village in Latakia.

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So, this is in the middle of the village Besin, and there is about 650 meters about the sea level and about 45 kilometers from Latakia in Al Qurdaha District.

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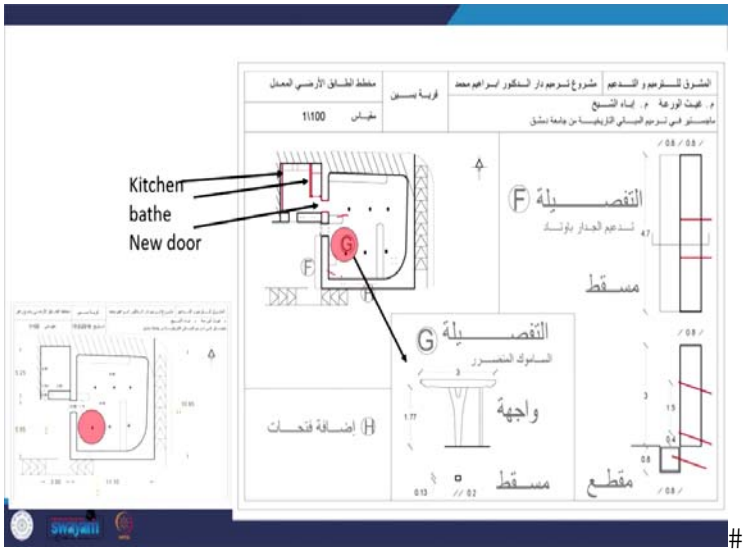

So, what happened was, this is on a kind of slightly terrain, and then there is a car which was parked and then that has completely damaged this wooden structure and that is one of the important cause of this destruction.

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So, someone has parked the car on the top of it and that obviously has affected this internal structure that is how many problems have laid in, but here we can see whatever we have

discussed the corners quoins are actually composed with the larger stones which gives certain conformity the structural stability as well.

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Now, in the process of documentation of the damaged conditions, you can see that there is already certain plasters, which has been applied before a decade ago, some cement plasters were applied in order to stabilize this, which is not a very convincing practice though. And also, some of these rocks are getting disintegrated.

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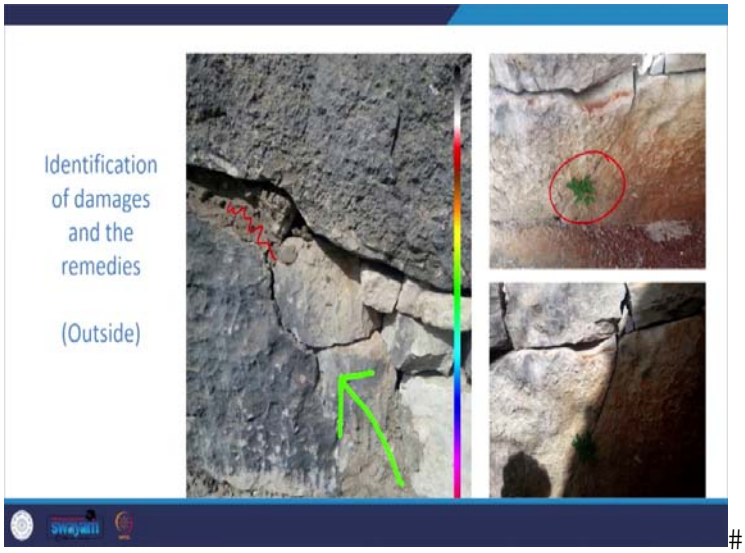

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And one can actually notice that there is a layer of the cement concrete which has applied and certain trees and plants are coming up within that smaller joints.

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And in terms of the roof structure, where these are oak and the mulberry wood trunks, they are almost damaged and this is almost a 400-year-old house.

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And gradually the wood has deteriorated and the mud plaster also have deteriorated, the render record also deteriorated.

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So, after doing the survey, they have identified what are the important objects that they have to safeguard which actually reflects back to the memories of the inhabitants and their ancestors. So, they collected these and first preserved those aspects.

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And then they did the whole survey and they investigated, they interacted with the client who was a professor from Berlin University.

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And so, after doing the whole site documentation, the very some of the important aspects is first they started taking out that cement plaster out and they started clearing everything. Once if you look at the roof after the clearance of it, this is how it looks and they first put a barricade so that no other people will pass on to it and create a further damage and they created some support systems for the roof so that they can actually take out all these trunks and see which are the damaged trunks they take it out and see how this could be reconstructed further.

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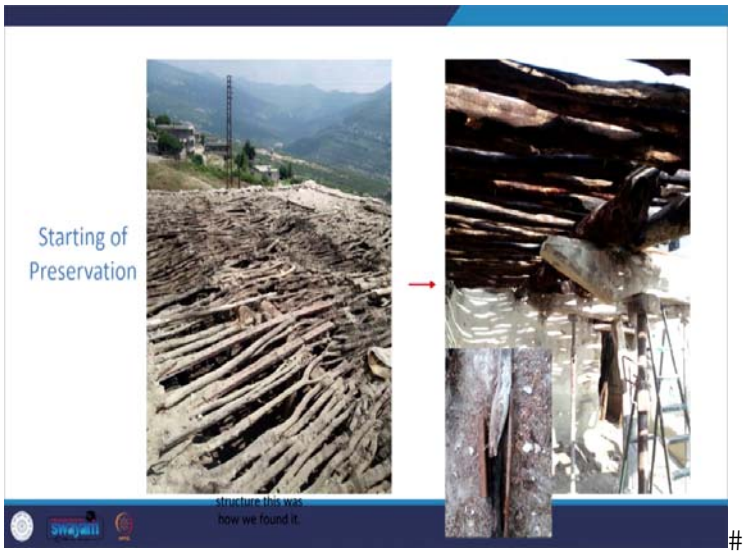

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So, this was a situation where the damage trunks have been once the soil has been taken out on the top and then when this was the condition of the roof.

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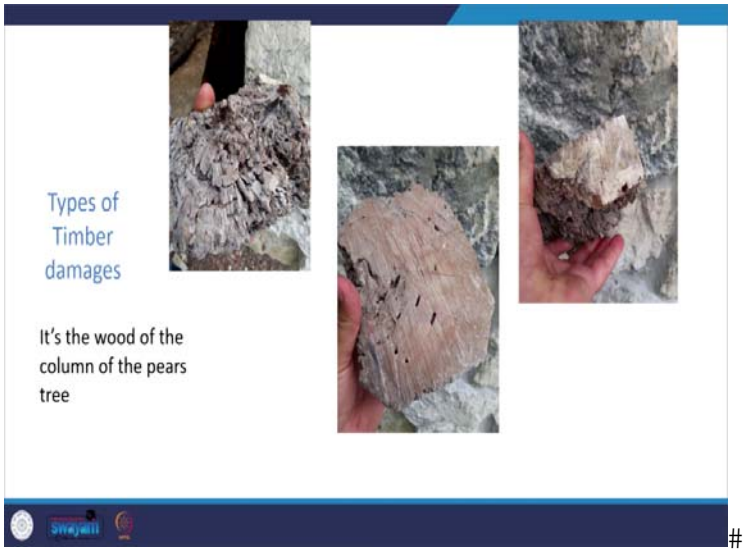

And later on, even the kind of timber they have used this is how it was all made from the pier tree and it has completely damaged, is not useful.

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So, they brought the newer trunks and they got the straw. So, what they did was they first replace this with the newer trunks and over that they have the straw and then they have this gravel and they have this sand. So, that is how the thick layer has been made. So, the roof has been redone again without disturbing the structure.

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And the created certain temporary supports for the wooden post, which were actually supporting the roof.

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So, they created these support systems.

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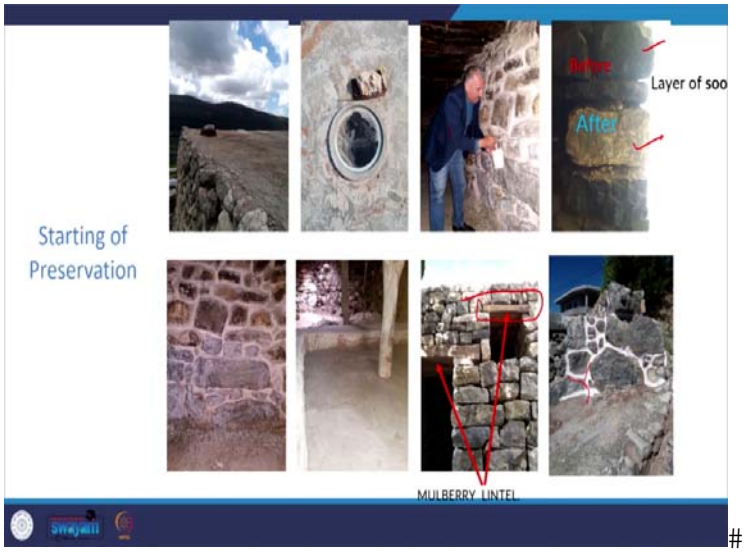

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And they also have done a treatment for these because the suit has covered almost turn this whole stone wall into black color. So, what they did was Gheith have applied the lime coating for two days. And after that he did every day twice, with washed with water for 20 days. And then he waited he make it dry for another 20 days, total 40 days. And this is what the result is after and before.

So, the whole suit has disappeared. And he completely washed it with the lime water and the normal water wash. So, completely, this is where the chemical reaction works out with a carbon dioxide and it completely takes out. And this is what the result is. And he got these mulberry lintels made out of its mulberry wood. And he also taken out the cement plaster on the exterior surface he made with his lime filling.

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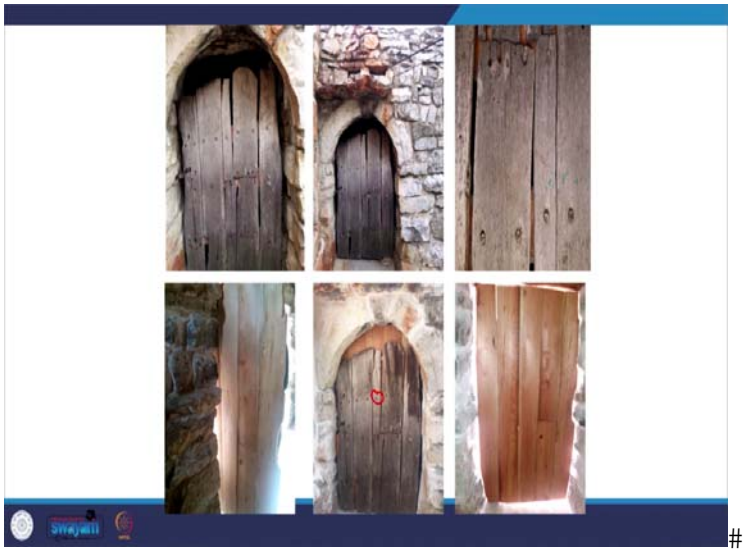 #

And even the wood, the wooden doors. They are not even the iron nails they used in 400-year-old house, they use the wooden nails. So, what he did was without touching that he treated that are not he added an additional layer of wooden so that it can be stable enough so that the old remains as old and the newer one remains as a newer one.

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So, he denied bringing any newer fantasy elements into the building. And especially the aesthetic part of it. Of course, in some newer construction, there is a part which he constructed as a newer component, so that is where he applied the newer elements.

But whereas in the older building, older part of the building, he makes sure that the older elements remain as it is and they are retrofitted and they are repaired and reconstructed. But similarly, here he has made an effort of how to strengthen the foundation of this particular wall.

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And this is how all these efforts have been made.

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And as a result, what we can actually see here is, this has turned into a kind of small teaching center, where the owner have agreed to support the poor students of this Besin village who are studying in the nearby secondary school and they get some training for it. So, in that way,

this has been modified, understood, and part of it has been reconstructed. And this whole thing has put for a different use, which is serving the community.

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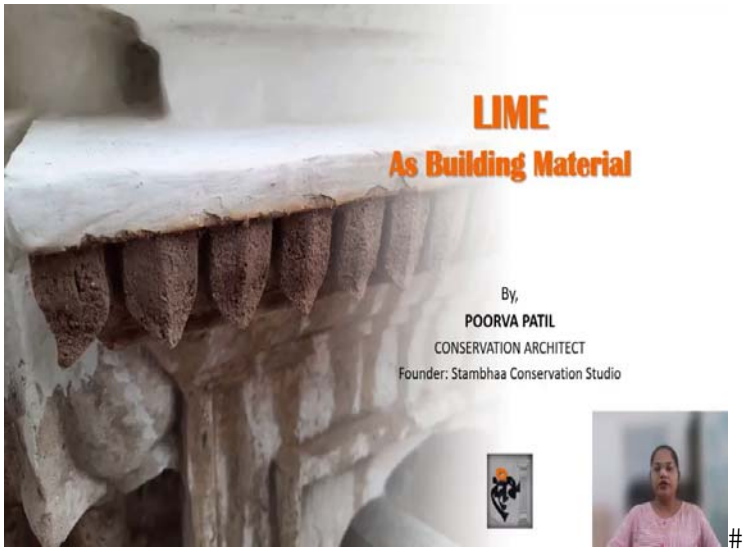

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I hope Ghieth's work was helpful for you to understand restoration and reconstruction of a 400-year-old house. Now, I am going to show you architect Poorva Patil from Pune and her work, especially working with lime. I hope you will learn from these experiences, how we can take lime as a building material and how we can work in the stone constructions.

Poorva Patil: Hello everybody. I am Poorva Patil, I am a conservation architect. Today we are going to talk about lime as a building material.

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Lime has been used as a building material for centuries and has been explored extensively in different parts of the country. There are a variety of techniques associated with lime and each developed truly by generations of artisans and it has a wide range of applications as a masonry mortar, plaster, tile bearing, and waterproofing, exterior stucco and interior plaster systems can also contain lime and finally decorative finishes can be created with lime washers and these advantages are multiple.

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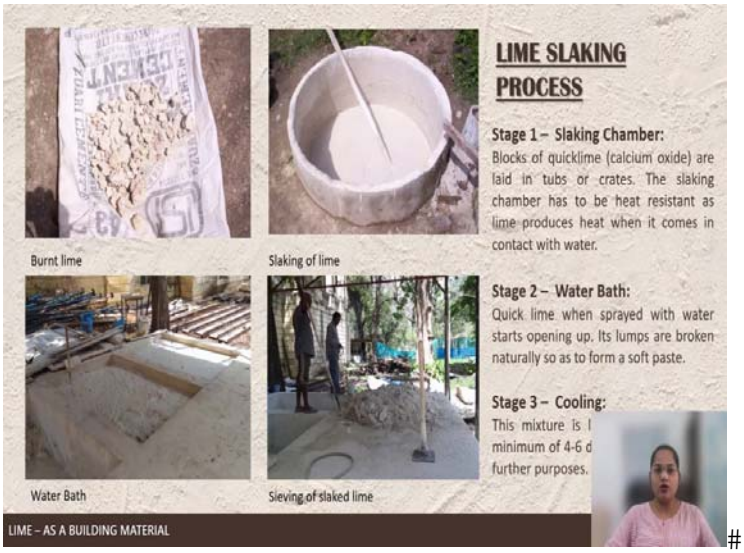

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The rock is heated in a country (27:58) kiln 950 to 1000 degrees Celsius and these processes releases carbon dioxide leaving lumps of calcium oxides and burning of these minerals in a lime clean converts them into a highly caustic material, burnt lime and unslaked or thick lime called chunna and subsequently additions of a water causes and exothermic reactions and turns quick lime into less caustic select lime or hydrated lime or minimum one inch of water is allowed to stand over the lime and is left on the side 10 to 15 days.

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Next is the slaking process, slake lake lime is sieve through a very fine metal jali or a cotton cloth to remove porous particles leaving behind it.

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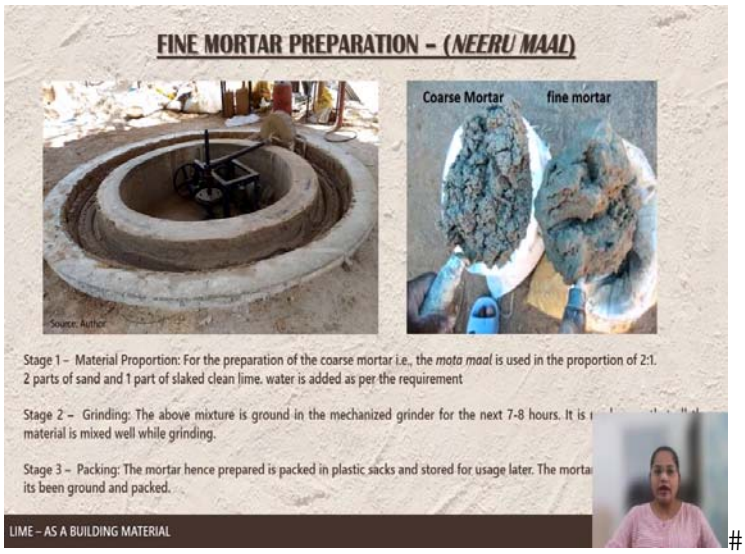

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Preparation of a mortar. For the preparation of a porous mortar that is a mota maal is used in the preparation of 2:1 where 2 part of a sand and 1 part of a slaked clean lime. And water is added as per the requirement. The above mixture is grind in the mechanized grinder for next 7 to 8 hours and make sure that all material is mixed well while grinding of it. The motor hence prepared and is packed in a plastic sacks and stored for the usage. The model is used 2 to 3 days after it is been grind and packed.

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The unique practices of making motor with a different proportion of organic matters to impart better workability and waterproofing properties developed across the country. Methi is used as a binder and imported pesticides properties to the mortar. Beal fruit is another next ingredient used as a binding material in now in a traditional lime water specifically in Maharashtra. Aloe Vera for enhancing the sticking of the particles to each other.

Also used animal hairs and jute fibers to get a strength. Gur is used extensively all over India to improve workability and provide waterproofing to the wall. Urad dal was commonly used in Maharashtra as a binder in a traditional lime motor. Eggwhites were used in Tamil Nadu in lime plaster to impart a shine to the plaster and keep the interior spaces cool.

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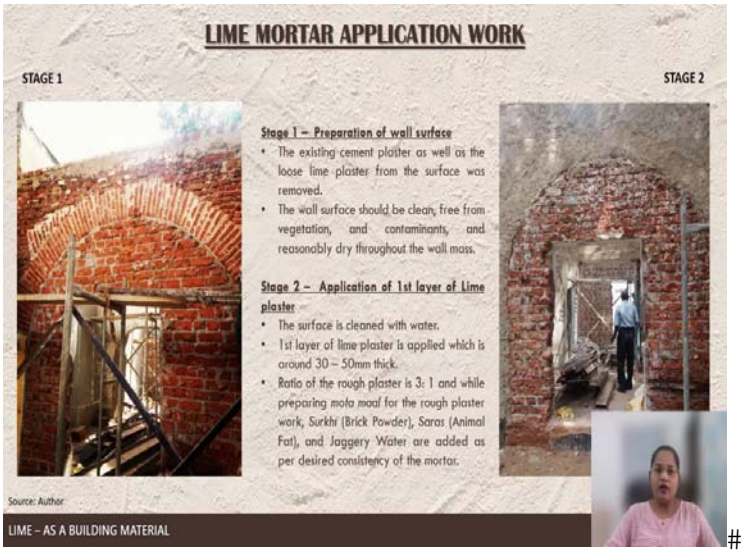

Moving towards the application of a lime plaster here I am giving you the example of a restorations of this building. Removing first the existing cement plaster from the surfaces make sure that all surfaces will be clean free from the vegetation and dry throughout the dry with the entire mass.

Then second stage is application of a first layer of the lime plaster, the surface has been cleaned with the water the first layer of a lime plaster is applied and which is around 30 mm to 50 mm thick. The ratio of the rough plaster is 3:1 and while preparing the mota maal for the rough plaster is either Surkhi plus jaggery water as per the desired consistency.

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Application of a second layer is the second coat which is about 25mm to 30 mm thick is applied on the wall after curing is computed with the same ratio of a first layer of a mota maal and this is the final layer as a rough plaster on the wall surfaces. Then moving towards the final finishes called the neru maal applications.

Once the second layer of plaster dry completely the wall surfaces gets ready for the final first surfaces and for the application of a neru maal. The ratio of the lime model is 2:1 and get desired consistency the jaggery water and brick powder added into it. Also, sometimes you are adding marble powder to get the shine or aggregate strength more into it.

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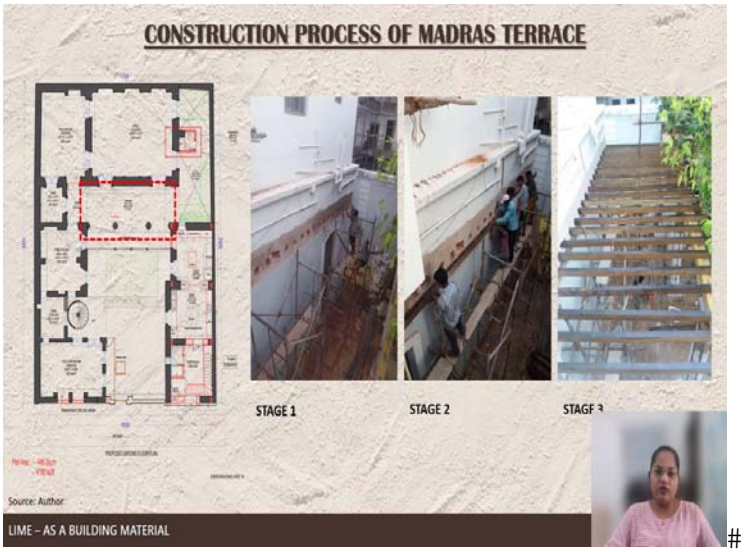

Moving towards one more construction process. With the use of traditional lime it is called Madras terrace majorly found in South India, first stage is the making holes in the brick wall for the fixing of wooden rafters.

Then second stage is about the fixings of a teak wood wall plate in the wall to hold the wooden rafters for the Madras terrace of veranda where the wood faces is towards a masonry wall, the surface is painted with a black Japan paint. Stage three is placed chemically treated rafter size around 5 inch by 2.5 inch total 29 rafters placed over here.

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Stage four is plywood shuttering the placing of the, that is important to placing of the lime concrete and brick for the Madras terrace slab. Stage five is the cutting of the wire cut bricks around the size of 8.75 inches by 3.5 inches by 1.5 inches.

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Stage six is placing of wire cut bricks at 45-degree angle with the lime motor as a first layer of the Madras terrace. Seven stages placing of a wire cut bricks at 90-degree angle with lime motor as a second layer of Madras terrace.

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Lime cuppy is adding in the eighth stage where 2:1 ratio broken pieces plus hydraulic lime plus jaggery water. The stage nine is the first layer around 3 inch of cuppy is compacted well

using wooden bats to repeatedly strike on the ground and after 10 days second layer of lime concrete around again 3 inch laid on the top of the first layer of the cuppy with the same procedure. And a stage ten is after the cuppy layer gets dry completely laying of this terracotta flooring tile as a final finishes.

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Moving towards the decorative domes construction, re-construction actually this is one of the project where we have done the reconstructions of the missing elements we have used 16 mm thick SS metal rods fixed at the center points of the smaller domes elements for the main supports and wrapped with the coir rope with the better binding and lime motor. The desired shape were achieved by using the mercenary and align motor around 1.5 to 2 inch thick rough lime plaster has been applied as a first layer to it.

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Then step 4 to 6 after the application of the rough layer around some 1.5 inch to 2 inch thick layer of the rough lime plaster was applied to get a desired shape of the elements. After drying of the rough surfaces the finishes has been started with the application of a very fine smooth lime plaster called neru maal and adding marble powder for the strengthening and the smooth surfaces into it. So, here we are getting in step 6, we are getting the final finishes of this dome.

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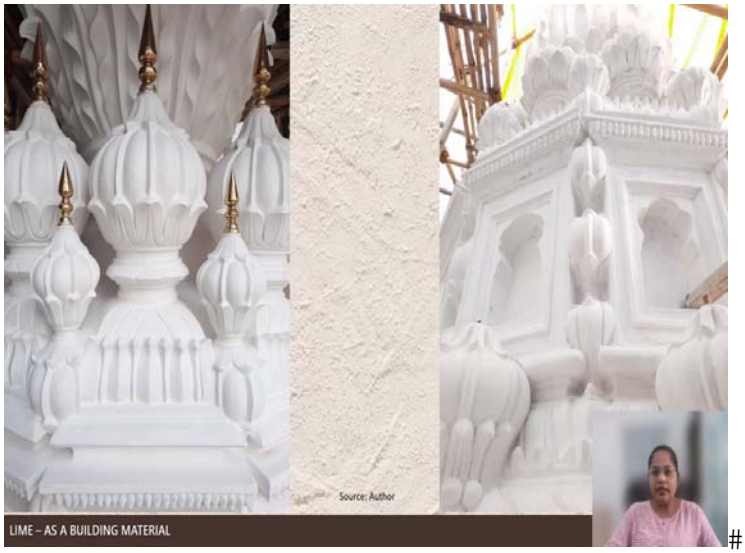

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The advantages of a lime motor are not necessarily in manufacturing energy but have multiple benefits in applications health, beauty, costs, durability and long edge. The various advantages of a lime over cement can be only be explored further by the revival and

advancement of this age old and wonderful material that is lime. Given the numerous benefits of lime as well as its green properties, it is imperative to recognize and further explore the potential of a lime and its application in current times. Thank you all.

Professor Ram Sateesh Pasupuleti: So, this is what we learn as one of the simple practical example of how to deal with the stone, how to understand it, how to test it, and how to process it and at the same time, how to interface with the newer things, the old processes and the newer things, how to keep them intact, and how to bring the new along with it. And this is how I would like to end the session. Thank you very much.