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Introduction to Ancient Indian Technology
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Module 5
Lecture No 21

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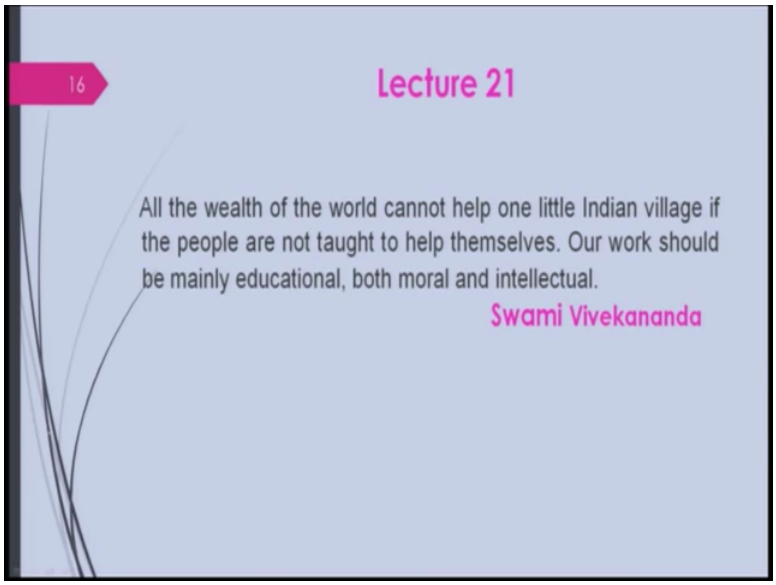

Let us start this lecture with a thought process from Swami Vivekananda who says all the wealth of the world cannot help one little Indian village if the people are not taught to help themselves. Our works should be mainly educational, both moral and intellectual. Unfortunately today the education being important in this country is lacking both moral sense and also intellectual sense. And we are not really teaching people how to take care of their life and basic needs like food, shelter and what you call the cloth. And in the last few lectures we have already discussed about agriculture and also the textile and in the last lecture we initiated discussion about housing.

And we have seen in the last lecture that how our housing was in ancient rule India. And we discussed about various aspects about starting event for cultural signatures in our houses, even today it is still exist but it is just going out at an alarming rate. And beside this we looked at scientific aspects of that if you recall we are discussing towards end about aerodynamic aspects of what you call roof. And today we will also continue to discuss that traditional knowledge was having applied science. We what you call teach science and

technology but we do not really you know make them to practice in their life. So, let us look at about you know certain more aspect about.

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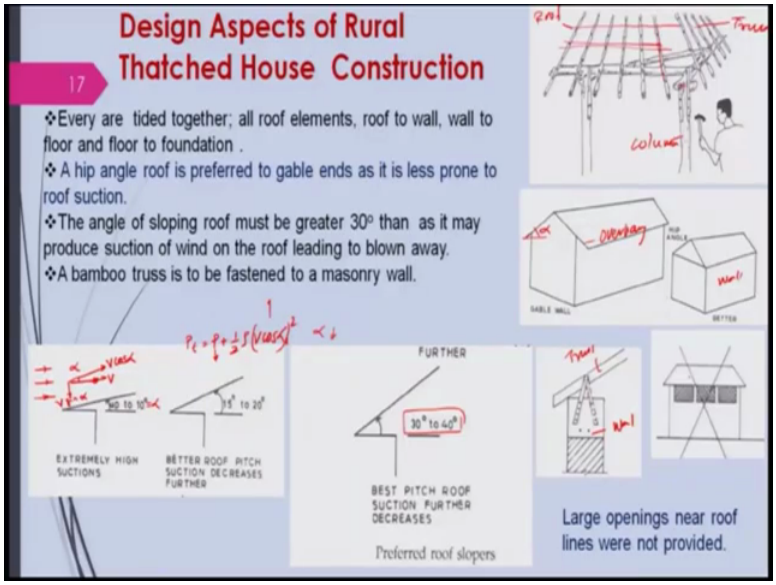

So, as we have seen like you know in a thatched house like several things will be there. For example, in thatched house there will be roofs here made of may be bamboo or this basically truss there will be others also like an reefs and this you can call it basically sparse right and this you can call it as a revere kind of things and this is a truss. And this truss has to be connected with this is your basically column and all the roof elements, this is part of the roof has to be joined together that is the first important thing and then the roof has to be joined to the wall and also to the column. In this case it is joined here, but in earlier days people were using the a coir rope and later on also people started using the nail, iron nails. And again this wall to the floor and floor to foundation which is not shown here, those are very important thing has to be joined otherwise you know structure would not be that stable.

And beside this there are two kinds of roofs one can think of; one is angle, this is the hip roof and other is a gable roof there is a over-hang here right? This you can call over-hang. Generally the hip angle roof is preferred over the gable ends as it is less prone to the roof because it is secured very well with the wall. This is your wall therefore it will not really go you know out particularly when the wind speed is very high it will not lift out. But unfortunately in the last lecture we had seen that you need to have an over-hang of a proper size and angle also to prevent the direct heat sun falling on the wall particularly in summer season. And therefore beside this the walls are generally in rural areas made out of mud and those walls has to be protected from the rain, for that reason over-hang is also given.

So therefore you cannot afford to have a mud wall house without over-hang. But of course if it is a concrete or mortar one can give but steel over-hang is required because you will have to protect the wall. And this angle if you look at, this angle the angle of the sloping of the roof must be greater than 30 degree as it may produce suction of wind on the roof leading to the blown away. So, if you look at this is a angle which is a small if I say this is equal to Alpha right, and this of course 10, 15 to 20 degree. And generally it is recommended that it will be more than 30, question arises why? Let me try to explain you, suppose the wind is coming like this and this is having angle if it will come this way I can resolve this with the what you call angle here so, this angle is alpha and this is your if I say this is velocity V, this will be v cos alpha and this is v sin alpha. So therefore, if the angle is small, this velocity v cos alpha will be higher, right. And then what will happen the pressure, static pressure on the surface of the roof will be more.

We can use simple Bernoulli's principle like if I say this is Pt equals P + half row v cos Alpha square that means if alpha is small is small is lower in the down right, then what will happen v cos alpha will be square will be higher and then pressure will be lower, right? So, as a result if the small angle then there will be more suction that means smaller angle will be more suction and higher angle will be less suction. If suction is higher then there is a more chances that roof will be blown out. Therefore if you look at most of the houses in rural India and other places also like angle is will kept around 30 to 40 degree although if you look at if I will make a a small angle roof and then the amount of the thatched materials you know like straw and hay will be very low and then cost will be lower, right. But still we will have to use the higher angle because of that it will not be blown out.

So, that is the kind of you know knowledge were there in our traditional you know wisdom, so therefore we need to look at that and we today we just do it and in case of what you call flat roof if look at what we do with concrete and other things there is a big problem of how to take out the water sometimes in the flat roof we will have to make it slope little bit such that the water will be you know flown down particularly during rainy seasons. So, those things concepts you know are very you know interesting and they have done. I was wondering why they are having this inverted V shape having certain angle. People are having, they may not be knowing the Bernoulli's equation at that time hopefully or I do not know but at least they were knowing what has to be done and what angle and that angle amongst to be the right one.

So besides this of course the joining if you look at this is the part of the straw, this is the limb like truss limb and it has to be joined with the wall, this is your wall properly. And if you look at this also the windows should not be kept near the line of the roof. Why? Because if it will be then, there might be a chances it may help in blowing of the roof, because too many wind will be entering into and then it will pressure will raise and then already this thing particularly in the rainy season where the wind is higher and so also other times cyclone and other things and therefore large opening near roof lines are not provided. You must have seen this in a rural area ok, but today we are not, we can put anywhere what we like because we are using concrete and then mortar we are not bother about it ok? People were very concerned so you can think of putting a roof, windows here in this place you know, somewhere if you want two generally people do not go for three unless it is a big house having a width of you know larger width.

Generally two are placed so that the strength of the wall will also be lived in ok? So, these are the kinds of ideas scientific ideas people were having at that time. So, which you can see today even like in may be in more places you may find the houses having this but in modern you know village where the now the concrete and motor has been used profusely you will not find this kind of you know concept being implemented because they do not know what they are doing, right. So, beside this there is a ventilation system what was a very important in ancient rural housings because, air velocity created discomfort particularly when either the cold or the hot air blows directly onto the human being, right. You might have experienced yourself, right. But if it is comes tangentially or with not directly then you may feel good provided the velocity is not high, so therefore that has been taken care in the house also.

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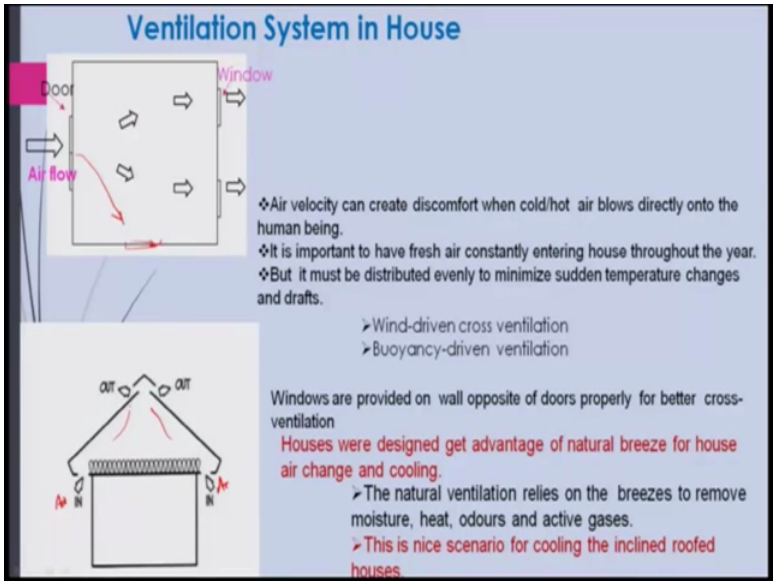

It is important to have the fresh air constantly entering the house throughout the year not only in the you know summer or may be in the rainy season but in other seasons that also is important. And it must also be distributed you know evenly to minimize the sudden temperature change or the draft in the room, right. And those are taken care and by the two ventilation systems what you can find in rural houses; one is wind-driven cross ventilation, which you people will be knowing right, that has been done and other is Buoyancy-driven ventilation system.

And for Wind-driven cross ventilation system windows are provided on wall opposite of the doors for better cross ventilation. And generally you know this kind of thing is being used and this is your door, right and the air can enter, then it will and then windows are not just front put place in front rather it puts in the corners somewhere so that the wind will enter into the room and then go, right. And sometimes some windows are placed here also in this portion you know, so that the you know wind will come over here and that depends upon this design so that the velocity will be distributed evenly across the room, ok, this is a system being placed, right.

And so also the other things and generally houses were designed earlier days to get advantage of natural breeze for the houses you know for a house kind of thing and so that the cooling you know can be kept. And natural ventilation relies on the breezes to remove the moisture, heat, odors and active gases, there are several things that is very essential to be get removed instead of closing it. Now-a-days you people are staying in air-condition room and it is all

close the oxygen level goes down if you close it. And of course we have already seen that you know like nice scenario for cooling of inclined roofs you know why we are having in a thermal we had seen earlier.

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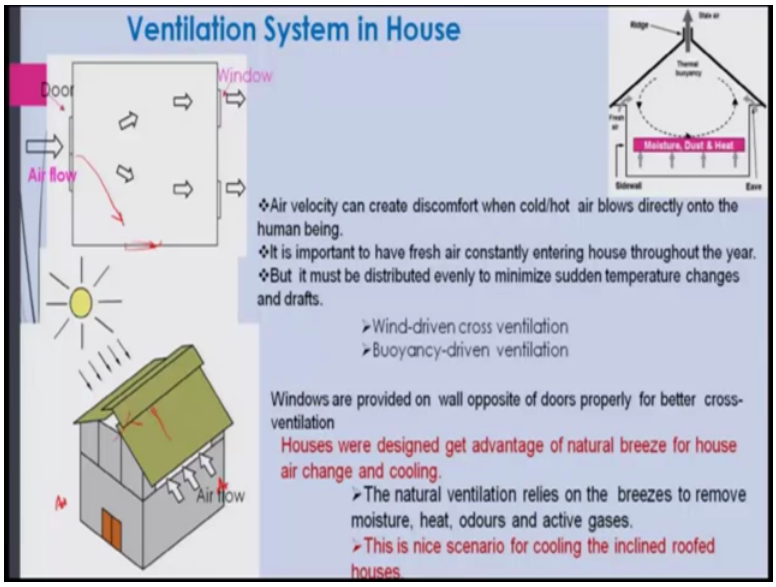

And if you look at let me look at a Buoyancy-driven ventilation system here, like there is a air is enter right? Air here and then there is a system over openings and then air will come and go here. Due to what they would basically Buoyancy because heat will be coming in and let me show you a little 3 dimensional figure, right? This is the air which will be entering and then this is the sun which will be falling the heat and then there will be a buoyancy will be there and it will be the air will be going through this vent and then going through this and then go up and passing through that. Let me show you another may be figure that will be clear.

So, if you look at the fresh air is entering here and there will be of course some of the thing there will be recirculation and then and it will carry this moisture, dust and heat to some extent and it will be driven by Buoyancy, right it will be driven by Buoyancy. And that helps in taking out and it will be very clean. So, this is you know good part of this inclined roof and also there is a ventilation can be provided, right. So, those things were there in earlier houses but unfortunately today it is not prevailing, right although we are saying that we are very advanced, right.

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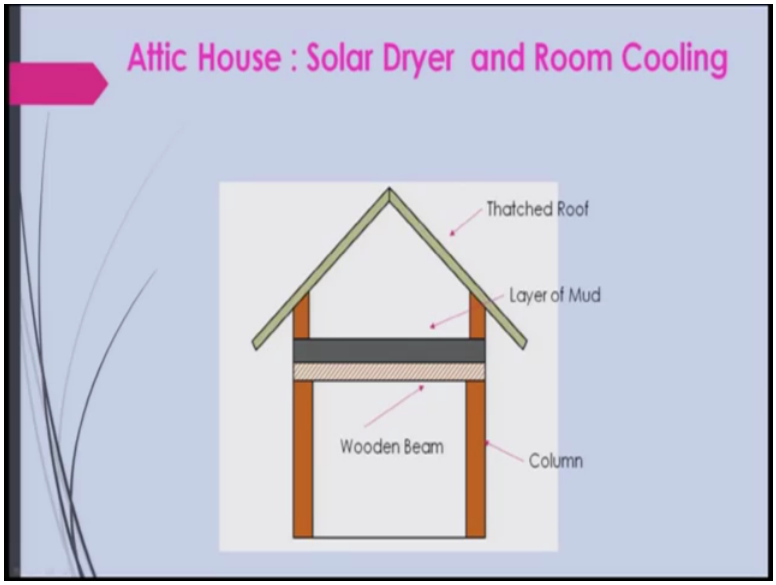

And there is a another thing which I have observe when I was a kid like you and I had visited rural areas at that time. Now I am trying to relate this attic house to the solar drawer and also it can be used for cooling the room. Let me show you how it is. It is as I told this is the inclined roof, thatched roof, right? And there is a of course this is your living place, living space here and this regions and there is a attic portion is this like this is the wooden beam, this is the wooden beam, right. And this there will be a layer of mud and then on the top of it generally the things like grains are been dried because the heats is coming over here. If you look at the solar the heats are entering here right, and then it will be dried and then that has been used, I remember that we are also use to store a lot of like grains here so that it will be remain and the air of course there might be some holes here some air might be circulated also in some places there is a opening over here like that ventilation system were there particularly those things you will get in some houses you may find.

And it was very good and now-a-days I find that people are drying the grains on the direct sun light which is not supposed to be because it spoils the nutrient values of the grain. But at that time the people use to do this, right and in the winter season this kind of what you call ceiling what is given here on the top of the thatched house right, which helps in maintaining the temperature in summer, summer it was cool like at least I had lived for of course may be for few days whenever I visit whenever I had visited to my native place, a village and then it was very good, right. So, it was all there but today you will not find this kind of attic house, today in village because all are people are making concrete buildings.

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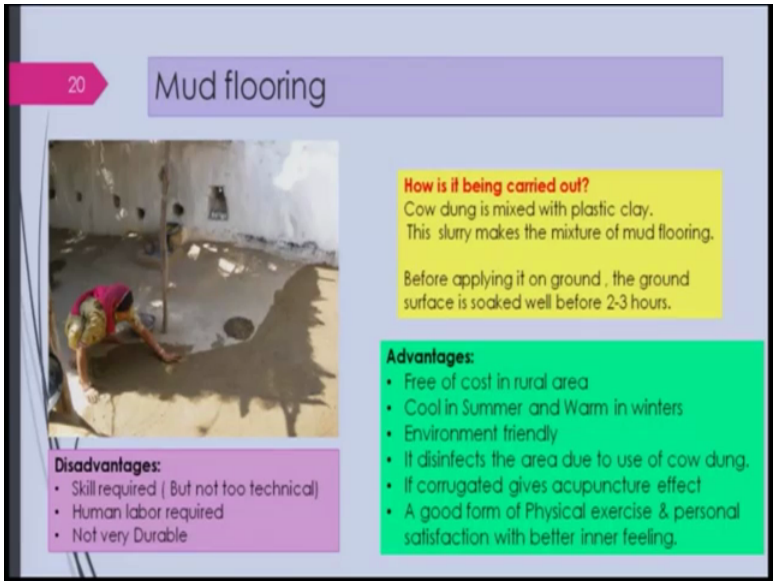

And mud flooring is a very important I will be talking about because this is of course very rare to see. A woman is you know basically smearing a slurry which is prepared by the mixing the cow dung with the mud and of course for doing that one has to soak this the floor with the water for 2-3 hours and it is should not be too much also the water be you know too much water must not be placed in that. Otherwise it will be difficult but that is an art one has to learn and then you know do that. And then you will have to smear this slurry with either hand or with the help of a may be some brass kind of thing made out of cloth, of course she is doing in her own hand. And what are the advantages one may think of, because if you look at this is the free of cost because the cow dung is available, it was a part of rural India where the agriculture is the main you know way of living.

And it will be cool in summer and warm in winter right that is the thing what you can get and it is environmental friendly, it disinfects the area due to the use of cow dung. Of course, I had a talk with somebody, they are saying that it is little controversial and some people claim that it is the pathogens getting decreased because of using cow dung. But some other people say something, so therefore one has to be very careful and check it. But as my gut feeling is that as the people are doing for ages together and they were very healthy, so therefore I would believe that it may be you know disinfect the area. But however more research is to be done with the present context of the natural imbalance what is happening. We should not take as it is, we should check and correct, verify it and then take.

And also there will be little bit you know very little vary you can see there is a some small up and down it is not as polish as the your now tiles house or mosaic house, it is having something and that helps in giving may be acupunctures and the pressure to the thing and will be helpful for maintaining health and also you will not fall down there. But today, where lot of old people particularly falling down on the floor and then going to medical hospitalize for the breakage of legs and hands and what not. But that kind of thing beside this I am just remembering that this floor height also was different from room to room. Particularly for kitchen it will be different for may be for your Pooja room it will be different. I was wondering why they were making different. But an idea came to my mind, it might be like you know the height will be maintained for certain utility but the other thing is that if you move around, do your work it will be a good exercise, right? So that your bone and other things will be strengthened you know that one can think of.

And as I told this when you make it is a basically one has to maintain it is a good form of physical exercise and when you do something and you get a personal satisfaction a little bit art is required not everybody can really make this mud floor, right and maintain it. So, you feel satisfied that you are having capability to do and maintain that. But disadvantages if you look at Skill is required, but not that technical and human labor is required but I will put it other way around that if you will not do physical exercise then you know your body will get lot of diseases particularly now-a-days. And it is also not very durable that is the negative part. But it is also can be converted into advantage that is the disadvantage can be converted into advantage if you look at proper prospecting.

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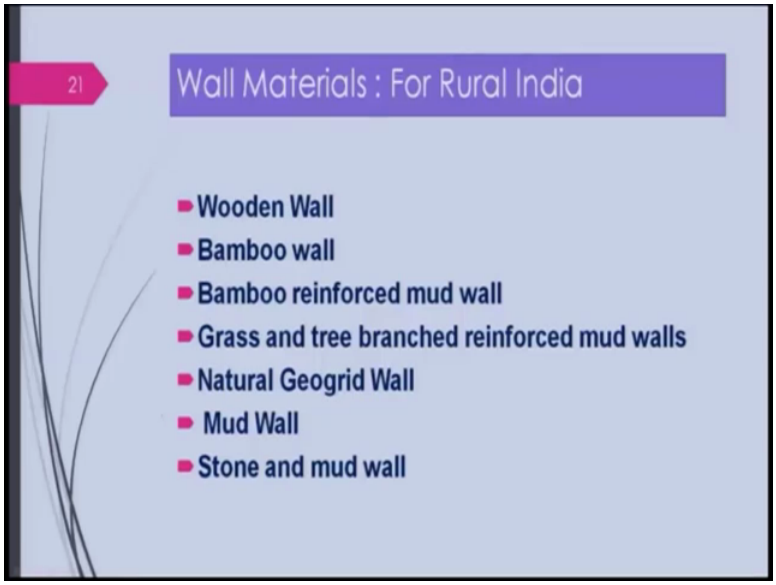

So, therefore this is the thing what our ancestors were doing in ancient India, so we need to look at it. And we can re learn it and do whatever the way we can at this moment. I will be showing some of the things that what people have improvise. May be I will come to that particularly mud wall and show how people have improvised it. And if you look at wall material there are several of them like wooden wall, bamboo wall, bamboo reinforced mud wall, grass and tree branched reinforced mud walls, reinforce is not that you know what concrete you know mortar and then iron rod, it is the people are using earlier days, ok? It's not a new concept, it is earlier concept. So, also people have talking about natural geo grid wall right, and of course the mud wall I will show you little bit more and stone and mud wall. I will just go through or we will learn little bit about those things.

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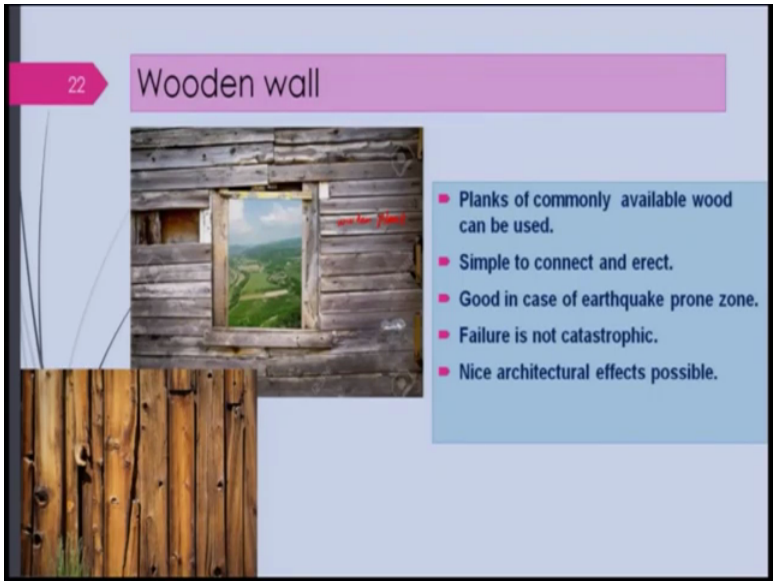

Because, if you look at wooden wall is a very simple to do and here in can it can be the wooden planks are being use like commonly these are wooden planks, right and of different sizes and it can be horizontal, it can be vertical you know these are the vertical things depending on the thing and it looks very elegant and earlier days wood was very much available, but today it is a scarcity or is a scarce commodity. And it is simple to connect and erect because wood you can join very easily, right. And it is easy to handle unlike your brick or the mortar or other stones, right. And in case of earthquake it is very good. Nothing will happen like that's why people in Japan they use the wooden houses; you might have studied, right. Even in our area you know particularly in Arunachal Pradesh and Himalayan region people use to make wooden house.

And failures if it will be there it will not be catastrophic like your concrete and mortar structures, right kind of things. And nice architectural effects possible because I had lived in a wooden house which was quite good aesthetically you feel good about it as if you are with the nature. If you love nature you know you feel part of it. So, that kind of feeling you will get. But of course it will be having disadvantages also like you know it will be more theft cases like with the criminal activities going on in our country and other places. So, you know it is a lot of safety issues are there and there might be termite right, or other insects may be spoiling maintenance is problem, there are several other problems associated with it.

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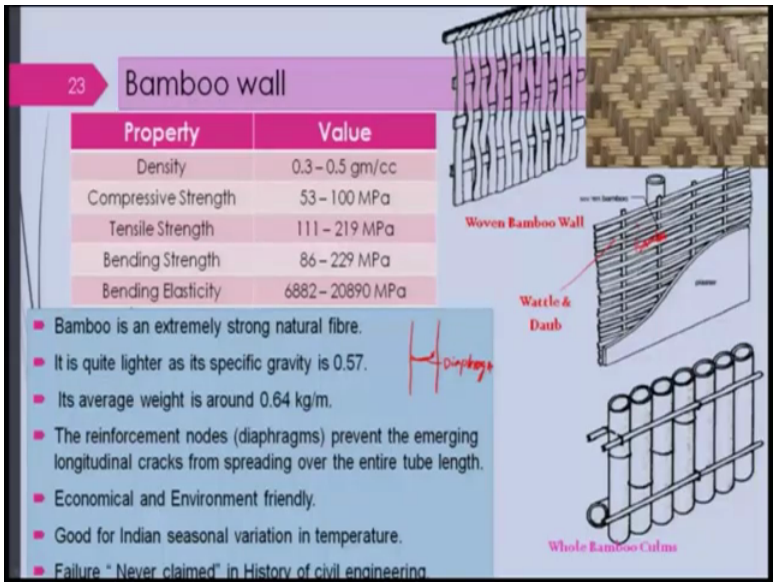

Bamboo if you look at is an extremely strong natural fiber. When I was a kind you know bamboo was used left and right particularly in Odisha because we were growing a lot of good bamboos, but today it is not and it is quite lighter as its specific gravity is around 0.57, its average weight is around 0.64 kg per meter like it is quite lighter that source. And very important thing they reinforce nodes like diaphragms kind of thing prevents the emerging longitudinal crack spreading over the entire length of the thing. Suppose there is a crack which may likely to occur in the bamboo but it will not spread because if you look at a bamboo there will be something diaphragm will be here, this is the and that will not allow it to spread. This is naturally available with that, you need not to do anything, right.

So, it is economical and environmental friendly, right and it can be also biodegradable. And good for Indian seasonal variation in temperature, because there is a lot of temperature difference and it will be good that way. And of course if you look at the failure which may

likely to occur but in civil engineering the history of civil engineering people say `never claimed' you know that bamboo is that strong and then people use it. And of course these are some of the data I have just put and it is it may vary but I have just given you so that you can have a feel. And you can see that this is some variation I have given may be more variation will be there. It will be having good tensile strength and is having also compressive strength, density is very low and it is having the bending elasticity is quite high and so also the bending strength.

So, it is of course comparable with any other material and it is far better than the wood even and if you look at of course metal it can be comparable to some extent. And this is a wall one can think of having being needed this kind of thing. Even you can think of using the dresses out of the out of bamboo textiles are there you know you might have seen like people have done like yarn they can produce anyone can do and this is being needed. And bamboo if you look at, it is oven bamboo wall like these are the bamboos, it is being ovened properly right and one can say without even mud cladding and there is a another one it will be these are the bamboos, right and these are being you know like a wattle we call it wattle, these are the wattle right, ok. And then you can have a plaster what you call daub right, and then you can use it.

And there are several designs one can think of, I am showing some of them you know if you go across the country, various design in various places you will get. That is a this known as whole bamboo culms like single bamboo, entire bamboo, right will be placed together and you tied with a another to small bamboos this thing and tied with the wire or the rope and you can place it, right. So, there are several kinds of design of wall you can find. I have just shown you few of them, right and one has to of course I would suggest that you please may be take some photography if you come across and if it is lying particularly in the Arunachal Pradesh and other places still people are using that, Assam, Arunachal Pradesh and other places. If you could get and put a picture it will be nice because I was searching I could not get actual pictures you know. So, what we will do, we will stop over here and we will may be discuss in the some other aspects in the next lecture, Thank you very much.