

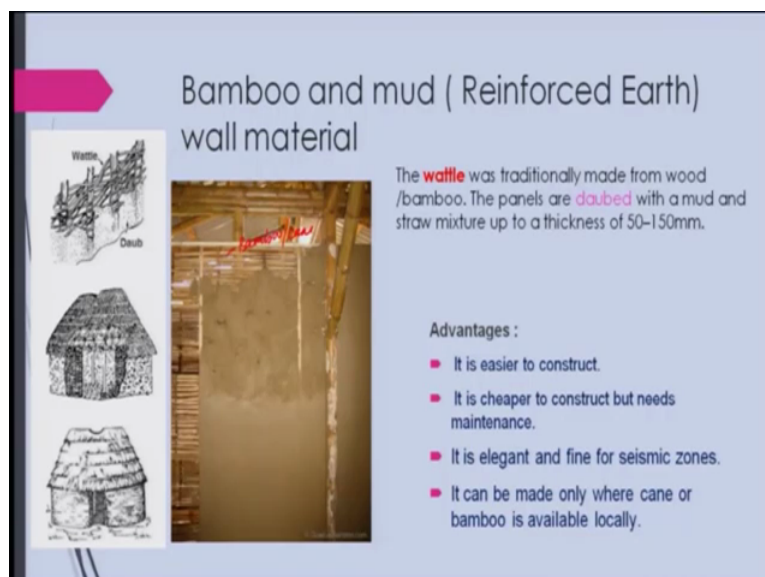
Introduction to Ancient Indian Technology
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Module 5
Lecture No 22

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Let us start this lecture, a thought process from Rabindranath Tagore. He says that 'Trees are Earth's endless effort to speak to the listening heaven.' It is a very beautiful statement and let us recall what we learned in the last lecture. We are basically looking at how the wall being made and various you know walls we have looked at it and we are discussing about bamboos. And we will now see the rain force you know bamboo wall and along with the mud.

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And there are as I told like there are several way of doing this, these are the huts and wattle and daubed is there. And wattles are traditionally made from wood or bamboo or any other like may be sticks which will be available plentifully in that area. And the panels are daubed with a mud and straw mixture up to the thickness of 50 to 150 mm depending on that. This is what I am showing of course here these are the bamboos right? And it can be cane also, see this can be made of cane any other reeds you can say reeds you can think of and this is bamboo or cane or any other materials.

So, advantages if you look at it, it is easier to construct and it is cheaper to construct but needs maintenance. It is elegant and fine for seismic zones right and it can be made only where cane or bamboo is available locally. Basically you need not to really transport and then you know material and the cost will be high when you transport, here you can have your own backyard you know you can grow. And as you know that bamboo grows in a two-three years, you can have enough bamboos to make your house right. And even if you take one bamboo out of the tree, it will not spoil that is the best good part of the bamboo.

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26 Cow Dung and Local Vegetable Husk + Local available Grass/Straw

Advantages:

- Low cost
- Cool inside in summer and warm in winter
- Easy to construct
- Good strength due to reinforcement
- Good against vibration
- Reasonably durable

Disadvantages:

- Disintegrates if there is permanent moisture.
- Wash out in floods
- Fire susceptible

A rice husk is good heat insulating material, is applied on the outer layer of mud plaster. It is also water repellent.

And Cow dung and the local vegetable husk and local available grass or straw can be used and this is been shown here you know again this is the thing right. And this is the straw are being used right along with the mud. They can use local materials and this rice husk has been used, this is basically rice husk. Rice husk is a good insulating material; it is generally applied to the outer layer of the mud plaster because it is water repellent. Even if water will fall on that you know it will not erode the mud if it is there, so that is why rice husk is been used

very much. Of course, advantages will be similar; low cost, cool inside in summer and warm in winter, easy to construct, good strength due to reinforcement right, and good against vibration particularly you know like in earth quake and other reasons and reasonable durable right, if you add these saw dust and other local material which will be there right.

And the disadvantages; disintegrates if there is permanent moisture like you know you know particularly in the coastal areas there might be a little problems and wash out in floods and fire susceptible that is the one bad thing about, but when you use mud it will not affect that much.

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27 Practice of Natural Geotextile Material

- The geotextile in the form of Geogrid or Geonet kind was made in ancient India using the strings made of coconut coir.
- The coir fibres are threaded into strong cords.
- The thickness of these cords is specified as two "Yava" means 2-6 mm. The strings are made by twisting two cords.
- This strings combination in vertical and horizontal direction makes Geonet kind of material which used in ancient times to provide stability in fort material where sands and silts are only available construction material for forts.

(a) रज्जुबंधनम्
नरीकेलाफलार्थं सारं जलमपोहेच ।
द्विपञ्चमशिलानं सतुल्यस्येद्वयम् ॥२४-१५ ॥
सज्जम्बुपं तु संयुक्तं युतं बद्धोपयोगेभ्यु ।
पञ्चमशिलानं सतुल्यस्येद्विपञ्चमम् ॥२४-१५ ॥

(b)

The slide also features an image of an ancient stone fort structure in a landscape.

So, there is a Practice of Natural Geotextile Material right, in the form of Geogrid or Geonet kind in ancient India. And using the string of basically coconut coir, if you look at this is the Sanskrit shlokas and I am not going to read fully but you can say `Narikela Phalacharma sara jalamapohecha' right? These are the nets which are used made out of coirs and the coir fiber are threaded into strong cords. Of course this fibre this cord can be 2 to 6 mm and this is a you know it can be horizontal, vertical and other things this is being used in the earlier days even the fort area, so that you know it will be having you know, good strength and then durability also. And where sand and slits are only available for constructing the material not stones where stones are not available you can use this right as substitute.

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28 **Mud Wall**

Cob is an ancient earth building technique of mixing earth, sand, gravel /pebbles, silt and straw with a little water.

A good soil:

Good soil = Gravel 15% + Sand 50% + Silt 15% + Clay 20%

Advantages:

- Low cost if local availability there
- Less skill required
- Appearance is aesthetic and natural.
- Structural capability
- Heat and Sound Insulation.
- Fire and vermin resistance.
- Durability and moisture resistance.
- Breathability and toxic less.
- Keep room cool and healthy.

Disadvantages:

- Less bonding between mud and big pebbles
- Not easy to handle after certain height
- Affected by flood and torrential rain.

And Mud wall is basically ancient techniques like because cob, what you call some people will call Cob also. Cob is an ancient earth building technique, mixing of earth, sand, gravel or pebbles slit and straw with little bit water right, and this of course proportionate is important. And if you can see that there is I have shown you like this is the mud wall right? Even this house is existing today in UP I got from one village and if you look at they are made this very good house and of course there is a little bit cracks here, one has to maintain it. And if you look at the good soil for this wall, will be Gravel around 15%, sand 50% and silt will be 15%, clay will be 20%. But you know you need not to worry about this much, this is of course better if you could get, but people will be knowing they can put this and then also test it like whether it is good or not like by hand by their own judgment right, they will be knowing, those people who are using.

But of course most of us we do not know which is the good or bad or ugly, because we do not have experience, but those people are having also used the judgment. And it is the low cost of course if available locally right, and less skill is required, and appearance is aesthetic and natural like that is a good thing. And I will show you also how we have improvised this wall and structural capability and heat and sound insulation. Of course the fire and vermin resistance right like because mud you know is a good you know it will resist the fire. Durability and moisture resistance unlike the bamboo when used and the other things that will be problematic, and it can breathability you know like it can breathe it can also the moisture and air kind of things and less toxic in nature. Because if you look at modern days

we use paints on that and that paints are very-very toxic, we do not know and we are not aware about it, and keep the room cool and healthy.

And of course disadvantages; less bonding between the mud and big pebbles if you are using that is also a problem, so you will have to use proper size of the pebble. Not easy to handle after certain height. But if you look at the history particularly other countries also like they have used very big houses even you know 3-4 floors and then big mosque are there in Iraq and Iran you can see that, and affected by flood and torrential rain.

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And let us look at Improved mud wall right and this is the improvised mud wall which you can see here, it looks very nice you know and of course they are using some binding material here. One can use a Portland cement and also one can use lime and other things. I will be also talking about compressed wall little later on, like you can get also to the very good strength and stability. And this is another one this is interior, this is the exterior kind of thing, you can have nice things, you cannot think of this is made out of mud, this wall right in today. So, what I want to emphasize not that we will just look at them, but we can improvise it and then use it today, right. That is the point we can learn from this lecture and then from our ancient wisdom.

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Mud & Stone Composite wall



Advantages:

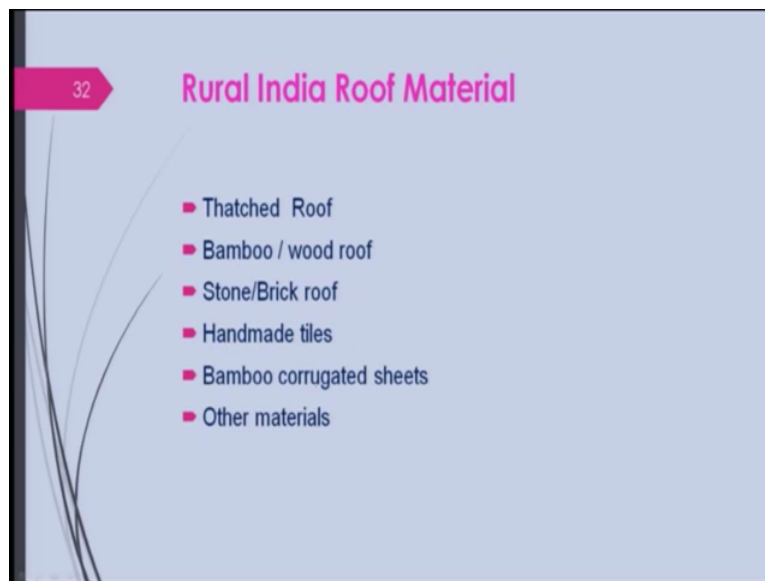
- Low cost if local availability there
- Less skill required

Disadvantages:

- Less stable against vibrations
- History of max. failure during earthquake
- Bad technique for earthquake prone zone
- Less bonding between mud and stone
- Not easy to handle after certain height

And Mud and Stone composites; you can have stone and you can also join together but these are not size stone, it will be any size I have shown this is also one way but this not good you should have a proper size and made then you can use a mortar mud as a mortar joining or a binder. But low cost if locally available and less skill required right. And disadvantages; less stable against vibrations and other things, history of maximum failure during earth quake because these are not very stable right? But if it is a stone, at least it will be stable. Properly stone means, stone properly breast and properly placed with certain weight like your temple structures, but these are not like temple structures. And of course for temple structure there is proper standard is been maintained. And less bonding between mud and stone, not easy to handle after certain height because These all the problems because these are all different shape and sizes stones are being used, so that is not really good one has to adopt.

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So, let us look at Roofing Material; Roofing will be several kinds, Thatched Roofs, Bamboo or wood Roof, Stone and Brick Roof, Handmade tiles, Bamboo corrugated sheets and other materials. There are several kinds you can see and it may vary from region to region. And I will whatever I am showing is little bit tips of the iceberg, there are several things are there in this country and Thatched is one of the oldest form of roofing. According to me it is as old as Indian Civilization. And we will see in the afterwards when we talk about town planning in about that.

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And this is the one kind of thatched roof you can see. Basically roof of covering made of dry vegetation like straw if you look at this are basically straw and palms, water reeds, other

natural growth you can think of. And it is a very old roofing method has been used both in tropical and temperate climate like India, because it is a good insulation of heat. And is not very popular among the people in recent time, because of two factors; one is that people are very much you know interested to have a pakka house the you know concrete and these things and maintenance is very high in case of thatched house unlike the concrete. And beside this also like today labor it is more labor intensive and even the straws are not available because you know it is costly.

And advantages of course, when the it is related to agriculture, then it is economical, light weight, bad conductor of heat but if you want to buy the straw from the market and then use, then it will be little costlier. And also the people are not available today to make this house, the skill is not with the people today. And disadvantages are fire susceptible, less durable need to change periodically because in each may be 3-4 years you will have to change or may be sometimes 5 years. And good attachment required with ribs so that it can bear the heavy wind blow.

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Basic Principle of Making a Thatched Roof

- A thatched roof is to be as simple as possible. But it should have ability to adapt to free curve shapes.
- A thatched roof slope angle **must be greater 30°**.
- A thatch around 80-150 mm thick was used earlier.
- An average cut length of Straw was around at least 700 mm.
- The straw bundle used for roof must be strong, supple and able to resist efforts to break it by twisting a handful continuously.
- The bamboo/wood poles with diameter from 50 to 100 mm were spaced 400 to 800 mm apart.
- Eaves /overhangs was around 600 to 1200 mm to protect the mud wall from erosion and direct exposure of wall to the direct heating from Sun in summer.
- Rain water must not be allowed to discharge from a very high level roof onto another thatched roof at a lower level.

And let us look at the basic principle of making a thatched roof. Of course you need to have straws and then it was made of bamboo or the wood and it has to be done properly and then properly designed to take the load right. And this is of course the carding the straw like if you look out you will have to separate it put it and this is the thatching of the roof. And thatched roof must be as simple as possible. It should have ability to adapt free curved shape of things

kind of things because here is not shown, but suppose you are having you can have that. And a thatched around 80 to 150 thick wall was used earlier days that depending upon the rain and then you know torrential rain another thing area wise.

And average cut length of the straw will be around 700 mm of course you can manage with the lower, bigger it will be better you know kind of things, the labor cost will be reduced right. And also the here if you look at the it should be have the design of the what you call these straws will be dependent on the straw length right because the what you call the spars will be pushing putting it will be interval decided by this ok. And then the straw bundle used for roof must be strong, subtle and able to resist efforts to break it by twisting a handful continuously, so therefore, people use some kind of tight and then put it. If look at this are the poles here this is a pole right, Poles would be around something 50 to 100 millimeters diameter and may be space around 400 to 800 millimeter apart depending upon the design of the roof and also the (())(14:28) if it is very heavy then you will have to take the load of that.

And if wall is there, wall will take care it, but in some places you do not use the wall, you use the pole right. And overhangs; these are the overhangs right, it will be around 600 to 1200 mm to protect the mud wall from the erosion and direct exposure of the wall to direct heating from the Sun in summer. And if you look at that depends upon what you call the area where it is right? What is the as I told the path of the Sun taken in the winter and the summer season has to be taken care.

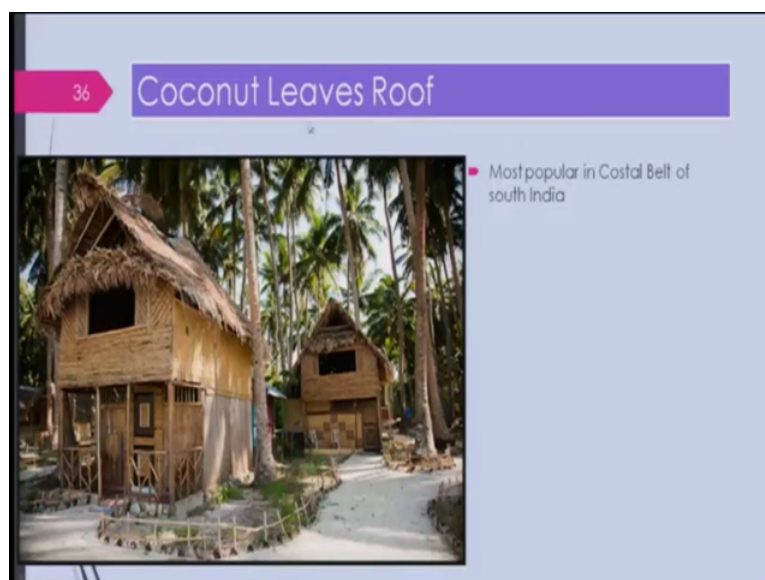
And rain water must not be allowed to discharge from a high level of roof to another thatched roof at a lower level. Let me tell you the people have designed their houses earlier days the height of the thatched house in such a way that you know it will be what to call preventing the Sun, summer Sun particularly to enter into your house one over another. And that is a beautiful thing which I had seen somewhere and when I inquired they told this will be like you know, when the Sun will move with the shadow will be coming in another roof so it will not be heated that much.

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So, let us look at a video how the thatched house can be made you know this is the small video and this is the straw which is has to be you now trimmed here. This is the bundle of straw right, depending upon the length what is required which will be dependent on the what you call distance between two spar right, which is not shown here. And unfortunately this kind of people are not there today who are skilled enough to have thatched house, so that is the problem today.

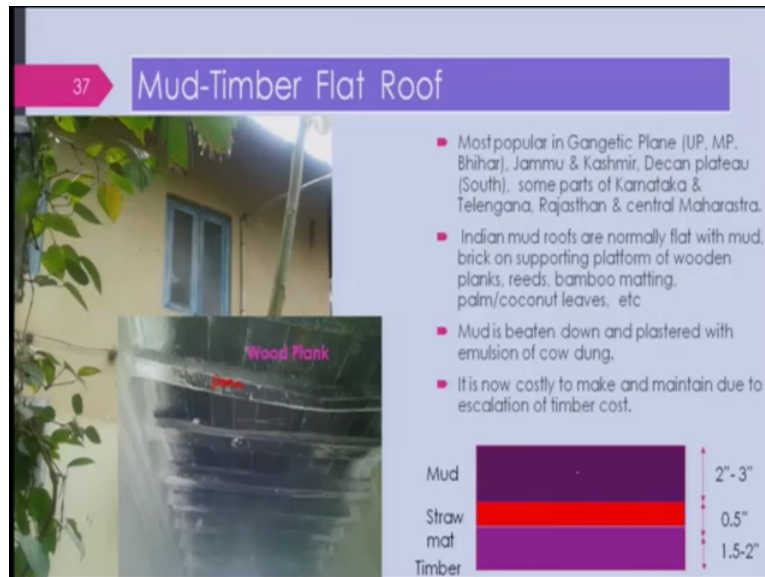
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And of course there are several other things like coconut leaves roofs are been used particularly in the coastal belt of the South India. If you look at this two storied building like,

which having coconut roof here and here they might be using the may be wood planks or may be the mud you know house, mud roof what will be having.

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And mud timber flat roofs if look at it is most popular in Gangetic plain in UP, MP, Bihar, even in Jammu & Kashmir you can find and Deccan Plateau and some parts of Karnataka, Telangana, Rajasthan and also Central Maharashtra we find. Even it is because I have seen in UP this kind of mud timber flat roof particularly rural area. And Indian mud roofs are normally flat with mud, bricks on the supporting platform of wooden planks, reeds and bamboo matting palms or even palms or coconut leaves any matting you can use right mat. And sometimes people use also the brick and mud ok apart from your wood planks right.

And let me show you a house here, this house is basically something around 40 years old. 40 to 50 years old, my student who is residing in Trivandrum he told me and he sent this is his own house in rural area of course and it has been modified later on and this is the roof is basically mud timber flat roof right. And this if look at this the planks and this is the beam, if you look at, this is your beam here and these are wooden planks kind of things are used. And here what will happen that the mat what you call timber or the wood plank right, this will be a kind of thing around 1.5 to 2 inch depending upon the load what it is coming. It may be more that that this I have shown you typical.

And there is a straw mat or may be bamboo mat or something given such that it will soak the any water will be passed through this mud because when the rainy season mud may absorb some water. So, these are as far that timber should not get affected by that right and this is

been used and this life is people says you know around something 100 years. And even some people claim more than that I do not know and I did not get any data. Let us look at what are the advantages of using mud roof over the cemented roof.

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Mud roof	Cemented roof
Mud is truly natural, cheap and local material	Material is not available locally
Provides excellent heat insulation, the internal part of the house is cooler in summer and hotter in winter	Poor heat insulation. It acts as a heat source.
Life is around 100 years	Life is around 50 years only
It can be recycled and is reusable	One time use only. It can not be recycled
Dismantling cost is low.	High dismantling cost
Construction cost is low.	Higher cost of construction
Stronger in compression and so make good roof.	Crack appears if not casted and cured properly.

Mud is truly natural, cheap and local material right, and it provides excellent heat insulation and internal part of the house is cooler in summer and hotter in winter. Life is around 100 years of course I have talked with several people I have arrived at these years, whereas the life in cemented roof is around 50 years. And cement you will have to buy from the market. And it is a poor heat you know for heat insulation. So, and it act as a heat source. You might have observe in your when you are using the ceiling fan in summer, lot of heat will be coming and they have to put you know coming towards the body and from top to that. And it is unfortunate that we are using that ceiling fan, we are basically instead of cooling our self we are taking the heat from the cemented roof and then bringing down you know it is a foolishness to do that.

And we are basically one has to have a Ceiling kind of things right, such that this heat should not come but we are not using and then after that you use the ceiling fan right? And also the it can be mud roof you know mud in the mud roof can be recycled so also the planks and other things and is reusable and concrete can be one time you can use and you are also it is using a lot of you know energy for doing that. For mud no need, you will have to use what you call dig and then use it you know like or you will have to use the mud from the ponds or some other places, it cannot be recycled and dismantling cost is low. But concrete house if you want to dismantle it is very high. And construction cost is very low because any ordinary

person can do, here you need especially higher cost of construction and stronger in compression so far mud is concerned and so it is very good for the roof.

That means mud is a very good material for the roof, whereas the cemented you know crack may appears if not properly casted and cured properly and also you know cost of construction of the concrete house or cemented roof is very high right. And of course there will be disadvantages; Mud is eroded easily by water, Mud has low strength, of course it behaves poorly in the event of earth quake. And of course cemented if you compare it is a good resistance to earth quake provided you know it is not with the severe, low range you know Richter scales. If it is low one can manage if it is high then it will be devastating and high maintenance is required, you know few intervals of you know after certain intervals of years one has to maintain the mud roof.

So also the concrete also the one can do otherwise you know sewage will be a problem. And mud soaks up rain water and becomes heavy and of course cemented roof will not soak the rain water. And mud roof is susceptible to mechanical damage where as the damage due to the you know mechanical forces in case of concrete is not that much provided the load is not that heavy like an earth quake or a heavy cyclone or landslides you know this also tend manage. The load due to what you call earth quake or heavy cyclone or the land slide cannot be managed by the even cement roof.

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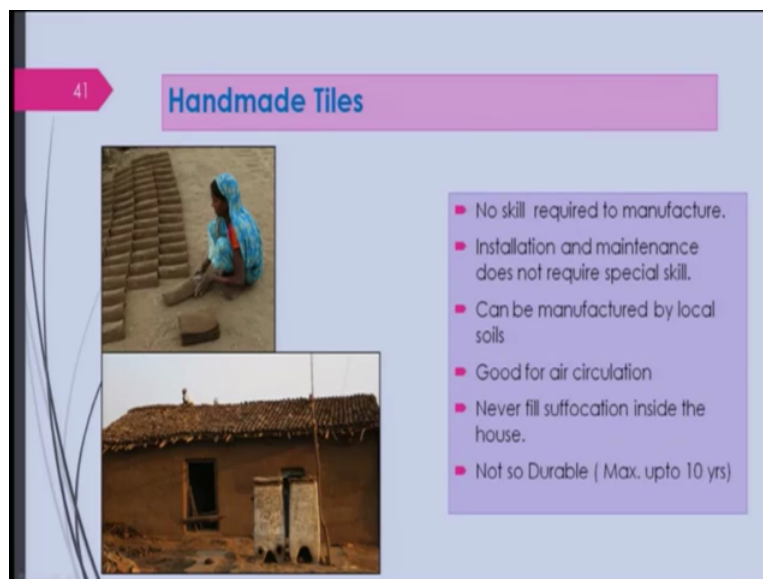


So, therefore if look at it is having certain advantages, let us look at the bamboo, or the wood or the grass roof kind of things. And this is the bamboo roofs which is well designed and then

it has to be joined properly also, these are joints right. And it has to be you know properly maintained so that water can fall on this thing and this is of course a made of kind of a bamboo also and this is the one which is made of wood. If look at this is the wood roof, and sometimes people use over it brick or may be some mud can also be use but even you can also use some mat on it right on the top of it.

And of course these are proven techniques; it is um you know what to call durable particularly when you use bamboo and other things. Bamboos should be seasoned properly, that is also important. And is good strength aesthetically and then well for Holistic health but creates a environment good environment inside house you will not feel you know suffocated while the concrete or other thing. So from that point of view is good and it is a biodegradable that is very important one, and it is a eco-friendly in the sense it is not guzzling the energy and creating some in-house gases like your cement and other things you know so also the iron rods.

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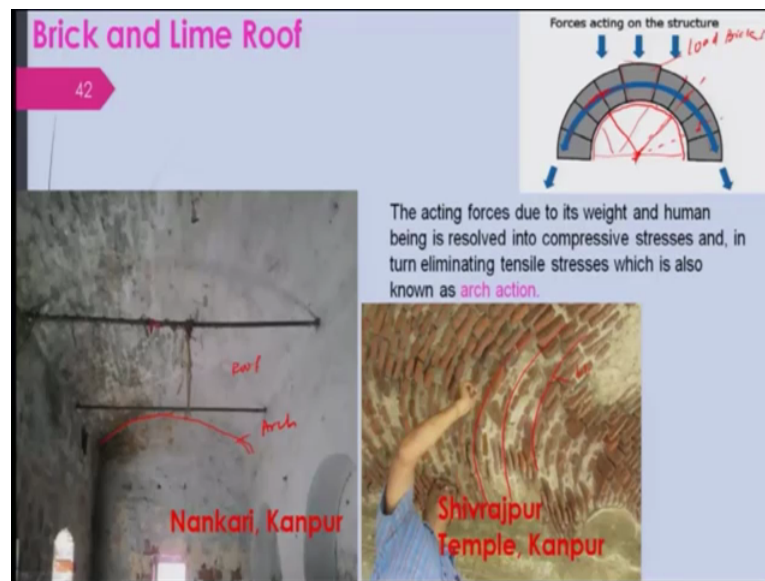
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Handmade Tiles

- No skill required to manufacture.
- Installation and maintenance does not require special skill.
- Can be manufactured by local soils
- Good for air circulation
- Never fill suffocation inside the house.
- Not so Durable (Max. upto 10 yrs)

So, handmade tiles if you look at people can make and dry it and even they can bake it not much skill is required to manufacture. Installation and maintenance does not require special skill, you just keep properly ok; of course to some extent skill is required but not that sophisticated skill is required. Can be manufactured by local soils right, and good for air circulation, and never feel suffocated inside the house, and not durable as much as the concrete, but however one can manage up to 10 years you know kind of things what people are having?

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And Brick and Lime Roof; which is if look at I am showing here, that this roof I have got in nearby IIT, Kanpur there is a just adjacent to IIT, Kanpur, there is a village Nankari I got this house if you look at this is your roof. If you can see this thing is a arch here. Now this arch is made and it is what the person is claiming it is more than 60 years old this house and it is not maintained properly let me tell you, it is abandoned, they are not using they are going to dismantle it also. And without maintenance they could manage to get 60 years ok? And which is not in that bad condition from the look you can see. And there is another you know question arises, this arch how it is working? If you look at these are the forces acting on the structures, right? And these forces is been transferred over here right to that and this is a very important stone which is known as the load stone or the key stone. Key brick you can say here, this will be what you call load brick right?

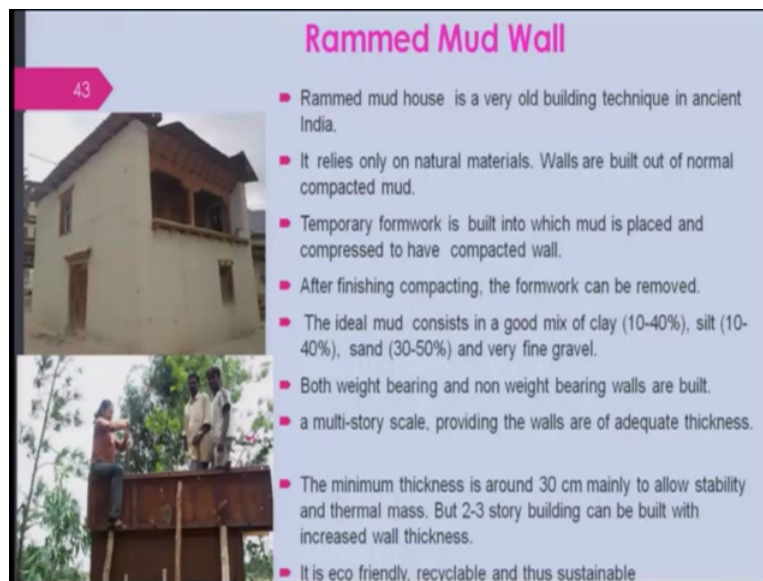
And the acting forces due to the weight and heat and also the human being, suppose you can have a you know moving around you can have go for a second storey building it is result to the compressive stresses in turns because these forces is transferred to this way this is compressing you know right. And in turn eliminate the tensile stresses here nearby right it has been joined so the force is coming and which is also known as the arch action. Because of that it is basically remaining and then of course you can use these kinds of a mortars here or the binders so that it will remain. But how they might have made it? And keep in mind this is a very large arch here, this is the very-very small arch here ok. What they could have done, they would have made a frame like this before hand right.

And frame of course it could have been a stress kind of thing joining so that load can take right kind of structures right and then they could have set these bricks right put it and then of course keep in mind that these bricks should be of proper size that is very important. And such that at the center will be coming to that this center of you know this thing will be matching with this radius that is the important point one has to make right. Dig making and putting it, a little lot of skill is required and so also each brick has to be looking at you know this load whatever it will be coming.

And this is the house which you can make brick and lime you know. You can make 2 storey building, 3 storeys building also people have used it. And there is another way I happen to see in Kanpur and this is again in a dilapidated condition by the side of Ganga it is in Shivrajpur. This technology is little different, this is basically what you call the vertical the arch is vertical in nature, in this case it is vertical arch. This is a horizontal arch if look at these are all arch, horizontal arch right? And how it is working and then they might have a you know frame kind of thing they could have used and if look at the center there will be some center here some other place not shown here that brick size has to be properly maintained and kept.

So, therefore it is very important to what you call see that this kind of technology can be revived such that it can be you know use even today and without getting disrupting to the concrete. And the lime is far superior as compared to the Portland cement because you can make it locally and then you can use it and also from the heat transfer point of view it is having you know better properties right. And advantages; Old technique. Durable and usable and it is quite cheap to make it but the skill you know with which we can make is not available today with the people that is the very important challenge one has to look at it, we can revive this technology.

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Rammed Mud Wall

- Rammed mud house is a very old building technique in ancient India.
- It relies only on natural materials. Walls are built out of normal compacted mud.
- Temporary formwork is built into which mud is placed and compressed to have compacted wall.
- After finishing compacting, the formwork can be removed.
- The ideal mud consists in a good mix of clay (10-40%), silt (10-40%), sand (30-50%) and very fine gravel.
- Both weight bearing and non weight bearing walls are built.
- a multi-story scale, providing the walls are of adequate thickness.
- The minimum thickness is around 30 cm mainly to allow stability and thermal mass. But 2-3 story building can be built with increased wall thickness.
- It is eco friendly, recyclable and thus sustainable

So, there is a Rammed mud wall; is a old building technique, it is found in ancient India not in the modern way but in a little different way. And it relies only on the natural materials, walls are built of normal compacted mud, and temporary formwork is built into which mud is placed and compressed to have a compacted wall. And let me show you this is the house which is built out of the compact rammed mud wall, right? And this is the thing how you can do like you can have a this frame in which you will be ramming this mud and let me show you that and you are having a mallet here and these are the frames right which has to be you know supported properly and then you can put you know ram it, this frame is we call it form work right.

Of course there will be (31:40) level here and then you can having. And ideal mud consists of good mix of clay 10 to 40% silt around 10 to 40% and sand 30 to 50% and very fine gravels but people do use in modern time cement, even lime can be used. And both weight bearing capacity and non-weight bearing walls can be built, of course when it is wet bearing you will have to increase the strength right. And multi-story you know building can be made out of this provided the walls are of adequate thickness, and minimum thickness is around 30 cm mainly to allow the stability and thermal mass. Of course 2-3 storey building can be built with increase wall thickness, and it is eco-friendly and recyclable and also sustainable.

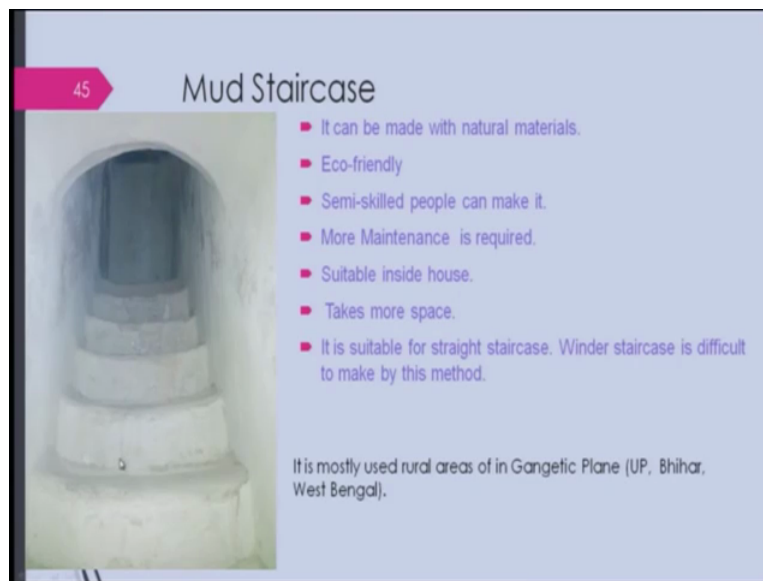
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If you look at this kind of technology earlier days used in fort walls you know particularly outer walls will be made out of compressed what you call or the rammed mud wall and they were using elephant for making that you know to load right. So, let me show you a video just to say how it is being done and it is done in modern time in Uttarakhand in some region. And if you look at this is the technique they have used and this is two plates here and one and they are using a person is just standing and putting his own load so that you know he is also pressing it. And after this of course this is the one pressure you can think of this handle of the pressure which will be you know pressed by the both the side of the formwork of the plank wooden plank so that he is doing right now so that it will be compressed right, both the vertical compression and the horizontal compression has to be given so that it will be take a proper shape and compacted.

And they have also made this house themselves all family members and including the roof also, if you look at this roof, this is the roof which is basically made out of mud ok, in recent time. It is not the old time they have improvised the technology then they have use it.

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Mud Staircase

- It can be made with natural materials.
- Eco-friendly
- Semi-skilled people can make it.
- More Maintenance is required.
- Suitable inside house.
- Takes more space.
- It is suitable for straight staircase. Winder staircase is difficult to make by this method.

It is mostly used rural areas of in Gangetic Plane (UP, Bihhar, West Bengal).

So, you might have seen mud staircase but for me it was a great this thing I could you know get a mud stair case which is made of these are the steps right. Steps of the staircase and it is still been used in rural areas of U.P and particularly the poor people who cannot afford to have a concrete house, they are using today. And I was having a video may be due to paucity of time I will not show you. It can be made with natural material and it is eco-friendly, semi-skilled people can make it, and of course the more maintenance is required. It will be suitable inside the house, and it takes more space, these are the disadvantages. And it is suitable for straight staircase like straight. Bu if you want to have a winder staircase like in modern time due to space what we are using you cannot use it but however, we can really improvise it, find out ways and means how to do that? And it is mostly used in rural areas like Gangetic Plane, UP, Bihar and West Bengal also to some extent, right.

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And this is the huts in Rajasthan, if look at this, particular shape is there and this we call it as a Wang. And this is a very nice, decorated walls they were having that is the aesthetic sense they are having.

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BHUNGA HOUSES

- The Bhunga is a traditional construction type in the Kutch district of the Gujarat state in India, which has a very high earthquake risk.
- A Bhunga consists of a single cylindrical shaped room.
- The Bhunga has a conical roof supported by cylindrical walls. Bhunga construction has existed for several hundred years.
- This type of house is quite durable and appropriate for prevalent desert conditions.
- Due to its robustness against natural hazards as well as its pleasant aesthetics, this housing is also known as "Architecture without Architects."



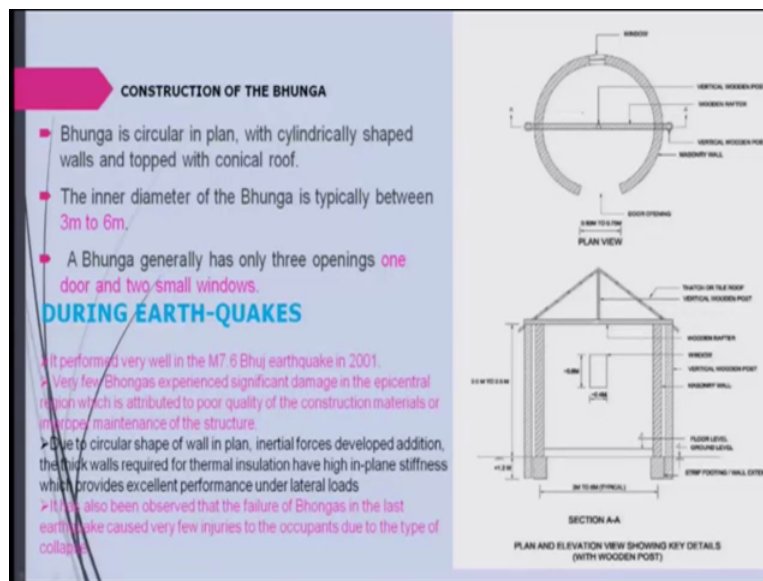
BHUNGA HOUSES



And this is the same thing and which is known as Bhunga houses in Kutch in Gujarat which is basically in seismic zone. And Bhunga houses are traditionally construction type in Kutch district of Gujarat state, which has a very high earthquake risk as I told just now. And it consists of single cylindrical shaped room, right. Like this it is a single cylindrical shape it is not a rectangular shape it is a cylindrical shape. And Bhunga has a conical roof this is like a cone right, this roof is like a cone right and supported by cylindrical walls right, these are all cylindrical and Bhunga's has existed for several hundred years and is quite durable and appropriate for prevalent in desert condition. This is meant for desert condition because any side wind will come, it will not affect, the roof will be balanced properly you know. That is the beauty of this house.

And due to its robustness against natural hazards as well as its present aesthetics this housing is also known as "Architecture without architects" right, nobody has made, people have made that. And it looks very beautiful that you can see and these are the some other houses in which are having thatched roofs and we shown and they do always indulge paintings, the walls and other thing. And these are also what you call the windows they are having.

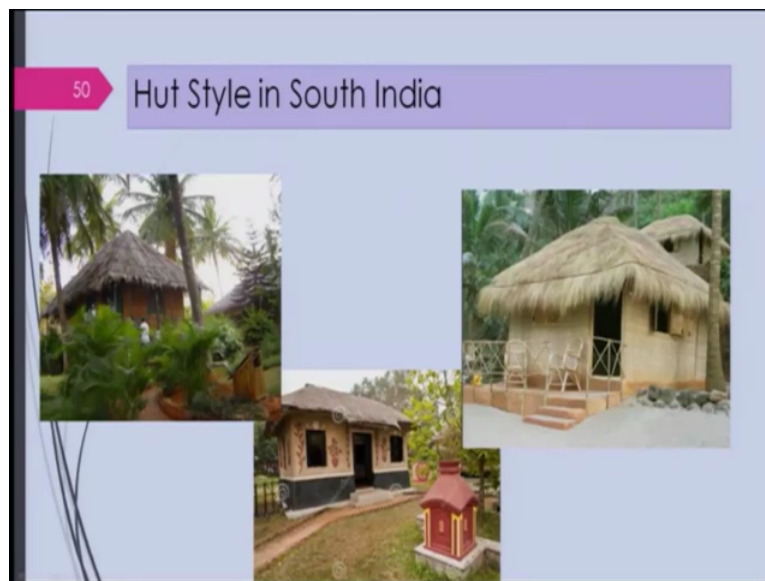
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And the construction of the Bhunga house is basically as I told you circular in plan with cylindrical shape so, this is basically the circular in shape and inner diameter of Bhunga house is typically between 3 meter to 6 meter, right? And generally this house will having 3 opening one is the of course the door right here and there will be windows also another window, two small windows. And during earth quake if you look at which happened in the Bhuj region of Richter scale of 7.6 in 2001 it was not really very much affected. And as the record says that very few Bhungas experience significant damage in the epicentral region, which is attributed to the poor quality of construction materials and improper maintenance of the structure because you need to have maintain.

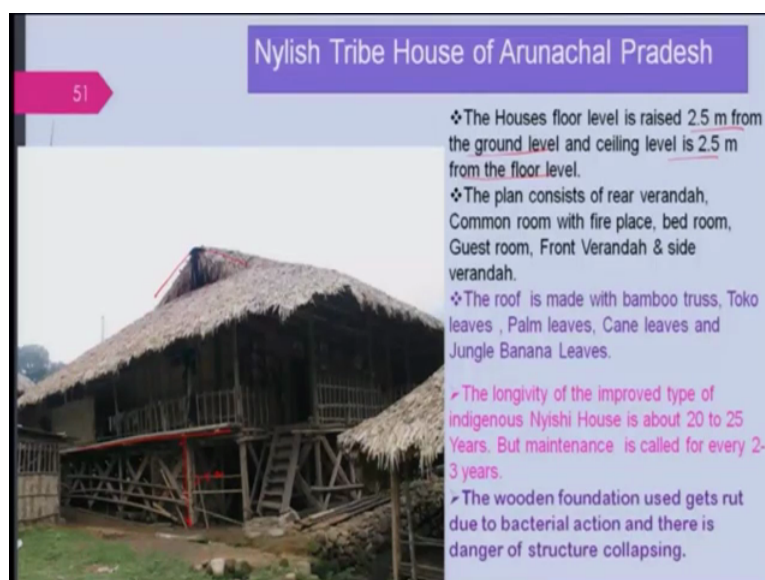
And why it is so? Because due to the circular shape of wall in the plan this is the circular shape right? And inertial forces developed addition the thick walls required right inertial forces are developed that in balance each other and thick walls required for thermal insulation have high in-plane stiffness, which provide excellent performance under the lateral loads, when the loads are coming it is all balancing because of circular inside. And it has also been observed that the failure of Bhungas in the last earth quake caused by the few injuries to the occupants due to the type of collapse, right. So, this is a very good house you know which having, of course this thatched house will be having vertical wooden post which will be there to make it balance kind of things and structural digit.

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So, of course the hut style in South India will be little different and these are the I have shown you like you know different styles of huts in the rural South India, right. And there is a one house I am thinking to discuss; of course you know each region will be having different kinds of house design which I could not cover in this lecture. But however I will eyes open people to look at it and document it. If possible send to us and take some video and pictures right of those houses particular regions.

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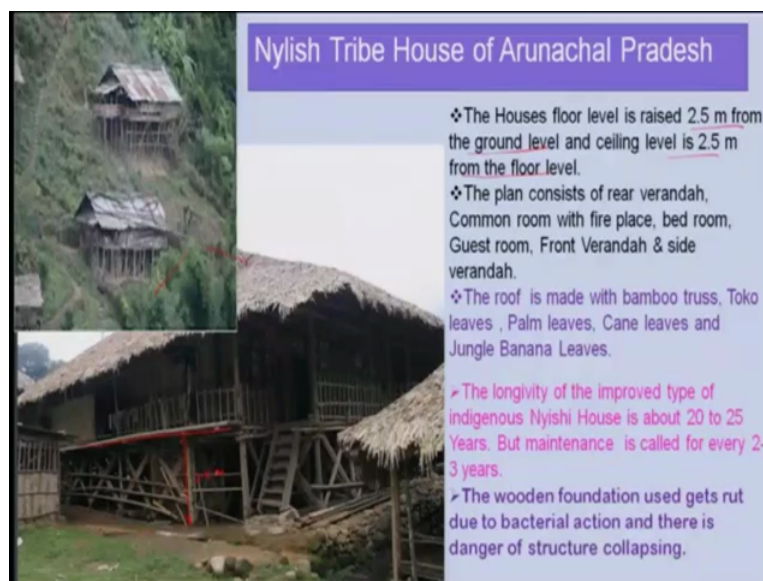


And this is a typical Nylsh Tribe House of Arunachal Pradesh and this house floor level is raised something 2.5 meters from the ground level right, and ceiling level is around 2.5 meter from the floor level. If you look at this height is generally it is not very strict 2.5 meter it may

be varying but generally average is 2.5 meter right. And this is around 2.5 meter if you look at this is the thatched portion over hanks and this is the V-shaped kind of thing used and these are all what you call foundation you can see. That plan consists of rear verandah, right on the back side common room with a fire place, and also very important thing how they make fire in this wooden house?

They are all bamboo houses ok? It is not having a floor of mud or some other thing that is very interesting which I will not be discussing but it is they know how to do that. And like side verandah, there will be lot of verandahs, roof is made of bamboo truss and Toko leaves in that areas, palm leaves, cane leaves and jungle banana leaves, there are several kinds of leaves they can use. And of course the longevity of the improved type of indigenous Nylish House is about 20 to 25 years. But the maintenance is called for 2-3 years like any other thatched house. And this wooden foundation, these are basically foundations you know, gets rut due to the bacterial action and there is a danger of structure collapse also, the one has to look at it, basically it is required that what you call maintenance.

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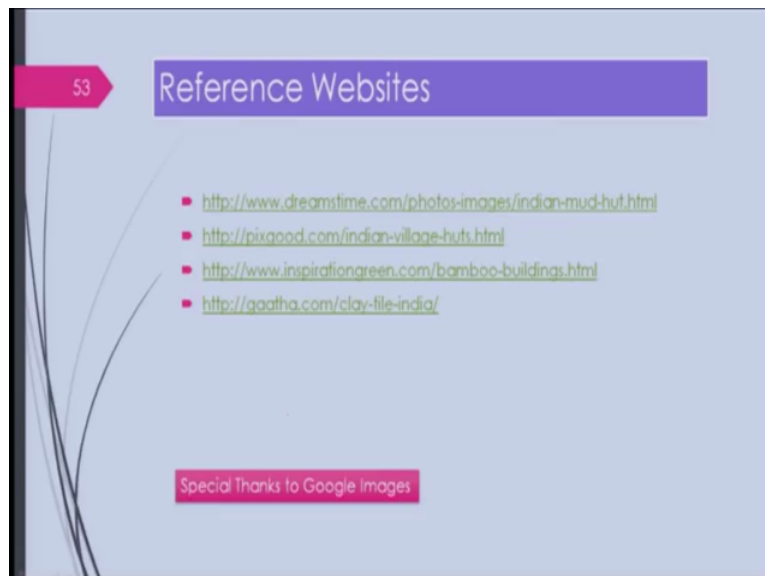
If you look at these hill areas they need to have houses like that that is the reason why they were making and to have a concrete house in this region is a hell of affair. Ok? It is not that ordinary people you need this and they knew how to do that. These houses if you look at this side you will foundation is high because of slope this is a slope right. And they knew how to do and this has to be protected and this you know indigenous knowledge they will be having. Of course there is a ladder here to you will have to get up into the house right.

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And this is the of course various bamboo architectures I have taken need not to be from our country but just to show you that bamboo can be a good material.

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So, thank you very much. Actually I have just give you glimpses of the housing in rural areas, it is not existing but lot of science involved and lot of things you can learn from it and we need to preserve those technique, methodology and also the skill with the people. And they should find out what they want to do according to their region not that you know copy and paste the concrete and make it a concrete jungle. So, we will have to retain our heritage and culture of making house and doing it yourself and taking the all the scientific aspects into it.

Thank you very much listening, I hope and wish that you people will do something and at least record it and preserve it that is important, Thank you very much.