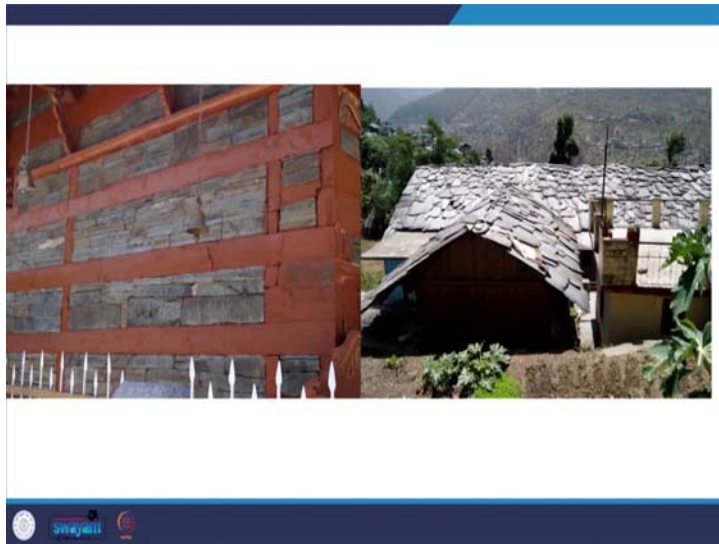


International Studies in Vernacular Architecture
Professor Ram Sateesh Pasupuleti
Department of Architecture and Planning
Indian Institute of Technology, Roorkee
Lecture 10
Advanced Material Adaptations: The conclusion

Welcome to the course International Studies in Vernacular Architecture. Today, we are going to talk about advanced material adaptations and which is also the conclusion of the unit 2 materials. So, in our last lecture, we briefly discussed about the kind of timber frame buildings and also the wooden architecture in Uttarakhand.

And today, what kind of responses we are able to get without having proper access to the local materials and the notion of local materials availability of these materials have changed drastically in these past few decades.

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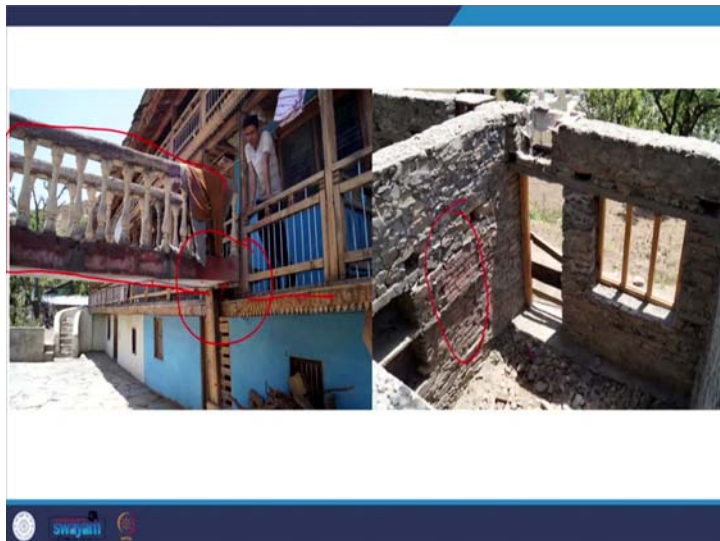




So, one can actually see that today people are not ready to invest in many of these traditional technologies, because one is they are not able to access these materials. The second is the absence of the skill resources, the craftsmanship, who can actually deliver these buildings.

So, in many of the cases, what we can notice is though, many of the stone buildings which are abandoned, they might have been affected by various earthquakes, we can easily notice that there are common problems in these buildings there are some times the cracks have appeared in the corners, there are sometimes the joinery is not great. So, how do we provide a guidance to these artisans to these contractors who make these buildings?

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Like for example, you can see in this particular house, this was a traditional house, but then later on added this concrete slab, but without any support landing on the timber floor. So,

which means lack of technical wisdom like how, how it can actually bear the load of it, whether having this can also have an impact on this, so this kind of understanding like there are no some of these they are mixing various other materials, whatever they are able to get.

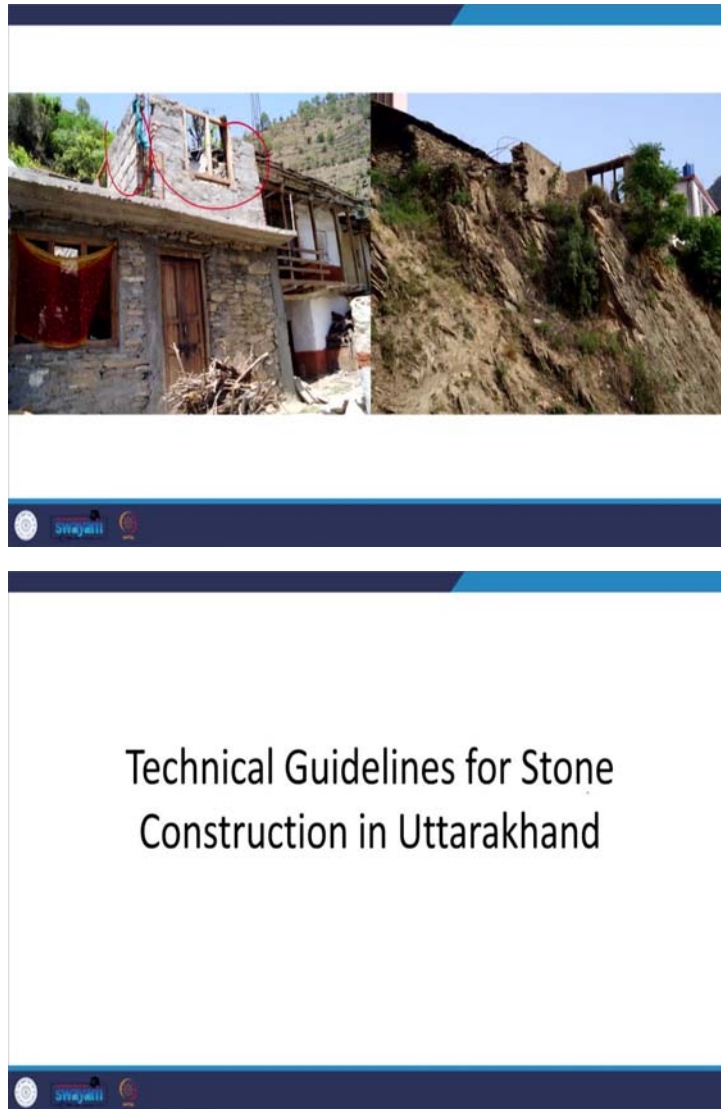
Sometimes they stone, they use stones, sometimes they use brick within it, sometimes they are not using any sill bands. So, this is what my observation is certain understanding the present generations they are not able to tap with the local knowledge, what their ancestors have adopted, at the same time, they are trying to mix with these newer things, but without having an appropriate connections.

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So, here also we can see that there is no intermediate bands in the whole construction being an earthquake zone 4 or 5 areas. So, it is required there should follow some structural measures.

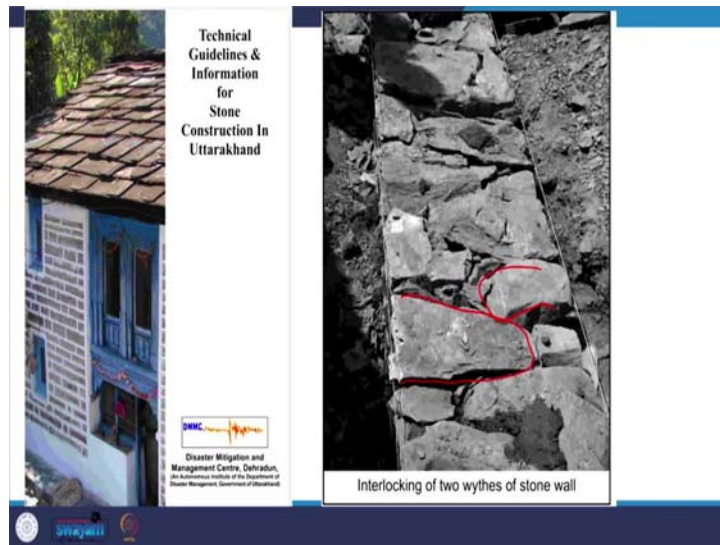
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But what you can actually see is a mix of different construction like you one floor that use a different material, another floor, they use a different material, and sometimes the columns are done from the first floor also not from the ground floor so, in that way, inappropriate consideration of these modern techniques also results in a major disaster.

So, we can see some of these newer buildings have fallen down. And so, in that notes, there are some efforts made by the Uttarakhand state that they have issued certain technical guidelines for stone construction in Uttarakhand.

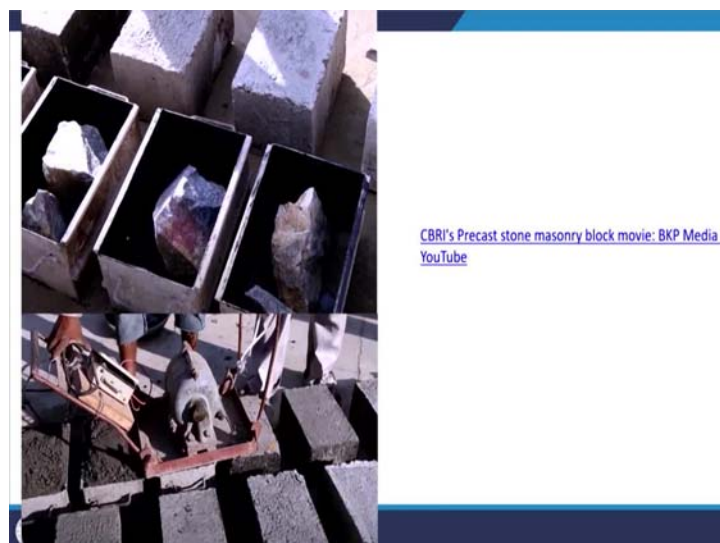
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So, the DMMC Dehradun, DMMC Uttarakhand so, they have developed these technical guidelines and information for the stone construction. So, for example, when we talk about these laying of the stones, so, how we have to provide an interlocking nature both in the form of not just only an elevation side of it.

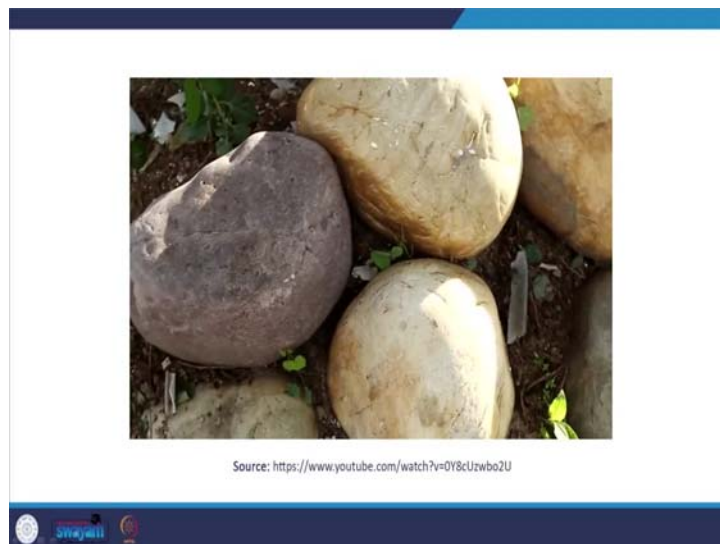
But in terms of the plan, how we have to interlock these 2 voids and there is also an advanced techniques which the Central Building Research Institute in Roorkee CBRI also have promoted certain techniques, how we can adopt the stone constructions with interfacing with modern technologies. So, this is one of the techniques which I am going to show you a small video.

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So, basically they use part of it as a stone material and then they use regular make this as a blocks with certain procedure, which you can actually watch in this video. And the elevation of this actually appears with the stony facade we get these parts of block is appeared on the facade it appears as a stone. So, this is the kind of techniques which they have adopted and have implemented this in some projects.

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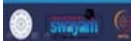
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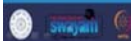
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Stones

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Concrete mix : 1 part cement, 5 parts sand and 8 parts of coarse

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Approximately 100 to 129 mm size stone pieces

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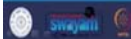
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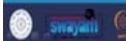
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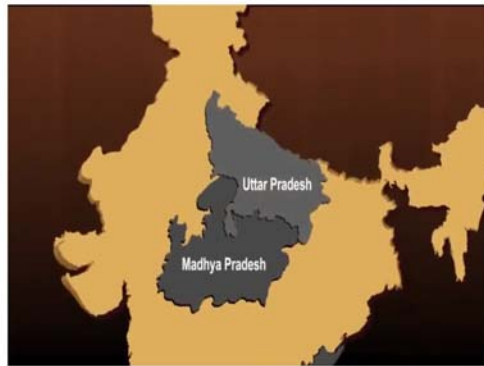


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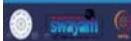
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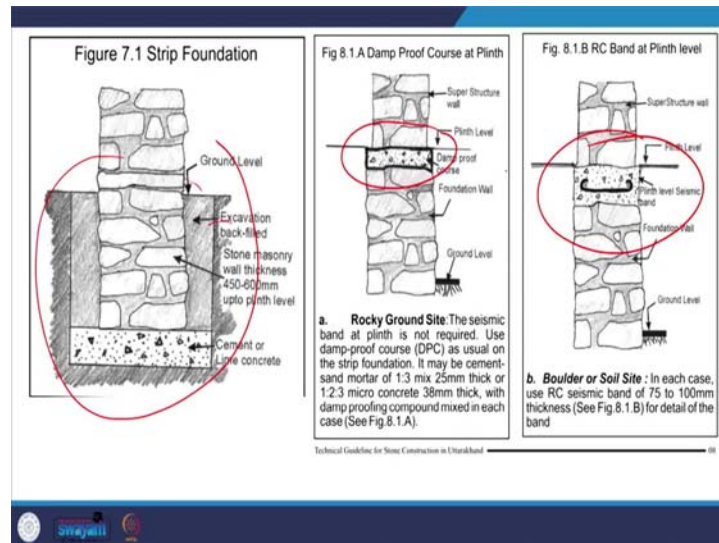
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Spaces for fixing electric switchboard etc. should be created by using thinner blocks when large openings are needed, especially for sanitary fittings, full block be left without mortar during wall construction. So, this is the look and feel of the stone mastery block wall building. This is a unique concept, no doubt CSIR CBRI has taken all the pains for innovating building materials and this time they have created history.

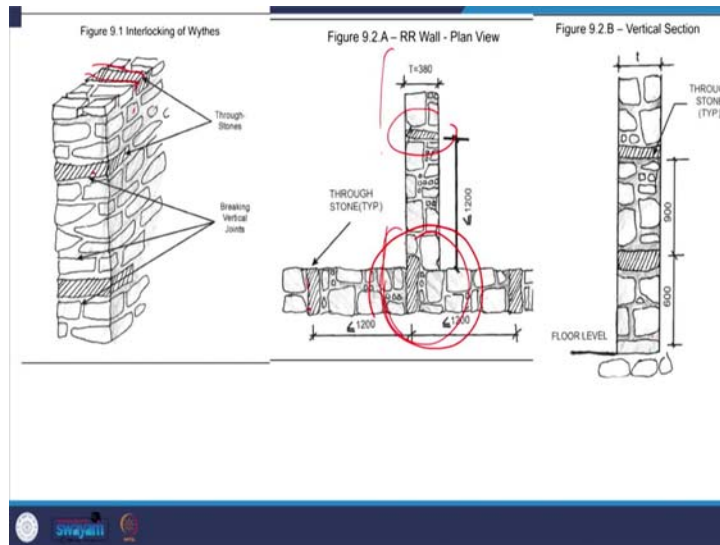
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So, again, there are some broader guidance which has been provided how we have to do with this stonemasonry and how at the foundation level, how we need to do having a stone wall thickness of 450 to 600 mm and how we can do up to this plinth level. And similarly, especially, many of these houses that are situated near to a water body or somewhere how we have to provide the damp proof course here.

And that is what kind of mixture it could be 1:3 and whether it could be cement and sand in the 1:3 ratio or it could be 1:2:3 micro concrete 38 mm thick with damp proofing compound mixed in each case so, that way they have given certain guidelines having an RC band at the plinth level and this is again a systemic band considered as a systemic band.

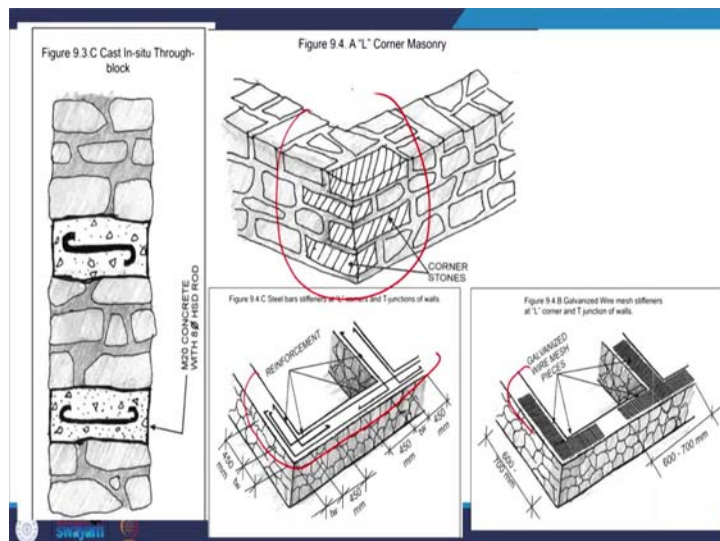
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So, when we talk about the interlocking of wythes, how we actually through the stones, how like, for example, you have the smaller stones, but how we create an interlocking through the bigger larger stones at the corners and at the intermediate places, so that we can actually break these vertical joints and also in plan if you see the junctions, how do we do the junctions, because most of the cracks appear at the junctions.

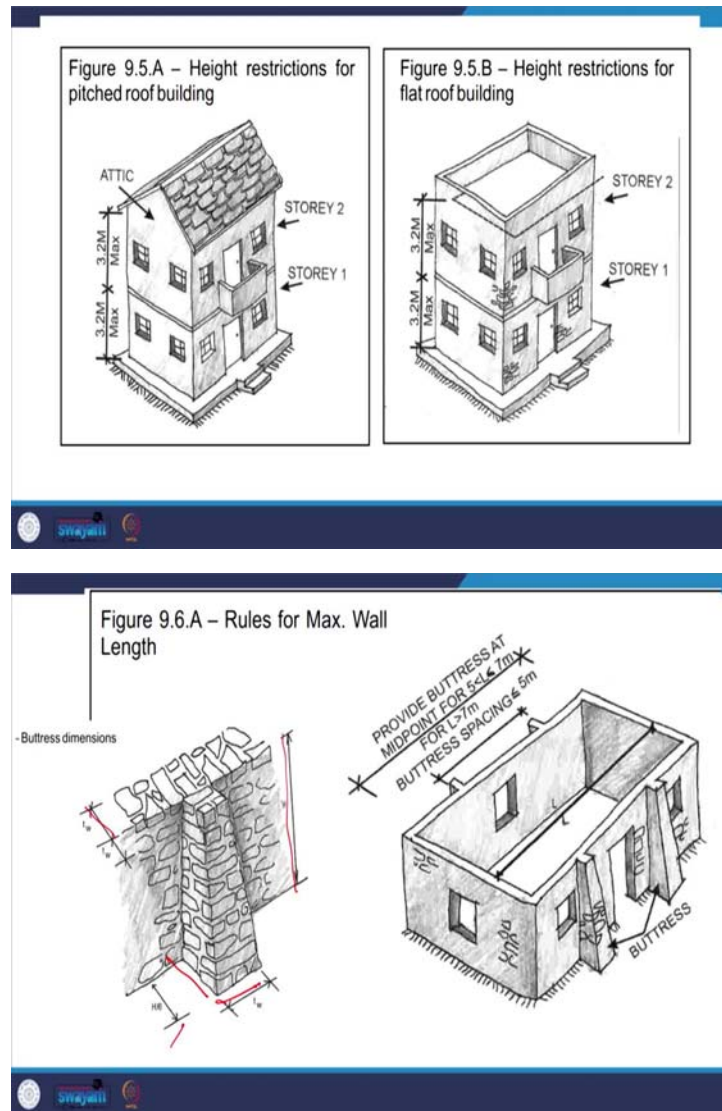
So, what are the techniques we use in the interlocking process? So, this is how we have this through stones and so that it can break this wall at different junctions and it can actually bind these walls at these junctions and the also through stones in the vertical sections it looks in this format.

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So, you have the reinforcement, when we are actually making these L corners or the T junctions, we can either do with this format of these having the reinforcement and or else we can have a galvanized wire mesh pieces, and in that way that stiffens these corners, and also this L stone corner masonry with the kind of alternate facing one face this side and another face this side like this. And so, in that way, we can actually develop this particular corner integrations.

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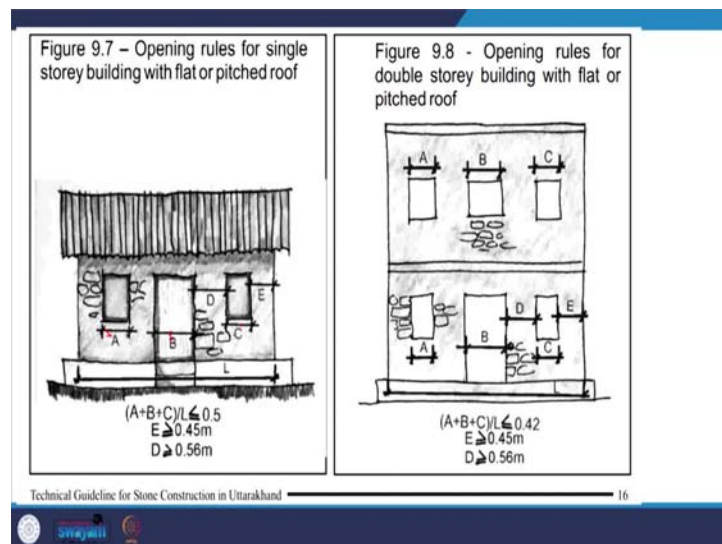


And also there are been a guidance especially on the Hill conditions, what kind of heights if you are going for a flat roof, what kind of high to should go and about 3.2 maximum and here we are going for attic how we can go all these height restrictions they have already

incorporated and especially for the walls sections, if you are going for a wall between 5 and 7 a midpoint we should provide a buttress or if you are actually going more than 7.

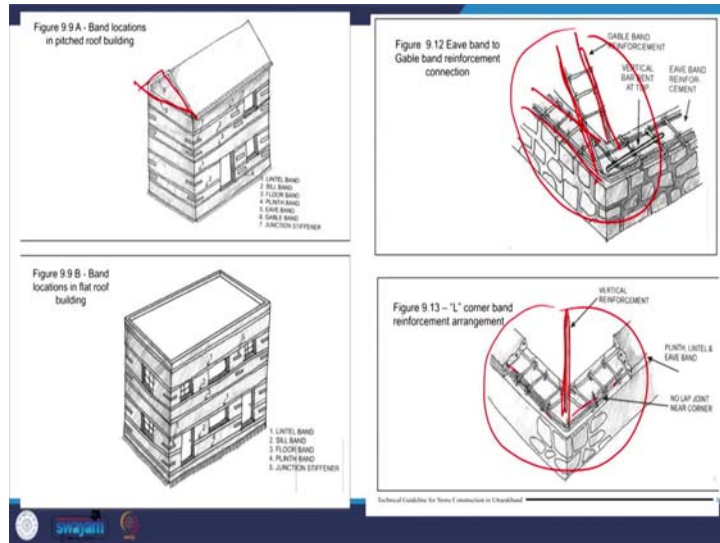
So, the buttress spacing should be less than 5 meters. And in that way, we need to provide this buttresses so that it can actually give an intermediate support for this wall component like what is the proportion of these buttress dimensions, if this is the height of the wall and this is the width of the wall and this should be the $H/6$ and this should be the width of the wall. So, this is the kind of thumb rules which they have provided for how to make the buttresses.

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Similarly, the openings the proportion of openings, how we should do that you have the $A+B+$ the windows + those should be divided by the overall length of the house should be less than 0.5. So, similarly, like that, they have given these rules for both single storey building or a double storey building. So, in that way, it can actually configure within this seismic compositions.

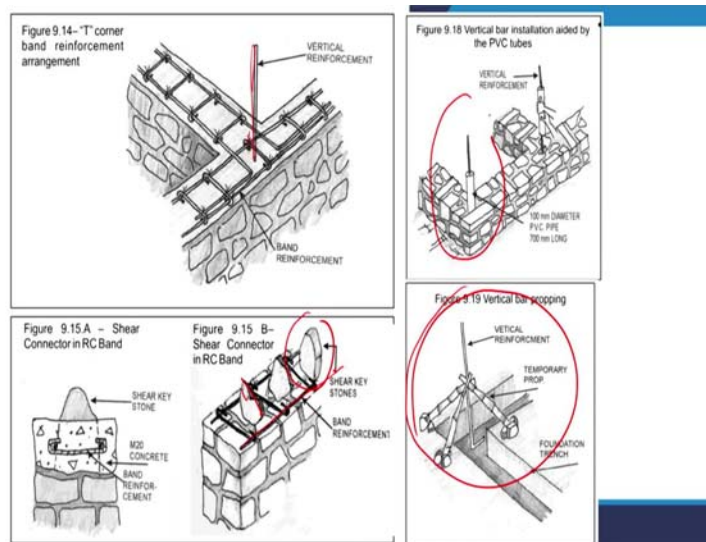
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And also the band locations you have these if you have a look at the plinth band, the sill band and the floor band on the lintel band, then the U bands here and the gable band here so, in that way, so, each of these structures which is having an intermediate bands, that actually divides the whole structure into different compartments.

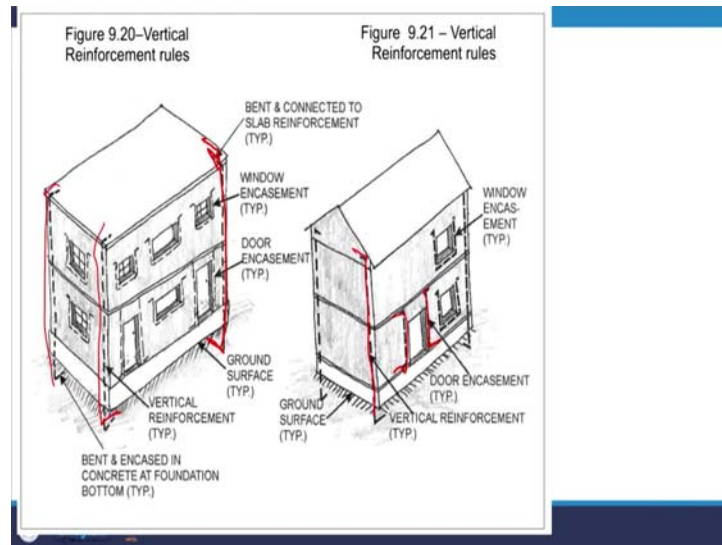
And when we talk about the detail of the U band versus with the gable band and this is the kind of detail which is going the U band is here and the gable band is going on this side and similarly you can also have the corner band reinforcement you have this corner band but then you also have this vertical reinforcement to this.

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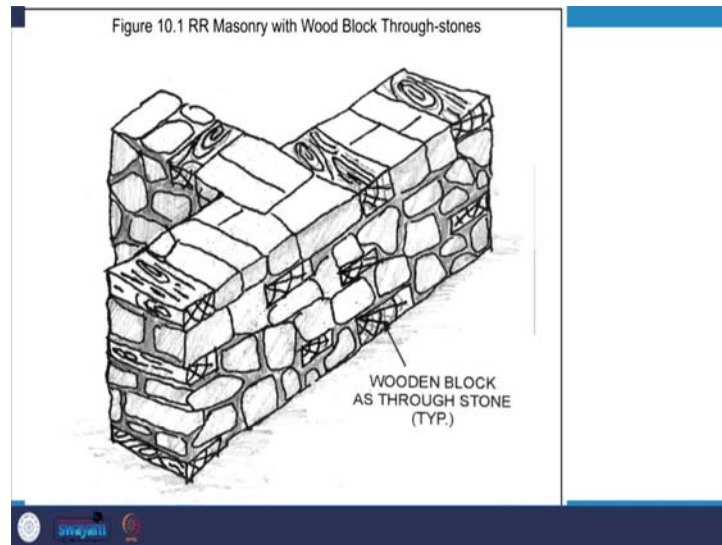
Similarly the T junction again here we can see the vertical reinforcement of course, the details of this reinforcement go along with the structural calculations. And similarly, when we talk about the shear keystones, how we actually do these bands and then we have these stones vertically and then we place the rest of the stones so, again how to prop the vertical things and sometimes we also use this PVC pipe and which actually supports this vertical reinforcement.

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And if you look at the vertical reinforcement the pattern the way you have to keep these vertical reinforcement is also had been advised. So, for instance it has to be bent on from so that it ties the whole building in one go this is how the process has to be done. And similarly with the openings also in the similar format. Like you can see that the openings or the junctions at the corners so it has to be bent and connected to the slab reinforcement.

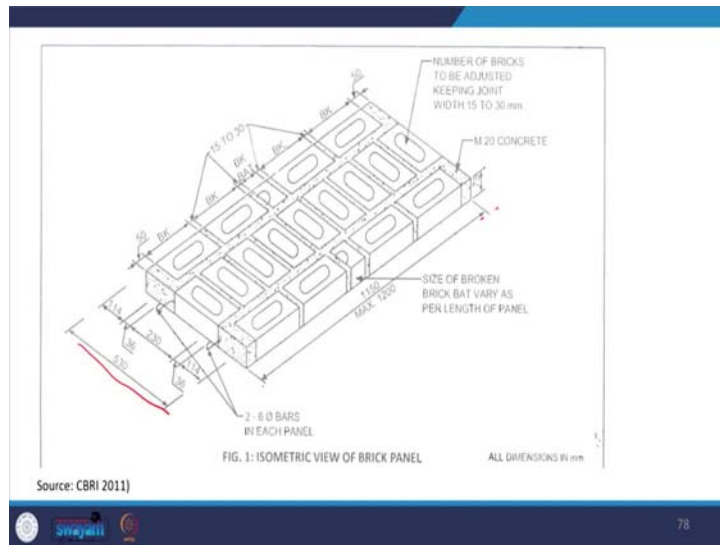
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And they are also advised how we can use the combination of woodblock through the stones. So, how we can actually use wood block as a through stones, and so that it can actually gives certain resistance to any kind of movements. So, that is some of the details about certain technical guidelines. But now I am going to talk about some other systems which has been implemented in the housing projects. Like in the past, we have also discussed about the earthen technologies, Adobe constructions and compress stabilized blocks.

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So now, I am also going to talk to you about the prefab understanding at a small scale or medium scale housing projects. So, here these are developed by the CBRI, and these are referred as a brick back panel technology, and the photographs are from the Technology Park. And so, this is about 53 centimeters by about maximum of 1200 mm, and you can see that there is a parallel reinforcement on either sides.

And basically what they do is they place these bricks and then the mixed with this concrete so for instance you have these about maximum of 1200 or 1150, we can go and about 530 mm is the width of this panels. And we have to we should have at least a joint width about 15 to 30 mm, and we use the M 20 concrete and this is how a brick...

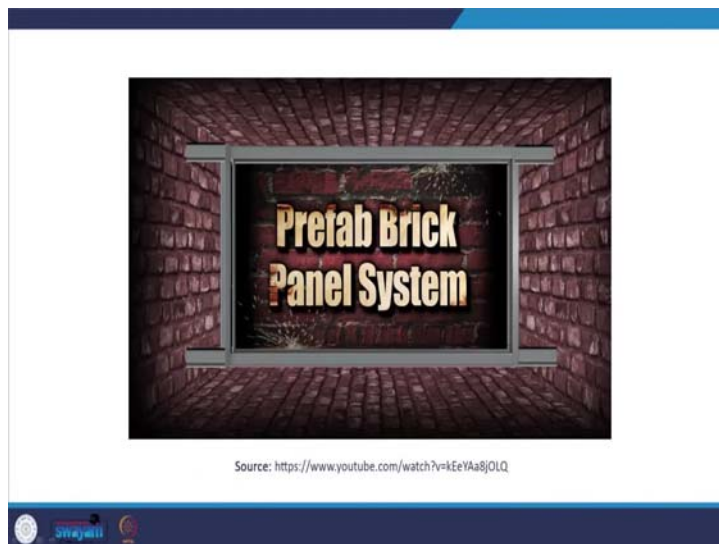
So basically this panel is very successful because it can be lifted by 2 people even a normal house or smaller house you are constructing 2 people can easily cast it on the side, and they can lift it and they can put it on the roof.

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So I am giving you a small film about how this panel is made, you can actually watch this and from this video, and the same time over the top of it this is how when you actually make these intermediate beams and then over that you put these panels and over the top of it you have this deck concrete so that actually gives a kind of finished roof section like this.

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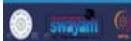
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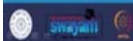
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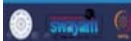
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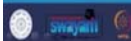
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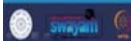
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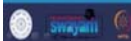
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Steel Bars of 6mm diameter

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Steel Bars of 6mm diameter

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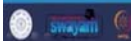
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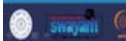
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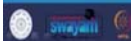
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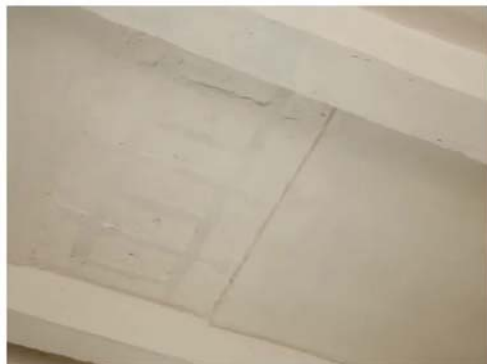




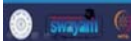
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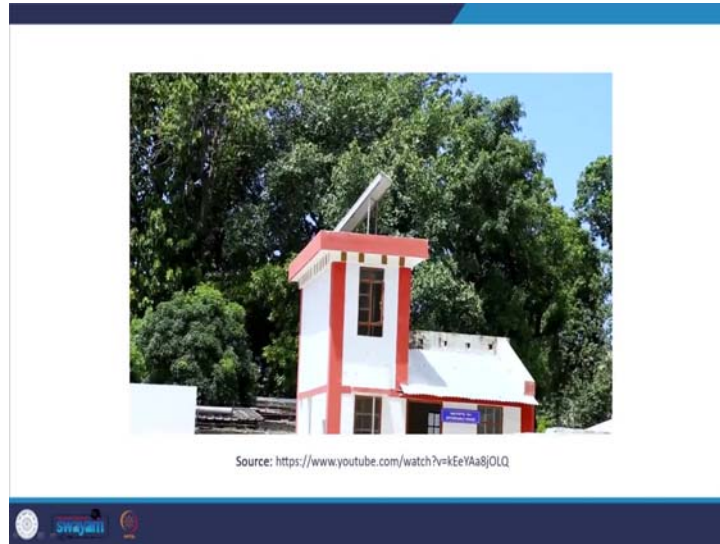


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The sky is the limit. If you have a roof over your head, the basic needs to be met in a lifetime include a house and the most difficult part of the house building is the roof. Here is a progressive Outlook to the whole idea of roof construction. This is the concept of making brick panels for building their off and floor structure.

Let us explain the process step wise. First of all, a mold needs to be fabricated in the shape and size of the brick panels made from seasoned timber of good quality of steel sections. Length of the brick panel varies from 900 millimeters to 1200 millimeters depending upon the room size.

Now comes the next step casting of the brick panel. These panels are cast on a level ground prefab brick panels are made up of first class bricks and reinforced with 2 steel bars of 6 millimeters diameter. The gap is deliberately for placing reinforcement into the brief panels. The width is normally kept at 530 millimeters.

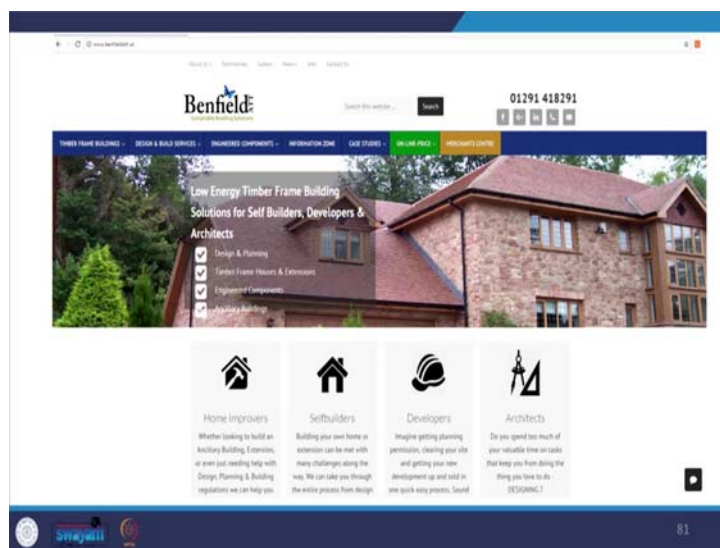
The mold can be removed after 2 hours of casting depending on the weather conditions. The panel can be transported to the curing yard after 48 hours of casting in summers and 72 hours in winters. Precast RCC joist should be cured for a period of 14 days and then dried for another 14 days before placing them on the supporting walls.

Now, the brick panels are ready to use. For assembling the roof or the floor, first of all the RCC joists are placed on the walls. Now, the brick panels are cleaned with wire brush to remove dust, loose sand and soil particles. Then, they are lifted and placed in position over the walls and between the precast RCC joists to make the roof.

Actually, the joints are placed over the concrete bed blocks they are properly leveled with 1:4 ratio of cement and sand mortar. All gaps between the panels are filled with M-20 concrete. Later cement concrete of 35 millimeters thickness is laid over the panels and the joists with temperature reinforcement.

So, the final roof structure looks somewhat like this beautiful and at the same time reliable. Simplicity, economic and ease in adoption are a few characteristics that make this per-fab brick panel system for roofing and flooring a great success. This system requires no shuttering construction is faster and lesser quantity of cement and steel is required. This type of roof is almost 25 percent cheaper than RCC slab in the plains of northern India.

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So that from the bottom you actually see the brick, the brick as in surface, but in the top you will see as a flat slab. So similarly we can use in the jack arch form also. And also this is some of the advancements which we can actually see in both the stone construction and the brick constructions. Of course, there are many but I am just showing you a few in this particular lectures. And considering the timber also as a building material.

We can also see that how the timber has been used in advanced building technologies, especially in the timber frame technologies myself working with Benfield advanced timber from technologies earlier in UK. So my personal interaction with these timber frame buildings my learnings I am also going to share with you.

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TIMBER




Sustainable timber
Timber is the most sustainable building product available. It is naturally renewable - over 97% of softwood timber used in the UK comes from Europe, where the forest area is increasing by the equivalent of 90 football pitches every hour of the day and night.*

For reassurance for softwoods and hardwoods look for certification labels like FSC® (Forest Stewardship Council) or PEFC (Programme for the Endorsement of Forest Certification).

The FSC label guarantees that the trees that are harvested are replaced or allowed to regenerate naturally.

WHY FSC?




<http://www.fsc.org/39/good-reasons-to-choose-fsc-30-min>



So in fact, when we talk about timber especially in the European countries or in the UK 97% of the softwood timber used in UK comes from the Europe and here the forest area is increasing by the equivalent of 90 football pitches every hour of the day and night so, first of all we have to understand there is hardwoods there are soft woods and there are the processed woods.

So, when we talk about the soft woods and the hardwoods, they we also talk about the FSC the Forest Stewardship Council, which actually certifies that it has followed proper supply chain process and it has made sure that the regeneration of the forest has been in an accountable manner right. So, this FSC label actually guarantees that the trees that are harvested or replaced are allowed to regenerate naturally.

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Parts of the forest are protected entirely, in order to protect rare animals and plants.

FSC protects the rights of indigenous people to use the forest. If they have sacred sites in the forest these are exempt from felling.
FSC gives an assurance that future generations will be able to enjoy the benefits of the forest.





When we are cutting down the forest, we should make sure that it should not hamper the wildlife or the flora or fauna in any way. So, we have to make sure that the forest has to be protected also and not only the animals, the indigenous people who used to survive on their forest, their sacred sites associated to it, how do you protect?

So FSC gives an assurance that these future generations will be able to enjoy the benefits of the forest. So similarly, there are ways how you can employ these indigenous people into the construction process and we can also provide these local workers providing them the training safety equipment and also a decent salary.

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CHOOSE AND USE OF RIGHT TIMBER

Timber used for structural applications must be graded and clearly marked to show it complies with the correct standards and strength requirements laid down by building codes and regulations.

The load a member can carry depends on several factors, including its span, thickness, width and species. Usually the deeper/wider the section, the longer the span.

Different species have different strength properties
– a factor that needs to be considered when choosing your timber.

So wherever we can find this FSC symbol so that is very important so that it has followed a particular process. And why do we have to how do we choose timber because a different species have different strength properties when we are actually choosing where we are applying or you are choosing hardwood completely for the facade treatment, are you using it for a floor, are using for this trust purpose, are using as a structural element.

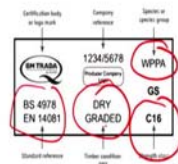
And there are also different building codes and regulations which we need to follow that, like in the UK we have certain building codes and regulations here we have certain building codes and regulations we need to follow how what kind of timber we are using and how we can actually do the visual strength grading how the timber is graded.

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How timber is graded?

Visual strength grading

Visual strength grading rules define the size, type and number of strength-reducing characteristics allowed in each grade (for example, natural features such as knots, wane and slope of grain, plus splits and shakes which may have developed as a result of drying).



Wane: uneven edge caused by a residue of bark.

Shakes: fissure caused by the splitting of the wood fibres along the grain.

Machine strength grading
Machine grading is based on the relationship between strength and stiffness. The machine grades each piece and stamps it with the appropriate mark.

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Machine grading is based on the relationship between strength and stiffness. The machine grades each piece and stamps it with the appropriate mark.

GS (General Structural) and SS (Special Structural), are the visual grades of the timber assigned by the grader.

The table below shows how some of the softwood species and grades most commonly used in UK construction are grouped into strength classes.

SOURCE AND SPECIES	GRADING RULES	STRENGTH CLASSES					
		C14	C16	C18	C22	C24	TR26
BRITISH							
British pine	BS 4978 visual				SS		
	BS EN 14081 parts 1-4 machine		*			*	*
British spruce	BS 4978 visual	GS		SS			
	BS EN 14081 parts 1-4 machine		*			*	
Douglas fir	BS 4978 visual	GS		SS			
	BS EN 14081 parts 1-4 machine		*			*	
Larch	BS 4978 visual		GS			SS	

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So, here by looking at their natural features such as knots, wane and the slope of the grain and any splits or shakes, and they can actually grade it accordingly. Look, for example, you have these British Standard and you have this is WPPA is the reference to the species group. And this talks about the strength C16 is the strength in class and this is a dry graded timber.

So, in that way each and every aspect will be observed or if there is an aspect you can see M it is referred to as a machine graded. So like that in the British context, we have this British pine, British spruce, Douglas fir and larch and how we have the strength classes C14, C16, and C18, C22, C24, and TR26. So in that way, there are general structural and special structural properties, which actually determine these visual grades.

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The following examples which apply to solid timber members show how to use span tables for domestic floor joists at 400mm centres.

Size of joist (mm)	C16 clear maximum span (m)	C24 clear maximum span (m)
38 x 97	1.76	2.05
47 x 97	1.96	2.26
38 x 220	4.29	4.78
47 x 220	4.60	5.12

Changing to 600mm centres will change the span distances for the same timber sizes:

Size of joist (mm)	C16 clear maximum span (m)	C24 clear maximum span (m)
38 x 97	1.43	1.68
47 x 97	1.60	1.87
38 x 220	3.71	4.17
47 x 220	4.01	4.45

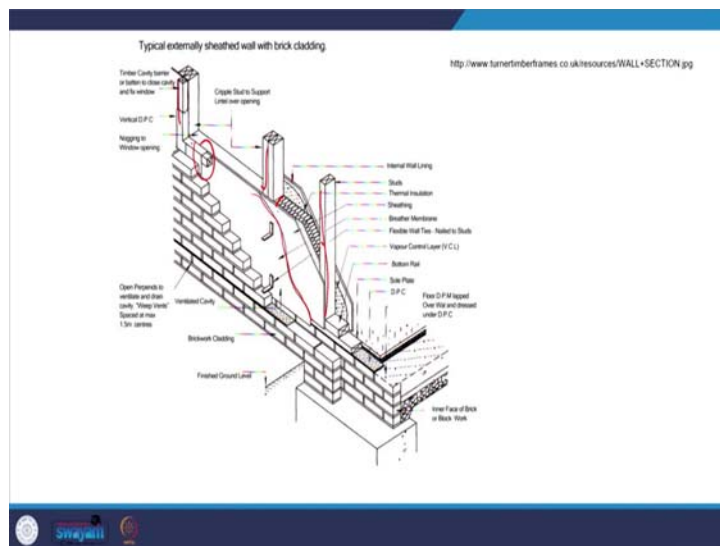
So if you wanted to span four metres at 600mm centres, you could use 38mm x 220mm C24 instead of 47mm x 220mm C16, a lighter weight option.



And also, we have to understand that these grades for example, if you want to use this size of a joist of 38x97. And you can go up to the maximum span of 1.76 if you use this, but if you use the C 24, you may go for 2.05 span. So, which means by just changing the grade of the timber, you can actually assign your different spans even largest spans also.

So, for example, you have 47x220. But you can see that you can go up to 4.02 meters, but if you use the C 24, you can go up to 4.4, also the changing of this center to center like you have the center to center either 400 or 600 mm, that also matters a lot.

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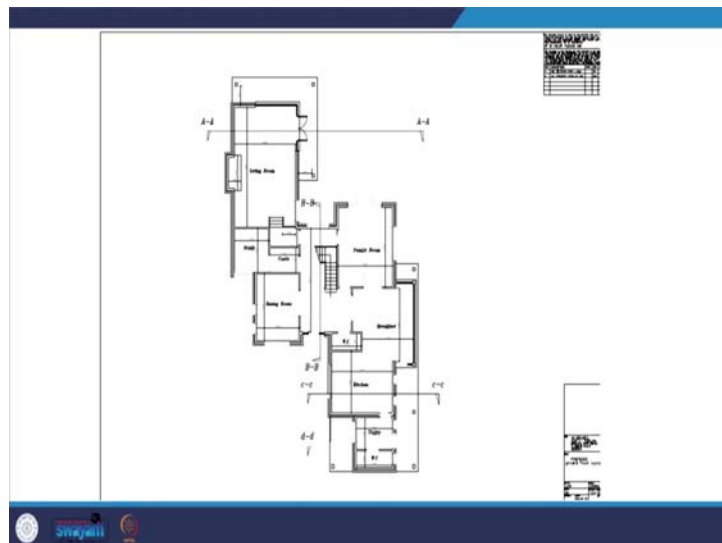
So, if you look at the traditional the way the timber frame is constructed in the modern building setups, like you can have these timber studs and there is a 2 sections of the wall. One is the inner section, which is the timber studs the outer section is made with a normal brick wall. But whereas the inner sections, it will have the infill material, whether we will also use the celotex, 70 mm celotex.

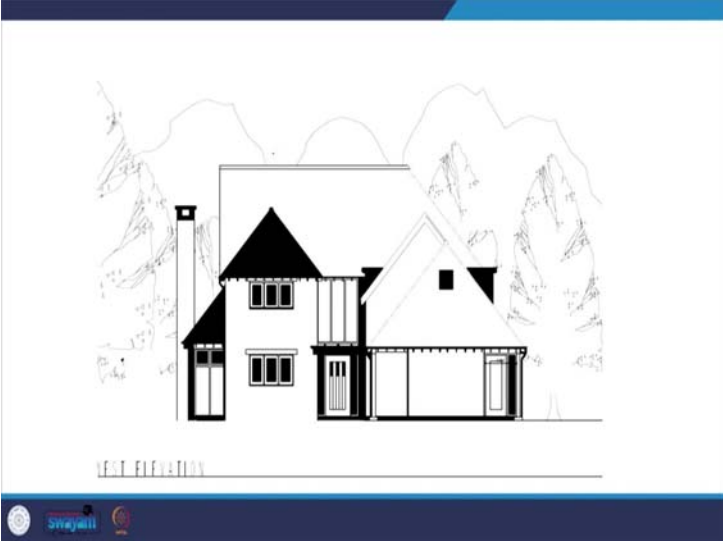
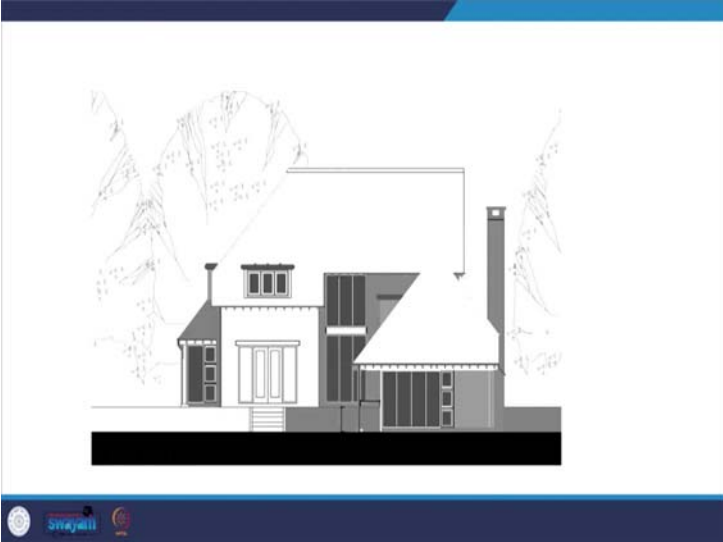
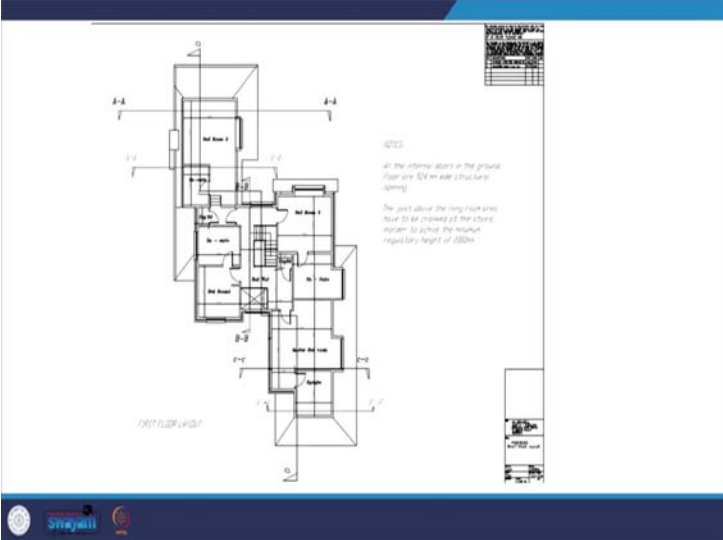
And you will also use a 9 mm OSB oriented strand board and we will also use a breathable membrane of Tyvek membrane and the internal side will have this lining material it could be a plaster board. So this is how the makeup of this is done. In case if you do not want the bricks if you want to have the timber cladding, then you can have these battens like the way I explained you in the previous lectures.

And you can have this timber clades or any other noggin material or any other material you can actually work with but the basic fundamental skeleton goes with these timber studs and these which are formulated as panels in the prefab constructions what we actually do is we prepare the panels we pre-engineer the whole building.

So, once we know that this is the layout of this building, we pre-engineer it and we actually make the panels we assembled all the insulations and everything and we basically erect them send it to the site and we erect at them in the site. So then there is no more constructions in the site so it just only the erection part, rather than any preparation of it, the whole preparation can be designed in the factory. And in considering the insulations or any other things, we can also do that as a whole house also.

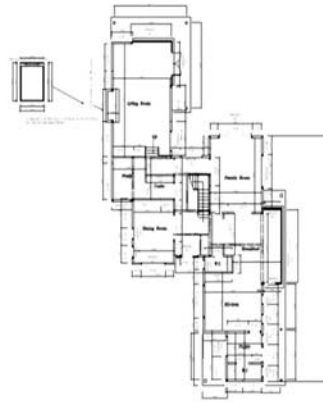
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WEST ELEVATION



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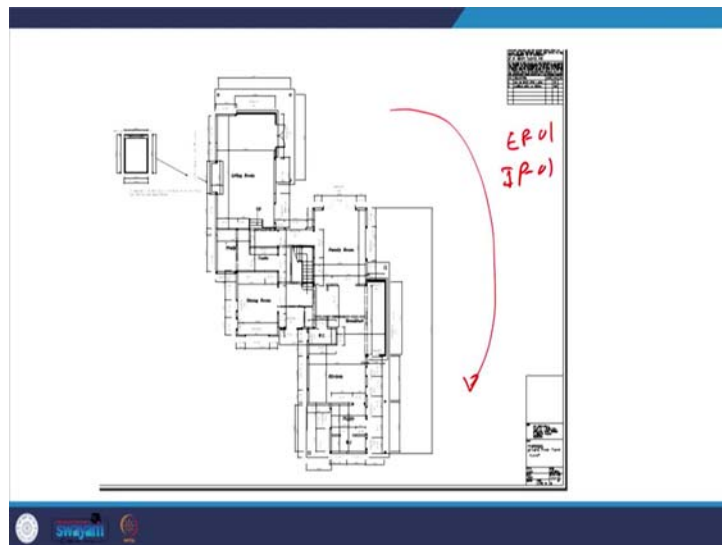
WEST ELEVATION

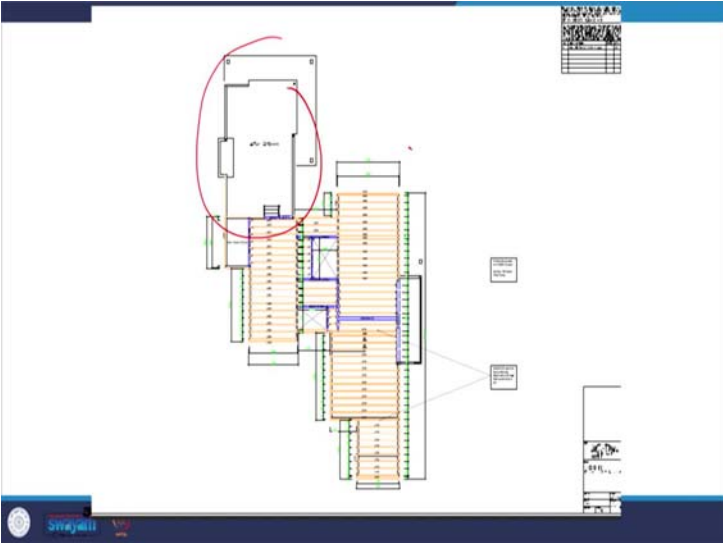
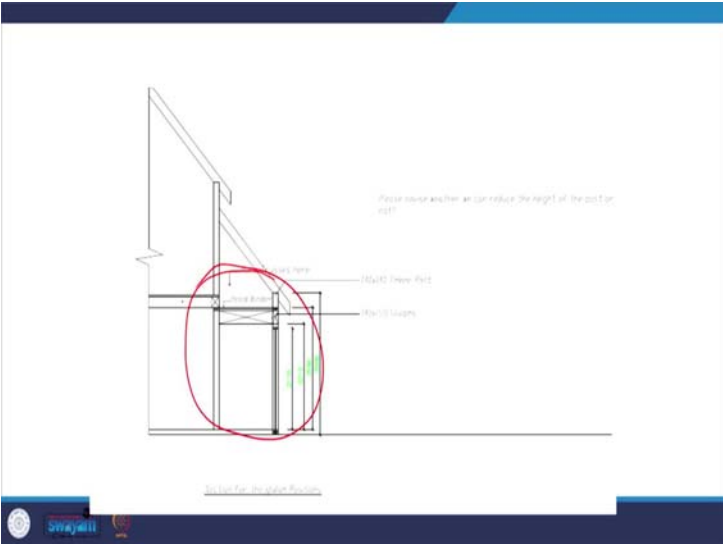
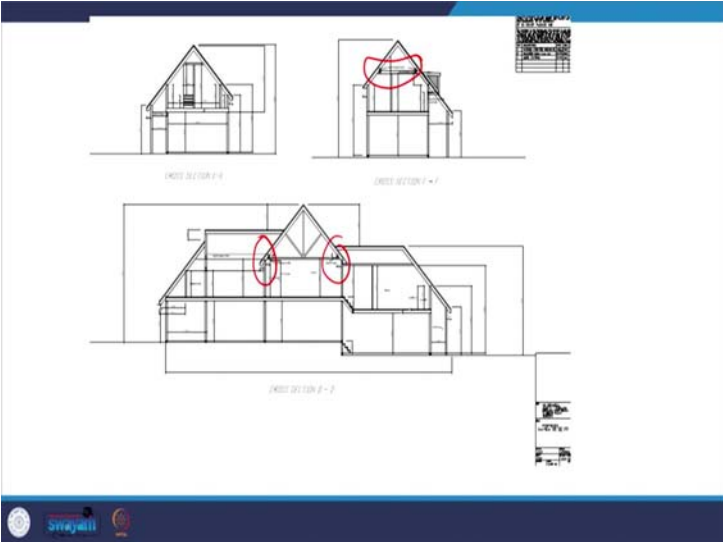
So this is one of the house which I was working on and where we can see that. So we have these different types of roofs. And how what we do is like you can see these elevations and different types of the roofs, how the merger with different levels is a little complex when we are actually making the roofs in different heights and different directions.

So what we do is we normally first when we get these plans, we basically start at one point taking as a reference, and then we start dividing that into panels EP 1, EP 2, EP 3, EP 4 like that, and we make sure that not any panel is more than 2400 mm so because that is the size which we get the 9mm OSB sheet or we get the panels so that it is easy to carry.

And there is also an another aspect, when we are making these panel designs, we need to actually consider the bridges which it has so that whether our truck can pass through this load of that particular height or not. So that is why we mostly do not cross the 2400 mm wide panels and also the height.

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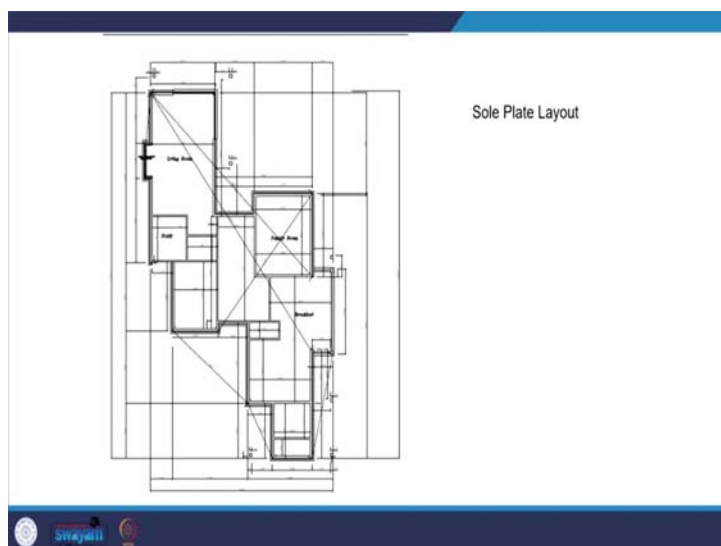




So in that way we divide that and we go in a cyclic process. So we start with EP 1, which EP means external panel, IP means internal panel and IP also we take a reference. So in that way, we develop all these panels and we draft all these sections for example, we know the structural engineer have referred us to keep these beams here. So obviously integrating those beams, that is how my design on the panel is also made in the factory accordingly.

So here we have this glue lamps and how the joist has to be done like you can I will also make the joist and here I can do this attic trusses. So the completely the roof and the floor are integrated together in an attic truss. So now I can actually send to the site, the joist sizes cut exactly to the required size. And I will just send them as one bunch. And it is just nailed onto the top of the wall plates.

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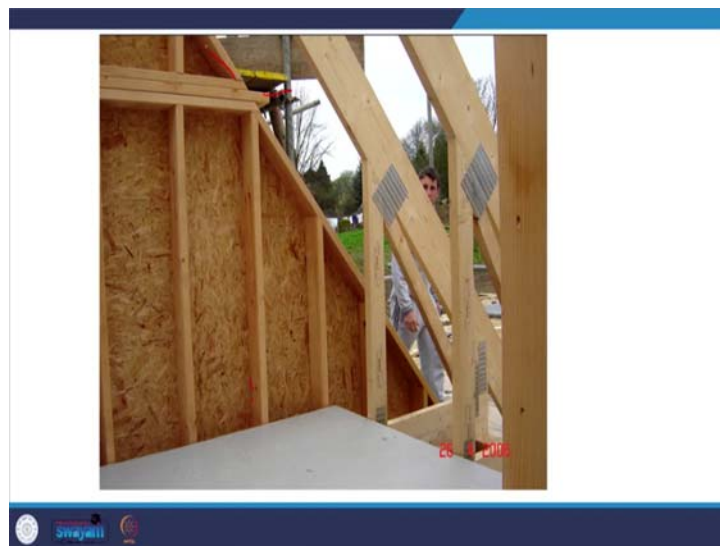
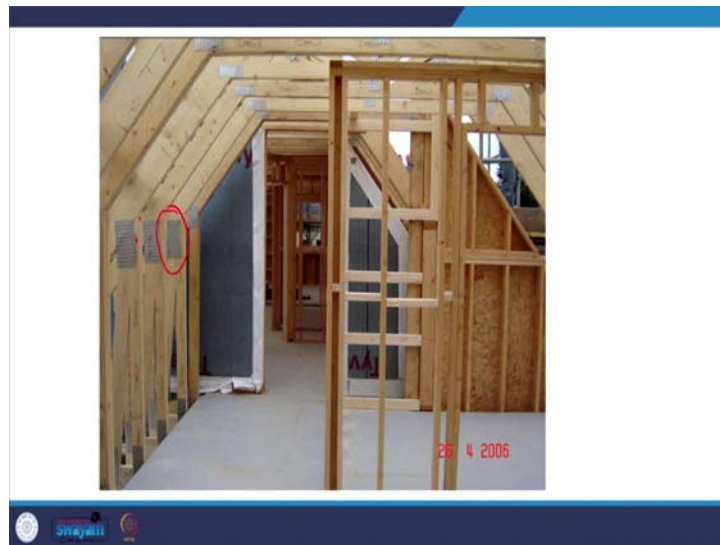


So, this is some of the site work which I would like to show. So, you have this beam and block foundations and which actually creates a level and over the top we have 3 layers of sole plate and this is the sole plate network and which we also check the diagonal conditions whether they are exactly formed in the rectangle or the required square format or not.

And this is one of the restoration project where we are using the stone as an outside facade because that is located in the historic context. So, in that way, the modern technology interfacing with the regular stone construction has been adopted. So, this is an attic trusses, but if you see here, these trusses, because of its height, we have sent these trusses in 2 different segments.

So, there is a height restriction. So, obviously, the later piece has been sent later. So, in that way, you can see these are the nail plates, which are actually tying up these different sections and what you are actually seeing is oriented strand board and the Tyvek membrane is this.

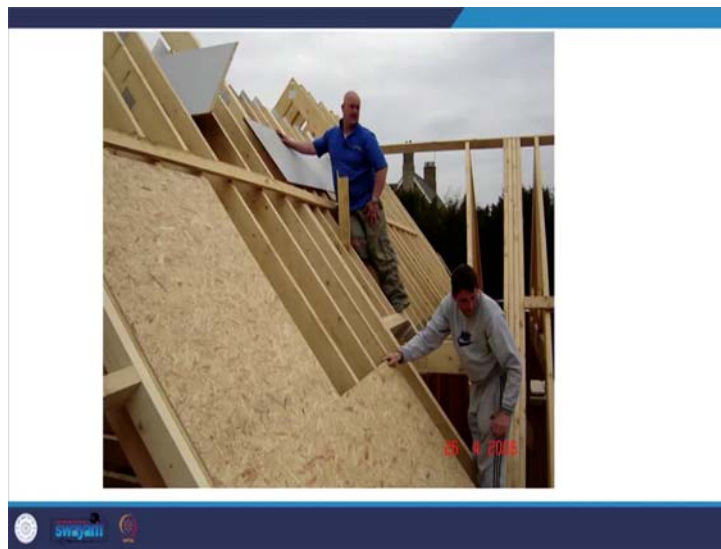
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So, this is the interiors of it, where you can actually see these nail plates are fixed as per the structural recommendation and these are the panels, but this is called the head binder and this is the top portion of the attic trusses and this is the 9 mm OSB sheet and you can see the window what we do is here we can actually see the lintel is fixed.

But according to the Building Regulations, I need to have these external facade window at this size. So I have to fill the packer material into it. So in that way and after that once we erect all these things, we fill these installations and then we cover with the plaster board from inside.

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So, similarly, we have to also follow certain you know the process how we actually put these plastered OSB boards on the top of the roof and how one roof direction and another roof direction how they are merging at this point, so, in that way, we this these are all the temporary braces, which will be removed later for the temporary support they have able to put that and they also have to follow certain safety measures how they climb up. And there is called Bird's Mouth where the truss is cut and it is actually placed on the top of the wall plate. So that is called referred as bird's mouth.

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And similarly we have these 22 mm deck as a flooring material. And so, I mean that is a brief about a prefab construction techniques and again, there are many this prefab timber frame buildings are used in the disaster affected areas because that is something which we can repetitively do fast and we can actually erect in maybe 20 days of time. So, especially in the Kashmir earthquake also they have adopted these techniques in the Pakistan region also.

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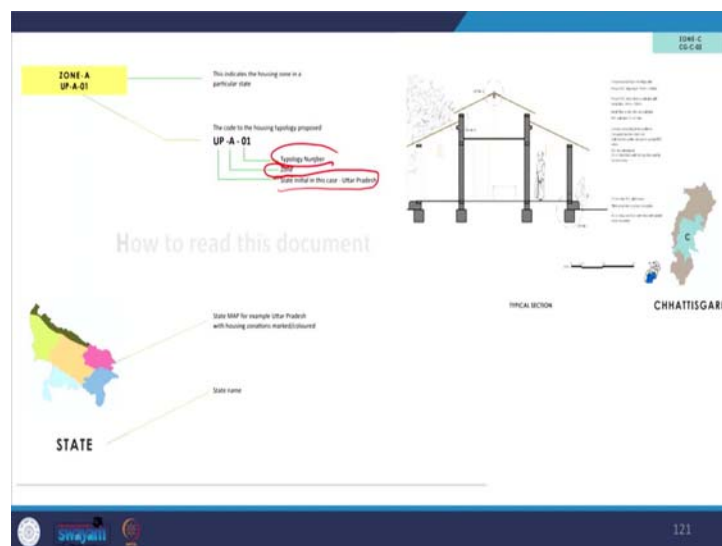


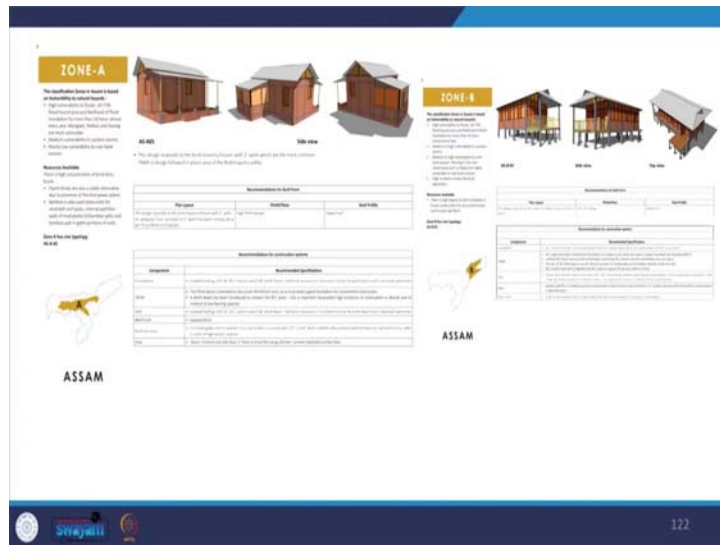
So, now, what are the challenges because our design becomes a challenge for this ensuring the sustainability because can we reduce waste by design, because if you do a mistake in our design process, it will produce waste in the factory, it will produce much more waste in the construction site and to get it back and to send it back it will cost you the transportation cost.

So we need to plan with time and the money as well. And especially the demand with the builders and the owners look for it.

So, the prefab is one of the other solution which has been advanced with the timber frame technologies. And the main challenge will be especially in cold countries, the weather is a most crucial challenge how do we really deliver on time. So, this is the brief about the timber frame technologies and we did discussed about advancements in stone, we did discussed about advancements on the brick back panels, there are some low cost technologies.

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But the same CBRI also have come up with a document called Pahal which is a compendium of the Rural Housing typologies. So, this is I am giving the link of it, so, one can actually go through it. So, this is for your information. So, how what they did was they have documented about 13 states and each state they have identified different zones and for example, you have the state name and you have the state map with different housing zonations.

For example, one in Assam particular state will have a part of the region with Hills part of the region with Valley or part of the region with the plane lands. So maybe they are associated with these with different zones. And they have numbered it like this. So, they have this UP-A-01 which is the state initial, which is Utter Pradesh and you have the zone A and the typology number. So, within the zone there may be 2 – 3 typologies.

So, like that, this is how they prepared a document to read for a common man to understand. Similarly for Chattisgarh you can see zone C and this is a typology number 2, so, the different there are rammed technologies, there are wooden technologies, there are brick technologies like for example, you have in the zone A in the it is basically classified in the terms of vulnerability of the natural hazards.

And you can see there is a particular typology, what is a typical plan of it, what is the typical section of it, what is the materials of it, and what is the composition of it, what are the BOQ's of it, the bill of quantities and the specifications, then how much it actually cost to make that building.

So, in that way, it gives a kind of very systematic understanding of the typical traditional dwellings and of these different regions in a particular state, it becomes a kind of

compendium of all these variety of housing typologies, the traditional technologies and the components they use and how much it cost, so for any user, it is very friendly. So all these advancements has been taken place and still going on.

So it is very important that from the studies of vernacular architecture, we understand the materiality of it and how they really negotiate in the contemporary and the future context. And at the same time, we also discussed about the legality of it, how we can provide certain legal frameworks associated with it, how we can actually provide certain guidance for these masons and contractors, and how we can also develop certain self-build options.

So there is all variety of understanding or variety of efforts have been put by various organizations and development of incorporating and integrating the local technologies and adapting to the newer demands and newer available materials. So is always in the process. So I hope this helps you with some understanding on the vernacular resources and materials. Thank you.