Course Name: Building Materials as a Cornerstone to Sustainability

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Lecture 02

Laterite Quarry Waste

Dear students, so today we will be looking at the last segment of traditional or vernacular building materials and today we will look at use of laterite and laterite quarry waste. Now, laterite is a kind of a rock which is formed by the intensive weathering process that happens specifically in the tropical regions. So, it is a rock which is more, what shall I say, it is more prevalent in the tropical regions. The weathering process favors the formation of different oxides like iron or aluminum or manganese, titanium. So, with the seasonal fluctuation in the water table of the area, these oxides result in a reddish brown color of the lateral soil. The term laterite is derived from the Latin word later meaning looks like brick.

So the laterite surfaces may extend to hundreds of kilometers and laterite mainly forms in the basaltic hills and plateaus of the tropical regions. Francis Hamilton who was a medical officer of East India Company and he found this rare weathered material which is indurated with clay, red color and has cavity and pores and it has a good amount of iron content. And he found this primarily in the Malapuram district of Kerala. First, to be very specific in Angadipuram.

So, he has described the laterite as a material that is initially soft and can be cut easily into blocks of the required size by an iron blade or iron instrument and it hardens when got exposure to air and he is the one who coined the term laterite. Because he found this laterite in Kerala, he found that the laterite was soft. But not all laterite is soft. If you look at some of the laterite which is found in Tamil Nadu, especially the Chettinad area, they have used a lot of laterite in their building. In fact, almost all their buildings, especially temple tanks, they are lined with laterite blocks and that laterite is actually very hard and if you see so which means the laterite is not restricted necessarily to Kerala, but some parts of Tamil Nadu also has laterite, especially the one down south has lot of laterite.

So, this belt has some laterite. So, you can see how laterite is formed, it is the almost each one of the layers has certain transitions happening in it until finally we are able to

get the laterite gap. So, after almost 5 layers the laterite block is got and the soil as well as the block is reddish in colour and quite porous as well the block is quite porous. If you look at the composition, now laterite is naturally occurring and it is reddish clayey material. It forms the topsoil as we had seen in the previous slide and it is also subsoil in tropical regions.

Now this has been used widely as a building material, especially in vernacular architecture. It has taken various forms such as adobe bricks and the soil has been used in traditional rammed walls, and some integrated techniques like wattle and daub houses all of which we have seen in the previous few classes. So, laterites from different locations they behave differently because of variations in their sources and therefore, laterite which is found in Kerala will not be similar to that found in Tamil Nadu and vice versa. It varies even within a particular state because it is very region specific.

If you see overall the composition of a typical laterite, it has between 30 to 60 percent of iron ore in it and it has 20 to 40 percent of aluminum oxides, 5 to 20 percent of silica, hydroxides they constitute 5 to 15 percent and clay minerals they form 5 to 15 percent. there are certain trace elements. Now, if you actually see the range of these oxides is very vast and that is why laterite comes in different compositions, but the overall family is called as the laterite family. So, depending on the composition of these various oxides, the quality of the lactride and its color would also vary. You have very extremely reddish brown color lactride as well as dull colored also is available.

Now, it has certain benefits, laterite blocks have certain benefits. It is a good thermal insulator and it can easily adapt and adjust to different weather conditions. If you look at laterite as a block, then laterite stone has very good thermal mass. And it has properties for keeping the indoor because of its thermal mass, it keeps the indoors very cool when the outside is very hot. So, it is an ideal material for hot and dry regions in for arid climates because the vice versa also happens.

When the outside is very cold, the inside is very warm and both of it happens because of its high thermal mass. So, laterite blocks have high thermal mass because of which it keeps the indoors comfortable in all extreme weather conditions. That said the laterite soil is coarse or rough and it allows water and air to pass through it. That is it has good porous properties and it does not swell with water or anything like that. So, that is also a very important property that it is porous and breathable.

And therefore, one should be very careful when they decide on the kind of mortar to be used. If there is a possibility of water seeping in through the laterite soil, then it is best to have mortar or binders which are breathable, which are porous, which will allow the

block to breathe. Only then the block will also dry itself automatically. If that is not done, then suppose there is a wall like this, external wall and there is water seepage happening like this.

Now, if you put a layer of cement or something like this to block the water, what will happen? The moisture will get retained here. You might as well facilitate this water to be absorbed and it will also dry automatically. Now, laterite is a very locally available material. When it is looked at as a locally available material, laterite can be very cost effective because if it is sourced locally. Otherwise, it can get very expensive because laterite is a heavy material.

Especially, if you are looking at laterite slabs, then the slabs are extremely heavy, not only transportation cost, but the embodied energy of the block. by virtue of transportation energy can rise very high. Now, it is also found that the blend of laterite and quarry dust mix can be used to replace river sand and the maximum compressive strength of say 1.67 newtons per meter square was observed in a 30 is to 70 mix ratio of dust is to laterite. So, when you use 70 percent laterite soil plus 30 percent quarry dust.

It is found that this can be a replacement for river sand and that makes it a very significant material considering the fact that river sand is in scarcity. Now, also the demand for natural sand by virtue of this replacement- the demand for natural river sand can be reduced and this can help preserve the natural resources and reduce the environmental impact of sand mining. As you know sand mining is a very rampant procedure which happens and it can lead to a lot of environmental degradation. Now, let us look at the applications of laterite soil as well as blocks. Now, laterite blocks can be cut into any sizes that you want.

So, we can have any size variations of the block is available and laterite large chunks of laterite stone can be fine cut to custom size blocks and laterite soil can also be used. Laterite soil is primarily used in two areas. One is as a replacement for sand with a combination of quarry dust and it is also used for plastering. So, when you use it for plastering the building itself gets a reddish hue.

We will just see an application of use of laterite soil. So, in the madhouse project as it is called, laterite was experimented with transitioning from simple renders to a Tyrolean technique. So, instead of using it only as a render or as a plaster, a specific technique was used with laterite. Before I proceed on to it, you can see the color variation that is got by virtue of using laterite in various proportions. So, after certain trials an optimal mixture was identified for making the render or the plaster.

It was found that one fourth part of cement with one part of sharp sand and three parts of laterites. So, this combination of one fourth cement plus is to one part sand is to three parts laterite soil. This gave a combination which was able to balance between the structural integrity and the aesthetic tone. The color was also excellent not too dull but at the same time it was able to hold on to a vertical surface. And then the laterite exploration it extended to the Abijo Mosque, encountering challenges during the rainy season. So, what they did was the introduction of polyvinyl acetate strengthened the finish against adverse weather conditions. Beyond how the building looks, beyond aesthetics, the use of laterite in Abijo Mosque significantly impacted the thermal performance of the building also. it resulted in cooler indoor environment and it reduced the energy consumption. Now, building on these successes, Latterite found its application in many projects and it served the purposes which ranged from keeping the indoors cool, or I would say indoors comfortable because the indoors would be cool during warm season and warm during cool season.

That was one. The second one was aesthetics and reduced energy consumption reduced depletion in natural resources, reduced embodied energy and embodied carbon, reduced operational carbon because of load dependence on the electricity from the grid because using latrite itself made the indoors comfortable. So, this PVA apart from aesthetics when you add this the strength of the finish also becomes better. It improved this laterite finish, improved the thermal performance of the building and it resulted in all the subsequent things which I have listed here. So, based on this success, laterite found application in many projects and it served its purposes ranging from insulation to the development of laterite paint and it enhanced the surface receptive to Tyrolean finishes. So, now finally what we saw was laterite could potentially be a versatile and locally relevant construction material and it made noteworthy contributions to both aesthetics as well as functionality.

This is the Abijo Mosque. And the aesthetics of the mask is based on the notion that the materiality had to be sustainable, locally sourced, so that frequent intervention by virtue of maintenance of the building was reduced considerably. So, to be bringing a material from far away was not considered relevant and therefore, for this building laterite seemed to be a good option because it was locally available and in order to strengthen laterite as a finished material the Tyrolean method was followed. So, a textured skin consisting of laterite, sand and cement mixture was used to coat the external face of the envelope of the mask. And this is how it happened. You can see how the plastering has happened resulting in a reddish color mask.

The mask per se was a rectangular structure. But then the finish was made of red colour lateric plaster. Now the objective was to avoid the usage of air conditioning in order to cool the building. The mosque is located in a very hot place. So, it was very important to

ensure that the indoors remain cool by virtue of its architecture because use of air conditioning was to be avoided.

So, earthy colors were the theme and that was also the priority so that it blends with the nature and the surrounding. So, for the doors to maintain the same hue as the external walls, mild steel door panels were acid etched to give a earth color rusty finish because the agenda of the building itself was to have a very rusty and earthy finish. Now, the same burnt finish was applied to all the mild steel used in the building such as sliding door frames and fence rails, etc., which merged very well with the finish that had come from the laterite, which was again reddish in color. So, today we have seen the use of laterite soil for plaster finishes and also as a replacement for sand when it is mixed with quarry dust.

We have also seen how laterite blocks can be used or rather can be used as a recycled material because its recyclability is very high when one again cuts and finishes it. So, with this we come to the end of our discussion or our classes on vernacular and traditional building materials. Now, if you look at what vernacular and traditional building materials do, for example, we have seen mud, bamboo, laterite soil, reed. So, we have seen all these materials. One thing is certain, all these materials were got from locally available sources. Second is all these materials have been handled with traditional wisdom and therefore, it is very important for us to document and learn the traditional wisdom with which these materials were used in buildings.

All these materials are very very low carbon materials - which means these materials will not accelerate or cause any damage to the greenhouse gas and also these materials will propel our agenda to go carbon neutral. Because by 2070, we have given a word that we would go carbon neutral. We will be a zero carbon emitting country. So, if we have to do any of that, it becomes very important for us to choose building materials that are locally available, building materials that are net carbon zero or carbon neutral building materials for that to happen. We need to combine the traditional wisdom along with modern technology because the need for the building or the typology of the building that we need is different from the context when these were the most prevalent building materials.

And therefore, we need to combine the local wisdom and technology to arrive at products, building material products which will be low carbon. For that to happen, you need to first understand the versatility, the application and usage of the building material. I think we have done wonders with mud, we have done wonders with bamboo. Bamboo structures are not only independently bamboo structures but bamboo integrated with other building materials. or integrated in building components, we have done wonders in

that area also.

So, in order to go carbon neutral, let us not forget to understand that these materials can be as versatile as we would want them to be. by a proper amalgamation of the traditional wisdom and the modern technologies because this had to be locally sourced. There is no point in using these materials but spending high on transportation because your embodied carbon by virtue of the transportation component will increase. So, we have completed our unit on traditional and vernacular building materials. In the next class, we will move on to alternative building materials.

So, thank you and we will move on to the next segment in the next class. Thank you.