Building Materials and Composites

Prof. Sumana Gupta

Department of Architecture and Regional Planning

Indian Institute of Technology-Kharagpur

Lecture - 07

Wood: Procurement details, Properties, Classification

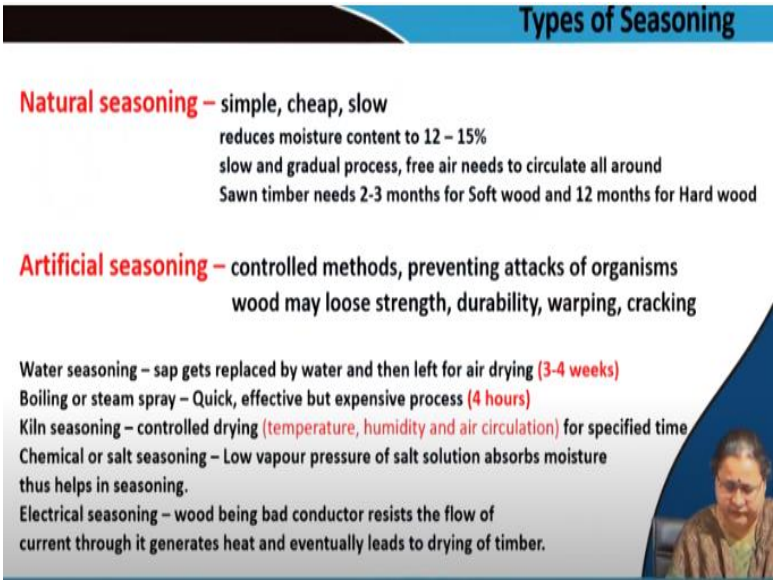
In the previous lecture, we had started module 2, which is on wood, engineered wood and bamboo. So in the first lecture we had started with wood and we had gone for the classification and how do we get wood, what are the stages of getting it from the tree and finally to how we use it for our purpose. Here we will go into further details and this time we will study procurement details, properties of wood and the classification. We will study different types of commercially classified timbers and not just the types of trees.

We will try to cover types of seasoning as we know that seasoning is required because wood is a natural material and it get weathered; it has to be kept exposed to the weather. So we will look into the different types of seasoning. Then after getting seasoned wood, we need to know how to convert it to usable form. We will look into different ways of preservation as wood is an organic material mostly comprising of cellulose which is attacked by termites, white ants and various other organic growths. Then we will go into the properties of wood and the commercial classification of wood and then move to lecture 3.

Let us see the types of seasoning. Seasoning is a long process in which the natural material is kept exposed for a considerable period of time. This we had also seen in our first module when we covered stone. So here it actually reduces the moisture content because the tree trunk is full of sap and it contains a majority of water. So it needs to be brought down to around 12 to 15% and make it to usable form. It is a slow gradual process because it is naturally happening. Free air needs to circulate all around. So the entire assembly of logs has to be kept apart from the soil- say around one feet above and the logs are arranged in perpendicular direction.

So every layer in perpendicular direction is kept apart at a distance so that free air can circulate and it is allowed to stay in natural weather. So for sap wood or soft wood you will see it takes two to three months of time, but for hard wood it takes 12 months of time. So this is a simple way, cheap way, but a slow way. In this process, the outer part may get more seasoned, whereas the inner part may be full of sap or the moisture content so one has to be very careful when they are handling. When the wood is worked on, that is when any kind of sawing is done it would be understood if it is rich in moisture content. So seasoning is necessary and it can be found out whether it is rightly done or not.

Next we come to artificial seasoning. This is a controlled method and there are a series of methods, which you can see on the slide. It prevents attacks of organisms. In the natural process when it is lying for 10 to 12 months, then some kind of organic growth may happen which you cannot solve because there may be rainy season in between. In this particular artificial seasoning it is a controlled environment and are not allowing the organism to grow. It is much quicker, less time intensive and wood may lose strength in that case. When it was happening naturally, the fibres were releasing the water in a very gradual way. The fibres were not getting affected but here as the water is drawn out artificially or the moisture is drawn out artificially, it may affect the durability, it may lead to cracking and it may lead to warping. Again the word warping comes. If you remember during brick lecture we used the word warping. That means deformation. So the wood may warp or get deformed. That can happen when it is artificial seasoning. Under this you see there are water seasoning, boiling or steam spray, kiln seasoning, chemical or salt seasoning and electrical seasoning.



You can see in the brackets the time periods are also given where water seasoning takes three to four weeks. Here the wood logs are allowed to stay in water and gradually the sap containing the minerals come out and is replaced by natural water. So the sap which has maximum organic items gets diffused to normal stagnant water where the log is kept. And then again you have to take it out and leave it to dry whereas the boiling or steam spray is a very quick and effective way where you need to allow the logs in boiling water and the boiling water moves through the grains or the fibers and the sap is replaced by the water.

This is again an expensive process because the sizes of logs of trees are few feet long-even one to two feet wide and then you are allowing it to boil in boiling water. So the volume of water required to boil etc, is more and you need lot of energy in it. Maybe you will get the work done in four to five hours. Next is the kiln seasoning.

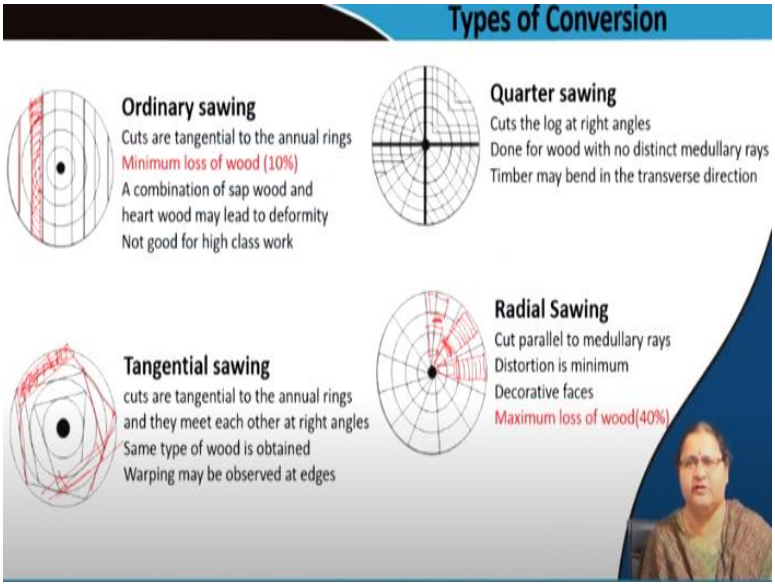
Here actually you can control the temperature, you can control the humidity and you can control the air circulation. So in the kiln these logs are arranged, organized and then it is control drying. Everything can be controlled and there is no external water. What you saw in

the other two processes, water seasoning and boiling seasoning, boiling or steam spray, there you are actually allowing water to replace the sap.

But in kiln seasoning the water is being extracted out. This has to be done for specified time. So depending on the type of wood, whether it is hard wood or sap wood, whether it is soft wood or hard wood, you have to control. Next, it is chemical or salt seasoning where low vapour pressure salt solution absorbs water or the moisture from the tree trunks logs. This helps in the process of seasoning as low vapour pressure replaces moisture and allows moisture to come out. The last is electrical seasoning. Wood being a bad conductor resists the flow of current. Sap wood contains more of moisture and hard wood is dense. When there is charge flowing through it, they want to resist the current to flow which generates heat inside. This heat actually helps in the drying process and there you get the dry or seasoned timber. You may note that many a times I am telling wood, many a times I am telling timber. So timber and wood you can use simultaneously.

They have the same meaning particularly to this particular course, particularly to our trade. So what do you understand by natural seasoning and artificial seasoning. Natural seasoning is a slow process, cheap process and simple process. Artificial seasoning needs intervention through water, through chemicals, through heat, through electricity and lesser amount of time gets involved. You get it faster, but yes at the cost of strength and durability of the wood.

We come to the next item. Once the seasoning is done, you need to convert timber or wood. Now what is conversion? You cannot handle such big logs. Those are not allowed to be used directly because those sizes and dimensions do not match with furniture or door window sections, support sections. So you need to convert it to sizes appropriate to your use. You have to take out the ready wood from this so that it is marketable. This point of conversion was discussed when we discussed the points. Now you see the first picture which is ordinary sawing, which is a schematic section where you see the cuts are directly made tangential to the annual rings. So what is happening?



You are getting timber with varying wood quality from inside to outside and if there is any defect inside, all are coming in that section. But what is the beauty of it? It leads to minimum loss of wood. So you will get wood as a mixture of heart wood and sap wood and thus, it will have different moisture content. When the moisture content is different, it may have unequal expansion and contraction and against the annual rings if you are having any pressure applied here, eg: if you are nailing at this point, it may split. So you have to remember that you are achieving almost hundred percent wood, by just taking off the barks etc., it will lead to the central pith or the dry dead part and will lead to some eventually 10% loss, but it is not good for high quality wood work.

You can get a good amount of wood. So let us look into the next process that is the tangential sawing. Here you are following the tangent but you are trying to get a little more of similar quality wood. You are cutting almost at 90 degree and getting usable slices. So you can use this similar kind of wood from one cross-section between two tangents.

You can get this kind of wood. They will be very much similar and you will have only one or two annual rings passing through it. Yes, that may have some warpage. It may move and expansion may be differential but you will get better than what you are getting through ordinary sawing. So this again is a mechanized process.

The upper one is also a mechanized process because it is not humanly possible but a skill is required. Here it was allowing the blade to pass through and through. Here you have to pass it after understanding where the annual rings are passing through. So you will get more or less same type of wood. Majority of the portion will be same type of wood. Say if this is one this is one section, you will get majority of similar kind of wood and you can use it for better cause but remember in both the cases you are not getting rid of any defect which may be inside the timber or the wood. Let us see what happens next. In quarter sawing, you are dividing the entire log into four parts and then you are cutting at right angles to right angles and getting the pieces. This can be done for wood which has no distinct medullary rays that is mostly for soft wood. That is pine, where no distinct medullary rays and timber may bend in transverse direction. Longitudinal means when you are cutting it is the longitudinal direction, the way it is cut. Transverse direction is it may bend on the bed side; it may bend because you are having mix of different levels of wood.

Next is radial sawing. This is considered to be the giving you the best kind of wood. Now why? Because you are moving radially and you are getting pieces which you can actually take it out in this way. So you can get more or less similar quality wood. You can take out another piece from here like this. You may avoid some defect which may happen. You can take a big piece and then convert it into your usable pieces. You can avoid, say some defect is here, you can take this portion and again take this portion separately. What is happening eventually, you may lead to losses, but you will get good quality timber separated out. So here you will get similar kind of wood like what you get in ordinary sawing where you are using up the entire of it, but here you are making it as per your wish by sorting it, finding the defects and using that particular portion. Yes, you can do that with ordinary sawing also and

here you get minimum distortion. You can create; get decorative faces, because you get the grains passing through it, which can be seen properly.

This has the maximum loss and you can avoid the medullary rays. So the cuts are actually radial and you can follow the medullary rays to avoid the cracks or those lines which are due to the formation of those medullary rays, where the things are weak. Now let us move to the preservation of the timber. Why preservation? As wood is a natural material, we have to avoid growths. Its capability of drawing moisture or with dampness it may lead to growths and also to make more resistant to fire as you know wood is flammable. So what are the different types of preservatives? Chemical salts can preserve. By putting a layer of protective chemical salts, you can preserve timber.

If you use large, long sections, you can paint it with coal tar. When it is embedded below the ground, you cannot access that portion and that portion continuously faces groundwater and also the microbes within the soil. That can be prevented by the impervious layer of tar. Creosote oil- that is by oil treatment you can preserve timber, mainly to avoid attacks of termite. You can also impregnate or push in or inject in some oils to give preservation from inside because timber can have growths externally. Being natural, it may have entrapped organisms inside which may lead to attacks from inside. To prevent that you can actually use, apply pressure and inject certain oils. You can also apply paints to preserve it from termite attacks and moisture decays.

How are the applications made? Obviously painting is one. So you can paint with help of a brush. You can spray as an arsenic, copper and arsenic, copper and potassium dichromate mixture which is called AsCu which is hydrated that is mixed with water and is sprayed on top of the wood surface. So this also prevents the growth of termites and protects it from white ants and microbes and helps in preservation of timber.

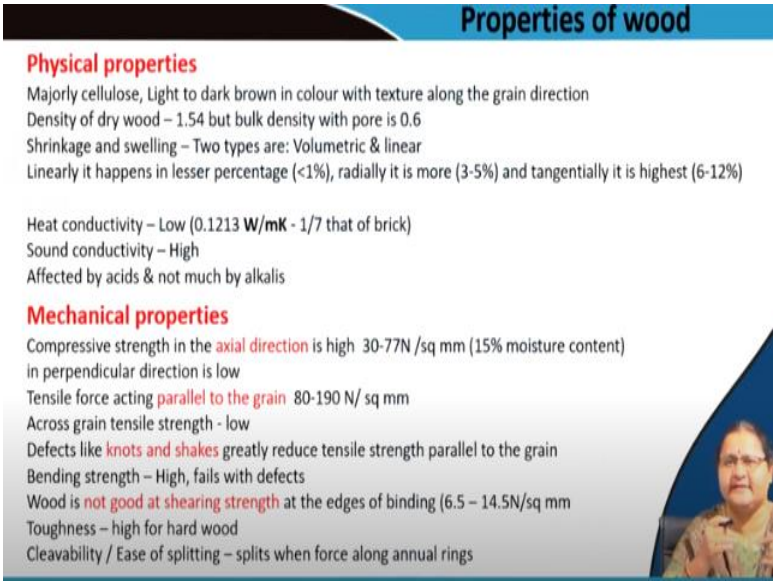
Spraying is another way. Dipping in solution or in a way applying on top of it is another way where you can dip the entire timber pieces that is the converted timber into solutions. So this is a better way, why because during through brushing or through spraying some portions may not be covered. There may be some loose, some non-covered areas, which you do not experience when you are dipping entirely in the solution and injecting what I told you like pressure difference applying through vacuum process, you can inject the oils into the timber so that to avoid any internal defects, internal rots. After converting wood into usable form, you can use it for your purpose. It may be a structural purpose, it may be making furniture, it may be making a table-top or it may be for making a partition wall. When you are putting you have to know what the properties are. You can use it for making a truss, wooden truss.

As you have been told wood acts in compression as well as tension, you can understand. After the physical properties come the mechanical properties. Under the physical properties you all know that wood is dark brown or light brown in colour we have seen some pictures of it earlier. It is mainly made of cellulose and it is the texture along the grain direction, which gives it a unique look and this texture actually makes it more appealing. If you preserve it by

coating it, hiding the texture, you may lose its value. Density of wood is around 0.6, it always floats in water and it is actually the bulk density with pores it .Shrinkage and swelling: Yes, it shrinks and swells by absorbing moisture or giving out moisture and it may be in the volumetric direction or it may be in the linear direction.

When it is in the linear direction, it is much lesser in percentage but tangentially it is the highest. So by volume it increases maximum. Timber is very less heat conductive and very good resistant to heat and has a very low conductivity value of 0.1213, which is almost one-seventh or one-eighth of a brick but it conducts sound.

It is affected by acids but not much by alkalis. These are chemical properties. Now we come to the mechanical property because we use wood as a structural member also. As I told you earlier, truss is one such. In wooden furniture, you actually putt compressive load or you subject it to tension. When it is parallel to the grain that is along the xylems, the phloems and the xylems it takes maximum tension of 80 to 190 Newton per centimeter square. In compression in the axial direction it is 30 to 77 Newton per square millimeter. In the bracket it is written with 15% moisture content so we always consider this moisture content as 15% given.



Defects of timber: Moisture reduces the strength particularly on the tension member. We have to be very careful when we are using wood as a tension member in truss, in form of beams, some member spans to ends. You have to remember minimum defect is the better. Wood is not good at shearing strength at the edges, the values are given.

When you are using wood for flooring, nowhere when you are using as wood panels on walls they are subjected to loads, toughness is important. Wood splits as I already told in the ways of conversion, if you are hitting a nail on annual rings, those positions, cleavability takes place. Ease of splitting is more at those points. It should be looked into that we are putting the

nail in the right portion, which is the carpenter's job. When we will discuss joinery in the next lecture we will look into it again.

Now we come to the simple commercial classification of timber where we see based on produce in our country, given by the forest department, we say X grade timber which is most commonly available. Produce is more than 1415 cubic meter. These are not very recent figures. It may have changed. But yes it is based on some figure based on the produce. Y grades are common, which is of the mid order produce and Z grade is less common, not much yield. Based on durability you see highly durable timber that means it is measured through time, 120 months that is 10 years. Modern moderate durable, you see 5 years to 10 years, 60 to 120 months and low durable is less than 60 months. So it will rot or decay within 5 years.

Another classification is based on the modulus of modulus of elasticity. That is Group A that is the best quality, Group B and Group C. You see, these are the modulus of elasticity in bending that is the maximum it can take is 12.5 Newton per square millimeter. That is for A group and for C group it is within 5 to 10 Newton per square millimeter. So these are the commercial classifications.

Now we can actually summarize telling seasoning makes wood more durable and workable. Proper conversion methods are to be adopted to get quality timber. One can understand on seeing the cross-section, how the conversion had been done. Based on this conversion the price tag is also given. Once usable wood is obtained, it needs preservation by practiced methods, which we have already elaborated and appropriate use to be made considering the properties and its availability. Availability means the growth or how much it is available. Availability affects the cost and the conversion method also affects the cost.

By seeing the cross section you can understand or an experienced eye can understand what kind of conversion has been done and based on the availability in the market, the price is fixed. Here I again mention, wood is purchased in cubic meters or cubic feet. We get the price according to one cubic feet of wood and then we need to convert it to our necessary items that require the specialty or the workmanship, which we call carpentry.

Next lecture will be mostly on wood joineries which we require after giving a brief on the defects which one may come across while obtaining timber and how we can rectify it.