

Building Materials and Composites

Prof. Sumana Gupta

Department of Architecture and Regional Planning

Indian Institute of Technology-Kharagpur

Lecture - 06

Introduction to Wood

This module is about another naturally occurring material, wood. You all know what wood is. We get it from trees and other along with it we see engineered wood and bamboo. So from wood, a lot of wood like materials or similar kind of materials are made as a by-product from wood industry.

We also see bamboo, which had use in our system as a structural material which are also being used as a building material nowadays. Wood, what is the beauty of it? It is naturally occurring and got from trees. It is a thermal insulator and is light weight compared to other building materials like maybe brick or maybe stone which we have already covered. But what is the drawback in it? It is an organic product. How is it made? How do we get wood? What are the classifications of the different types of wood and how do we process to get it appropriate for the building industries are to be discussed in this particular lecture.

So if we look into what is wood, it is a hard fibrous organic item formed from mature trees after being processed. So there are lots of carriers of water, bundles going from the root, transporting water and minerals to the leaves. As you all know these are called xylems. Xylems and phloems actually form the conducting system of a live tree. And these are fibrous; these are fibres moving together and they as a whole form a bundle, which also has strength. It gives strength to the tree, tree can move, sway and it can face lateral forces and stay still again when it is in the form of wood processed, it behaves in the same way.

So wood can take both compressions when it is subjected to load from the top as well as if you hold it, if you allow spanning it, resting it between two walls support walls, you can allow any kind of movement on top of it. The bundles inside it which are continuous help in taking the tensile load. So wood can be used as a spanning material and can be also used as a compressive material. So it can be used as a structural framework for making partition walls of which, the infill may be made of plywood, which is again another processed wood. Different varieties of wood can be seen because it is a naturally occurring material. They grow in different ways and they have different characteristics and hence its use differs.




In the above picture you see some big logs. You cannot carry huge logs so they have been cut into a certain size and transported later on as you can see in this picture. Here are some logs where you can see a human figure, where from you can understand the size of each. So the base of a tree, the main major trunk is the usable part of which you can make the most.

Yes the heavy branches they also can be converted to our usable wood. So these are called logs which are taken from the site to prepare usable wood which would be helpful for building industry. You can see two more pictures here, where you can see some knots, some grains, some patterns or lines. These are showing the grain, how the xylems and phloem's are moving, how they were interrupted due to wind and it has eventually given such kind of knots. Yes, they may be good, they may be bad, but they give a beautiful texture to the wood surface and seeing these lines and knots, you can go for some identification criteria also. Also as you notice in the second picture the colour of these log sections are very uniform but if you see the cross-section in the first picture, it is little different. You can faintly see some separate lines, which you can distinguish some layers.

TYPES OF TREES


Exogenous Trees – grows outward

- Conifers –** soft wood like pine, cedar
- Deciduous –** hard wood or engineering purpose wood like teak, mango, sal, rosewood



Endogenous trees - grow inwards

fibrous mass is seen in their longitudinal sections like **bamboo, cane, palm**



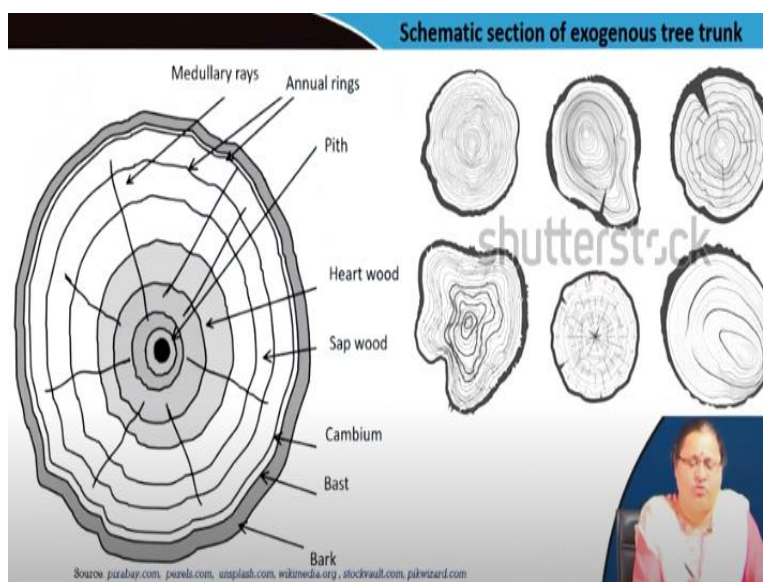
Source: pixabay.com, pexels.com, utoplab.com, wikimedia.org, stockvault.com, pikwizard.com

Maybe it will be much clearer in the next discussion because there are different types of trees. You see, highlighted in red, exogenous trees and endogenous trees. Under exogenous trees there are conifers and the deciduous. The picture in the top is a deciduous tree whereas the picture below is the coniferous tree. The conifers are long but not much in the dimension diameter whereas the deciduous tree has a larger trunk size and are shorter in length. And if you see the coniferous, earlier shown in the picture, are pale in colour and actually softwood,

pine cedar, fir, birch. Whereas deciduous cross sections if you see they are not so light in colour, they are a little more brown and they are used mostly for engineering purpose. So are the conifers of no use? No, they can be used for furniture's and interior items. Endogenous trees grow inward. Fibrous mass is seen in their longitudinal section. If you cut a bamboo slit, you can see fibres in the longer face of bamboo whereas the exogenous grows outward. Deciduous tree grows much larger than the conifers. So you can get a long layer of wood in the deciduous variety. Exogenous tree grows year after year showing the different shades in it. Those are called the annual rings. It is not much clearly seen in case of the coniferous trees. Endogenous trees have annual rings in the vertical direction. So you can see at a particular time interval they have segments grown together.

You see that bamboo tree is shown in the picture above and you can see that see that the segments growing at a certain period of time. So let us try to see the section of an exogenous tree trunk. This is a schematic section where you see the lines which are called the medullary rays and concentric lines moving outward which are the annual rings. You can see there are different colour shades, gradually moving from deeper colour to lighter colour. The deeper colour portion is called the heart wood- the core whereas the lighter colour portion is called the sap wood and the entire thing is protected by the cambium layer, then the bast and then the bark or the covering, the top coating. You see a dark portion at the centre, which is the dead cell, forms the pith. So these are the nomenclatures.

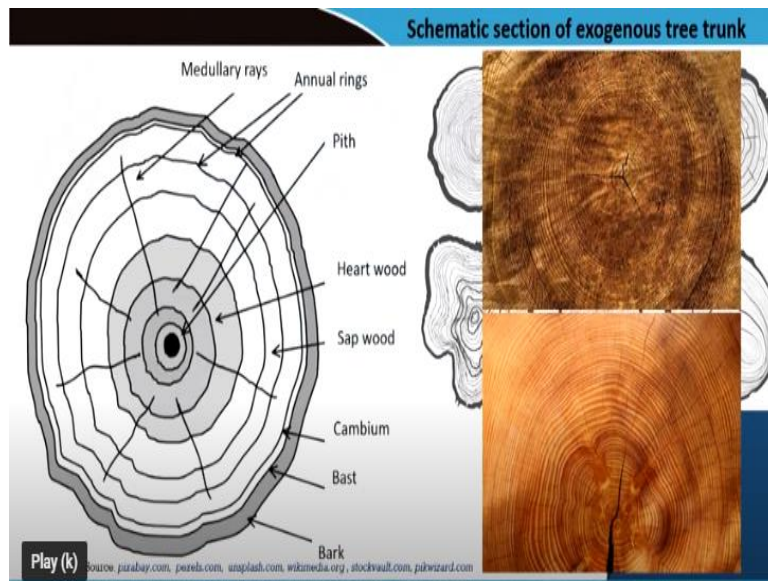
This is a schematic diagram showing very the basic of the exogenous tree and from here actually we get the wood after conversion. You cannot use this entire log for your purpose. It is not the entire tree trunk which you can use because you have to transport it. So you have to remember to make it to sizes which can be carried by the transport vehicle and hence, you have to reduce it into desired dimension.



Not all sections are uniform; they may be different in shapes. So when you are converting this to usable timber, you have to look into how the annual rings are arranged and also with this section where you see everything perfect, there may be a lot of defects or unusable parts

inside it which has happened due to natural weathering, natural conditions because of different growth.

And this is what you see naturally. So here one is having a lighter colour, one is having a little deeper colour, the central part is darker and the outer part is lighter. So which one should we use for our work? It is the heart wood, which we usually use. Sap wood is still in a life state, which we usually try to avoid using particularly when it is for some structural purposes.



Let us see the difference between soft wood and hard wood which we are get from the coniferous trees and the deciduous trees. As we understood the annual ring, in case of coniferous trees, the soft wood it is distinct, whereas in case of hard wood it is not so distinct. Colour of soft wood or the coniferous trees is light that of hard wood is little dark. Density which is a reflection of weight, the soft woods are lighter in weight, whereas the hard woods are higher in weight or weightier. Fire resistance: soft woods are poor whereas hard woods give a better resistance. The medullary rays are not so distinctly seen in case of conifers, whereas they are distinct in case of hard wood. Sources I have mentioned. Strength: strong for direct pull and weak for resisting thrust or shear in the case of soft woods whereas hard woods are very good for both tension, compression, shear and any kind of engineering loads. Structure wise soft wood is bit resinous and can split away. So it may split along its annual ring whereas hard wood does not. That is why annual rings are distinct in case of soft wood, whereas in case of hard wood they are not so distinct. So they are very similar kind. They have gone through years and it has transformed whereas annual ring in case of soft wood are distinct, and they split easily.

Now as we were talking of the heart wood and the sap wood, the sap wood is the outer part where the wood formed is from the live xylem which is light in colour and as you had seen, they are forming the outer part. The inner part forms the heart wood. So this portion is the

heart wood whereas this portion is the sap wood. So age wise sap wood is young whereas heart wood is old and because it is old, it accumulates lots of tannins, oils, which makes it resistant to decay. It makes it resistant towards attacks of termites, insects, and goats. They are strong and durable. So which one should we prefer? The old matured portion which is called the hard wood. Sap wood is also good but they are subject to decay.

Sap wood – Outer part of wood formed from live xylem light in colour
live part and subject to decay, light in weight

Heart wood – Dark in colour with lots of accumulation of **tannins**
which make it resistant to decay, strong and durable
Through this zone the xylem bundles pass and dry gradually



Now when we get some wood, what should we do? We see a number of trees and anyone is suitable for our purpose? No, you have to cut those trees which are rightly matured. So age of the tree is very important and this process is called felling of tree. If you have a plant plantation where from you will take wood, then you know the right age, you know the variety of plant and you know the climatic condition. So based on that you make it convenient to cut when it is a dry season, when the sap movement is not happening and the age is just appropriate to get the wood out of it. After you get such trees, you need to season it as we had done for stone. Seasoning is the process of keeping it exposed to the natural conditions such that it can get acquainted to that particular condition.

Reducing the moisture content of the sap from the tree which was a live one to the average humidity of that particular region is the primary purpose of seasoning. What will this lead to? This will lead to less of shrinkage or expansion due to changing humidity or changing weather condition and this will lead to less of warping. Warping term I have already discussed when we were studying bricks. So change of dimension leading to convex or concave surfaces will not occur. The log which is straight would not warp or bent unevenly or it may not have uneven expansion. It remains straight and rigid to its form. Seasoning also increases the strength, durability and workability. What does workability mean? Workability means cutting of log. You can work on it if it does not have more of sap in it. It also reduces splitting off.

Splitting against the annual ring is a very common phenomenon if it is not properly seasoned. Attack by decaying items that is the termites, insects, microbes, bacterial growth, algae,

fungi, moss growing on it, gets lessened and you can make it suitable for putting or applying paint. Through seasoning you also control or reduce the weight of the mass.

After the process of seasoning, we need to convert it to timber. So the wood, which we had obtained after felling of tree and after seasoning, we convert it to usable form and suitable sections for use. Suitable section is not as per I desire or you desire. It is to be found out which portion is really usable. After identifying you have to use machines because such huge logs cannot be worked by one or two persons or human labour.

So you have to use machines to split it into two halves or into four halves or tangentially. There are various methods of conversion, which we will try to cover in our next lesson. After converting, we need to know how to preserve the timber because preservation of timber increases its life. It makes it durable. Some preservation techniques may be external, painting is also a preservation technique. Sometimes preservation may be required to be done from inside also. So the preservation process protects this natural resource from attacks of fungi, insect, microbes, termites, etc. Yes, the term preservation refers to when it is put to use. So once it is put to use, we need to preserve that timber and increase the life of the member so that we do not end up destroying it by external agencies like fungi, insect etc. So we may conclude stating that wood is a naturally occurring product obtained from tree trunks. It can take both tension as well as compression because it is made of the xylems, the continuous fibrous carriers of water and minerals of a live tree. These bundles of fibres act together and help in taking both compression and tension.

It has to be procured and processed to make it usable as a building material. It is similar to stone. You have to procure it, process it and then cut it into its proper sizes so that it can be used as a building material and you have to be very careful that being an organic product, being a naturally occurring product, it is liable to decay due to attack of insects and termites, which is very common and needs treatment. We use naturally occurring material as a building material with caution that it needs to be treated, it needs to be seasoned, it needs to be procured properly from the right mature tree and we can actually use it for our building purposes. At the same time, I would also say here that we have alternative materials made from the wood industry, which also replace wood, which we already talked about: engineered wood.

Again, we are bringing in bamboo for some sustainable structures, built forms and that is also being practiced. We will try to highlight those also in other lectures of this particular module.