

Building Materials and Composites

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Lecture No. #09

Engineered Wood

Welcome everyone for the lecture 4 of Module 2, which is on engineered wood. As I had closed my previous lecture telling that wood is a very important building material, which has been used since so many years, but people have not stopped researching on how to use the wood in further better way and even use the wastes or the remnants which are coming out from the wood industry.

First we will have a discussion on what is engineered wood and the different types of engineered wood, making of it, using it, advantages and its disadvantages. So what engineered wood is, it is made by human beings and it is not only wood, but it is a wood composite. It is made with help of adhesives and we use up the waste, which is generated after getting usable timber. As you had gone through the process of conversion you learnt that a lot of wood goes waste. At the same time, wood has to be joined to make it a total big surface. So wood is very good when it is in cross sections and you are using for support.

When you need to cover long spaces, to make flooring there you understand that you have to go for joinery, and then only you can use it. If we can convert wood, we can use it in a much better way as a spreading element. So let us see the first one which we will discuss is plywood, which is not a by-product but a converted wood. Others what you see is laminated board, block board and batten board which are made from the remnants of the wood industry.

Man made composite with adhesives and wood or wood products

Plywood
Laminated board / Glulam
Block board
Batten board



Plywood

Particle board
Low Density Fiber board
Medium Density Fiber board
High Density Fiber board
Oriented strand board



Fiber board

Source: pixabay.com, pexels.com, wikimedia.org, stockvault.co



On the other hand, you see, we have another set which are the boards. We see particle board which also is called as low density fiber board of which again we have oriented strand board which also is a kind of particle board. We have medium density fiber board and we have high density fiber board. So you can see the pictures maybe you have seen these applications in furniture. So let us come to what is plywood. We talk of plywood every now and then and let us see what it is made of. So you all have used a pencil and a sharpener. So let us see if a big log of wood can be pushed in and rotated against a blade. What you do in case of a sharpener. You can get thin sheets of wood or the lamina. So you can split the wood into a lamina. What advantage happens here?

You are taking it out and the grains are all in the in this direction in this direction. Now if you take another lamina of the same wood and place it in the cross direction, then one layer of fiber moves in this direction the other layer moves in the opposite direction. So then it strengthens, Just think of the clothe you are wearing, the fabric. It is a mesh. So here you cannot do that. So you are placing one layer on top of the other with the grain direction perpendicular to each other. So two adjacent sides are placed, such that the grains are in the perpendicular direction and that gives strength. You are not weaving it, but you are joining it. So you are using adhesives in between. So the quality of adhesive is also very important.

When you keep on doing this you will go to more thicknesses as you can see in this picture. So you can see the different layers, one joined after the other and if you can see, when there are only three layers, as you can see in the picture, you can differentiate this is the first layer, in between there is a sandwiched layer and then is the next layer. So it is all made and combined with adhesive and when you see these three such layers, you call it a ply.



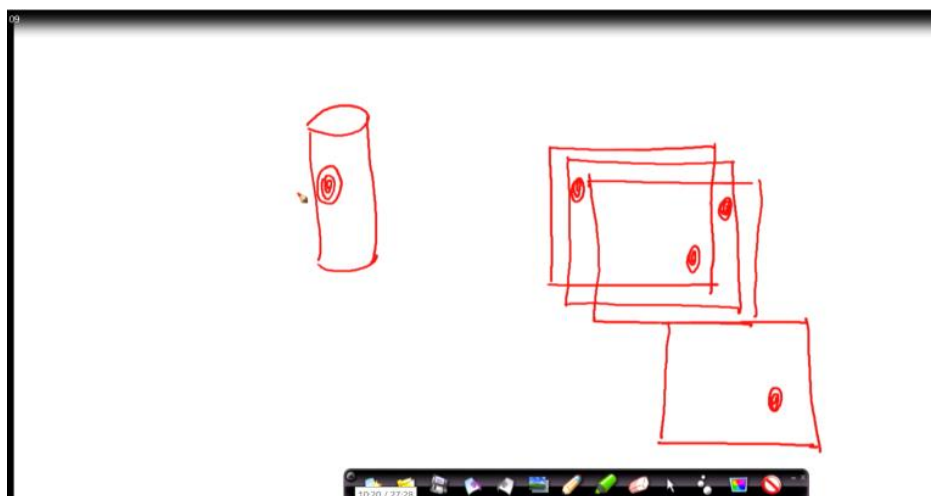
So only one layer like this, we call it a veneer. And when three such combines, we call it a ply. How thick you can go. 13 plies are the maximum and that will achieve you a thickness of one inch or 25 millimetres almost. So you can get ply boards of different dimension and what is happening here. Here you are getting more strength. It would not bend in this direction; neither would it bend in this direction. So it is much stronger than wood. You can apply any

kind of load on it. Let us come to the salient points. How do we prepare it? We have the log as you saw the pencil, there is a blade through which the wood has to be rotated, as the wood was dry, we could do this with a pencil because it is soft. In this case, we have to again wet the log by putting passing steam through it and make it pliable.

So the blade when it rotates, it should be little soft it should have little more of moisture. So you are again putting it putting moisture into it and then you are rotating in a veneer cutter. So the entire log is put in a veneer cutter. So now you understand you can get long sheets that gives a dimension almost up to 8 feet. That was not achieved with wood unless and until you could join them. So if you have the width of the blade known and you can around 8 feet long. So it is usually coming in sheet form of 8 feet by 4 feet. Now when the thing comes out, you need to trim it. The edges are to be trimmed then they are to be placed for drying. Sun drying is possible if there is abundance of land, otherwise you can go for controlled drying and it is desired that the moisture should go down to 4 to 10%.

Next you are to glue each of the veneer with application of adhesive in between. So once you are gluing one over the other, this crisscross of the fibers or the grains happen which gives it more strength. What more happens there? Say there was a rotten part in the wood log. So this would log is being converted. So say there was a rotten part in the wood log. So this will come somewhere here. The next sheet when you are overlaying on top of it that rotten portion will shift somewhere here. So when you are placing this on top of that your weaker portion comes here. So when this happens, the weak part gets spreaded in layers.

So that is again another advantage of using plywood. So you are spreading the knots on different sides. So maybe the next layer which comes you can just orientate it little different, this knot which was supposed to come here if in the same orientation could go here. So you are spreading the defect within the surfaces and that reduces its weakness. So at single point when the timber was not good at this part you have utilized it in this way.

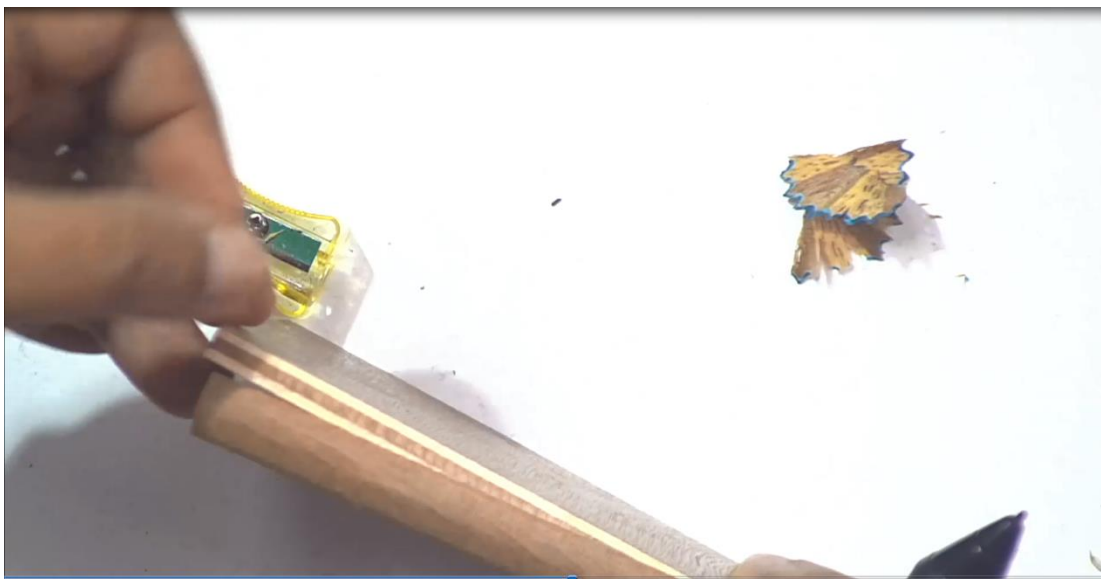


So let us come back. So this while you are orienting during gluing this has to be kept in mind and then after it is done with the specific number of plies you require you can go for redrying after subjecting the entire thing under pressure, you are going for the redrying. That is, it will set, the adhesive will allow the plies to get together and the strength will be gained. And finally it is cutting the board in, chipping out the board uniformly in all directions. So finish should be neat because it should be marketable. So this is how we make plywood and get the advantage of it that you need not go for detailed joinery, rather you can use it in a different way as a covering material. You can use it as a partition wall. You can use it for furniture. You can cover the top surface with a nice finish.

You can have a finish similar to that of good quality wood and no one can understand what is inside it unless it is moistened and the adhesives get loose. So that has to be remembered that adhesive should be proper. It should not absorb moisture. Once it absorbs moisture, these plies these veneers will just come off. So that will lead to the decay of the item. So usually the top covering is made of a better sheet.

That is called the face veneer. Even by orienting it in different ways, you can create some star patterns, some diagonal pattern and those will all be giving you some aesthetically pleasing look. You can have a teak ply finish. So it is very difficult to understand exactly what is it made of. Furniture, partition boards, office partitions, wall paneling, formwork for casting concrete, seats for chairs, internal doors, all can be made with plywood.

Exterior grade plywood is also made of hardwood veneers and it should have waterproof adhesive. Organic adhesives are not preferred, because wood itself is an organic item and adding organic items to it organic adhesives to it, makes it more vulnerable to termites, attacks of growths. Now how to allow the edges to remain better? You can actually seal this edge, what you see with the help of a lipping.



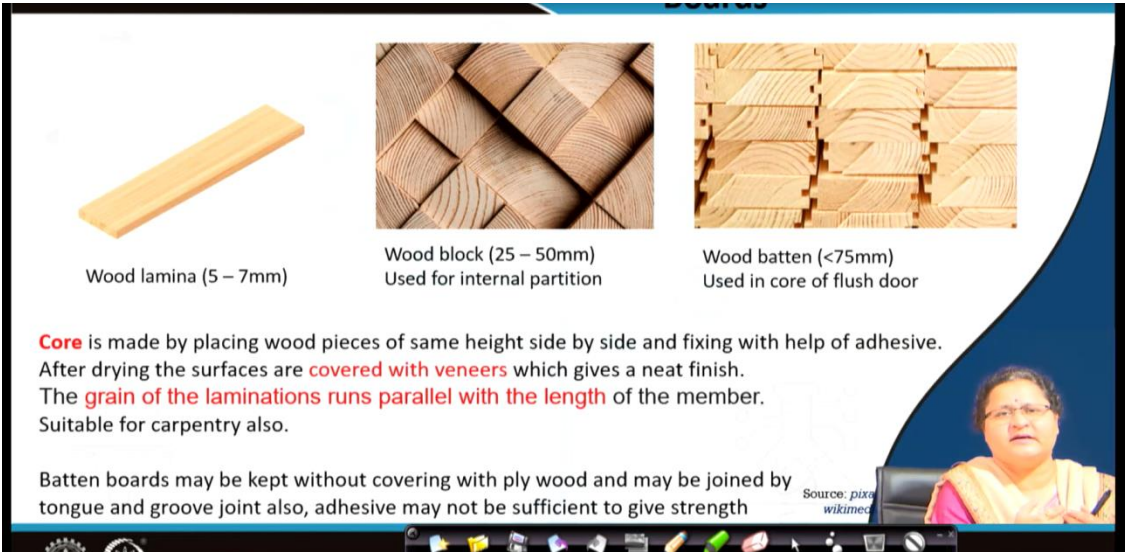
So once you finish this lipping with a good paint or a good varnish or a polish no one can understand what it is. So the edges are protected so that they do not come out. Water cannot it

cannot get affected by water and this is made of pure wood. So this is called a lipping which closes or ends the edges. So you need to add it at the end to give a neat finish and also allow this edge to be protected from moisture. Now let us again come back. We have summed up the merits. Shrinkage and expansion is low due to this cross grain structure which I have explained to you. It is stronger than wood in some cases. It does not split when you are nailing, you have seen the property of cleavability. When you are putting a nail along the annular ring, wood might split, but in case of plywood it would not.

Large sizes of wood panels are obtained, which is very difficult to get through proper joinery, when you are using pure wood. Defects can be spread out as I have shown you. Thicker plywoods can stand as a partition wall without any supporting framing also. So you if you use internal partition walls you can directly go for thicker ply woods and you can allow it.

The greatest enemy is the moisture and low quality adhesive. Good quality adhesive and proper lipping or sealing the edges would give a life of around 10 years of plywood which is comparable with wood. Yes, interior uses are much preferred. You can even go for joinery in case of plywood, which we had discussed while we covered wood.

Now let us move to boards. The first one you see here is the wood lamina. The thin pieces of wood which comes out from the wood industry they are to be shaped in such form of 5 to 7 millimeter. So first you need to sort out what are the by-products from the wood industry. So these are all coming out from the waste generated. So these are wood laminas. See the dimension it is 5 to 7 millimeter thin. Now if you can have same thickness by cutting through machine and keep on adding one after the other you can get a core of thin laminas of wood. So every time it is joined by means of adhesive. So if the height is uniform that is the thickness is uniform and this varies from 5 to 7 millimeter, you get an assembly of laminas, which will similarly work like wood. But what are the good points here?



Wood lamina (5 – 7mm)

Wood block (25 – 50mm)
Used for internal partition

Wood batten (<75mm)
Used in core of flush door

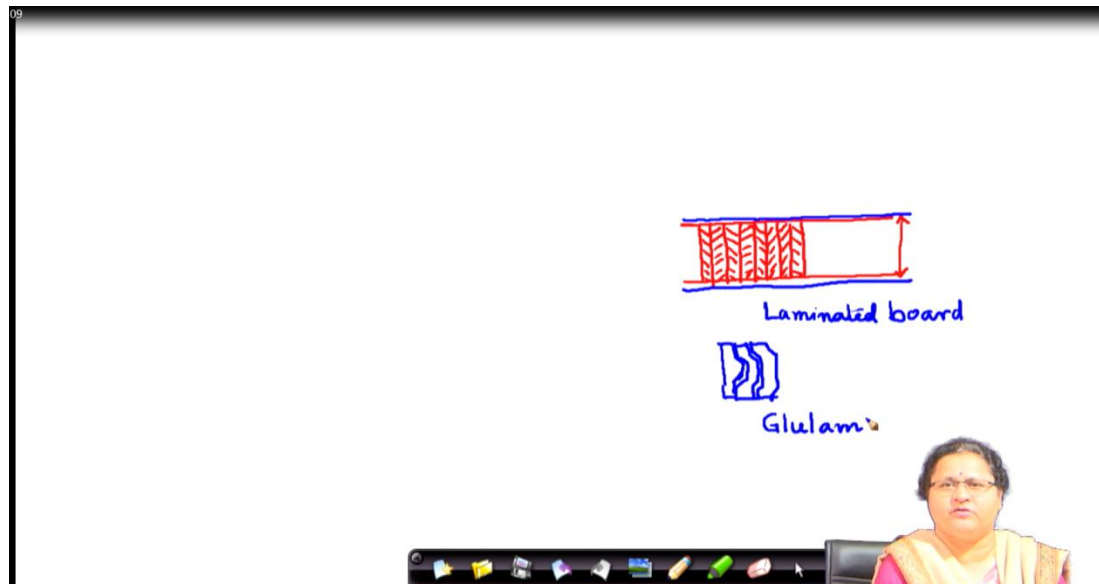
Core is made by placing wood pieces of same height side by side and fixing with help of adhesive.
After drying the surfaces are **covered with veneers** which gives a neat finish.
The **grain of the laminations runs parallel with the length** of the member.
Suitable for carpentry also.

Batten boards may be kept without covering with ply wood and may be joined by tongue and groove joint also, adhesive may not be sufficient to give strength

Source: pixa wikimed

You are using up the waste generated and then you can cover it with the help of a ply on top of it and on the bottom of it. So it becomes one whole. Unless and until you see the cross-

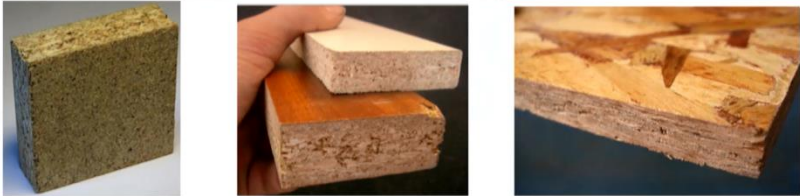
section, you cannot make out what it is. Yes, it can be used for any kind of superior work. Joinery can be done with it and this is laminated board. You can also have very thin laminas added like this one after the other glued together, which will also give a wood like finish that is called glulam. So glued lamina is called glulam. That also behaves similar to that of wood. Now when this lamina size increases, let us go back to the slide, you see wood blocks 25 to 50 millimeter that is one to two inch.



You can assemble them one after the other and you can create cores. You can cover it with ply on both sides and you can hide that how it is made. Yes, you can do go for any kind of furniture work. The other one you can see wood battens. Here also as the pieces are big, maybe only adhesive is not good, it cannot hold. So in that case, the joints are created that is tongue and groove joint keeps on adding one after the other. So glulam, laminated board, block board, batten board are the names and you see the grains of the lamination runs parallel to the length. So you have to identify the pieces and orientation first. So sorting out and then you create such boards which are equivalent to wood but you are using up the waste from wood after doing some refinement of it.


Covering it with the veneer or the ply gives it a better look, gives it a uniform look and allows the adhesive to be protected and the entire internal core to be protected from exposure to moisture. These are all suitable for carpentry work also. Let us move to the next one which is the MDF the particle boards which have majorly three classifications the light one, the medium density one and the high density one. How do we attain it? We attain it again by use of adhesive and application of pressure. So denser it is the name is changing. Low density fiberboard, medium density fiberboard, high density fiberboard. What are these?

Particle board



- **Particle board** – made by mixing wood particles with adhesive and they compressing under flat pressure. Also called chip board. Oriented strand board is a particular type of particle board where strands of wood are placed in specific orientations.
- **Weak member, not for structural purposes**
- **Low cost, light in weight**
- **Absorbs moisture, does not hold screw rigidly - loosens**

Source: pixabay.com, pexels.com, wikimedia.org, stockvault.co



Particles which are all leftovers which are after sawing the waste they are made into a pulp by adding adhesive. Then they are subjected to pressure. In case of high density fiberboard you have to also additionally put heat. So what you see in the first one in the pictures, you can see the particles in the cross-section. Here also you can see the particles. That is why here you can understand them because they have not gone compaction properly. The pieces are also bit crude so they were not made finer. So the grains are visible, the particles are visible. This one the third image is oriented strand board. See the orientation of the strands that is the long pieces are oriented in one direction when they are being made and they are then pressed.

So these oriented strand board is a particular type of particle board where wood pieces or straws or pieces are placed. Wood fibers are placed in a particular orientation. So low cost, lightweight, insulation, all these are the key points to be remembered of these particle boards. These are weak, not for structural purposes, but as a filler wall as a thermal insulator.

Because of the addition of adhesive, they have further improved thermal properties means they give you thermal insulation. Sound insulators, you can use it but remember they absorb moisture. You cannot apply screw because they would not hold it. The fibers are not there to hold the screw rigidly. So they will loosen with little bit of push to the member. So usually they are not giving rigid rigidity to the screwed items, nailed items. Let us see the medium density fiberboard and high density fiber board. I have a sample here.

You can see the sample where you can see a little bit of the small fiber grains, but if you see the cross section, you cannot see what you could see in the particle board from any direction. But yes you can understand it is made of something together. So this is not like particle board but much denser. So there is application of pressure in the whole thing to form this kind of board.



You can get big pieces, the edges are dressed. This can become a table top. This can become a chair top. It can take load. It can become a partition wall. All interior purposes you can use it because of its high density, it can hold screw, but screws are specially made for it-remember that. Not the normal screw which we use for wood where the screw actually the fiber actually winds into the screw and gives it the hold.

Here actually you are not doing that. So there special screws for MDF and HDF boards. For the high density fiber board which are also called as masonite you also need to add heat when you are making it. So that makes it more compact and the name just changes from medium density to high density. So it is the same material and these fibers are also cut down into smaller smaller pieces. So minimize the gaps. You can protect the edges by lipping to avoid it from moisture. So moisture is the enemy because these are all wood items. Termites are the

enemy but yes, you can do a lot of coverage with such kind of material. So here are the uses and the disadvantages.

With this we conclude by saying that engineered wood is obtained from natural wood and the defects can be reduced. Large continuous surfaces can be made without use of joinery. So it is more and more being used. It is stable because plywood has grains in both the directions. So they do not bend. There is minimum of warping. There is role of adhesive in the strength of the item. Usually it is almost at par with wood so far as strength is concerned. Joinery can be done for most of the cases. It is preferred to be used for internal uses. Cores when made of laminas, cores made of block boards, batten boards can go for doors. All internal doors can be made and we have to look into water absorption, how to check it by use of lipping.

So that gives an end to this engineered wood lecture. Thank you.