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Wood as an Engineered Product from ages past to the evolution of Engineered Wood Flooring

Dissemination of IT for the Promotion of Materials Science (DoITPoMS)
About DoITPoMS

History

DoITPoMS (Dissemination of IT for the promotion of Materials Science) was set up in 2000, as a joint venture involving the Department of Materials Science and Metallurgy at the University of Cambridge, and five partner institutions: Institutute for Materials Research, University of Leeds; London Metropolitan Polymer Centre, London Metropolitan University; Manchester Materials Science Centre, University of Manchester/UMIST; Department of Mechanical Engineering, Oxford Brookes University; Department of Engineering Materials, University of Sheffield. Close links also exist with the UK Centre for Materials Education and with the MATTER project, both based at the University of Liverpool.

Engineering Natures Natural solution for our Buildings

We hope this technical page helps you to understand the benefits of using engineered wood flooring solutions.

Wood has many advantages as an engineering material. For example, its high toughness is due to the cellulose microfibrils present in a matrix of lignin and hemicellulose. As wood is a fibre composite, its toughness can be analysed in terms of a fibre pull-out mechanism of failure. For a typical commercial wood a fibre pull-out mechanism of failure would predict a value of G_c (toughness) of 1.5 kJ m^{-2}, whereas in fact the measured value is 15 kJ m^{-2}. The extra toughening is due to the helical winding of cellulose microfibrils in the cell wall, offset at 10 to 30° to the trunk axis. Because of this offset, the axial modulus of the wood is decreased but there is a great increase in toughness.

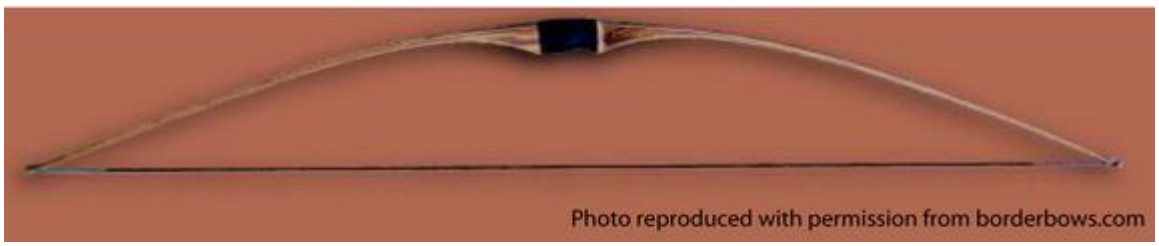
On failure, the middle layer of the cell wall parallel to the fibrils cracks first. This leads to a decrease in the diameter of the layer, causing it to separate from the outer layer of cell wall and fold inwards. An enormous absorption of energy results, leading to wood's high toughness. On bending, splitting also occurs parallel to the grain and ahead of the crack, blunting the crack. High toughness is therefore imparted to the wood as it reduces the force concentration at the tip of the crack. The progression of the crack may be stopped or at least slowed down, increasing the amount of work needed to reach breaking point.
Other advantages of using wood as an engineering material include:

- the low energy content needed for production,
- the low cost of production,
- wood is an environmentally friendly material,
- wood is a renewable material. When trees grown in sustainable forests are cut down, more trees are planted, keeping the trees from extinction and maintaining the levels of oxygen production by living trees.
- wood has a very high specific strength due to its low density and reasonable strength,
- wood's low density also makes it easier to transport,
- there are very low costs associated with the disposal of wood,
- wood is not electrically conductive,
- most woods are non-toxic,
- wood is low in thermal conductivity,
- nails and screws do not measurably weaken wood, if put in with care, showing that wood is very resistant to stress concentrations.

However wood also has disadvantages as an engineering material which generally stop its use as a high-tech material. These include:

- there is large variability in properties between species and, depending on growing conditions and the position of the wood within a trunk, within a species.
- wood is dimensionally unstable, as water changes its dimensions.
- wood's strength decreases when wet.
- time-dependent deformation such as creep and viscoelasticity occur in wood. Creep of wood makes it important that longbows or violins are not left tightly strung. Creep occurs due to movement of the non-crystalline (amorphous) sections of the cellulose microfibrils.
- wood is highly combustible.
- wood is susceptible to termites, woodworm and infestations.
- wood can't be used at high temperatures.
- wood is susceptible to rot and disease.
- wood is highly anisotropic, although this can be limited by the use of plywood. Plywood involves assembling layers of wood with orthogonal grain orientation, decreasing the anisotropy.

Despite these disadvantages wood is the most commonly used building material in the world. It is used to make houses, furniture, cricket bats, longbows and was in the past used for wheel rims and hubs, among much else.



Longbow

In longbows yew wood is commonly used. Yew was used to make bows as long ago as 3500 BC, from which time a bow was found in the Somerset Levels. Such bows could shoot an arrow over a hundred metres. Medieval longbows, such as those used by the English against the French at the Battle of Agincourt in 1415, could shoot effectively as far as 220 m. The longbow was used by the English in battle for roughly 400 years, being treated until 1662 AD as a military weapon. The bow was also a successful hunting weapon. Yew wood is hard, dense and finely grained. A region of the tree bordering both the sapwood and heartwood regions is used to make the bows. The sapwood can withstand the tension produced on drawing the arrow and so acts as a backing to the bow. On the other hand, the heartwood will endure the compression occurring on the inner edge of the bow.

Roof trusses

Wood is also generally used to make trusses on which to build house roofs, still used today in most houses, as other alternatives, such as steel, are too expensive. For this application, the primary consideration is cost, with the wood needing to be cheap as reasonably large quantities are used. It is also useful to choose a wood that will not easily succumb to rot, disease or infestation. The wood must be strong in order to carry the weight of the roof and allow trusses that span greater distances. However, it must also be light for easy transport and manufacture of the roof, and so that no unnecessary weight is placed on the walls of the house. Spruce and pinewoods are often used as they are easy and quick to grow, and hence cheap. They can adapt to a wide variety of growth conditions and are widespread in North America and Europe, making them widely available.