



Bending Wood for Hobbyists

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Bending wood is one of the ancient arts enjoyed by the wood working hobbyist. Furniture pieces, frames, snowshoes are some of the oldest examples of bent wood. This fact sheet presents some of the techniques for wood bending related to properties of different wood species for hobbyist.

Why to Bend Wood

Wood consists of tubular type structures called cells which are connected to each other end to end running through the length of a tree. Each cell has hollow area called lumen and cell wall having three major chemicals, cellulose, lignin, and hemicellulose in addition to some extractive materials such as resin, oils, minerals and wax. Moisture also exists in two forms in wood cell, free water located in the lumen and bound water in the cell wall. If you want to soften wood to bend three main methods can be used to achieve this. Wood can be heated so that water is turned to steam. In the second method steam is produced and forced into wood to make it more flexible. The third one involves with boiling water to make the wood softer so that it can be bent. Size of the sample, its moisture content, and species are three important parameters which influence overall bending quality and to select which technique will bend the wood most effectively. Microwave bending is also used for thinner and smaller pieces. Microwave bending is much faster as compared to a typical steam bending. Wood usually is wrapped with wet fabric or wet towel and placed in microwave for 30 seconds as a typical starting time span. Similar to other conventional methods processing time will depend on species and sample size.

Any visco-elastic materials including wood has properties of both elastic and plastic body. Plastic materials can be permanently damaged under an applied load while elastic material can be stretched but it returns to its original shape as soon as the force is released. Visco-elasticity of wood plays an important role on overall bending quality. One of the advantages of bending of wood is to consume less material so that resource can be used more efficiently. Also when wood is bent its grain orientation is adjusted based on curving axis so that better strength properties are yielded. When wood is bent compression and tension forces are developed along the curvature as shown in Figure 1. Once these forces are balanced without applying too much force wood can be bent successfully without any breakage or splits.

Alkali softening of wood using chemicals such as sodium hydroxide, caustic potash is also another way to bend wood. The wood piece is soaked in a 5 to 20 percent concentration of these chemicals, diluted with water. The main function of the

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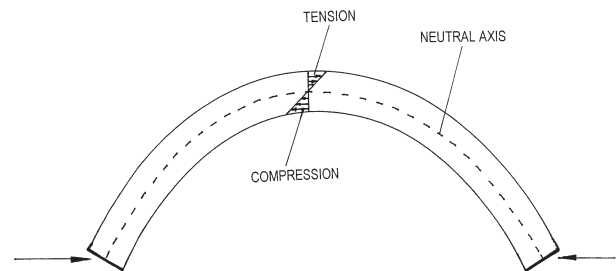


Figure 1. Development of stresses in wood during the bending.

chemical is to causing slacking of the wood cell structure so it can be bent easily. One of the disadvantages of this technique is the color change to the wood due to the chemicals.

Kerf cutting can also be used to bend wood, this can be achieved by simply cutting thin slots in the wood ranging from 30 to 60 percent of its total thickness and bend it with a radius. Removed material from the kerf will give more flexibility to the material which can bent easily.

The most popular and easiest way to bend wood is steam bending, which is generally done in a steam box. A sketch of a typical steam box is illustrated in Figure 2. Steam is introduced into the airtight steam chamber or box having constant flow of steam for a certain period of time to allow for a successful process. Steel boiler with a capacity of 10 to 20 gallons with a propane heat source would be ideal to create sufficient heat British Thermal Unit (BTU- it is defined as amount of heat required to raise the temperature of one pound of water by 1 F at a constant pressure of one atmosphere). Overall steaming process and time varies based on species, for example softwood species are not ideal for the steaming bend process. However, hardwoods can be bent with very few problems using this method. Ash, elm, white oak, and beech are some of the hardwood species that can be steamed and bent easily. Steam bending can be quite a time consuming process. Typical steaming time is around 1 hour for every 1-inch thickness air dry which is 12 percent moisture content wood and 1.5 to 2.0 hours for green wood with a moisture content well above fiber saturation point (fsp is 28 to 30 percent.) Of course there is a great variation among species regarding steaming time. If wood has not been steamed long enough to plasticize it

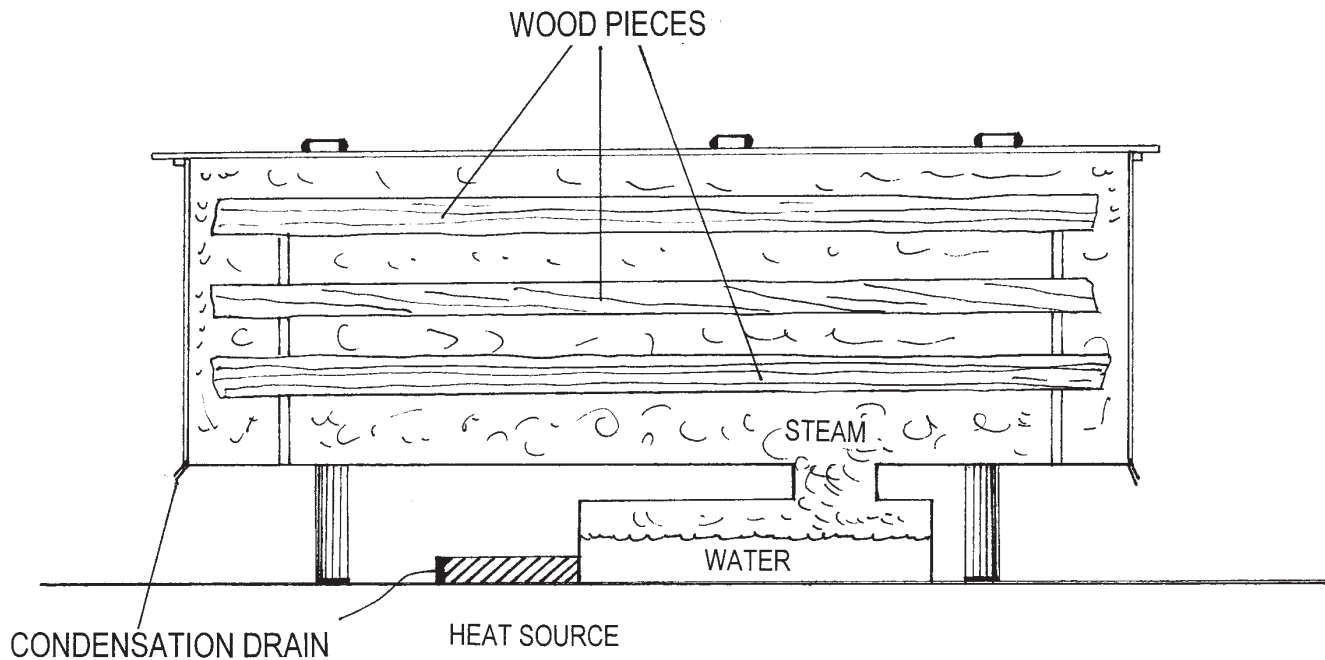


Figure 2. Steam box to bend wood.

may break during bending along the grain orientation. When wood is steamed and ready for bending, it needs to be bent within seconds to achieve the shape, clamped for 24 to 28 hours and left to cool completely. Any extended delay from steambox to clamping process can cause cracking or splitting of the wood during the bending. As soon as clamps are released, the wood can spring back depending of species and grain orientation. Therefore it is important to makes sure the material is dried at high temperature without taking it from the molder or shaper. Drying temperature can vary 45 F to 50 F for approximately for 10 to 12 hours.

Further reading on bending of wood can be found in following literature

- Hoadley, B. 2000. Understanding wood, A craftsman's guide to wood technology. The Taunton Press.
- Wood Handbook, Wood as an Engineering Material. 1999. USDA, Forest Service. Report FPL, GTR-113, Forest Products Laboratory, Madison, Wisconsin
- Jackson,A., Day.D., Jennings,S. 1997.The complete manual of woodworking. Alfred A Knopp, New York.
- Feirer,J. 1980.Wood:Technology and Processes.Glenco Publishing Inc. Mission Hill, California.

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