FINGER JOINTING OF GREEN LUMBER*

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One of the primary problems in choosing wood structural members is the limitations of dimension presented at the source - trees don't grow square timbers.

In sawing trees into the standard lumber lengths and sizes some 40 per cent of the wood ends up too small for use. Two-by-fours, for example, are generally cut to eight and 10 foot lengths, shorter pieces of two-by-four are usually turned into wood chips for conversion into paper.

If a way could be found to effectively and economically join together the shorter pieces of wood, more structural grade lumber and high value specialty products could be derived from each log.

Laminating sheets or strips of wood is one way of making stronger wooden construction components in unnatural shapes, but too complicated a process to be economical on smaller dimension sizes, such as two-by-fours.

Over the years, finger jointing has been developed as one means of joining the butt ends of timbers to get one continuous strong piece. This method involves cutting a series of very narrow yet deep V-shaped notches in the ends of the boards.

When two such end-notched boards are pushed together, the V-shaped "fingers" of one fit into the V-shaped notches of the other.

The effect is a much greater adjacent surface area between the two boards. When properly glued under pressure, such joints can be made as strong as the wood.

The problem is moisture. Even in standard kiln dried lumber moisture can interfere with the glue bond, when it is made using radio frequency curing techniques.

Dr. Suezone Chow, a scientist at the federal Department of the Environment's Western Forest Laboratory on the University of B. C. campus, who has been researching this problem for the past two to three years and found a solution, explained the technology involved to The Journal.

"The difficulty is to find a method that's both fast and effective despite the moisture. Radio frequency ovens will cure the glue very quickly, but if there's more than 14 per cent moisture in the wood, electrical arcing and blistering occur and prevent good bonding."

Not only does this preclude the use of green lumber, it also excludes standard kiln dried lumber, said Chow, which permits up to 19

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percent moisture content.

The moisture interference with the glue bond can be overcome with longer applications of heat and pressure to the joint, but this slows down the manufacturing process to the point of uneconomicability.

The only present alternative for finger-jointing was special extra drying and even then use of radio frequency oven curing restricts board size to six or eight inch widths.

Some attempts have been made to find other glues than the common phenol resorcinols - glues which do not cause electric arcing when microwave cured with wet wood.

Chow said such glues had been found, but there are cost drawbacks. The more sophisticated glues cost from 60 to 80 cents a pound while the more conventional phenol resorcinol tends to run around 30 to 40 cents per pound.

Chow told how he first approached the problem. He spent a long time simply looking at the finger-cut end of a board.

"Look how different are the characteristics of the wood fingers than the rest of the board," he said. "The surfaces of the fingers are mainly end-grain and the fingers themselves are very thin. The rest of the board on the other hand, is side-grain and thick in comparison with the area of surface."

Subjected to warm, dry air, the fingers could be dried in only a few minutes.

"What you get is a single piece of wood with two moisture profiles," Chow noted, but explained that this variation could be used to advantage.

"The excess water in the main body of the wood acts like a heat sink to take up any excess heat from the fingers." Very intense heat can be applied to the fingers then without burning them.

"Yet, when the heat source is withdrawn, the thin fingers cool very quickly, while the rest of the wood stays warm," he continued.

Incorporated into a production system, Chow said the technique would be used like this: the fingers would be cut, the boards subjected to a short period of intense heat, glue applied to the finger surfaces and the two pieces of wood butted together under brief compression.

"Knowing the temperature at which the glue solidifies - about 60 to 80 degrees Celsius - we can pre-heat the boards in the fast drying period, so that the heat from the more moist body of the board, which will migrate to the fingers as they cool, will speed the curing of the glue."

Chow also used two auxiliary techniques in his finger jointing operation to achieve greater bonding strength. First, a hot roller was applied to the top and bottom surfaces of the boards during compression curing. This assured that sufficient heat was available for complete glue curing in these portions of the joint - very important to bending strength.

Second, a borax solution was applied to the bonding surfaces (a patented process) prior to drying. This prevents overdrying, said Chow, and also helps the curing of the glue.

Average results, using Douglas fir, spruce and pine test specimens were quite positive.

Starting with wood with a 150 per cent moisture content, dried for 15 minutes at temperatures from 100 to 180 degrees Celsius and glued in a hot press for only five seconds under 200 to 450 psi pressure, Chow got joints with immediate bending strengths of 500 psi, without employing the hot platen.

These joints showed bending strengths of 3000 psi after a few hours, slowly rising to around 3,500 psi after two days. Tested to failure 70 per cent of the joints broke in the wood, he said.

Bringing the hot roller - set at 350 degrees Celsius - into the operation, Chow increased the immediate strength to 2000 psi and boosted the percentage of breaks in the wood in the failure test to 100 per cent. Delayed bending strengths were unchanged, however.

The method shows potential particularly for specialty products. The partial drying methods is fast, safe and reliable, he said. The finished appearance of the joint is also superior, Chow said, because no gaps are left at the bottoms of the V-notches, as often occurs with other finger-jointing techniques.

Finally, because curing heat is not provided by radio frequency energy, thickness of the timbers to be joined is not restricted.

Canadian Patents and Development Ltd., a Crown corporation charged with obtaining patent protection for developments of Canadian government agencies has initialed patent protection for the borax treatment process and the new finger-jointing technique for green lumber.

Those interested in licensing the processes should contact Mr. K. F. Crowe promotion officer, Canadian Patents and Development Ltd., 275 Salter St. Ottawa K1A OR3.

Further technical details can be obtained from the director, Western Forest Products Laboratory, 6620 N. W. Marine Drive, Vancouver V6T 1X2.

QUESTIONS AND ANSWERS

Q. Is there any significant degrade in the areas between the finger joint which is dried and the green part of the 2 x 4? It seems to be a severe moisture gradient.

A. No, this is one of the benefits of the process if you dry short lengths. Under normal drying conditions you get a lot of end degrade but this method avoids that loss of material.

Q. Do you have any ball park figures on the economics?

A. We don't have the advantage of all the economics compared to industry. Presently, it's marginal on dimension lumber. It is economical for long joists and specialty items like cedar panelling and joining cedar clears with a white glue line. If someone installs a plant for specialty items, this makes it more attractive for dimension lumber because you've already paid for it.

Q. What problems have you encountered in finger jointing vertical grain to flat grain pieces? There should be quite a difference because of shrinkage.

A. We have not noticed any great abhorations around the joint with variation of grain. This is something we are looking for very closely, but we don't expect any real problems.