IMPROVED RECOVERY THROUGH GREEN FINGER JOINING - THE GREENWELD PROCESS

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History of the "GREENWELD PROCESS"

For years producers have yearned for a method to bond "green" or unseasoned wood. The primary justification for this idea is the avoidance of kiln drying small pieces of wood or drying a substantial volume of waste wood that will later be discarded at the cut line. Drying to moisture contents of 10-12% oven dry basis has generally been preferred to insure good adhesive bonding.

In 1988, a team from the New Zealand Forest Research Institute embarked on a project to find a suitable method to bond unseasoned wood. Radiata pine, which makes up the bulk of the New Zealand plantation forest reserves in that country, has relatively low structural value due to the rather large and uniform knot whorls characteristic of the species. The long clear span distances between these defects is typically 36" in this fast growing tree. By removing the knots, the upgraded material becomes much more stable and stronger when finger joined.

Radiata pine is normally kiln dried, typically in high temperature, short cycle kilns, as it is subject to attack from a variety of forces. Dry kiln space is at a premium in New Zealand and kiln costs are high in the direct fired gas kilns.

Thus the justification for a method to join the wood in the unseasoned state. Removing the low strength, low value waste materials prior to kiln drying, thereby maximizing kiln capacity and reducing the high cost waste generated in the traditional method. Whatever method was developed would have to handle the rigors of kiln drying at high temperatures.

In 1989, the team headed by Jeffrey Parker discovered a combination of a structural resin system and a cure accelerator that showed promise. Standard structural resins will bond surfaces of relatively high moisture contents; inconsistently, but they will bond some pieces. This is due to uneven penetration of the cell structures of the adjoining wood surfaces. In some cases the glue will totally migrate out of the joint interface leaving a joint starved for adhesive.

The discovery by Mr. Parker and his associates was based on the premise that if the adhesive could gel fast enough, the over penetration could be reduced or eliminated. The problem would be to devise a system with just the right gel time that would allow adequate penetration to form a structural bond that would handle the shrinkage during the kiln drying process.

A number of very fast adhesives were tested to see if traditional application methods could be utilized. They finally found the right combination that is now called the Greenweld Process.

The process is actually quite simple. It consists of a very specific formulation of phenol-resorcinol-formaldehyde (PRF) adhesive and an accelerator of known properties. When the two products are mixed, the curing reaction is speeded from a normal cure rate of hours to a matter of minutes. It was discovered that separate applications of mixed glue to one set of fingers and accelerator to the opposing fingers yielded the desired results. Consistently high breaking strength values, combined with high wood failure and low delamination have shown this process to be very effective.

From this process of research and development we have moved forward to were we are today. The process is in commercial production at 4-5 plants in New Zealand and 2 plants in Australia. The first North American operation is currently scheduled to be on line by mid-May in western Canada, with two to three additional facilities expected to be on line by the 4th quarter of 1995. The New Zealand and Australian plants are producing a wide range of products from pallet stock to floor joists to siding and paint grade facia.

Greenweld - The Process

Greenweld was designed to bond green or unseasoned solid wood together via the method of finger joining. The Process is not moisture content dependent, although handling time can be affected to some degree. Testing has shown the process to be equally effective on kiln dried wood or 150% moisture content; 6% has been joined to 150% with good results. The Process has also been shown to work on frozen wood, which is of great interest for producers in northern Canada. In the case of frozen wood, the handling time is extended, but is still within reasonable production limits.

The process requires little modification to existing finger joining technology. Standard machines produced by Industrial Woodworking or Western Pneumatics Machinery Group can be easily adapted to utilize the Process. This consists primarily of the addition of a spray system for application of the accelerator just downstream of the first profile section. Standard glue application systems which have been used in the laminated beam industry for years are quite suitable for applying the glue in this process.

The normal assembly process is adequate for use with the Greenweld Process. The nature of the finger joint itself gives the assembly a certain amount of mechanical "lock" which helps to hold the joint together until the handling strength has been achieved - typically 5 to 10 minutes. Testing by Weyerhaeuser has shown that tension values approaching 80-85% of full cured strength are obtained within 20 minutes. High wood failure values are typically established after 24 hours of cure time, in the absence of induced heat, i.e. dry kiln.

The assembled products can be loaded directly into the dry kiln, or, in the case of Douglas-fir, can obtain high values while still in the green condition. Testing has shown that Douglas-fir studs can be produced, with joints as short as 1/4" under this process which will surpass the stud values by up to 3-4 times the required tension values. Values increase as the wood moisture content drops. This is more a function of wood fiber strength rather than of joint performance.

More recently, testing has been conducted both in New Zealand and in the US on expanding the Process to include edge gluing and face gluing. Early results suggest that the process is quite effective on smaller cross section materials. Boards up to 4" in width have been bonded with reasonable performance obtained. Typical clamp times of 20-25 minutes are reported for radiata pine; 25-35 minutes for Douglas-fir and hemlock. Testing is continuing in New Zealand using the expired Weyerhaeuser patent for sector sawing. This profile sawing has the potential to yield very high recovery from very small logs.

Value Added Products from Greenweld

The Greenweld Process opens up the possibilities to produce value added products from materials that heretofore were considered only chip value. As stated previously, the Process is approved for use in the production of finger joined wood products. This includes vertical use only studs, paint grade facia and siding, mouldings, and shows the potential for utilization in horizontal structural applications.

The addition of face and edge gluing options opens the market for additional stud production from wane edge pieces (edgings and other sources) and plate stock. In the future, the possibilities may include laminated veneer lumber (LVL), glued laminated beams (Glu-Lam) and plywood. These will require substantially different handling procedures from those now in use, and the glue cost may turn out to be prohibitive for some applications.

Performance Tested Products

The Process has been tested on a variety of species by a number of different testing groups. In general, the Process has shown excellent performance on most, if not all, softwood species. Products have been tested by NZFRI, Weyerhaeuser, PFS/TECO, the Wood Science and Technology Centre at the University of New Brunswick, and witnessed by Caribou Lumber Manufacturers Association (CLMA - Canada) and West Coast Lumber Inspection Bureau (WCLIB). In all cases the process has met expectations, and in most instances has substantially surpassed expectations.

Species tested to date include the following:

Radiata pine
Northern white spruce
Black spruce
Western red cedar
Jack pine
Southern yellow pine

White fir
Hemlock
Balsam fir

Australian slash pine
Aspen

As a general rule, the process shows very good performance on softwoods. Hardwoods are a different story. Preliminary testing has yielded good results on Aspen from Canada, but poor results on most species of oak. The oaks contain extractives which tend to counteract the curing processes in PRF adhesive systems. This is widely held to be the reason for the poor performance. Additional testing is expected on hardwoods to determine those candidate species which can work under this process. The softer hardwoods, like alder, aspen and poplar, so far seem to show reasonable performance.

Along the way, the Greenweld Process has yielded excellent performance results on softwood species when tested to a wide range of standards. Greenweld has met or exceeded the following test standards:

ASTM D 4688-90 (NZFRI Lab)

ASTM D 3110-90 (NZFRI Lab)

ASTM D 2559-92, Section 16 (PFS/TECO) (Resistance to Deformation Under Static Loading - "Creep Test")

ANSI/AITC 110 (PFS/TECO) (Cyclic Delamination)

Canadian SPS 1 (NZFRI Lab) (Frozen wood)

CAN3-086-M84 (NZFRI Lab) (Frozen wood)

Improved Recovery for Solid Wood Products

Improved recovery through the use of the Greenweld Process is recognized when materials previously destined for pulp chips or other low value alternatives are diverted for conversion to higher value solid wood products. A substantial volume of material could be recovered from a number of sources at the sawmill. These sources of raw material include planer trim ends, edgings and lower grade product such as economy and utility. In most mills, if a board does not make 8 ft. count, it is considered to be of marginal value. Yet this same piece of wood, processed through a finger jointer and trimmed to a precision end trim length can command a much higher value.

In Canada, operating procedures are already in place in at least one sawmill where the boards are scanned to determine the recoverable volume of wood in a given piece. If the piece shows a reasonable total, it is diverted as a full length piece to be shipped to a finger joint manufacturer. The manufacturer in turn defects the piece to obtain finger joint quality pieces which are then processed into studs. This process eliminates the prospect of trying to pull bits and pieces from the waste stream in an effort to recover more usable wood.

More recently, the NZFRI has received a great deal of interest from the wood products producers in New Zealand and Australia regarding the use of

Greenweld for edge gluing. Edgings can yield much higher values when the wane edges are turned inward, trimmed, and a board with generally better stiffness values, and four square corners is produced. A sample of this product is available for your inspection.

Benefits of Rough Green Utilization

We have seen from the previous discussions where the material can come from and how the process works. What is of real interest to you is how can you benefit from using this process. The benefits are derived from improved efficiencies and values in a number of areas.

First is the improved efficiencies for dry kiln operators. By producing products of uniform length, kiln capacity can be improved substantially over random length drying. Also, when giving consideration to material that would be glued under previous traditional methods, the wood does not need to be dried to as low a moisture content; KD 19 is more than adequate. This has the potential to shorten drying cycles.

Second, the finger joined products are free of the major defects which cause cupping and warping in solid wood. This means that the finished product will stay straighter and be more acceptable to the end user. The product may even command a premium if it is known that there it is less likelihood of a percentage loss of usable product in the unit purchased. Finger joined products have been shown to experience dramatically lower yard losses in Japan and other markets.

Increased efficiencies are also recognized in shortening the processing time, reducing the handling time and expense (when compared to trying to dry short blocks or wood with substantial volumes of waste material), and reducing trim loss by producing lumber to specified lengths. The opportunity to market finger joint blanks will also increase with the increased competition for raw materials from the growing number of finger joint operators.

All this adds up to increased market opportunities for wood products. Some operators are marketing finger joined products as "Engineered Wood Products", which at least commands attention, if not actual higher prices. That edge can be critical in the competitive marketplace. The elimination of offsets, and the use of a full structural rated adhesive also make the product more aesthetically and technically pleasing. These two factors allow one producer in Canada to claim higher selling prices for his product.

Conclusions

Early in 1994 the price for studs hit levels that made stud mill operators giddy with the anticipation of profits the like they hadn't seen in years. Since then the market has taken one of its usual swings to the other side of the equation. Projections have the price returning to somewhere between these extremes.

Higher value added products still command very good prices and should be considered closely when performing a cost analysis of the Greenweld Process.

The Greenweld Process is a proven adhesive system with implications for future recovery of an increasingly scare commodity - solid wood. As world demand for wood products continues to grow, it will become more and more important to recover as much of the resource as possible for the highest value applications. Greenweld is here to help achieve that goal.

Finally, there are some work environment concerns which also must be addressed when dealing with the Greenweld Process. As with any chemical products, operators should exercise proper precautions and follow recommended procedures when mixing adhesive products. The adhesive has specific handling requirements which are well known in the industry. Dyno representatives will gladly explain the specifics of mixing and waste handling when dealing with PRF adhesives.

The accelerator also merits careful handling and will emit strong odors which should be exhausted from the work area. While not particularly hazardous, the fumes are annoying. The accelerator is not a VOC and it rapidly breaks down to harmless elements once exposed to the outside air and sunlight. The expected volume used in a normal finger joint operation will fall well below any discharge limitations imposed by local air pollution authorities, and in-plant studies have shown exposure levels well below OSHA guidelines.