

Technology Profile



**Value
to
Wood**

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Ensuring Quality Glued Products



Quality gluing is critical to the manufacture of quality value-added products. Poor gluing practices can cause your company to lose money, customers, morale and reputation—all of which are difficult to recover.

To ensure satisfactory performance of edge-glued, laminated or finger-jointed wood products, manufacturers need to pay close attention to a number of processes and variables that affect the quality of glue joints. Some of the

variables include the product and its end-use, the type of adhesive, the moisture content and storage of wood to be glued, as well as wood properties. Processing variables range from preparation of the surfaces to be glued, and mixing of the adhesive, to glue application variables and quality control procedures. The purpose of this Profile is to provide a summary of the key factors that affect the production of good glue joints.

Product Requirements and Standards

The type of product, the end-use applications, and any standards which must be met are the first elements to consider. Will the product be used for structural or non-structural purposes, and will it be used in an interior or exterior application? The answers to these questions can influence adhesive selection, joint geometry (for finger-joints), the quality control program and other variables, as well as the process itself.

Many domestic and international standards (American, Japanese and European) are relevant to the manufacture of glued products. These include:

- CSA O112 (as a guide for evaluation of adhesives);
- ASTM D 905 (strength properties of adhesive bonds);
- ASTM D 1101 (integrity of glue joints);
- Japanese Agricultural Standards (JAS).

Producers must be fully aware of the requirements imposed by the standard chosen. These standards establish the quality control and testing procedures that must be followed.



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Wood Raw Material Considerations

Woods' properties, its moisture content, and the handling and storage of it prior to gluing are three raw material factors to be considered.

Wood Properties

Various wood properties, including the differences between sapwood and heartwood, affect gluing. During the transition from sapwood to heartwood, substances called extractives (pitch, oil, minerals) are deposited in cell cavities and walls. These substances affect the gluability, density, porosity, machinability, decay-resistance and dimensional stability of wood. Species such as pine, Western red cedar and yellow cedar can experience gluing problems because of extractives.

Density affects glue spread and pressure application. It has an impact on porosity and therefore, on shrinking and swelling. Dense woods require heavier glue spreads and higher pressure.

Porosity affects the glue-spread rate. As porosity increases, wood becomes more penetrable by liquids.

Wood pH, which ranges from three to six, affects adhesive curing. Wood with a low pH can slow the cure of an alkaline adhesive and speed up the curing time of a glue that uses acid catalysts.

Moisture Content

Moisture content is one of the key factors to control in the wood gluing processes, and a frequent source of problems in manufacturing plants.

As it can have a moisture content from 40 per cent to 200 per cent, freshly cut wood has to be dried before it can be used. The optimum moisture content depends upon what the wood will be used for and the average relative humidity of the environment in which that use will take place. Wood must be dried to a moisture content that is within two per cent of the equilibrium moisture content of the in-use location. Equilibrium moisture content is defined as the moisture content that the wood will eventually reach when it is stored indefinitely at a particular humidity and temperature.

Specific wood adhesives also require ranges of moisture content within which they provide optimal bonding of the wood surfaces. Adhesive supplier recommendations about moisture content should be followed without exception, and the raw material must first be kiln-dried to the correct level.

Wood properties change as moisture content changes, and this affects processes such as gluing, machining, fastening and finishing. The most troublesome of these property changes are shrinking and swelling. If excessive shrinkage occurs in the wood after preparing the surfaces for gluing, sufficient distortion from warp or twist can result in poor surface contact when glued.

Within a few hours to a week after edge- or face-gluing, end splits can often be seen at the glue line if excess moisture was present when gluing. Joint failures will result if the wood has a higher moisture content than the equilibrium moisture content of the plant.

An important way to eliminate moisture-related problems is to ensure that every supplied load of lumber has the specified moisture content, and that each piece of wood has a similar initial moisture content.

Handling and Storage

Wood raw material to be glued needs to be handled and stored in ways that reflect the moisture content and temperature requirements during the gluing process. Maintaining the correct moisture content requires dry storage conditions, and sometimes even heated storage, depending on climatic conditions. In regions with cold winter temperatures, stock needs to be taken into heated storage areas in sufficient time to thaw the wood and/or raise it to an acceptable temperature range for gluing.

Adhesive Considerations

Adhesive Selection

It is important to select the right adhesive for the job. The choice is affected by the nature of the product (structural or non-structural), standards to be met, customer requirements and the gluing process (e.g., cold cure versus hot press or radio frequency). The adhesive supplier must be fully aware of these factors before the glue is selected so that the proper formulation can be provided to the user.

Glue Properties

Gluing problems that are caused by the glue itself are usually a result of choosing the wrong product, or using a product that has expired. It is important to monitor the properties and characteristics of the product delivered by the supplier. It should be checked for colour, viscosity, working life (pot life), shelf life (storage life) and pH. Working with the supplier to ensure that the glue selected is appropriate to the application and that it will be used correctly is advisable.

All processing factors are interdependent. Poor practice in one area cannot be compensated for by changing practices in another area. If each phase of the process is not performed properly, the final product will not meet expectations.

Glue Storage and Handling

It is important to follow the manufacturer's instructions for proper storage and handling of adhesives and catalysts. Contamination by wood dust is a common problem that reduces the effectiveness of adhesives. A separate room is normally recommended for storage and mixing of adhesives.



Glue Mixing

Incorrect glue mixing, contaminated mixing equipment and incorrectly calibrated measuring equipment all contribute to gluing problems. It is important to follow the adhesive manufacturers' mixing instructions. Some adhesives, such as the film types and the straight polyvinyls, are supplied ready to use. Because many adhesives can be either acidic or alkaline, it is important that they be mixed in containers that will not react. Gluing equipment must be kept clean to avoid lessening the bonding quality of the adhesive.

Processing Factors

When there are problems with gluing or with glued products, the tendency is to blame the glue although the reality is that most problems are due to poor processing practices. Here are key elements to watch for:

Preparation

Careful machining is essential to prepare wood for gluing. Surfaces should be smooth and true, free of machine marks, chipped or loosened fibre, or other defects such as snipe, scant and skip.

For face-gluing, each layer should be the same thickness so that gluing pressure is distributed evenly. Even small variations in layers can cause significant variations in the thickness of the final assembly and result in weak joints.

Machining should be done just before gluing so surfaces stay uncontaminated by wood resins and unaffected by moisture changes. Wood for edge-gluing should be true and square. Small variations in these edges may cause cupped panels or open glue joints.

Glue Application

Wood should be at room temperature before glue is applied so that the adhesive will spread properly. Glue spread varies with the type of adhesive, the product being bonded, the moisture content of the wood, and the temperature and humidity of the processing environment.

Dense woods generally need heavier spreads of glue than less dense species. Wood with low moisture content usually needs more glue. If the temperature in the processing area is high and the humidity is low, more glue may also be required, depending upon whether or not the assembly time can be adjusted to compensate for the faster drying that occurs under such conditions.

When the glue is applied, it must flow and form a smooth continuous film. This is impossible if the glue is too thick, the wood is too hot or too cold, has a dirty surface, or if there is insufficient glue. Too much glue

is wasteful, slows down the curing process and increases the reject rate. Too little glue creates weak joints.

Assembly Time

Assembly time is the interval between spreading the glue and applying full gluing pressure. This time must be properly adjusted to create quality joints. Too short an assembly time results in "starved" glue joints. This can occur particularly with low-viscosity adhesives and dense wood species that absorb the glue slowly. Too long an assembly time can result in a skinning over or drying out of the glue and cause inadequate transfer of adhesive from the spread surface to the unspread surface.

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Pressure Application and Pressing Time

Adequate pressure must be applied over the entire glue joint until the glue has set or cured. The pressure needed to create good joints is determined by the density of the wood species being bonded. Insufficient pressure and pre-curing are common causes of joint failure. Too much pressure squeezes out too much glue and too little pressure results in a thick glue line. Both create weak glue joints. Low-density woods (softwoods) require 100 to 150 pounds per square inch (psi) of pressure. Medium-density woods require 150 to 200 psi and high-density woods (hardwoods) require 175 to 200 psi.

Adhesive Curing

How fast glue cures depends on the catalyst used and the curing temperature. The higher the temperature, the faster the curing reaction and the shorter the curing time. Cold curing is done at room temperature and has an extended curing period. Hot curing is done at temperatures ranging from 50 to 80°C for about an hour. When this method is used, the press temperature must be monitored to make sure it is adequate and consistent. Radio frequency curing is the fastest method.

Machining and Finishing Glued Products

Problems occur when glued products are machined too soon after gluing. Wood swells around the joint when it absorbs water from the glue. Sunken joints result when wood is planed or sanded before this swelling has gone down and the moisture around the joints has dissipated completely.

In addition, finishes, especially those that are water-based, must be equally applied to both sides of the product so that the two faces don't swell at different rates and cause cupping or curving.

Quality Control

A comprehensive quality control program is key to manufacturing high-quality glued products. It should include:

- product design control
- incoming material control
 - wood—lumber grade, dimension, moisture content
 - adhesives—colour, viscosity, working life, shelf life, pH
- production control
 - material handling
 - equipment and tool settings
 - operation
 - maintenance
 - glued products' conditioning and handling
- in-line quality check of glue bond
- laboratory tests
 - shear tests
 - delamination tests
 - bending tests.

A quality product deserves quality treatment. Manufacturers should provide customers with clear information on how to handle the product—for future processing and for handling and storage.

For information on the 2003-2004 *Value to Wood* research program, visit www.valuetowood.ca



Ce Profil technologique est également disponible en français.



As part of the *Value to Wood* program, funded by Natural Resources Canada, Forintek's Industry Advisors are providing technical services to value-added wood product manufacturers in all regions of Canada. If you need information on any technical issue related to wood product manufacturing, you can:

- Send a request via valuetowood.ca (Help Desk).
- Contact a *Value to Wood* co-ordinator at one of the following locations:

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