FORESTRY EXTENSION NOTES

PROPER GLUING OF WOOD

Bonding of wood with glue dates back to ancient times but has increased enormously over the past decades. Glued wood products vary in size from tiny wood jewelry to giant laminated timbers spanning hundreds of feet.

The plywood industry is by far the largest user of adhesives. The structural wood laminating industry, furniture producers, and particleboard manufacturers also use large quantities of glues.

Proper use of wood adhesives offers the potential for increasing the size of wood elements and often promotes improved properties. The objective of the bonding process is to develop a glued joint as strong as the wood itself.

Wood Properties and Preparation

Various properties of wood affect its gluing characteristics. Perhaps the most important is wood's density. However, moisture content and the amount of dimensional change associated with changes in moisture content are also very important. Pitch content, oiliness, surface contaminants, and the presence of extractives may also influence gluability.

Woods with lower density and strength tend to be easier to glue. Developing bond strength equal to the strength of wood is obviously easier to achieve with weaker woods. Wood may be glued with moisture content ranging from 6 to 17 percent. However, the proper moisture content for gluing depends upon where the wood is to be used. In heated and air-conditioned buildings, the moisture content of wood to be glued should be about 7 or 8 percent; wood bonded for exposure to the outdoors should be about 12 or 15 percent. Remember, glued joints will remain most nearly free from stresses and perform best if the moisture content of the glued parts equals the average moisture content the product will attain in service.

In ordinary use, wood shrinks as it loses moisture and swells as it absorbs moisture. Wood species that exhibit only modest dimensional changes with variation in temperature and humidity are best for gluing. Higher quality glues and stronger glued joints are required for woods with high density and shrinkage potential.

Wood shrinks and swells many times more in width and thickness than in length with change in moisture content. Even wood dried to the correct moisture content can be expected to change modestly in width and thickness with fluctuations in temperature and humidity.

For the strongest glued joints, wood surfaces should be machined smooth and true with sharp tools. A well planed or jointed wood surface is the most pre-

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ferred surface for gluing. Surfacing should be done immediately before gluing; contamination and aging of the surfaces can decrease bond strength.

Wood Adhesives

Until nearly the middle of the 20th century, most glues for wood were based on naturally occurring materials. Animal blood, casein, starch, or soybean glues were used. However, the most important adhesives today are produced by chemical synthesis. The chief advantage of synthetic resin glues is the range of durability provided; some resin glues have excellent durability under severe service conditions.

Some highly-durable synthetic resin glues require elevated temperatures to cure. Phenolic and melamine adhesives, for example, may require temperatures in excess of 240°F. However, synthetic resin glues are available that can be cured at room temperature. These are the most important glues for the hobbyist or amateur woodworker.

Resorcinol resin glues provide excellent durability to severe exposure conditions and can be cured at room temperature. This is the highly durable adhesive available for gluing wood exposed to the weather or subjected to water that does not require an elevated temperature for curing. Resorcinol resin glues are typically supplied in two components: a dark, reddish liquid and a powdered hardener. The resulting glue line is very dark in color.

Urea resin adhesives can also be formulated to cure at room temperature. However, these adhesives are only moderately durable when exposed to water. These glues are commonly supplied as a dry powder that require only the addition of water. The final glue line is light colored.

Polyvinyl resin glues also cure at room temperature, but they are only suitable for wooden assemblies that are protected. These glues have limited resistance to water and to elevated temperatures. Polyvinyl glues are most commonly furnished as milky white fluids which generate an almost transparent glue line.

Elastomeric adhesives are finding growing acceptance in the building construction field. These adhesives contain natural, reclaimed, or synthetic rubbers and consequently give a somewhat flexible bond. Elastomerics are available in both interior and exterior formulations. They are easy to apply, economical, and require minimal pressure and pressing time. However, elastomerics should only be used in well ventilated places, may creep in stressed joints, and may have low heat resistance.

Assembly Procedure

Gluing lumber to increase width or thickness (side-grain-to-side-grain joints) can be easily accomplished with wood (fig. 1). Wood at the proper moisture content (with edges that have been machined true and smooth) can be

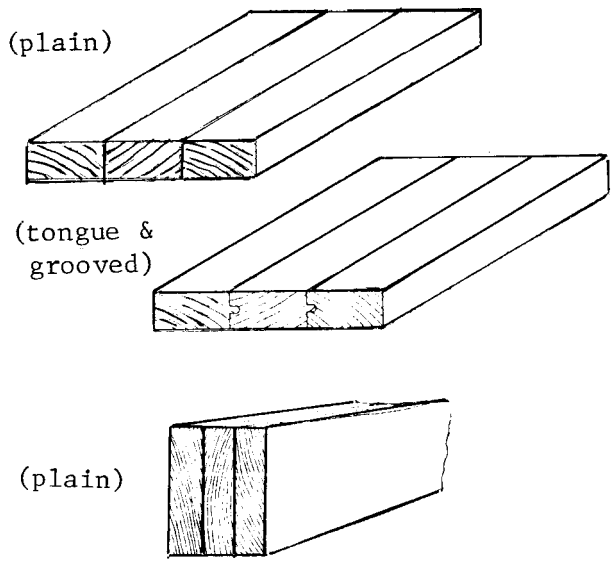

Fig. 1. Side joints

assembled into wide panels. Apply the selected adhesive (after mixing, if needed) directly to one or both of the mating surfaces of a joint with a brush or roller. Clamp the assembly to assure the two surfaces are in intimate contact. Be sure uniform pressure is applied over the entire joint area. Allow to cure at room temperature in the clamps for the time period recommended by the adhesive manufacturer. A similar procedure is appropriate where thin lumber is glued together to form thicker stock.

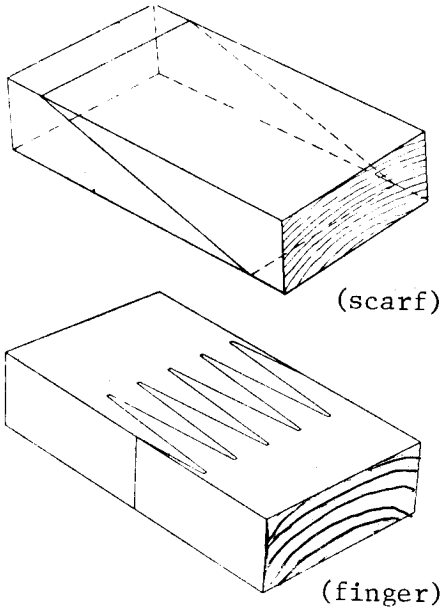

Fig. 2. End joints

Do not design an assembly that restricts the movement of wood in width and thickness during service. Fastening lumber or metal rigidly across the width or thickness will result in severe stresses and may generate warping and splitting.

It is practically impossible to make end-grain butt joints sufficiently strong or permanent for ordinary service. Using adhesives to make a longer member from two or more short pieces of lumber requires machining of special scarf or finger joints (fig. 2). This is not typically recommended for small wood-working shops, but it may be possible to machine adequate scarf joints; use slopes of about 1 to 12 or more.

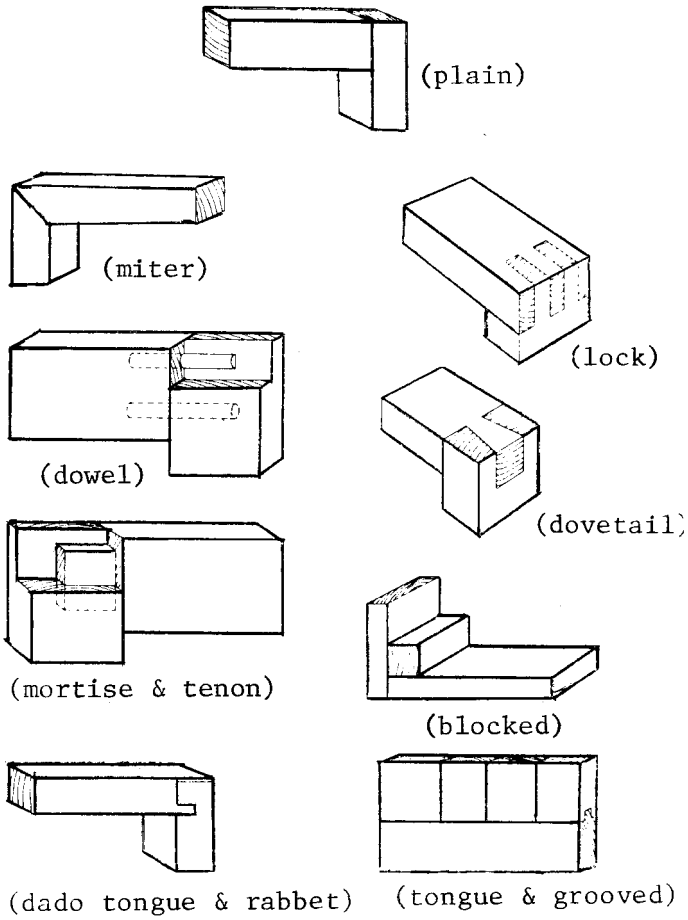

Fig. 3. Corner joints

End-to-side grain joints are difficult to machine properly and to glue adequately for ordinary requirements. Such joints are subjected to severe stresses in service due to dimensional changes as moisture is lost or absorbed. Techniques have been developed for improved gluing efficiency such as dowels, mortise-and-tenon joints, and corner blocks (fig. 3). These joints develop adequate strength but cannot be expected to develop the full strength of the wood.

Summary

Wood can be bonded to develop a glued joint equal to the full strength of the wood. The moisture content of the wood

components should be 7 or 8 percent for interior use and 12 to 15 percent for exterior exposure. The joints should be machined smooth and true.

Urea resin and polyvinyl resin are two synthetic adhesives for interior use that cure at room temperature. Resorcinol resin is the only wood glue for exterior use that cures at room temperature.

It is relatively simple to develop strong side-grain-to-side-grain joints for increasing width or thickness. Other joints require special machining and are more difficult to accomplish.

The summary table below classifies different woods according to ease of gluing. Satisfactory joints may be accomplished with any wood, but more care must be exercised with some species.

More information on wood gluing is contained in Adhesive Bonding of Wood, U.S.D.A. Technical Bulletin No. 1512, 1975, and in Adhesives in Building Construction, Agricultural Handbook No. 516, 1978. Both of these publications are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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SUMMARY TABLE--Classification of various hardwoods and softwood species according to gluing properties

Group 1 (Glue very easily with glues of wide range in properties and under wide range of gluing conditions)	Group 2 (Glue well with glues of fairly wide range in properties under a moderately wide range of gluing conditions)	Group 3 (Glue satisfactorily with good quality glue, under well-controlled gluing conditions)	Group 4 (Require very close control of glue and gluing conditions, or special treatment to obtain best results)
HARDWOODS			
Aspen	Alder, red	Ash, white	Beech, American
Chestnut, American	Basswood	Cherry, black	Birch, sweet and yellow
Cottonwood	Butternut	Dogwood	Hickory
Willow, black	Elm:	Maple, soft	Maple, hard
Yellow-poplar	American	Oak:	Osage-orange
	Rock	Red	Persimmon
	Hackberry	White	
	Magnolia	Pecan	
	Mahogany	Sycamore	
	Sweetgum	Tupelo:	
		Black	
		Water	
		Walnut, black	
SOFTWOODS			
Baldcypress	Douglas-fir	Alaska-cedar	
Fir:	Hemlock		
White	Western		
Grand	Pine:		
Noble	Eastern white		
Pacific silver	Southern		
California red	Ponderosa		
Larch, western	Redcedar, eastern		
Redcedar, western			
Redwood			
Spruce, Sitka			