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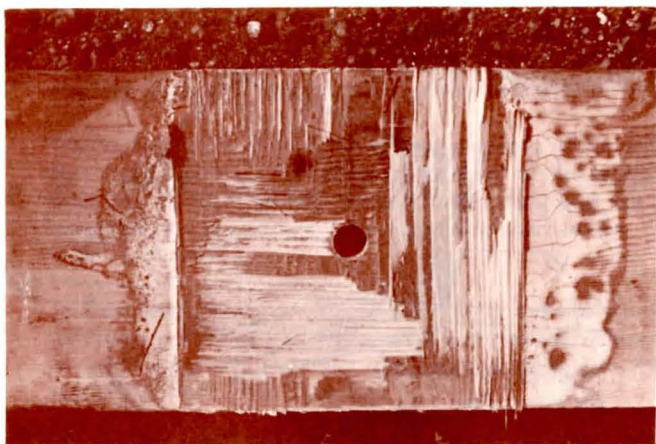
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GLUING WOOD

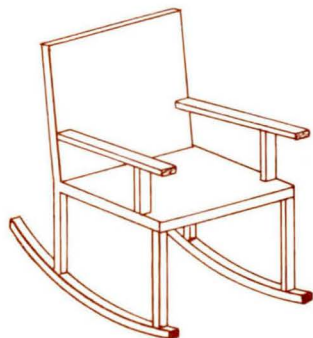
AGRICULTURAL ENGINEERS' DIGEST

introduction

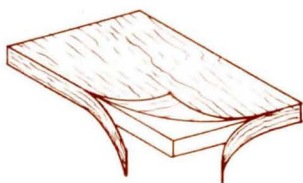
The use of glue in joining two pieces of wood is similar to using a welding rod when joining two pieces of steel. The joint itself is stronger than the wood. If something breaks, it will usually be the wood, not the glue.



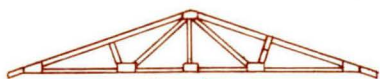
The big advantage of glue is that it can be used to make shapes that cannot be obtained directly from a tree. It would be very difficult to carve a rocking chair from a solid block of wood. By using glue, small pieces are easily and quickly assembled to make a chair that is strong and rigid. Many wood objects such as arches and tables would be almost impossible without glue.



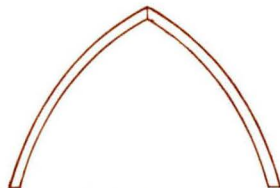
Furniture



Veneer



Framing



Arches

selecting wood

Each project has its own particular requirements of strength. Lumber must be purchased to meet these requirements.

Plywood for exterior uses, or where alternate wetting and drying may occur, should be of Exterior or Type I rating.

Heavy woods are usually more difficult to glue than lightweight woods. Hardwoods are more difficult to glue than softwoods. Heartwood is more difficult to glue than sapwood.

The wood to be glued should be dry, smooth, and free of dirt, oil, and other coatings. Most purchased lumber has been surfaced on a planer and is usually sufficiently smooth.

To clean dirt, paint, and other coatings from wood, use a scraper, wire brush, steel wool, or other abrasive. Do not use wood that has oil or grease at the joint location.

Structural members and members expensive to replace should be pressure-treated with oil-base preservatives if they will be exposed to wet conditions, soil, or termite attack.

Generally, preservative-treated wood must be planed prior to gluing to obtain maximum holding power. Wood treated with oil-base preservatives tend to bleed. Buy wood that has been steamed or otherwise cleaned until bleeding has stopped.

MOISTURE CONTENT

Wood gains and loses moisture as the humidity and temperature of the air changes. This change in wood moisture causes the wood to change dimensions and, therefore, puts stresses on joints.

Kiln-dried wood available at most lumber yards has about 15 per cent average moisture content. The moisture content of wood to be used for interior projects should be reduced to an average of 8 per cent. The most practical way to dry the wood is to store it in an atmosphere similar to that in which it will be used. To assure uniform exposure to the air, place small blocks between the pieces. After several weeks in this atmosphere, the wood will usually be near an acceptable moisture level.

Exterior siding, trim, sheathing, and framing can usually be used as it is purchased. If the moisture content is above 15 per cent, the wood should not be glued, but should be stored in a drier atmosphere for several days.

selecting a glue (See Table, page 4)

PICK the glue for the particular job and LEARN how to use it.

To find a glue that will satisfy all requirements is impossible. Glue should be chosen because it will satisfy the requirements of one job. No glue is fool-proof. Well-made joints require woodworking skill and close control of the gluing conditions. Improper use of glues and glued products may result in costly repairs or replacements.

The expected length of service should be considered. In permanent structures, the few added dollars needed to buy a more resistant glue and Exterior or Type I plywood are well spent.

Recommended glue qualities for farm building construction:

1. Water resistant for storage buildings and where the moisture content of the wood can be controlled.
2. Waterproof for livestock confinement buildings and where moisture problems are almost sure to occur, i.e. leaks in roof, outdoor furniture or equipment.
3. Crack-filling -- (gap-filling)
4. Easy mixing
5. Nail pressure for clamping
6. Cold setting -- cures without heat
7. Moderate cost

Two types are recommended -- Casein and Resorcinol Resin. (See Structural Gluing Requirements)

Recommended glue qualities for most interior uses:

1. Easy mixing
2. Moderate cost
3. Medium pressure requirements (clamps or nails)
4. Cold setting
5. Does not stain the wood or leave a visible glue line

Several glues usually have these qualities -- see page 4.

using a glue

WITH THE GLUE CHOSEN, FOLLOW MANUFACTURER'S DIRECTIONS

Have the room temperature above 70° F. Lower temperatures will slow curing.

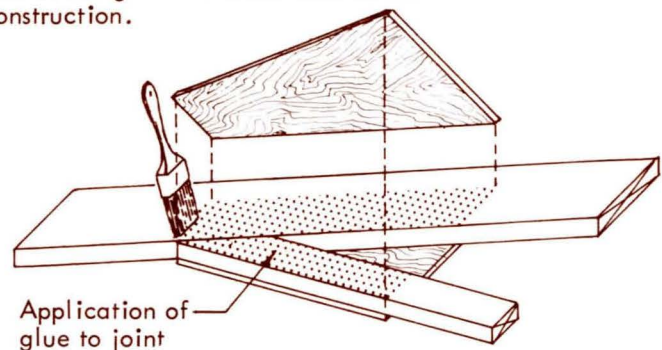
Mixing instructions, pot life (the length of time the glue stays usable after mixing), temperature during use, etc., must all be followed closely.

Foam, lumps, or glue that is too thick or too thin can lower the quality of the joint. To be sure of a strong joint, the film of glue should have no air bubbles or foreign particles and should completely cover the joint area.

Before applying glue, be sure of a good fit by testing the joint; both pieces should make contact at all points. Crack filling glues will give a good bond despite small surface misfits. Glue a sample joint to see if the glue will stain your wood.

Usually, glue need be applied to only one of the mating surfaces. The end grain of wood usually requires two coats. For farm construction, for heavy construction such as laminated timbers, or where the surfaces are rough and assembly periods may be long, spreading on both surfaces is desirable.

An adequate amount of glue must be applied to the joint. When pressure is applied, some glue should ooze out from around the joint. If it doesn't, you aren't using enough glue. Never skimp on the use of a glue; the cost of the glue is a minor item in the total cost of construction.



Apply glue with a brush, stick or paint roller. Put pressure on the joint with clamps, nails, screws, or other fasteners before wiping off excess glue.

ASSEMBLY TIME

Assembly time is the interval between spreading the glue and applying the pressure. "Open assembly" means the surfaces are open to air; "closed assembly" means the surfaces are in contact, but not clamped.

Permissible assembly time is affected by: the temperature of the glue film (shorter at higher temperatures); moisture content of the wood (usually shortened as the wood dries); the age of the mixed glue (shorter with the last parts); and whether one or both surfaces are coated with glue (shorter when one surface is coated). Most glue containers will have the assembly time and other precautions printed on the label.

applying pressure

Pressure is used to squeeze the glue into a thin continuous film, to force air from the joint and to bring the glue and wood together and hold them together until the glue has set and cured.

Pressures should be uniformly distributed over the entire joint and should not crush the wood. The joints should be kept under pressure at least until they have enough strength to resist separation. This usually is from 2 to 7 hours under favorable conditions. Leave pressure applied a longer time if possible.

The glue manufacturer's or engineer's recommendation on kind and quantity of pressure must be followed closely.

curing time

The time needed for joint curing depends on the catalysts added during glue mixing and on the glue-line temperature. Casein and polyvinyl glues usually have no catalysts added.

The higher the glue-line temperature, the faster the glue will cure and the shorter the necessary clamping time. When using room-temperature setting glues, most manufacturers recommend a temperature of 70° F or above. The minimum temperatures for curing have not been well established, but temperatures below 70° F are certain to increase the curing time.

glue durability

The durability of glued joints depends on the type of glue, the service conditions, the gluing technique and the design or construction of the joints.

Well-designed joints made with the proper glues will last indefinitely if the moisture content of the wood does not exceed approximately 15 per cent and the temperature stays within the human comfort range (-30° F to 110° F).

To increase the durability of the joints and the wood, use waterproof glue and preservative-treated wood; or use waterproof glue and apply preservatives to the wood after the joint is made.

structural gluing requirements

WOOD must be clean and smooth, and have a moisture content of less than 15 per cent. If the wood is pressure-treated, the surface must be dry and free of bleeding preservative. Use unsanded (preferred) or sanded Exterior Plywood.

GLUE should be either Casein or Resorcinol Resin. Use Resorcinol Resin when gluing treated wood.

Casein may be used for dry conditions only. Buy a glue that meets Federal Specification MMM-A-125 Type II. Apply glue at 40° F or above; 70° F recommended. Apply pressure as soon as possible. Maintain pressure for two days at 40° F, 4 hours at 70° F, or 2 hours at 80° F.

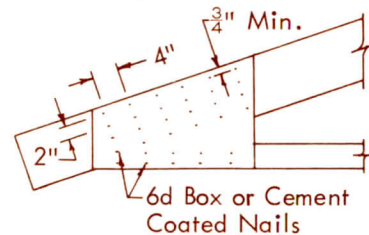
Resorcinol Resin can be used for both wet or dry conditions. Buy a glue that meets Military Specification Mil-A-46051. Apply glue at 70° F or above. Assemble but wait 5 to 10 minutes before applying pressure. Maintain pressure for 10 to 16 hours.

PRESSURE is often applied with nails or staples. The commonly used nails are box, galvanized, or cement coated and are not removed after the joint is cured. If staples are used, finish driving the staple with at least one hammer blow. At the end of the pressing time, the glued elements may be moved, but full load should not be applied for about one week.

typical joints

STRUCTURAL JOINTS

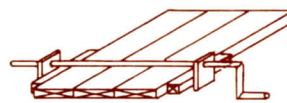
Joints connecting structural members are as critical as the members themselves. A pressure of one or more nails is usually required every 8 square inches of the joint. The location and size of these nails are usually given in a designed plan or in the engineer's recommendations. (See Structural Gluing Requirements)



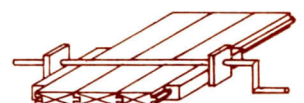
TYPICAL TRUSS JOINT

NON-STRUCTURAL JOINTS

EDGE-TO-EDGE joints can be made as strong as the wood itself. Tongue and groove lumber is easier to align, but can cause trouble if the shapes do not fit snugly. A shallow tongue and groove is just as effective as a deep one, and is less wasteful of wood.

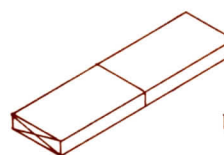


PLAIN

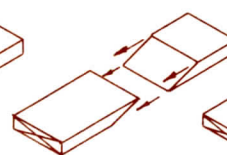


TONGUE & GROOVE

END-TO-END joints cannot be made to give the same strength as the wood itself. Use a shape that will give more glue surface area and, therefore, more strength.

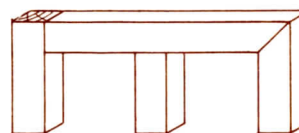


POOR

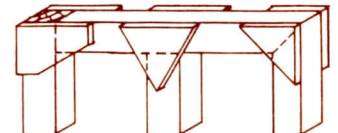


BETTER

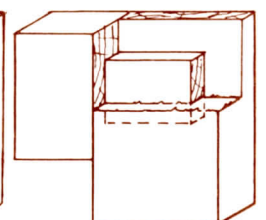
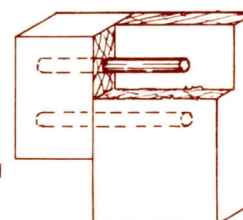
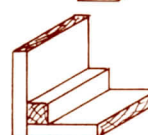
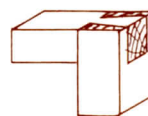
END-TO-SIDE joints are difficult to glue and have higher joint stresses than the edge-to-edge or end-to-end joints. These stresses are caused by the unequal dimension changes in the two pieces. End-to-side joints should be tightly fitted and held together by dowels, tenons, or other reinforcing device.



VERY WEAK



PLYWOOD GUSSET JOINTS



CABINET JOINTS

properties of glues

PROPERTY	SYNTHETIC RESIN GLUES					PROTEIN GLUES	
	Resorcinol	Urea	Polyvinyl	Epoxy	Contact Adhesives	Casein	Animal
Needs Mixing	X	X		X		X	X
Crack-Filling			X	X	X	X	
Applied Hot							X
Applied Cold	X	X	X	X	X	X	
Colorless Glue Line		X	X		X	X	X
Dark Colored Glue Line	X						
Tends to Stain Certain Woods						X	
Pressed at 70°	X	X	X	X	X	X	X
Over 8-Hour Working Life		X	X				X
Low Moisture Resistance			X				X
Medium Moisture Resistance			X		X	X	
Good to High Moisture Resistance	X	X		X			
Low Temperature Resistance		X	X				
High Temperature Resistance	X			X	X	X	X
For Structural Gluing	X					X	
For Exterior Uses ¹	X			3			
For Interior Uses ²		X	X	3	4	X	X

1 Exterior uses include outdoor furniture, boats, recreational equipment, animal shelters, etc.

2 Interior uses include furniture, cabinets, framing, and other shopwork that will be used in a moderately dry atmosphere.

3 Excellent for bonding metal, plastics, cloth, etc., to wood. No practical advantage on wood-to-wood gluing over resorcinol resin except it is a good joint filler.

4 Covering counters, cabinets, etc., with leather, linoleum, and plastic laminates, veneer, etc.

Plans for livestock equipment, and for farm homes and service buildings, are distributed by state Cooperative Extension Services, usually at a nominal charge. For further information, contact your county agricultural extension office or write your Extension Agricultural Engineer.