

TECHNICAL NOTE NUMBER 227

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

FOREST PRODUCTS LABORATORY

MADISON 5, WISCONSIN

REVISED

April 1957

TOOTH-PLANING NOT NECESSARY TO PRODUCE

STRONG GLUED WOOD JOINTS

The opinion, frequently expressed, that roughened surfaces such as are produced by tooth-planing, sanding, and similar operations are necessary to make strong glued joints in normal wood is not borne out by experiments conducted at the Forest Products Laboratory. An extensive series of tests with Sitka spruce, white oak, and sugar maple demonstrated that, if good gluing conditions are employed, it is possible to make, with smooth flat surfaces, joints equal in strength to those produced with surfaces that have been scratched or otherwise roughened.

In the experiments, animal glue was mixed in the proportion of 1 pound of glue to 2-1/4 pounds of water and applied hot to the wood. The strength of joints produced with tooth-planed surfaces was compared with the strength of joints produced with smooth-planed surfaces.

The wood used was allowed to condition in a room at 30 percent relative humidity to a constant moisture content of about 7 percent. The boards were then cut to about 3/4 by 5 by 12 inches and matched as to density. Approximately 30 depressions per inch, 1/32 inch deep, were made in a part of the boards with a hand-operated tooth plane.

In the gluing operation, pairs of blocks surfaced by smooth-planing were alternated with those surfaced by tooth-planing so that all conditions of gluing might be comparable for each type. Under this plan, any consistent difference in strength of joint must be ascribed to the method of surfacing the blocks. The blocks were glued together face to face.

The regular Laboratory block shear test, (American Society for Testing Materials Designation D805-52) by which the joint is subjected to a compressive shearing force in a specially designed fixture, was used to test joint strength. The strength of joints in pounds per square inch and the nature and percentage of wood failure¹ were recorded.

The experiments were conducted with the hot animal glue mixture under three sets of gluing conditions -- good gluing conditions, starved-joint conditions, and chilled-joint conditions. A starved joint is one in which the film of glue between the wood surfaces is not continuous; it results when thin glue is cured under high gluing pressure. A chilled joint usually results when the hot glue cools excessively on cold wood before pressure is applied.

Under good gluing conditions, smoothly planed surfaces have slightly stronger joints than tooth-planed surfaces on two of three species. The differences, however, are not great enough to conclude that tooth-planing weakens the joint to any marked extent.

Under conditions that normally produced starved joints, tooth-planed surfaces on two of the three species gave higher joint strength than smooth surfaces. The joints produced in this way were not so strong, however, as the smoothly planed joints made under good gluing conditions.

Chilled joints were stronger with smoothly planed than with tooth-planed surfaces. This may be accounted for by the fact that it is difficult to apply the extra pressure needed to force the chilled glue uniformly into the depressions produced in the wood surface by tooth-planing.

¹Wood failure is the shearing apart of the wood fibers near the glue joint, which indicates that the bond between the glue and the wood is stronger than the wood itself.

The following table shows the results of the strength tests with hot animal glue under the three different gluing conditions:

Species		Comparative strength of joints			
of wood	Normal condition of glued joints	Tooth-planed		Smooth	
		Strength	Wood failure	Strength	Wood failure
		<u>Lb. per sq. in.</u>	<u>Percent</u>	<u>Lb. per sq. in.</u>	<u>Percent</u>
Sugar maple	Good	3132	62	3148	69
	Starved	2261	4	1993	6
	Chilled	2718	36	3014	27
White oak	Good	2401	51	2317	66
	Starved	2019	28	1786	26
	Chilled	2501	64	2508	70
Sitka spruce	Good	1792	78	1853	88
	Starved	1932	94	1941	96
	Chilled	1649	33	1803	61

These experiments with hot animal glue show that, while occasionally the average strength of glued joints obtained with tooth-planed surfaces is higher than that obtained with smooth-planed surfaces, such results are apparently confined to starved-joint conditions. Where starved-joint conditions exist, the remedy is to improve the gluing conditions rather than to roughen the surfaces of the wood.