

# TECHNICAL NOTE NUMBER 227

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## TOOTH-PLANING OR SANDING NOT NECESSARY TO EFFECT 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 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.

Animal glue mixed in the proportion of 1 pound of glue to 2-1/4 pounds of water, and casein glue prepared according to a Forest Products Laboratory formula were used in the experiments, and the strength of joints produced with tooth-planed and sanded 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 per cent relative humidity to an approximate constant moisture content of 7 per cent. 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 tooth plane. For sanding, comparatively coarse sandpaper was used. Both tooth-planing and sanding were done by hand.

In the gluing operation pairs of blocks surfaced by smooth-planing were alternated with those surfaced by tooth-planing and sanding so that all conditions of gluing might be exactly 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, by which the joint is subjected to a compressive shearing force in a specially designed machine, was used to test joint strength. The strength of joints in pounds per square inch and the nature and percentage of wood failure\* were recorded.

The experiments were conducted under three sets of gluing conditions, namely, good gluing conditions, starved-joint conditions, and chilled-joint conditions. In general, wood with roughened surfaces produced no stronger joints than wood with smooth-planed surfaces. This held true for both animal and casein glues. When animal glue was used under conditions which normally produce "starved joints," - those in which the film of glue between the wood surface is not continuous, and which result when thin glue is used with high pressure - better results were obtained with tooth-planed and sanded surfaces, but the improved joints were not so strong as those secured with smooth-planed surfaces under good gluing conditions.

Under good gluing conditions smooth-planed surfaces gave slightly stronger joints than tooth-planed surfaces in two out of three cases. The differences, however, are not great enough to conclude that tooth-planing weakens the joint to any marked extent. Chilled joints were stronger with smooth-planed than with tooth-planed surfaces. This may be accounted for by the fact that it is difficult to apply the extra pressure necessary to force the chilled glue uniformly into the depressions produced in the wood surface by tooth-planing. Under conditions which normally produced starved joints tooth-planed surfaces, with a single exception, gave appreciably higher joint strength than smooth surfaces. It should be noted,

\*Wood 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.

however, that while the tooth-planed joints made under starved-joint conditions were stronger than the smooth-planed joints under similar conditions, they were not so strong as the smooth-planed joints obtained under good conditions.

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

| Species of wood | Normal condition of glued joints | Comparative strength of joints |              |                        |              |
|-----------------|----------------------------------|--------------------------------|--------------|------------------------|--------------|
|                 |                                  | Tooth-planed                   |              | Smooth                 |              |
|                 |                                  | Strength                       | Wood failure | Strength               | Wood failure |
|                 |                                  | Pounds per square inch         | Per cent     | Pounds per square inch | Per cent     |
| 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           |

The experiments 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; and that where starved-joint conditions exist, the remedy is to improve the gluing conditions rather than to roughen the surfaces of the wood.