

# A NEW METHOD FOR DETERMINATION OF GLUE JOINT SHEAR-STRENGTH IN LAMINATED WOOD

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## ABSTRACT

Cylindrical samples, 3.1 cm in diameter, were used for determination of "strength properties of adhesives in shear by compression loading." Testing was conducted by use of a hand dynamometer (torque wrench). Comparison of the results between cylindrical and standard orthogonal samples (ASTM D905-49) showed that the proposed method can replace the standard method with significant accuracy, and the relationship of values obtained is linear  $y = 2.19 + 173.19x$  with coefficient of correlation  $r = 0.67$ .

*Keywords:* Glue joints, shear strength, laminated wood.

## INTRODUCTION

The block shear test of ASTM D 905-49 is the most common method employed for measuring adhesive strength in wood laminates. The specimens (glued wooden blocks) are placed in a testing machine equipped with a special shearing tool and tested to destruction in compression shear (Fig. 1A). The pressure required to produce failure is noted and the percentage of area of the joint where the wood surface is torn out by the glue is estimated. Both of these values are then used in considering the quality of the joint.

In 1962 Selbo devised a technique for compression shear-testing 1-inch-round plugs drilled from laminated-beam assemblies. Gaudert and Carroll (1973) applied Selbo's technique to sampling and testing assembly gluelines in plywood-lumber composites using  $\frac{5}{8}$ -inch cylindrical cores. Fox and Warren (1973) modified Selbo's method by using 0.93-inch-round plugs and preparing two parallel loading surfaces a distance of 0.59 inch from each other.

The testing procedure adopted by the Plywood Fabricator Service of the American Plywood Association is based on cutting 2-inch-diameter plugs from nonvital parts of the assembly. These plugs are then sawn into rectangular specimens, which are used for block shear testing.

For the load application at all the above methods, a universal testing machine was used with suitable devices.

## PROPOSED METHOD

The method proposed here is based on a compression shear test. The sample is circular (3.1 cm in diameter) and is removed with a small cylindrical saw. Testing is conducted by use of hand dynamometer (torque wrench), while the sample is gripped in a wrench: the plane of test (shearing position) coincides with the glued surface (Fig. 1B). The shear force was directed parallel to the longitudinal fiber direction. The maximum work to produce failure is then estimated. Details

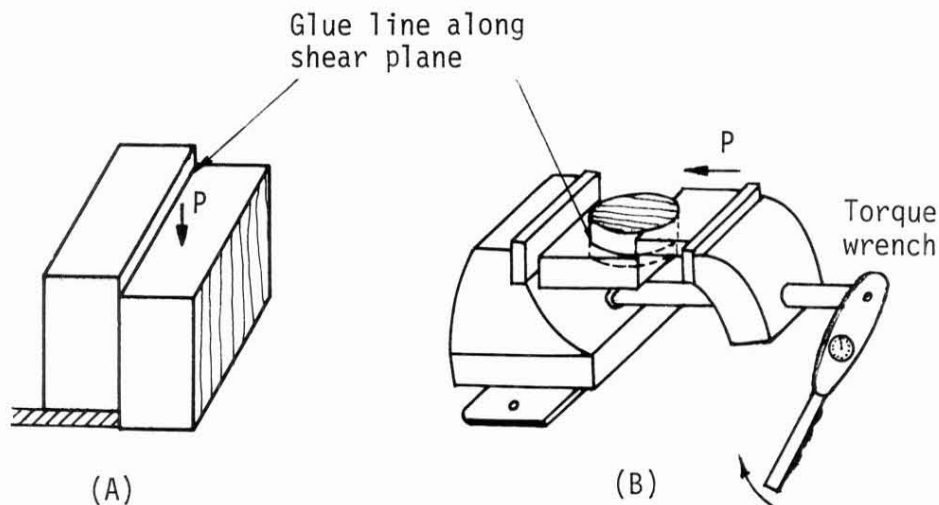


FIG. 1. Samples and direction of load application for determination of shear strength of adhesives (A) Standard method (ASTM D 905-49) and (B) Proposed method.

of sample preparation and shearing device are described in a previous publication (Passialis and Tsoumis 1982).

Circular samples, as opposed to standard (rectangular) ones, have the advantage that they may be quickly extracted from any position of wood laminate; the laminate is not cut off as in preparing standard samples; and the sampling position (hole) may be refilled. However, some difficulties in extracting circular samples may arise when high density wood species are used.

The assembly for load application is cheap and easily fabricated.

Circular samples with similar technique were used in a previous experiment for testing internal bond of particleboard (Passialis and Tsoumis 1982) or testing shear strength in the plane of the board and glue-line shear strength of particleboard (Passialis 1983). The present proposal, as described above, constitutes a simple and fast test.

#### EVALUATION OF THE METHOD

The proposed method was evaluated by comparing circular with rectangular samples prepared from four different<sup>1</sup> laminated wooden beams. Circular samples were prepared with 3.1 cm diameter, while the rectangular ones had the standard 5 × 5 cm dimensions according to the ASTM D 905-49 method (1972). The total number of tested samples was 42 (21 circular and 21 rectangular). Each laminated member supplied 5 circular and 5 rectangular samples (one member 6 circular

<sup>1</sup> In order to attain variability of strength values the four wooden members chosen represents different glued materials; i.e., poplar wood glued with urea-formaldehyde, pine wood glued with urea-formaldehyde, poplar wood glued with phenol-resorcinol-formaldehyde and pine wood glued with phenol-resorcinol-formaldehyde (poplar, *Populus × euramericana* cv. I-214 of dry density 0.32 g/cm<sup>3</sup> and pine, *Pinus nigra* of dry density 0.52 g/cm<sup>3</sup>).

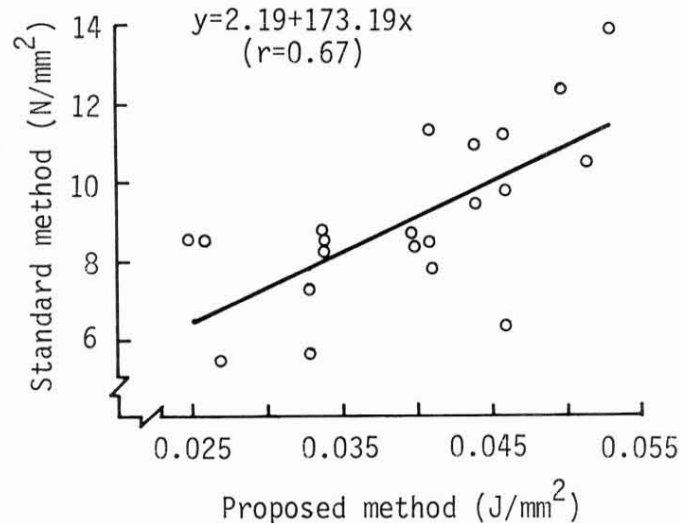


FIG. 2. Relationship of results obtained by testing with the proposed and the standard method.

and 6 rectangular), and each couple (one circular and one rectangular sample) was taken from adjacent positions.

The results<sup>2</sup> are shown in Fig. 2. The relationship of values obtained between the proposed and the standard method is linear, with a coefficient of correlation  $r = 0.67$  (statistically significant at  $P = 99\%$ ).

The method appears sufficiently promising to be used where it becomes necessary to make tests on glued joints of laminated members in quality control.

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<sup>2</sup> Percentage of wood failure is not included in this work.