SHEAR TEST FIXTURE DESIGN FOR ORTHOTROPIC MATERIALS

Jen Y. Liu
USDA Forest Service, Forest Products Laboratory, One Gifford Pinchot Dr., Madison, WI 53705-2398

This paper compares the Iosipescu shear test to its derivatives: the Wyoming, FPL, and Idaho shear tests.

Iosipescu Shear Test

In 1967, Iosipescu [l] published his shear strength test method for metals. The test specimen was a beam with two 90° notches located on the opposite edges at midspan. The depth of each notch was equal to a quarter of the total height. The test fixture was made of two identical portions antisymmetrically placed with respect to the specimen and introduced between the heads of the testing machine (Fig. 1). Under compressive or tensile loading, a uniform shear stress was introduced to the notched, or critical, section of the specimen. The pure shear state was verified by methods of photoelasticity.

Wyoming Version of Shear Test

Walrath and Adams [2,3] reported their version of the Iosipescu shear test for composite materials. The movable portion of the fixture is attached to a bearing post, presumably for maintaining stability (Fig. 2). Thus, the antisymmetry of the two portions is not maintained. This version was later adopted as an ASTM standard [4].

The interaction between the specimen and the test fixture was investigated by Odom et al. [5]. They identified three problems: (a) the fixture does not load the specimen asymmetrically; (b) the specimen twists during test; and (c) the two fixture portions may misalign during test. Ifju [6] also reported that the Wyoming shear test did not produce pure shear, as evidenced by the presence of normal strains in the critical section of the specimen.

Idaho Version of Shear Test

Conant and Odom [7] found that lateral instability of the specimen was the main cause of the undesirable effects in the Wyoming shear test fixture (Fig. 2). After testing a series of prototype fixtures, these authors devised the Idaho shear test fixture (Fig. 3). First, they restored the antisymmetry of the two portions of the fixture as specified in Figure 1. Then, they introduced two fixture guide rods to constrain the fixture to move along the rods only. The rods ran on adjustable linear bearings that could be tightened to obtain zero-play to prevent out-of-plane movement, which is possible when the specimen consists of a nonhomogeneous material such as wood. Under pure shear loading, a material undergoes a shear deformation if it is isotropic or a shear deformation plus normal deformation if it is anisotropic. A square element under shear changes its shape, and the distance between two opposite sides cannot remain the same. Thus, horizontal stresses will be induced on the guide rods (Fig. 3) and transmitted to the critical section of the specimen.

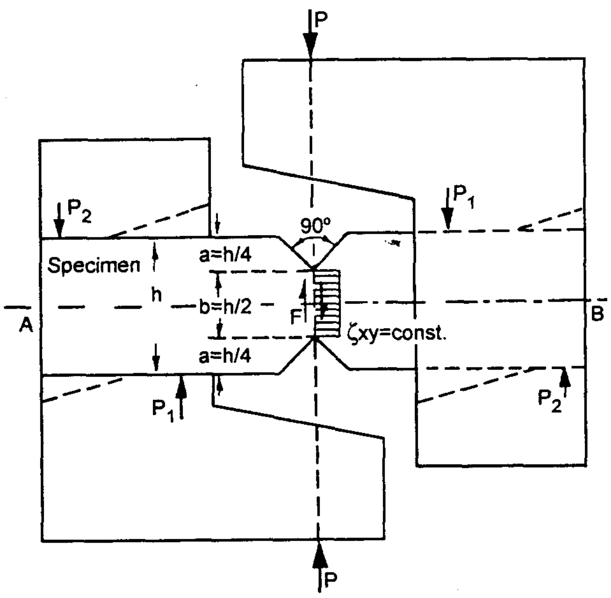

Fig. 1. Iosipescu shear test fixture [1]. Used with permission (Fig. 14a, *J. Materials* 2(3), 1994, p. 551).

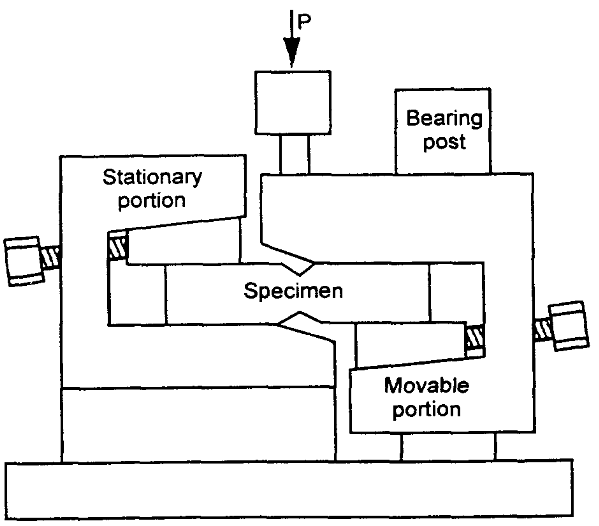

Fig. 2. Modified Wyoming shear test fixture [3]. Used with permission (Fig. 1, *Exp. Mech.* 34(4), 1994, p. 369).

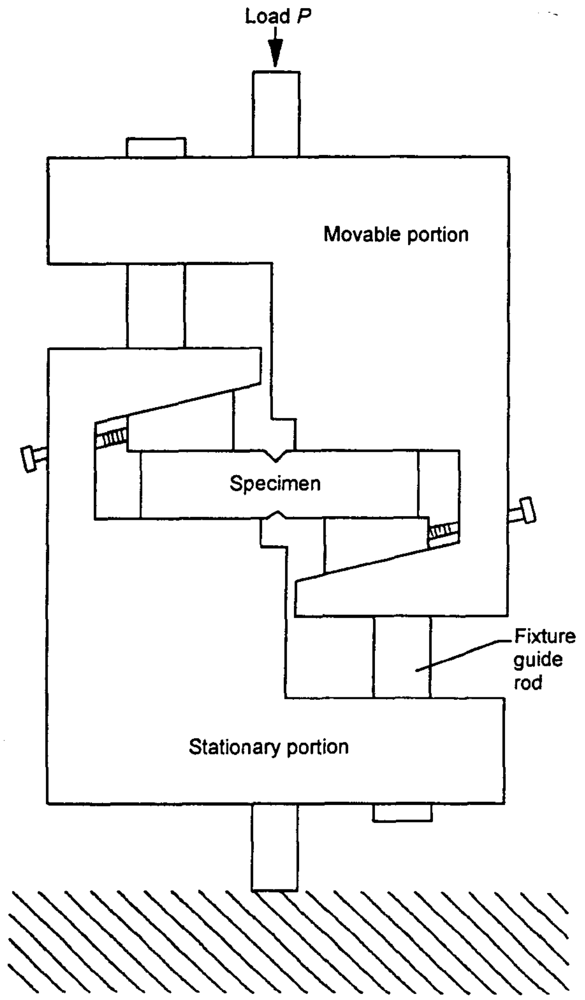

Fig. 3. Idaho shear test fixture [8]. Used with permission (Fig. 4, *J. Wood Sci.* 45(l), 1999, p. 26).

FPL Version of Shear Test

Liu et al. [9] designed the FPL shear test fixture (Fig. 4), in which the conventional parts consist of the right upper and left lower parts. The right lower and the left upper parts are the two controlling blocks. These blocks are guided in their orientation to the conventional parts by two pairs of rods that move on ball bushings. The left upper block is held in fixed orientation to the left lower part by two vertical rods and to the right upper part by two horizontal rods (only one is visible in Fig. 4). The right lower block is similarly installed with respect to the two parts. The loading devices rest on the top of the right upper part and at the bottom of the left lower part and are contolled by heavy screws. The design of the FPL fixture overcomes the constraint in the Idaho shear test fixture and functions the same as the Iosipescu fixture, except that the FPL fixture will not twist or misalign for specimens of wood or other orthotropic materials.

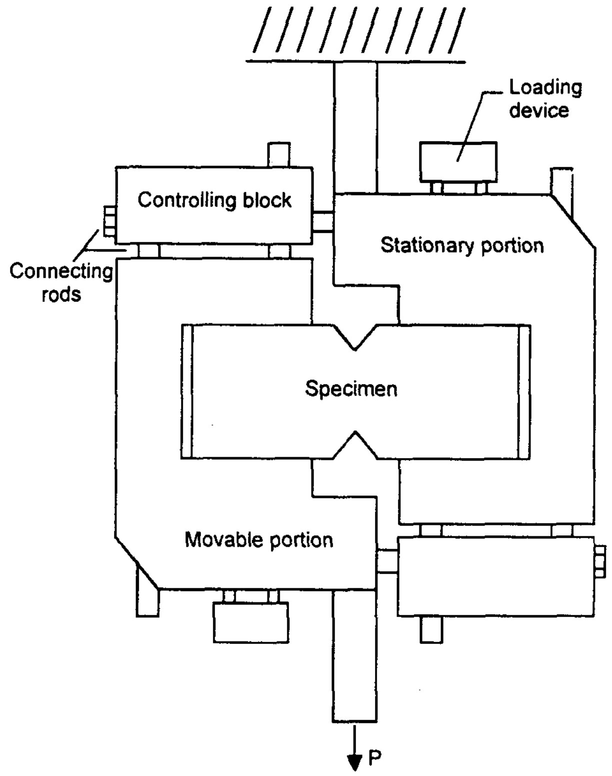

Fig. 4. FPL shear test fixture [8].

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