Designation: ~~D6958 – 03 (Reapproved 2014)~~ D6958 – 20

Standard Test Methods for Evaluating Side-Bonding Potential of Wood Coatings[1]

This standard is issued under the fixed designation D6958; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods describe an evaluation procedure for the determination of undesirable side-bonding of coatings for wood flooring. They provide two mechanical properties tests for the quantitative determination of the cohesive strength of wood coatings (tensile and lap ~~shear); they also provide a wood floor simulation test for the qualitative determination of side-bonding potential of wood coatings~~.shear).

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D9 Terminology Relating to Wood and Wood-Based Products

D2370 Test Method for Tensile Properties of Organic Coatings

~~D4444~~D7438 ~~Test Method for Laboratory Standardization and Calibration~~Practice for Field Calibration and Application of Hand-Held Moisture Meters

E4 Practices for Force Verification of Testing Machines

~~2.2 *British Standards:*[3]~~

~~B.S. 1204 British Standard Test for Synthetic Resin Adhesives~~

[1] These test methods are under the jurisdiction of ASTM Committee D07 on Wood and are the direct responsibility of Subcommittee D07.01 on Fundamental Test Methods and Properties.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 *Maple Flooring Manufacturers Association (MFMA):*[3]
~~Guide Specification for Double Plywood Floor System~~ Grading Rules for MFMA Hard Maple
~~Guide Specification for Sleeper and Sleeper with Plywood Floor Systems~~
~~2.4 *Wood Flooring Manufacturers Association (NOFMA):*~~[5]
~~Cracks in Hardwood Floors~~
2.3 *National Wood Flooring Association (NWFA):*[4]
~~Hardwood Floors Trouble Shooting Manual~~Technical Publication C200 Problems, Causes, and Cures

3. Terminology

3.1 *Definitions*—For general definitions of terms related to wood, refer to Terminology D9.

3.2 ~~*Definitions:*~~*Definitions of Terms Specific to This Standard:*

~~3.1.1 Definitions used in these test methods are in accordance with terminology used in Terminology D9. A few related terms not covered in these test methods are as follows:~~

3.2.1 *panelization*—~~adjacent boards~~ condition caused by side-bonding, excessive installation adhesive, substrate movement, or other factors where localized gaps develop between flooring strips while adjacent boards remain in tight contact acting as a composite panel instead of individual ~~strips when subjected to changes in temperature and humidity as well as other site conditions.~~strips.

3.2.2 *panelization failure*—~~the~~ condition where localized excessive gaps beyond specified limits develop between some strip flooring boards due to panelization.

3.2.3 *percent wood failure*—~~the~~ rupturing of wood fibers in strength tests on bonded specimens usually expressed as the percentage of total area ~~involved,~~involved which shows such ~~failure. The~~ failure and is the inverse of adhesive failure.

3.2.4 *side-bonding*—~~the~~ bonding of adjacent strips of wood flooring caused by the floor coating resulting in panelization. ~~This is one possible cause of panelization failure.~~
3.2.4.1 *Discussion*—
Side-bonding is most commonly caused when installed wood flooring boards have become adhered to each other. Finish materials, especially water-based products, that have seeped between the boards, and the glue used on the flooring tongue-and-groove joint are two common sources of side-bonding. Side-bonding wood failure can occur as side-bonded flooring boards shrink due to loss of moisture after installation.

3.2.5 *side-bonding wood failure*—~~the~~ failure of the wood within a strip, as in classic wood failure, when the movement of the strip within the floor is restrained from moisture-related movement by ~~excessive side-bonding. In this situation, the toughness or "work-to-break" of the side-bonding is sufficient to overcome the~~ side-bonding and the resulting stress overcomes the tensile strength perpendicular to the grain of the wood strip.

3.2.6 *tensile stress (nominal)—as used in Test Method D2370*, the load per original unit area at which a specimen fails or yields in a tension (pull) test.

~~SECTION I—MECHANICAL PROPERTIES TESTS~~

TEST METHOD A—MAPLE BLOCK TENSILE STRENGTH TEST

4. Significance and Use

4.1 This test method was originally designed as a means of quantitatively measuring the level of adhesion of the wood-wood

~~[3] Available from British Standards Institute (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., http://www.bsi-global.com.~~
[3] Available from the Maple Flooring Manufacturers Association, Inc. (MFMA), ~~111 Deer Lake Road, Suite 100, Deerfield, IL 60015,~~1425 Tri State Parkway, Suite 110, Gurnee, IL 60031, http://www.maplefloor.org.
[4] Available from the National Wood Flooring Association (NWFA), 111 Chesterfield Industrial Boulevard, Chesterfield, MO 63005, ~~http://www.woodfloors.org~~http://www.nwfa.org

interface caused by a wood coatings system applied to the substrate. The tensile test is useful in measuring bonding strength of coatings, such as gymnasium coatings, in which the wood strip flooring primarily expands or contracts in response to changes across the cross-sectional width of the strip floor.

4.2 This test method was further designed as a means of measuring the side-bonding potential of wood coating systems.

5. Apparatus

5.1 *Tensile Tester,* of the constant rate of jaw separation type, equipped with load cells having capacities of 100 to 1000 lb (445 to 4452 N), ~~and equipped with an indicating device such as an electronic constant speed chart recorder, a digital device that displays numerical values, or a printer that records the numerical values~~a data acquisition device capable of capturing the peak load, and suitably sized grips to hold the test specimens in place during testing. The machine must be capable of maintaining a cross head velocity during testing of 0.1 in./min (2.54 ~~mm/min), and if using a strip chart recorder, a chart speed during testing of 10 in./min (254 mm/min).~~mm/min). The load cells shall be calibrated to an accuracy of at least ±1 % in accordance with Practice E4.

5.2 *Clamp Assembly,* capable of holding assembled test specimen and maintaining a clamp pressure of 100 psi (690 ~~kPa).~~kPa) during curing.

5.3 *Moisture Meter,* meeting the requirements of ~~Test Method~~ Practice ~~D4444~~D7438.

5.4 *Foam Polybrushes,* 1 in. (25.4 mm) wide.

6. Procedure

6.1 Material for testing shall be ~~#2 or better, MFMA~~ "Second and Better," "MFMA-PQ" grade certified hard maple (Acer saccharum) ~~tongue~~ parquet flooring as specified in the Maple Flooring Manufacturers Association *Parquet Flooring Grading Rules.*~~and groove strip flooring, 2~~ These rectangular, edge-grained strips shall have a planed finish and be ⅞ ± 0.03 in. (~~57.2~~(22.2 ± 0.8 mm) in width by 7⁄16 ± 0.01 in. (~~19.8~~(11.1 ± 0.3 mm) in thickness. The segments chosen for testing shall be clear wood that is as straight-grained and free from visual defects as possible. Unless required to satisfy the test objectives and reported, adherence tests shall be conducted using factory-planed surfaces that are representative of typical field conditions.

6.2 ~~Test stock shall be prepared by cutting off the tongue and planing the edge smooth.~~ Blocks for testing shall be cut to a length of ~~3.00~~1.25 ± 0.01 in. (~~76.2~~(31.8 ± 0.3 mm).

6.3 Test blocks shall be conditioned at 75 ± ~~5°F~~5 °F (24 ± ~~3°C~~)3 °C) and 50 ± 2 % relative humidity for a minimum of seven days. These conditions ~~equate to an~~ are intended to produce at least a surface equilibration moisture content ~~(EMC)~~ of ~9 % (see X1.3). After ~~equilibrating,~~conditioning, use a moisture meter to determine the ~~EMC~~ moisture content of all test ~~blocks,~~ blocks in accordance with Practice D7438, then calculate and report the average ~~EMC.~~moisture content. Alternative conditioning environments shall be permitted provided that they are reported.

6.4 A minimum of ~~twenty~~20 test blocks shall be used to prepare a minimum of ten assemblies for testing of each coating to be evaluated (see Fig. 1).

6.5 Test assemblies consist of two test blocks "edge-glued" using the floor coating as an adhesive (see Fig. 1). The coating to be evaluated shall be applied using a polybrush to the smooth edge of both test blocks at a rate of 500 ± 5 ft^2/gal (12.3 ± 0.1 m^2/L) or as specified by the coating manufacturer. After a ~~5 min~~ 5-min open time the test block pairs shall be assembled by placing the coated surfaces together and clamping the joint at 100 psi (690 kPa) pressure. Test assemblies shall remain clamped for a minimum of 48 h.

6.6 Test assemblies shall be cured at 75 ± ~~5°F~~5 °F (24 ± ~~3°C~~)3 °C) and 50 ± 2 % relative humidity for a minimum of seven days including the clamp time. After ~~equilibrating,~~curing, use a moisture meter to determine the ~~EMC~~ moisture content of all test ~~assemblies,~~ assemblies in accordance with Practice D7438, and calculate the average ~~EMC.~~moisture content. Alternative curing conditions shall be permitted provided that they are reported.

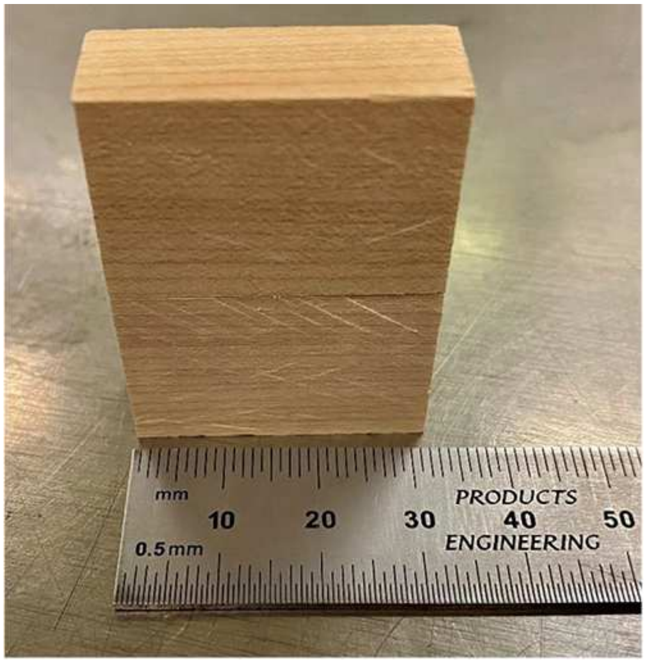

FIG. 1 Test Method A, Maple Block Tensile Strength ~~Test-Test Blocks (top), Test Assembly (bottom)~~Test—Test Block

6.7 Measure and record the length and width of the test assembly to the nearest 0.01 in. (0.3 mm). Calculate the test area of each test assembly.

6.8 Test assemblies shall be secured in a test machine using grips that include either a universal joint on each end or a means to adjust the grips to ensure that the direction of applied force is perpendicular to the adhered surface (see Fig. 2~~) and~~). They shall be pulled apart in tension at a rate of 0.1 in./min (2.54 mm/min).

6.9 Record the ultimate ~~load,~~ (peak) load, ultimate tensile stress, location of failure (coating-coating interface, coating-wood interface, within wood), an estimate of the percent wood failure, and the average ~~EMC.~~moisture content.

7. Report

7.1 Report the number of samples tested, ~~the~~ any deviations from the default conditioning or curing conditions, the location of failure (coating-coating interface, coating-wood interface, within wood), an estimate of the percent wood failure, the average moisture content, and the average ~~EMC.~~ultimate tensile strength as load and stress.

8. Precision and Bias

8.1 Until sufficient data are available as a result of performing these tests, no specific precision and bias statement can be expressed.

TEST METHOD B—MAPLE STRIP LAP SHEAR TEST

9. Significance and Use

9.1 This test method was originally designed as a means of quantitatively measuring the level of adhesion of the wood-wood bond interface caused by a wood coatings system applied to the substrate. The lap shear test is useful for measuring bonding strength of coatings used on parquet or other similar types of flooring, where longitudinal movement of the flooring is a concern (for example, the shear force as the individual wood pieces slide past each other).

9.2 This test method was further designed as a means of measuring the side-bonding potential of wood coating systems.

FIG. 2 Assembly Secured in Testing Machine

10. Apparatus

10.1 *Tensile Tester,* of the constant rate of jaw separation type, equipped with load cells having capacities of 100 to 1000 lb (445 to 4452 N), ~~and equipped with an indicating device such as an electronic constant speed chart recorder, a digital device that displays numerical values, or a printer that records the numerical values as well as~~ a data acquisition device capable of capturing the peak load, and suitably sized grips to hold the test specimens in place during testing. The machine must be capable of maintaining a cross head velocity during testing of 0.1 in./min (2.54 ~~mm/min), and if using a strip chart recorder a chart speed during testing of 10 in./min (254 mm/min).~~mm/min). The load cells shall be calibrated to an accuracy of at least ±1 % in accordance with Practice E4.

10.2 *Clamp Assembly,* capable of holding assembled test specimen and maintaining a clamp pressure of 100 psi (690 ~~kPa).~~kPa) during curing.

10.3 *Moisture Meter,* meeting the requirements of ~~Test Method~~ Practice ~~D4444~~D7438.

10.4 *Foam Polybrushes,* 1 in. (25.4 mm) wide.

11. Procedure

11.1 Source material for testing shall be “Second and Better” grade, Maple Flooring Manufacturers Association certified hard maple (Acer saccharum) tongue-and-groove strip flooring, 2¼ ± 0.03 in. (57.2 ± 0.8 mm) in width by $^{25}/_{32}$ ± 0.01 in. (19.8 ±

0.3 mm) in thickness. Alternatively, it shall be permitted to use ¾ in. (31.8 mm) quarter-sawn hard maple lumber planed to an approximate thickness of 1 in. (25.4 mm) for the source material. Regardless of source material type:

11.1.1 The growth rings shall be permitted to be at any angle, from 0 to 90° inclusive, relative to the face.

11.1.2 The source material shall be chosen so that the resulting strips shall be flat and free from splits, knots, whorls, and decay, that the angle of inclination of the grain across the face of each test strip shall be not greater than 1 in 9, and that the grain shall not be obviously inclined to the face (see Appendix X2).

11.2 Test stock shall be prepared by cutting off the tongue and planing the edge smooth. Strips for testing shall be planed from this test stock to a width of 1.0 ± 0.01 in. (25.4 ± 0.3 mm), a length of 4.5 ± 0.01 in. (114 ± 0.3 mm), and a thickness of 0.125 ± 0.006 in. (3.18 ± 0.15 mm). The face of the strip to be adhered should be planed; the opposing face that is not adhered shall be permitted to be planed or smoothly sawn.

11.3 Test strips shall be conditioned at 75 ± 5 °F (24 ± 3 °C) and 50 ± 2 % relative humidity for a minimum of seven days. These conditions are intended to produce at least a surface moisture content of ~9 %. Alternative conditioning shall be permitted provided that it is reported. After conditioning, use a moisture meter to determine the moisture content of all test strips in accordance with Practice D7438, and calculate the average moisture content.

11.4 A minimum of 20 test strips shall be used to prepare a minimum of ten assemblies for testing of each coating to be evaluated (see Fig. 3).

11.5 ~~Material for testing shall be #2~~ Test assemblies consist of two test strips "face-glued" using the floor coating as an adhesive. The coating to be evaluated shall be applied using a polybrush on a one-inch overlap test area on the ends of the test strips at a rate of 150 ± 5 ft^2/gal (3.7 ± 0.1 m^2~~or better, MFMA certified hard maple (Acer saccharum)~~/L) or as specified by the coating manufacturer (see Fig. 3~~tongue and groove strip flooring, 2~~). After a 5-min open time the test strip pairs shall be assembled by

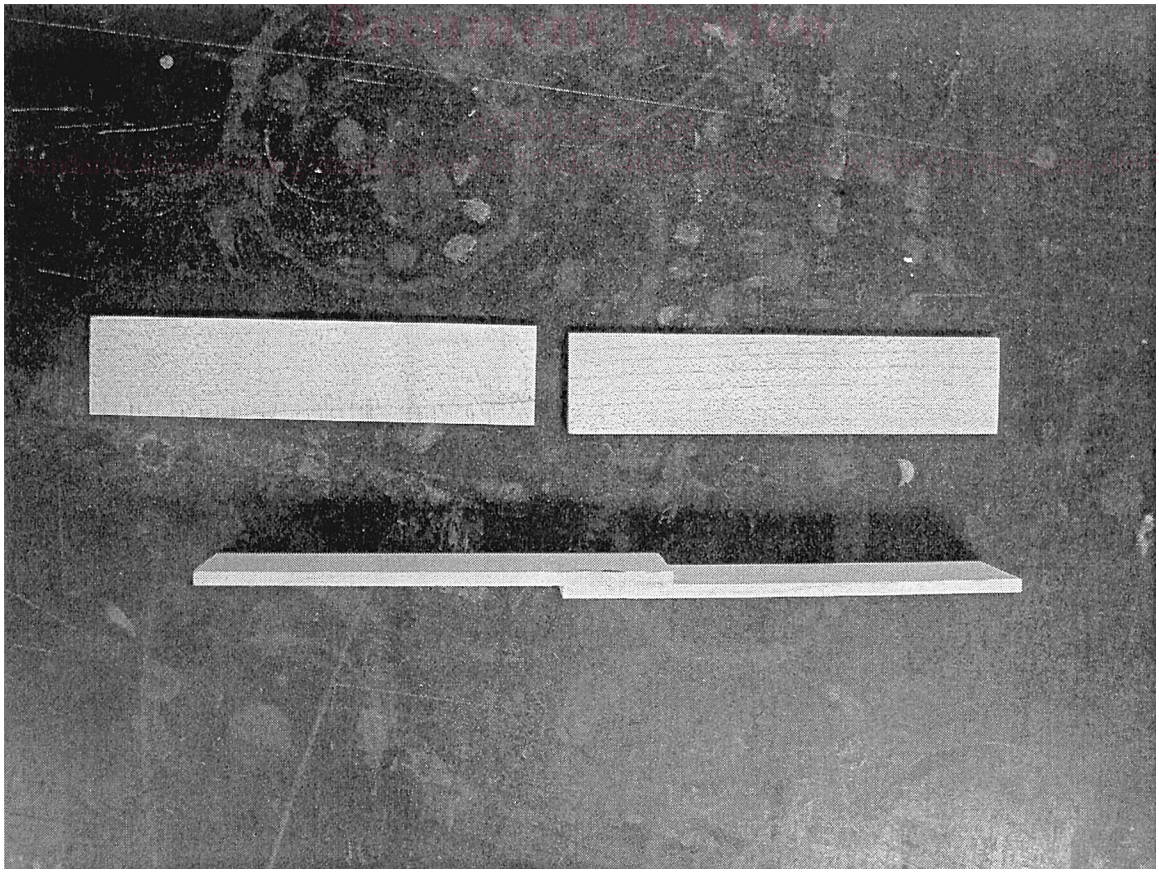

FIG. 3 Test Method B, Maple Strip Lap Shear ~~Test-Test~~Test—Test Strips (top), Test Assembly (bottom)

placing the coated surfaces together and clamping the joint at~~¼ ± 0.03 in. (57.2 ± 0.8 mm) in width by~~100 psi (690 kPa) pressure. Test assemblies shall remain clamped ~~25/32 ± 0.01 in. (19.8 ± 0.3~~for a minimum of 48 h (see Figs. 4 and 5~~mm) in thickness.~~).

~~11.1.1 Test stock shall be prepared by cutting off the tongue and planing the edge smooth. Strips for testing shall be planed from this test stock to a width of 1.0 ± 0.01 in. (25.4 ± 0.3 mm), a length of 4.5 ± 0.01 in. (114 ± 0.3 mm) and a thickness, 0.125 ± 0.006 in. (3.18 ± 0.15 mm) (see Appendix X2).~~

~~11.1.2 Test strips shall be conditioned at 75 ± 5°F (24 ± 3°C) and 50 ± 2 % relative humidity for a minimum of seven days. These conditions equate to an EMC of ~9 % (see X1.3). After equilibrating, use a moisture meter to determine the EMC of all test strips, and calculate the average EMC.~~

~~11.1.3 A minimum of twenty test strips shall be used to prepare a minimum of ten assemblies for testing of each coating to be evaluated (see Fig. 3).~~

~~11.1.4 Test assemblies consist of two test strips "face-glued" using the floor coating as an adhesive. The coating to be evaluated shall be applied using a polybrush on a one-inch overlap test area on the ends of the test strips at a rate of 150 ± 5 ft^2/gal (3.7 ± 0.1 m^2/L) or as specified by the coating manufacturer (see Fig. 3). After a 5 min open time the test strip pairs shall be assembled by placing the coated surfaces together and clamping the joint at 100 psi (690 kPa) pressure. Test assemblies shall remain clamped for a minimum of 48 h (see Figs. 4 and 5).~~

~~11.1.5 Test assemblies shall be cured at 75 ± 5°F (24 ± 3°C) and 50 ± 2 % relative humidity for a minimum of seven days including the clamp time. After equilibrating, use a moisture meter to determine the EMC of all test assemblies, calculate and report the average EMC.~~

~~11.1.6 Measure and record the length and width of the test area to the nearest 0.01 in. (0.3 mm). Calculate the test area of each test assembly.~~

~~11.1.7 Test assemblies shall be secured in a test machine (see Fig. 2) and pulled apart in tension at a rate of 0.1 in./min (2.54 mm/min).~~

~~11.1.8 Record the ultimate load, location of failure (coating-coating interface, coating-wood interface, within wood), an estimate of the percent wood failure and the average EMC.~~

11.6 Test assemblies shall be cured at 75 ± 5 °F (24 ± 3 °C) and 50 ± 2 % relative humidity for a minimum of seven days

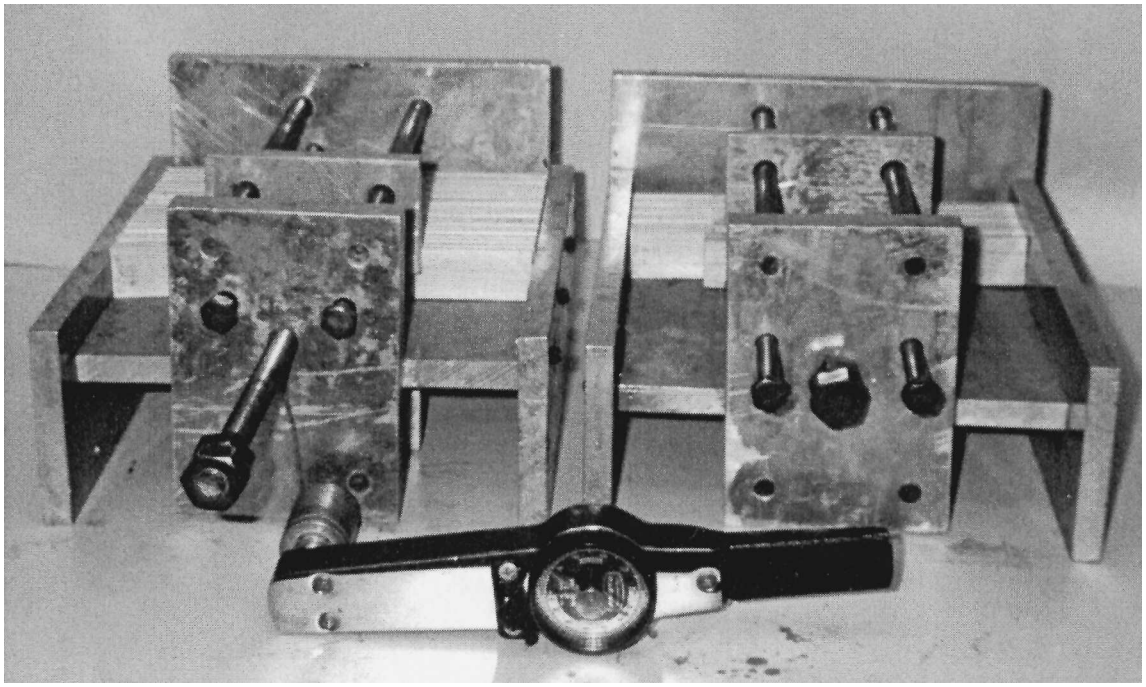

FIG. 4 Front View of Clamp Assembly