ICC EVALUATION SERVICE, INC.
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February 28, 2008

TO: **PARTIES INTERESTED IN EVALUATION REPORTS ON METAL HINGE PLATE CONNECTORS FOR WOOD TRUSSES**

SUBJECT: Acceptance Criteria for Metal Hinge Plate Connectors for Wood Trusses, Subject AC283-0208-R1 (MO/RB/RK/JS)

Dear Madam or Sir:

Enclosed is a copy of the subject revised acceptance criteria approved by the ICC-ES Evaluation Committee on February 5, 2008, effective March 1, 2008.

The following revisions were approved by the committee:

1. Updated references to the 2006 *International Building Code*® (IBC) and the 2006 *International Residential Code*® (IRC).

2. Added a reason statement to Section 1.2.

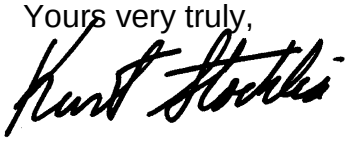
3. Made revisions to the allowable shear and allowable tension formulas listed in Sections 3.5.1 (A) and 3.5.2(A) of the criteria. The denominator (Factor of Safety) was changed from 3.0 to $(1.6/\Phi_C)$. Made companion revisions to Sections 3.5.3 and 3.5.4, to provide separate formulas for resistance factors for connections, Φ_C, and members, Φ_M.

4. Revised Figure 4 for joint testing of both 13-inch- and 24-inch-long specimens. Made companion changes to Sections 3.4 and 5.3.2 to clarify use of 13-inch test specimens.

Evaluation reports issued on or after the effective date noted above, and falling within the scope of this criteria, will be required to comply with the enclosed edition of the criteria. Evaluation reports issued prior to the effective date may be in compliance either with the enclosed acceptance criteria or with the previous edition. Evaluation reports based on a superseded version of an acceptance criteria must be brought into compliance with the most recent edition at the time the reports are reissued. Therefore, applicants should submit data verifying compliance at the time they apply for re-examination.

If you have any questions, please contact Michael O'Reardon, P.E., Senior Staff Engineer, at (800) 423-6587, extension 5685. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,



Kurt Stochlia, P.E.
Vice President

KS/raf

Enclosure

cc: Evaluation Committee

ACCEPTANCE CRITERIA FOR METAL HINGE PLATE CONNECTORS FOR WOOD TRUSSES

AC283

Approved February 2008

Effective March 1, 2008

Previously approved June 2005

PREFACE

Evaluation reports issued by ICC Evaluation Service, Inc. (ICC-ES), are based upon performance features of the International family of codes and other widely adopted code families, including the Uniform Codes, the BOCA National Codes, and the SBCCI Standard Codes. Section 104.11 of the *International Building Code*® reads as follows:

> The provisions of this code are not intended to prevent the installation of any materials or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Similar provisions are contained in the Uniform Codes, the National Codes, and the Standard Codes.

This acceptance criteria has been issued to provide all interested parties with guidelines for demonstrating compliance with performance features of the applicable code(s) referenced in the acceptance criteria. The criteria was developed and adopted following public hearings conducted by the ICC-ES Evaluation Committee, and is effective on the date shown above. All reports issued or reissued on or after the effective date must comply with this criteria, while reports issued prior to this date may be in compliance with this criteria or with the previous edition. If the criteria is an updated version from the previous edition, a solid vertical line (**I**) in the margin within the criteria indicates a technical change, addition, or deletion from the previous edition. A deletion indicator (**➜**) is provided in the margin where a paragraph has been deleted if the deletion involved a technical change. This criteria may be further revised as the need dictates.

ICC-ES may consider alternate criteria, provided the report applicant submits valid data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria set forth in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise demonstrate compliance with the performance features of the codes, ICC-ES retains the right to refuse to issue or renew an evaluation report, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

ACCEPTANCE CRITERIA FOR METAL HINGE PLATE CONNECTORS FOR WOOD TRUSSES

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for metal hinge plate connectors, used in the fabrication of wood trusses, to be recognized in an ICC Evaluation Service, Inc. (ICC-ES), evaluation report under the 2006 *International Building Code*® (IBC) and the 2006 *International Residential Code*® (IRC). Bases of recognition are IBC Section 104.11 and IRC Section R104.11. Applicable code sections for metal-plate-connected trusses are IBC Sections 2303.4 (Trusses), 2303.4.2 (Metal-Plate-Connected Trusses), 2306.1 (Allowable Stress Design), and 2308.10.10 (Conventional Light-Frame Construction—Wood Trusses); and IRC Sections R502.11 (Floors—Wood Trusses), and R802.10 (Roof-Ceiling Construction—Wood trusses).

The reason for the development of this criteria is to allow evaluation of metal hinge plate connectors for use with wood trusses, since the codes do not provide relevant test procedures in IBC Section 2303.4 or IRC Sections R502.11 and R802.10.

1.2 Scope: This criteria addresses metal hinge plate connectors that are installed in pairs in the 180-degree position on opposite faces of sheathed truss chord members. Figure 1 illustrates typical installations for these connectors. Hinge connector plates are intended to connect the wood chord members end to end in prefabricated wood trusses regulated under IBC Section 2303.4 and IRC Sections R502.11 and R802.10. The plates have a hinge and integral teeth and are designed to transmit forces between wood truss members. Unlike other metal plate connectors addressed in ANSI/TPI-1, hinge connectors include a joint that allows for rotation of the connected members in the plane of the truss. Various configurations of the hinge plate connectors allow for the connected members to rotate up to 180 degrees with respect to each other. Due to the rotation provided at the joint, the truss chord design shall be modeled as a pin connection at the hinge joint location, with the design shear force applied at 90 degrees to the longitudinal axis of the truss member.

1.3 Codes and Reference Standards:

1.3.1 2006 *International Building Code*® (IBC), International Code Council.

1.3.2 2006 *International Residential Code*®, (IRC) International Code Council.

1.3.3 ANSI/TPI 1-2002, National Design Standard for Metal Plate Connected Wood Truss Construction, Truss Plate Institute.

1.3.4 NAS-01, NASPEC 2001, North American Specification for Design of Cold-Formed Steel Structural Members, including 2004 Supplement, American Iron and Steel Institute.

2.0 BASIC INFORMATION

2.1 General: The following information shall be submitted:

2.1.1 Product Description: Information on the manufacturing process of the hinge plate; description of the teeth and hinge mechanism; specifications for the steel material, including gage, thickness and galvanization thickness.

2.1.2 Installation Instructions: Installation details and limitations, and fastening methods.

2.1.3 Packaging and Identification: A description of the method of packaging and field identification of the metal hinge plate connectors. Identification provisions shall include the evaluation report number.

2.2 Testing Laboratories: Testing laboratories shall comply with Section 2.0 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-ES Rules of Procedure for Evaluation Reports.

2.3 Test Reports: Test reports shall comply with AC85 and shall contain the information required by ANSI/TPI-1 Section 5.2.10, except that the load at critical slip of item (i) shall be replaced by the proportional limit of the wood-to-wood movement as described in Section 3.1 of this acceptance criteria.

2.4 Product Sampling: Sampling of the hinge plate connectors for tests under this acceptance criteria shall comply with Sections 3.2 and 3.4 of AC85, with sampling of solid metal coupons, from the steel coil utilized to manufacture the metal hinge plates, tested in accordance with this acceptance criteria, consistent with Sections 5.2.2.1 and 5.2.3 of ANSI/TPI-1.

3.0 TEST METHODS AND PERFORMANCE REQUIREMENTS

3.1 General: All testing, fabrication of test specimens, calculation of results, and adjustment factors shall be in accordance with ANSI/TPI-1 except as noted below. The test laboratory shall witness fabrication of the test specimens. All metal hinge plates shall be installed in the test specimens in a manner consistent with their intended use. The gap between the ends of the wood members of test specimens shall be the maximum gap that will be specified for use in design. Each joint shall be formed using two identical hinge plates with one on each side of the wood members. For the tests required by this criteria, the loads shall be applied using a universal testing machine set at a constant movable crosshead speed to attain ultimate load in not less than one minute. Wood-to-wood movement shall be recorded for purposes of obtaining a load deformation curve in order to establish the load at the proportional limit. Tests shall be performed with solid-sawn lumber having the lowest specific gravity for which recognition is sought. The metal connector plates, solid metal control specimens, wood members, and embedment methods shall conform to ANSI/TPI-1 Sections 5.2.2 through 5.2.5, 5.2.6.4 and 5.2.6.5. The thickness of the metal hinge plates shall be measured to the nearest 0.0001 inch before the test specimen is assembled.

3.2 Shear Resistance Test: Each test specimen shall be tested with the hinge plates in the 180-degree orientation. Five samples shall be tested for shear load applied at 90 degrees to the longitudinal axis of the wood members, using a setup shown schematically in Figure 2 of this criteria. The specimen shall be supported in three locations. One end shall be fixed by means of a steel collar and simple support over which the specimen cantilevers. The other end shall be simply supported on a single steel support. The load shall be applied to the specimen through a self-aligning steel loading block. The test report shall include details of the test

setup and calculations for the force transferred by the metal hinge plate between the two wood members of the test specimen.

3.3 Tension Resistance Testing: Five specimens shall be tested for tension load using a setup as shown in Figure 3 of this criteria. Other methods of applying the uniaxial tension load to the wood truss configuration may be used if submitted to and approved by ICC-ES.

3.4 Compression Resistance Testing: Five specimens shall be tested for compression load using a setup as shown schematically in Figure 4 of this criteria. The specimen shall be centered between two compression platens. The specimen length shall be 24 inches. It shall also be permitted that additional compression specimens be tested in an identical series of tests except using a 13-inch overall length when resulting design values are limited as specified in Section 5.3.2.

3.5 Hinge Plate Calculations of Allowable Basic Design Loads: For each of the tested configurations, the allowable load shall be calculated as follows:

3.5.1 Allowable Shear: P_V = The lesser of (A), (B), or (C).

where:

(A) $(P_{sp}\, R_U\, R_T) / (1.6/\phi_c)$

(B) $(P_{sp}\, R_g\, R_y\, (R_T)^{0.7}) / 3.0$

(C) The average load at the proportional limit of the wood-to-wood load deformation curves taken from testing per Section 3.2 of this criteria, divided by 1.6.

3.5.2 Allowable Tension: P_T = The lesser of (A), (B), or (C).

where:

(A) $(P_{tp}\, R_U\, R_T) / (1.6/\phi_c)$

(B) $(P_{tp}\, R_g\, R_y\, (R_T)^{0.7}) / 3.0$

(C) The average load at the proportional limit of the wood-to-wood load deformation curves taken from testing per Section 3.3 of this criteria, divided by 1.6.

3.5.3 Allowable Compression: P_C = the lesser of (A), (B) or (C).

where:

(A) $(P_{cp}\, R_U\, R_T) / (1.6/\phi_m)$

(B) P_T

(C) The average load at the proportional limit of the wood to wood load deformation curves taken from testing per Section 3.4 of this criteria, divided by 1.6.

3.5.4 Nomenclature for Section 3.5:

F_{tc} = Average ultimate tensile strength of the solid metal control specimens, psi.

F_U = Specified minimum steel ultimate tensile strength, psi.

F_y = Specified minimum steel yield strength, psi.

F_{yc} = Average yield strength of the solid metal control specimens, psi.

P_C = Allowable compression force, pounds.

P_{cp} = Average ultimate value of the compression tests, pounds.

P_{sp} = Average ultimate value of the shear tests, pounds.

P_T = Allowable tension force, pounds.

P_{tp} = Average ultimate value of the tension tests, pounds.

P_V = Allowable shear force, pounds.

R_G = Adjustment factor for specific gravity calculated according to Section 5.2.9.3 of ANSI/TPI-1, unit less.

R_T = Adjustment factor for thickness, unit less = t_{spec}/t_{test}.

R_U = Adjustment factor for ultimate strength, unit less = $F_u/F_{tc} \leq 1$.

R_y = Adjustment factor for yield strength calculated according to Section 5.2.2.1 of ANSI/TPI-1, unit less.

$t_{,test}$ = Average steel thickness of solid metal control specimens, inch.

t_{spec} = Specified minimum steel thickness, inch.

V_p = Coefficient of variation of test results, but not less than 6.5%, unit less.

ϕ_c = Resistance Factor for connections

$\phi_c = 1.672\, e^{-3.5\sqrt{(V_M^2+V_F^2+(C_P V_p^2) + 0.0441)}}$

V_M = 0.10

V_F = 0.15

ϕ_m = Resistance Factor for members

$\phi_m = 1.672\, e^{-2.5\sqrt{(0.057+(C_P V_p^2))}}$

C_p = (1+1/n)m/(m-2)

n = number of tests

m = n-1

4.0 QUALITY CONTROL

4.1 Quality documentation for the manufacturing of the metal hinge plates, complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10), shall be submitted. As a minimum, the quality control program shall comply with the quality control procedures of Chapter 4 of ANSI/TPI 1, except that the steel thicknesses shall be measured to the nearest 0.0001 inch.

4.2 Third-party follow-up inspections for the manufacturing of the metal hinge plates are not required under this acceptance criteria.

5.0 EVALUATION REPORT RECOGNITION

5.1 The design values shall not exceed those determined by this criteria under load combinations in accordance with the applicable code. No adjustments for duration of load are permitted.

5.2 Allowable tension, shear and compression loads shall be indicated in the evaluation report.

5.3 The evaluation report shall stipulate the following Conditions of Use:

5.3.1 Allowable loads shall be limited to applications of the metal hinge plates installed in pairs to truss chord members, where the plates are installed in the 180-degree position in the final installation of the trusses.

5.3.2 Allowable compression load values determined from tests of 24-inch overall length test specimens are valid for applications where sheathing is attached to the truss chord members containing the metal hinge plates, and lateral translation across the joint is inhibited by the sheathing~~'s~~ being installed continuously across the joint as prescribed by code or by other means acceptable to the code official. Allowable compression load values determined from tests of 13-inch overall length test specimens are valid for applications where lateral translation across the joint is prevented by the installation of a single piece of sheathing continuous across the joint and connected to each chord member at the joint by a nail penetrating through the sheathing and into the chord section at a location no more than 3 inches from the chord end at the hinged joint, or by other special measures specified by the building designer and acceptable to the code official. In all applications, the building designer shall not rely upon the hinge plate for transfer of any loads in a direction perpendicular to the plane of the truss, such as for design of load transfer at joints of unblocked diaphragms.

5.3.3 Materials and general design considerations shall be in accordance with Chapter 6 of ANSI/TPI-1.

5.3.4 Truss member design procedures shall be in accordance with Chapter 7 of ANSI/TPI-1.

5.3.5 Metal connector plate joint design shall be in accordance with Chapter 8 of ANSI/TPI-1.

5.3.6 Truss designs that contain hinge plates shall be prepared and sealed by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.3.7 Due to the rotation provided at the joint, the truss design shall be modeled with a pin at the hinge joint location. In the final installed condition, shear is applied at 90 degrees as shown in Figure 1 of this criteria.

5.3.8 Design of diaphragms is beyond the scope of this evaluation report.

5.4 The maximum allowed gap between the ends of the wood members at the metal hinge plates shall be stated in the evaluation report; and it shall be no greater than the gap tested.

5.5 Hinge plate use is limited to prefabricated trusses. Field installation is prohibited. Compliance with IBC Section 2303.4 or IRC Sections R502.11 and R802.10, as applicable, is required.

5.6 The evaluation report shall stipulate that the design load due to combined shear and axial loads shall not exceed the allowable load using the Hankinson formula as follows:

$$F_\theta \le P_\theta$$

where:

- F_θ = Imposed combined shear and axial load, lb = $(F_a^2 + F_v^2)^{0.5}$.
- P_θ = Allowable combined shear and axial load, lb = $(P_a \times P_V) / ((P_a \times (\sin\theta)^2 + (P_V \times (\cos\theta)^2))$.
- F_a = Imposed axial force, lb.
- F_v = Imposed shear force, lb.
- P_a = Allowable axial force, lb. (in compression or tension corresponding to imposed axial force).
- P_V = Allowable shear load, lb.
- θ (theta) = Angle between F_θ and the length of the plate. ■

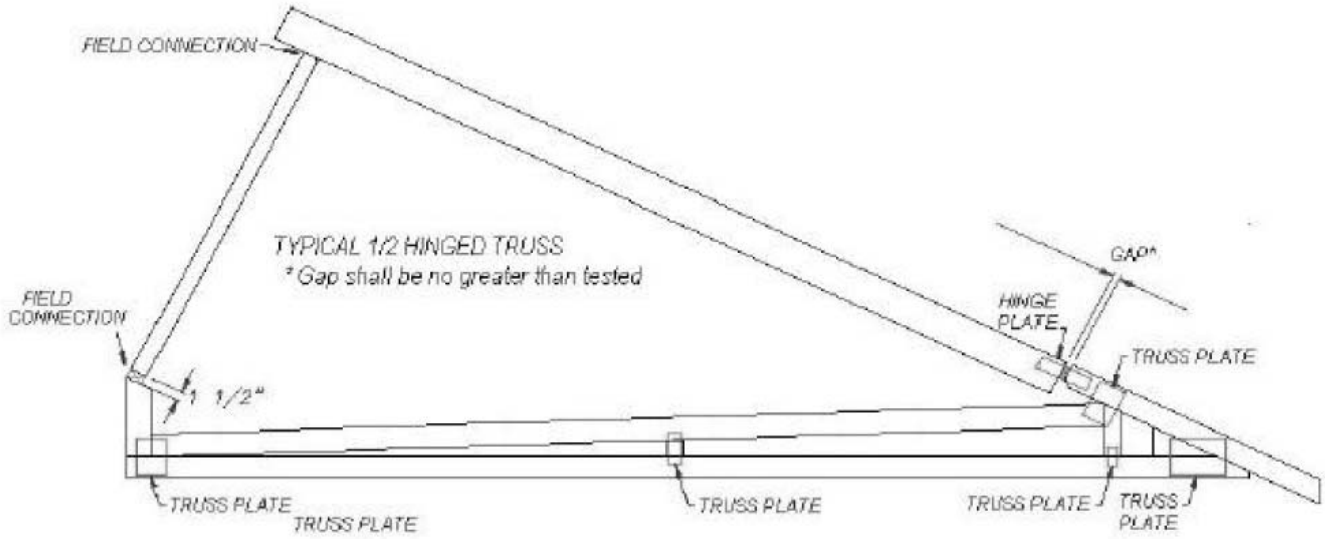


FIGURE 1—TYPICAL INSTALLATION FOR HINGE PLATE CONNECTOR

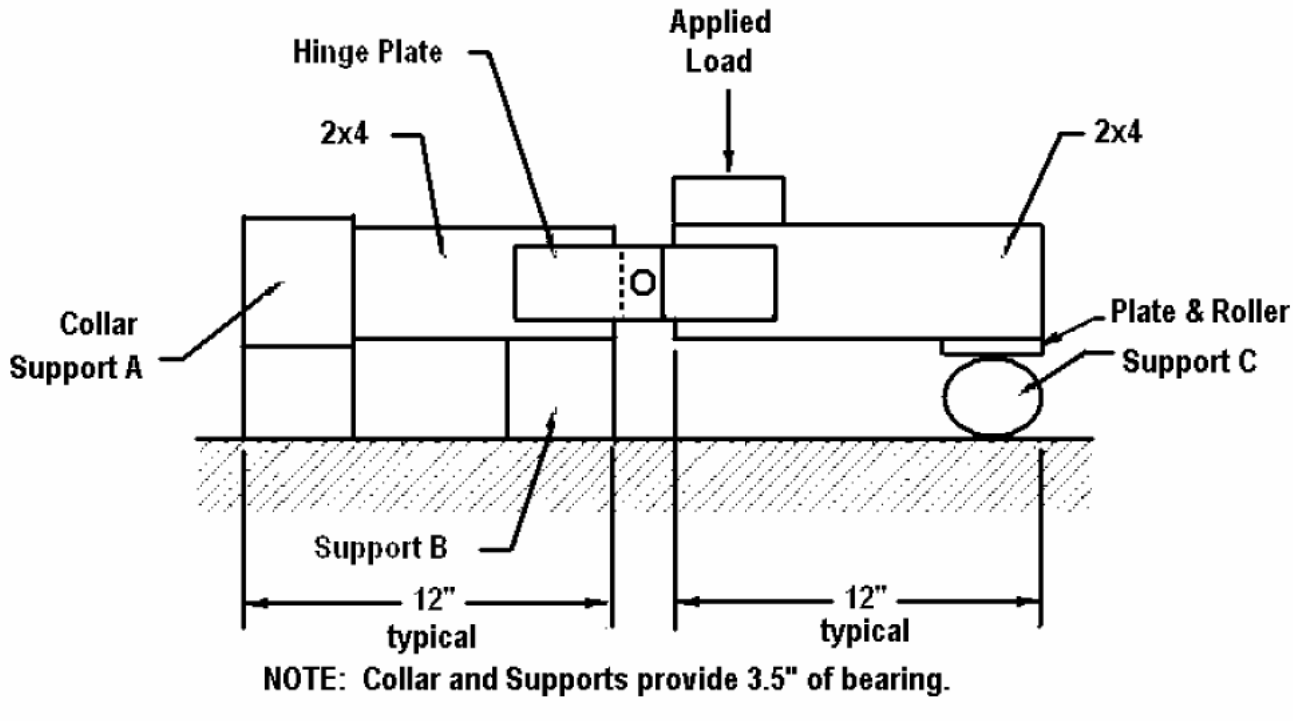


FIGURE 2—SHEAR TEST SCHEMATIC

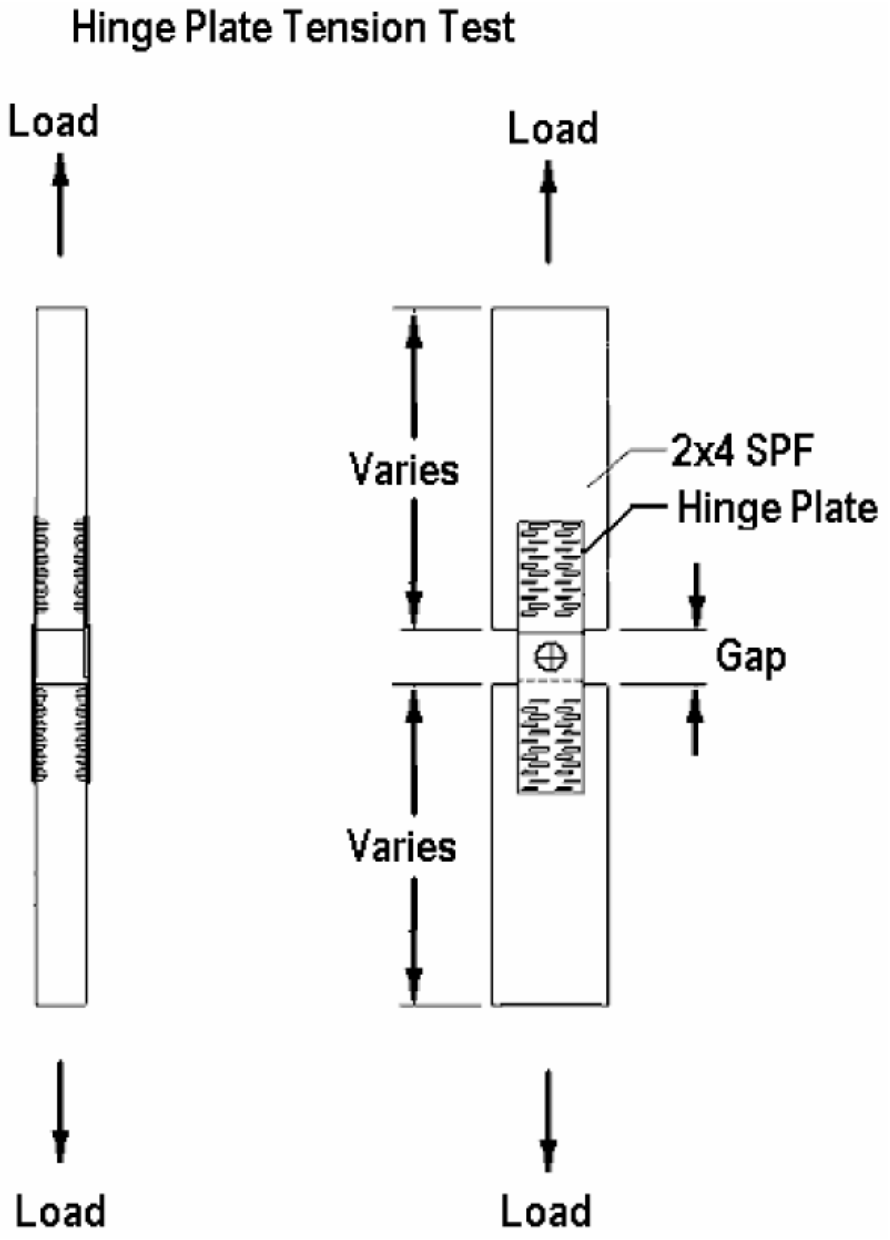


FIGURE 3—TENSION RESISTANCE TEST SCHEMATIC

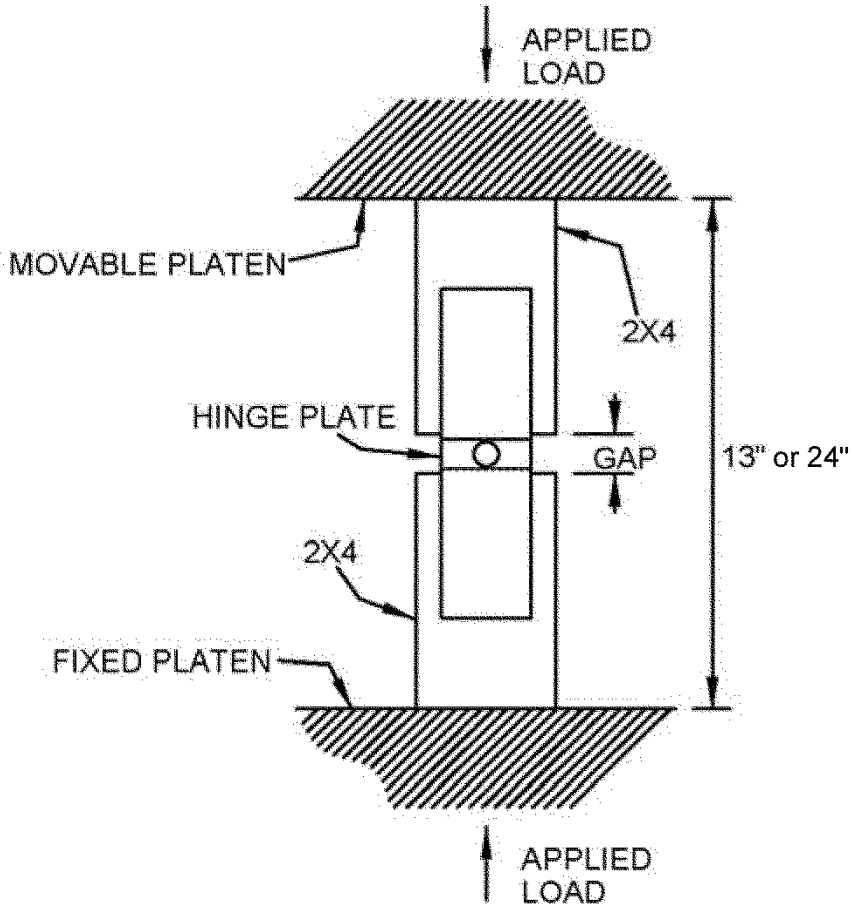


FIGURE 4—COMPRESSION TEST SCHEMATIC