ASAE EP558 FEB04
Load Tests for Metal-Clad, Wood-Frame Diaphragms

American Society of Agricultural Engineers

STANDARD

ASAE is a professional and technical organization, of members worldwide, who are dedicated to advancement of engineering applicable to agricultural, food, and biological systems. ASAE Standards are consensus documents developed and adopted by the American Society of Agricultural Engineers to meet standardization needs within the scope of the Society; principally agricultural field equipment, farmstead equipment, structures, soil and water resource management, turf and landscape equipment, forest engineering, food and process engineering, electric power applications, plant and animal environment, and waste management.

NOTE: ASAE Standards, Engineering Practices, and Data are informational and advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. The ASAE assumes no responsibility for results attributable to the application of these ASAE Standards, Engineering Practices, and Data. Conformity does not ensure compliance with applicable ordinances, laws and regulations. Prospective users are responsible for protecting themselves against liability for infringement of patents.

This standard may be designated ANSI/ASAE. If so, this standard is an American National Standard. Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.
Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

CAUTION NOTICE: In the case that this standard is an ANSI/ASAE standard, this American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Copyright American Society of Agricultural Engineers. All rights reserved.

ASAE-The Society for engineering in agricultural, food, and biological systems
2950 Niles Rd., St. Joseph, MI 49085-9659, USA ph. 269-429-0300, fax 269-429-3852,
hq@asae.org

Load Tests for Metal-Clad Wood-Frame Diaphragms

Developed by the ASAE Wood Construction & Engineering Committee; approved by the Structures and Environment Division Standards Committee; adopted by ASAE December 1998; reaffirmed February 2004.

1 Purpose and scope

1.1 The purpose of this Engineering Practice is to define a test method for determination of the in-plane strength and stiffness of a metal-clad wood-frame diaphragm assembly. The design values determined by this method shall be used in accordance with ANSI/ASAE EP484 or other acceptable standards to design buildings or structural systems to resist in-plane shear forces.

1.2 This method shall be used for diaphragm assemblies constructed with roll-formed metal sheeting (eg, steel, aluminum) attached to any type of wood framing system. If rigid or blanket insulation is to be installed between the metal sheeting and wood framing in the building being designed, identical insulation shall be installed in a similar fashion in the test assembly.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Engineering Practice. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Engineering Practice are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Standards organizations maintain registers of currently valid standards.

AF&PA (1997), *National Design Specification (NDS) for Wood Construction*

ANSI/ASAE EP484.2 AUG98, *Diaphragm Design of Metal-Clad Wood-Frame Rectangular Buildings*

ASTM E455-76, *Static Load Testing of Framed Floor or Roof Diaphragm Construction for Buildings*

ASTM E4-96, *Practices for Load Verification of Testing Machines*

3 Definitions

3.1 adjusted load-point deflection, D_T: Load-point displacement of a test assembly after adjustment for rigid body rotation/translation of the test assembly.

3.2 cantilever test: A load test arrangement in which the test assembly is supported along one edge and the shear load is applied at a corner of the opposite edge and in the direction parallel to the direction of the line of action of the supports (figures 1 and 2). Cantilever tests can be used to evaluate roof, ceiling, and wall assemblies.

3.3 diaphragm: A structural assembly comprised of wood or wood product framing, metal cladding, and fasteners capable of transferring in-plane shear forces through the cladding and framing members.

3.4 diaphragm design: Design of roof and ceiling diaphragm(s), wall diaphragms (shearwalls), primary and secondary framing members, component connections, and foundation anchorages for the purpose of transferring lateral (eg, wind) loads to the foundation structure.

3.5 diaphragm fasteners: The various fasteners and fastener patterns used to connect the several components of the diaphragm. These include fasteners between cladding and purlins, between cladding and girts, between diaphragm framing members, and between individual sheets of cladding (stitch fasteners).

3.6 effective shear stiffness, c: The in-plane shear stiffness of a diaphragm as determined by test. Defined as the slope of a line drawn between the two points on a shear load-deflection curve that correspond to zero load and the allowable design shear strength.

3.6.1 effective shear modulus, G: the arithmetic product of the effective shear stiffness and the aspect ratio (a/b) of the test assembly.

3.7 frame spacing, s: The distance between post-frames (see *post-frame* and *post-frame building*). In the absence of posts, the frame spacing is generally equated to the distance between adjacent trusses (or rafters). Frame spacing may vary within a building.

3.8 load, P: The force applied to a test assembly. For simple beam tests, P equals the sum of the forces applied at the two load points.

3.8.1 ultimate load, P_u: The maximum load that a test assembly will support.

3.9 metal cladding: The metal exterior and interior coverings, usually cold-formed aluminum or steel sheet, fastened to the wood framing.

3.10 post-frame: A structural building frame consisting of a wood roof truss or rafters connected to vertical timber columns or side-wall posts.

3.11 post-frame building: A building system whose primary framing system is principally comprised of post-frames.

3.12 primary framing: The main structural framing members in a building. The primary framing members in a post-frame building include the columns, trusses/rafters, and any girders that help transfer load between columns and trusses/rafters.

3.13 seam: Lap joint formed by adjacent pieces of metal cladding.

3.14 secondary framing: Structural framing members that are used to (1) transfer load between exterior cladding and primary framing members, and/or (2) laterally brace primary framing members. The secondary framing members in a post-frame building include the girts and purlins.

3.15 shear strength, V: The in-plane shear (expressed on a unit length basis) that is present in a test assembly. Calculated by dividing the force applied at an assembly load point by the length, b, of the assembly.

3.15.1 allowable design shear strength, V_a: The maximum in-plane shear that a unit length of diaphragm is permitted to transfer under allowable stress design procedures in the AF&PA standard.

3.15.2 ultimate shear strength, V_u: The in-plane shear (expressed on a unit length basis) that is present in a test assembly at the point of maximum loading.

3.16 shearwall: A vertical diaphragm in a structural framing system. A shearwall is any endwall, sidewall, or intermediate wall capable of transferring in-plane shear forces.

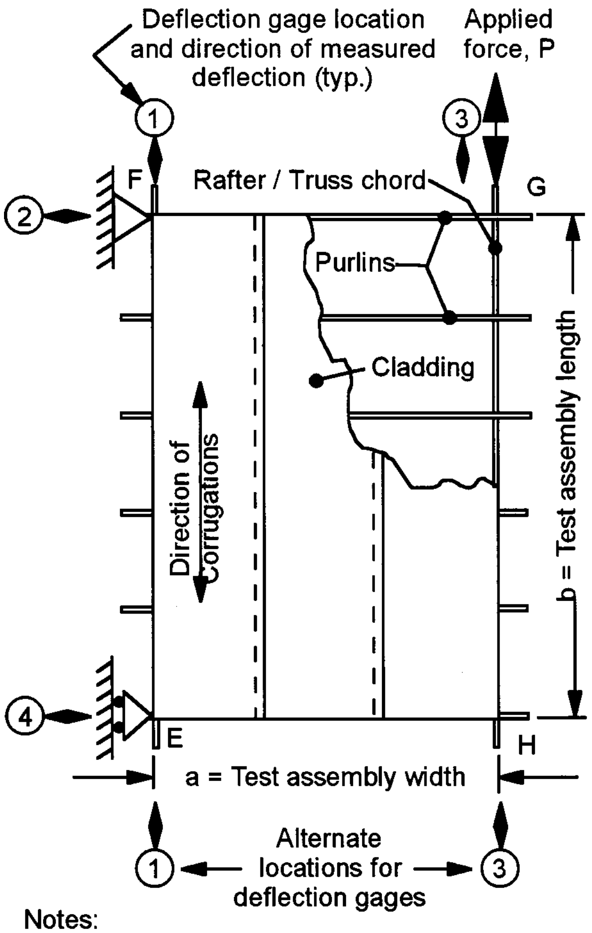
3.17 simple beam test: A load test arrangement for a test assembly in which the assembly is loaded as a simple beam (figure 3). Simple beam tests are only used to evaluate the strength and stiffness of roof and ceiling diaphragm assemblies.

3.18 stitch (or seam) fasteners: Fasteners used to connect two adjacent pieces of metal cladding.

3.19 test assembly: A roof, ceiling, or wall diaphragm of sufficient size to simulate the behavior of the diaphragm in the building.

3.20 test assembly length, b: Dimension of test assembly as measured parallel to the direction of applied load. For roof/ceiling test assemblies (figures 1 and 3), length b is equal to the distance between the outside edges of the outermost secondary framing members (eg, purlins). For wall test assemblies (figure 2), length b is equal to the on-center spacing of the outer primary framing members (eg, posts, wall columns).

3.21 test assembly width, a or 3a: Dimension of test assembly as



Notes:

1. Force P may be alternately applied at point H
2. Locate gages 2 and 4 on the edge purlins
3. Locate gages 1 and 3 on the rafter / truss chord

Figure 1 – Roof and ceiling assemblies, cantilever test

measured perpendicular to the direction of applied load. For roof/ceiling test assemblies (figures 1 and 3), width is defined as the on-center spacing of the outer primary framing members (ie, truss chords/rafters). For wall test assemblies (figure 2), width is defined as the distance between the outside edges of the outermost secondary framing members (ie, girts).

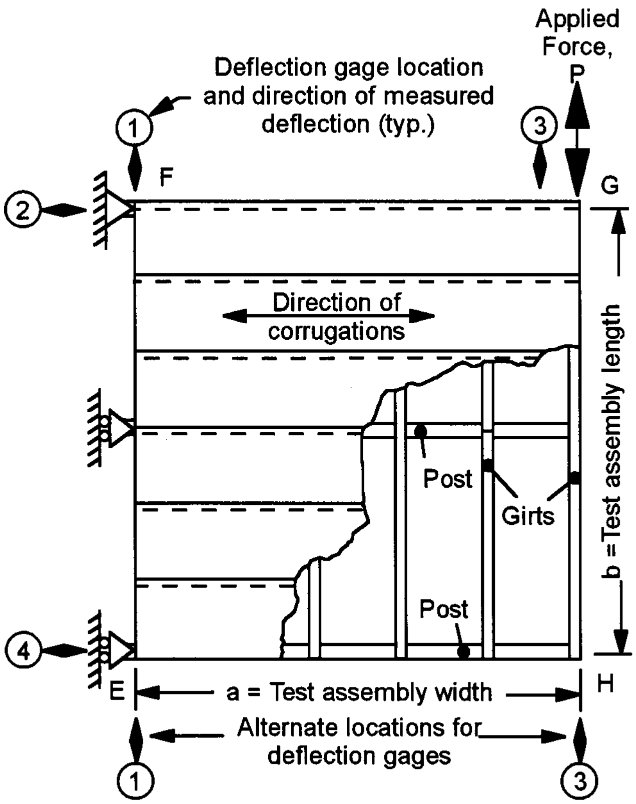
4 Test assembly fabrication

4.1 General. Cantilever or simple beam test specimens as described herein shall be constructed to produce an assembly that is functionally equivalent to that used in the building being designed.

4.2 Material requirements

4.2.1 Wood framing. Secondary framing members (purlins and girts) shall be of the same size, species, and grade as that used in the building being designed. Primary framing members shall have the same thickness as that used in the building being designed and shall have sufficient depth to accommodate full penetration of the fasteners used to attach the secondary framing. The moisture content of wood framing members shall not exceed 19% at the time of fabrication. At test time, the moisture content of each wood framing member shall be within 3% of the *average* moisture content of all framing members.

4.2.2 Cladding. The material, profile, and thickness of the metal cladding shall be identical to that used in the building being designed.



Notes:
1. Force P may be alternately applied at point H
2. Locate gages 1, 2 and 4 on the posts
3. Locate gage 3 on the girt

Figure 2 – Wall assembly, cantilever test

4.2.3 Fasteners. All fasteners shall be identical to those used in the building being designed.

4.3 Length

4.3.1 Roof/ceiling test assemblies (figures 1 and 3). The length, *b*, of a roof/ceiling test assembly shall not be less than 2.4 m (8 ft).

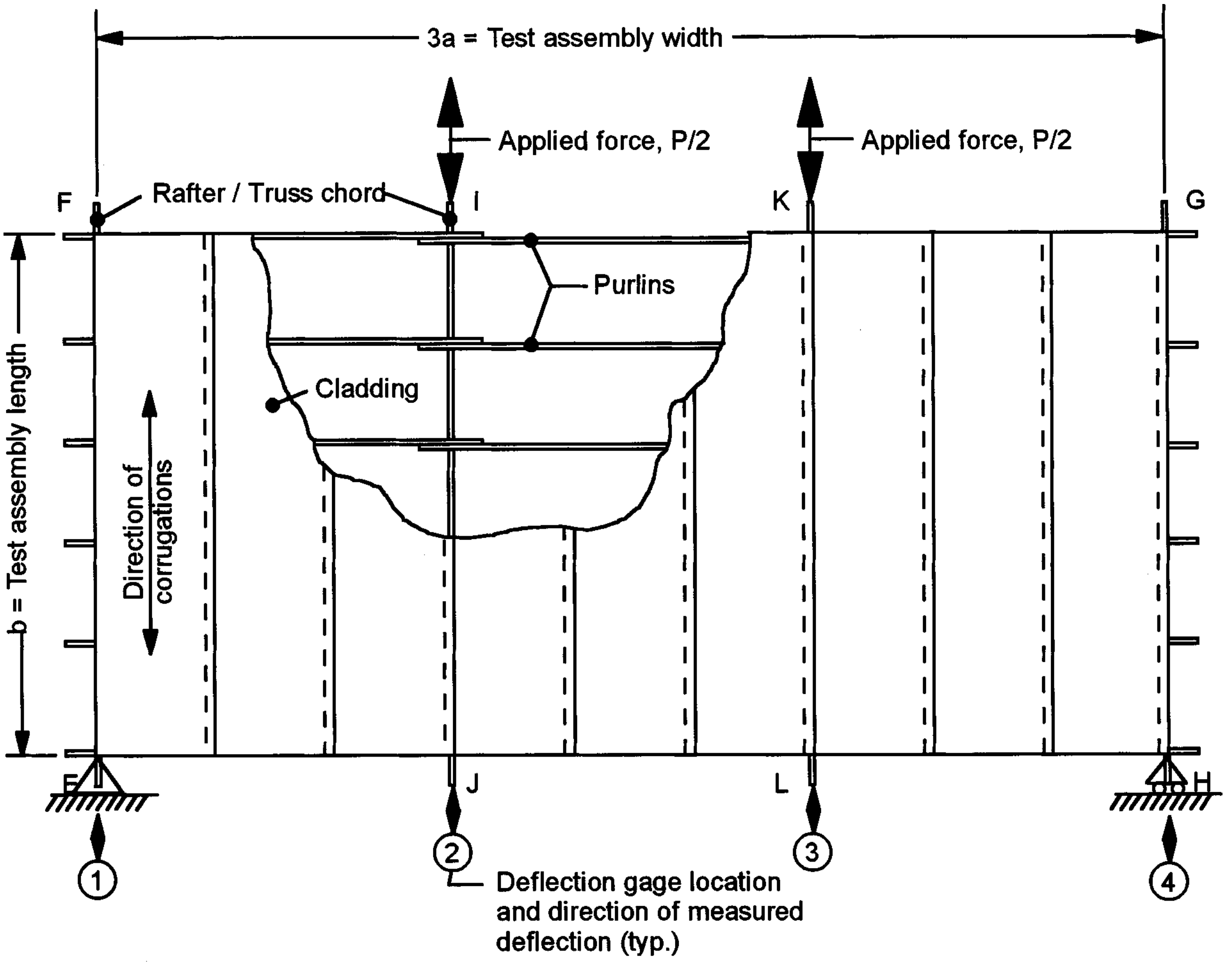
4.3.2 Wall test assemblies (figure 2). The length, *b*, of a wall test assembly shall be equal to a multiple (eg, 1, 2, 3, etc) of the post/column spacing in the wall being designed.

4.4 Width

4.4.1 Roof/ceiling test assemblies. For a cantilever test (figure 1), the width, *a*, shall be equal to a multiple (eg, 1, 2, 3, etc) of the frame spacing, *s*, in the building being designed. The width, *a*, shall not be less than 1.8 m (6 ft) or three sheets of cladding. For a simple beam test (figure 3), the width, 3*a*, shall be equal to a multiple of three times the frame spacing, *s*. The width, 3*a*, shall not be less than 5.5 m (18 ft) or the overall width of eight sheets of cladding.

4.4.2 Wall test assemblies (figure 2). The width, *a*, shall be no less than 60% of the wall height of the building being designed or 2.7 m (8 ft), whichever is greater.

4.5 Overall design. The spacing of wood framing members, the relative position of metal cladding seams, and the location of all fasteners shall be identical to that used in the building being designed. Cladding shall not unnecessarily extend beyond any side of the wood frame unless such an extension is done to produce a test assembly that is more functionally equivalent to that used in the building being designed. For example, an endwall test assembly may include the triangular-shaped gable end cladding and framing where such an addition significantly affects endwall shear strength and stiffness.



Notes: 1. The applied forces may alternately be applied at points J and L
2. Locate gages 1, 2, 3 and 4 on the rafters/ truss chords

Figure 3 – Roof and ceiling assemblies, simple beam test

4.6 Fabrication procedure. Just prior to fabrication of the wood frame, identify (eg, number) individual wood framing members and measure and record their properties as outlined in clause 8.3. Assemble each test assembly using similar equipment and methods identical to those used in actual construction (eg, do not pre-drill holes for fasteners if not done in practice). Prepare drawings in accordance with clause 8.2.

5 Test apparatus

5.1 Support placement

5.1.1 Cantilever test. Roof and ceiling assemblies (figure 1) shall be supported at corners E and F. Wall assemblies (figure 2) shall be supported at corners E and F, and at the location of all intermediate primary framing members (eg, posts, columns). For all cantilever tests, side GH shall be supported vertically by a series of rollers (for horizontal frame testing). A restraining force may be necessary to resist out-of-plane movement along GH.

5.1.2 Simple beam test (figure 3). The frame shall be supported with hardware to simulate a pinned connection at corner E and with a roller-type connection at corner H. In addition, lines IJ and KL shall be supported in a manner similar to the supports along line GH in the cantilever test procedure. The frame may also require restraints to prevent out-of-plane movement.

5.2 Load application. Proper load locations are illustrated in figures 1, 2, and 3. Loads shall be applied parallel to, and in the plane of contact between, the metal cladding and the wood frame. The method of loading and relevant equipment shall accommodate continuous application and uninterrupted recording of load during test. Load apparatus for the simple beam test (figure 3) shall be configured such that simultaneously equal loads are applied at the two load points.

5.3 Deflection measurement. Deflection measurement equipment shall be selected to permit load and deformation readings to be recorded without removing the load or adjusting the load rate. Deflections shall be recorded to the nearest 0.02 mm (0.001 in.). Proper gage locations (numbered) are illustrated and described in figures 1, 2, and 3.

5.4 Equipment calibration and accuracy. Loading equipment and measurement devices shall be calibrated and verified in accordance with ASTM E4-96. The full-scale accuracy of the load sensing and recording equipment shall be within 2% of the anticipated design load, V_a.

6 Test procedure

6.1 Number of tests. A minimum of two specimens shall be tested to determine the strength and stiffness of a given configuration. Each replication requires construction of a new test frame. If the test results for both strength and stiffness do not agree to within 10% of the lower values, a third specimen shall be tested.

6.2 Method of load application

6.2.1 Preload. Apply a preload to the test specimen of approximately 5% of the estimated ultimate load of the specimen. Remove the preload and record the initial deflection readings at all locations.

6.2.2 Load rate. Load should be applied continuously throughout the test at a uniform *rate of motion* (ie, displacement) of the loading device used. Select the load rate such that the ultimate load, P_u, will be reached in not less than 10 min under a uniform and continuous rate of motion of the loading device.

6.2.3 Standard loading. Beginning at zero load, continuously apply load until the ultimate (maximum) load point, P_u, is reached. This is the point at which the assembly cannot support increases in load level. Record the elapsed test time between zero and ultimate load.

6.2.4 Optional cyclic loading. An optional cyclic loading procedure can be used to investigate the inelastic behavior of the test assemblies. At load levels approximating one third and two thirds of the ultimate load, P_u, remove the load. Both the rate of load removal and the rate of load application shall equal the load rate defined in clause 6.2.2. For each load cycle, record the elapsed time associated with loading and the elapsed time associated with unloading.

6.3 Load and deflection readings. For standard loading (clause 6.2.3), take at least ten sets of uniformly spaced load and deflection readings between zero and ultimate load. If deflection measurements are taken manually, they should be read without stoppage of the loading device to avoid a stair-stepped loading pattern. For cyclic loading (clause 6.2.4), record load and deflection readings at points of load reversal. Also record a sufficient number of load and deflection readings to clearly define both the loading and unloading phase associated with each load cycle.

6.4 Failure. Failure shall be defined as the point at which the ultimate load, P_u, is first reached.

6.5 Cause of failure. Identify and record the cause(s) of failure.

7 Calculations

7.1 Shear strength, V. Shear strength at any load level, V, is calculated as follows:

Cantilever test: $V = P/b$ (1)

Simple beam test: $V = P/(2b)$ (2)

7.2 Ultimate shear strength, V_u. Shear strength at maximum load, V_u, is calculated as follows:

Cantilever test: $V_u = P_u/b$ (3)

Simple beam test: $V_u = P_u/(2b)$ (4)

7.3 Allowable design shear strength, V_a. Allowable design shear strength, V_a, is calculated as follows:

$$V_a = 0.40 \cdot V_u \quad (5)$$

7.4 Adjusted load-point deflection, D_T. The adjusted load-point deflection at any load level, D_T, is obtained from the deflection measurements D_1, D_2, D_3, and D_4 (figures 1, 2, and 3) as follows:

Cantilever test: $D_T = D_3 - D_1 - (a/b)(D_2 + D_4)$ (6)

Simple beam test: $D_T = (D_2 + D_3 - D_1 - D_4)/2$ (7)

7.5 Effective shear stiffness, c. Effective shear stiffness, c, is calculated as follows:

$$c = 0.4 \cdot P_u / D_{T,d} \quad (8)$$

where $D_{T,d}$ is the adjusted load-point deflection, D_T, at $0.4P_u$.

7.5.1 Effective shear modulus, G. Effective shear modulus, G, is calculated as follows:

$$G = c \cdot a/b \quad (9)$$

7.6 Design values. When only two assemblies have been tested, the allowable design shear strength for building design shall be set equal to the lowest of the two V_a values calculated for the individual test assemblies. When three or more tests have been conducted, the allowable design shear strength for building design shall be set equal to the average of the V_a values calculated for the individual test assemblies. Regardless of the number of individual tests, the effective shear stiffness, c, shall be the average of the effective shear stiffness values calculated for the individual test assemblies.

7.6.1 Adjustments for duration of test. If one or more of the test assembly failures (clause 6.5) was initiated by lumber breakage or by failure of the fastenings in the wood, then the allowable design shear stress shall be adjusted to account for test duration. To adjust from a total elapsed testing time of 10 min to a normal load duration of 10 years, divide the allowable design shear stress by a factor of 1.6. When this reduction is not applied (as would be the case when test assembly failure is not initiated by wood failure), the AF&PA load duration factor, C_D, cannot be used to increase the allowable design shear strength during building design.

8 Test report

The following information shall be reported for each diaphragm test assembly. The report shall be sufficient to allow for the incorporation of the test results into building design.

8.1 General information

8.1.1 Test ID

8.1.2 Date and time of test

8.1.3 Test location

8.1.4 Principal investigator and test technicians

8.2 Test assembly and test apparatus details. Provide one or more drawings showing the following:

8.2.1 Orientation, relative location, and identification of individual wood framing members

8.2.2 Frame attachment to supports and loading mechanism

8.2.3 Location and identification number of each deflection measuring device

8.2.4 Metal cladding size and relative location on the wood frame

8.2.5 Orientation and location of all fasteners

8.3 Wood framing member properties and characteristics

8.3.1 Grade and species of each member

8.3.2 Length and average actual size of each member at time of test assembly fabrication

8.3.3 Individual member mass at time of test assembly fabrication

8.3.4 Individual member moisture content at time of assembly fabrication and at time of test as determined with a properly calibrated resistance-type moisture tester

8.4 Metal cladding properties and characteristics

8.4.1 Manufacturer and profile name

8.4.2 Base metal type and grade or alloy (eg, ASTM A446 Grade A Steel)

8.4.3 Nominal thickness and measured average thickness of a random uncoated (ie, bare metal) sample

8.4.4 Profile cross-section including the form factor (the ratio of flat steel to coverage of the formed sheet)

8.4.5 Measured yield strength or yield strength from manufacturer's data

8.5 Fastener properties and characteristics

8.5.1 Manufacturer, brand name, and type (eg, screw, nail)

8.5.2 General description including diameter, overall length, and when applicable, such items as: thread diameter and length, washer type and size, etc

8.5.3 Base metal (eg, hardened steel, aluminum, stainless steel)

8.5.4 Measured bending yield strength or bending yield strength from manufacturer's data

8.6 Miscellaneous component properties and characteristics. Identify and record appropriate properties and characteristics for any special hardware (eg, hangers, brackets, reinforcement) used in the fabrication of the test assemblies. Record the brand, type, thickness, density, and location of any insulation used in the test assemblies.

8.7 Test procedure

8.7.1 Description of equipment used to apply, measure, and record load

8.7.2 Description of equipment used to measure and record displacements

8.7.3 Type of loading (standard or cyclic)

8.7.4 Rate of load application

8.7.5 Total elapsed test time (record for each load cycle)

8.8 Test results

8.8.1 Load-deflection readings as per clause 6.3 for each test assembly

8.8.2 Ultimate load and corresponding displacements for each test assembly

8.8.3 Ultimate and allowable shear strength for each test assembly

8.8.4 Cause of failure for each test assembly

8.8.5 Graph of the relationship between shear strength and adjusted load point deflection for each test assembly

8.8.6 Allowable design shear strength, effective shear stiffness, and effective shear modulus as calculated according to clause 7.6

9 Commentary

9.1 Purpose and scope

9.1.1 This standard prescribes a relatively static test method for obtaining diaphragm strength and stiffness values for use in the design of a complete structure. When higher level, non-static (dynamic) loads are expected, or when a diaphragm assembly is sensitive to large fluctuations and reversals in load, special investigation of the diaphragm is required. For a preliminary investigation of diaphragm sensitivity to repetitive loadings, the optional cyclic loading prescribed in clause 6.2.4 is recommended.

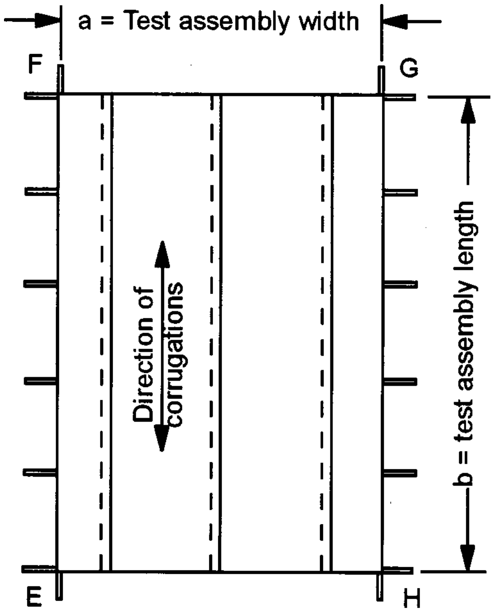
9.1.2 This engineering practice is not intended to test all connections required to construct a complete building diaphragm. All framing members and connections shall be designed to adequately transfer loads into and out of diaphragm assemblies.

9.2 Test assembly fabrication

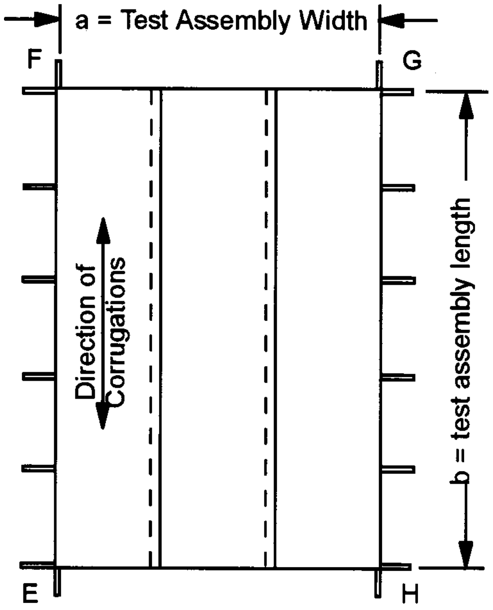
9.2.1 Simple beam test. In addition to the cantilever test, ceiling and roof diaphragms can be evaluated using a simple beam test with a two point loading. This is consistent with provisions of ASTM E455, but differs from ASAE EP484.1 (ie, an earlier version of ASAE EP484) which allowed the use of a cantilever test or a simple beam test with a single load point. The simple beam test with a two-point loading was selected over the simple beam test with a single point loading because of premature failures at the load point of simple beams with a single load point (Woeste, 1991).

9.2.2 Wood moisture content. Limits are placed on the moisture content of wood framing members to ensure that the framing will be closer to the equilibrium moisture content of wood in a typical building environment.

9.2.3 Test assembly size. Minimum dimensions and minimum number of sheets of cladding are specified to ensure that test assembly size is sufficient to model the building diaphragm being designed. Increasing test assembly size should result in a more accurate prediction of building diaphragm design values. Where two building diaphragms are identical in all aspects except length, conduct tests to obtain design values for the longest diaphragm and linearly interpolate these design values to obtain design values for the shorter diaphragm.



THREE INTERNAL SEAMS



TWO INTERNAL SEAMS

Figure 4 – Test assemblies, number of seams in metal cladding

9.2.4 Seam location. In many buildings, seam location (relative to chord location) cannot be fixed because bay width is not an exact multiple of seam spacing. In test assemblies, seam location (relative to primary framing location) is varied by varying the width of the first piece of metal cladding. As figure 4 illustrates, the width selected for the first piece of cladding can influence the number of internal seams, and this can significantly affect test diaphragm behavior. Generally, an increase in the number of seams located between the load point(s) and support(s) will decrease test diaphragm stiffness. Subsequent application of these lower stiffness values during post-frame building design will result in higher (and consequently more conservative) estimates of post-frame forces.

9.3 Test apparatus

9.3.1 Gage location. Varying gage locations from the positions defined in figures 1, 2, and 3 will significantly affect the adjusted load-point deflection. If, for example, all gages were located on the secondary framing members (ie, purlin and girts), the calculated shear deflection would not account for slip between the secondary and primary framing. Consequently, the adjusted load-point deflection, D_T, would decrease resulting in an increase in effective shear stiffness. When a greater effective shear stiffness value is assigned to a roof diaphragm during post-frame building design, the amount of load transferred to shearwalls increases (ie, a more conservative estimate of maximum shearwall force is obtained), and that transferred to individual post-frames decreases (ie, a less conservative estimate of post-frame loading is obtained). It follows that by using gages in addition to those shown in figures 1, 2, and 3, various components of deflection can be isolated. This is advantageous for research, and for designers who are conducting more detailed analyses of building systems.

9.3.2 Supports. Cantilever test assemblies (figures 1 and 2) are shown anchored with one hinge and one or more roller supports. It is permissible, and may be safer, to replace all roller supports with hinge supports when the axial deformation of the anchored member is small. These supports should be placed as close as practical to the primary-to-secondary framing connections to prevent weak axis bending of the anchored member (Anderson, 1990).

9.3.3 Corner reinforcing. A commonly reported mode of failure in cantilever test assemblies is a failure of one of the two secondary-to-primary framing connections located adjacent to the supports. In roof diaphragms, this represents a connection between the edge purlin and the anchored rafter/truss chord. Because this purlin-to-rafter connection failure would not be expected in the interior portions of a building diaphragm where purlins are continuous over rafters (or effectively continuous because of adequate butt or lap splicing), it is not uncommon to reinforce the purlin-to-rafter connection in test assemblies. When such corner reinforcement is done, it should be documented in the test report. Common methods of corner reinforcing are discussed by Anderson (1990).

9.4 Test procedure

9.4.1 Sample size. The small sample size specified in clause 6.1 reflects the fact that test results for diaphragm strength tend to be very consistent and, thus, reproducible. Consistency (or low variability) of test results is due to the high degree of load sharing between the many individual components comprising a single assembly.

9.4.2 Preload. Test assemblies are preloaded to reduce variability between individual tests that may result from differences in (1) handling of the assemblies prior to testing, (2) support alignment and attachment, and (3) initial alignment and seating of load application and deflection measurement equipment. The maximum amount of preload is restricted to a level at which diaphragms still tend to exhibit linear-elastic behavior. Once selected, the same level of preload should be used for each test specimen (ie, replication).

9.4.3 Load rate. To ensure consistency in test results, it is important to maintain a loading rate that is identical for each test specimen. Significant changes in loading rate will introduce variations in test results because of stress relaxation (creep) of wood under load.

9.5 Calculations

9.5.1 Adjusted load point deflection. The adjusted load point deflection, D_T, can be defined as the relative shift between the supports and the load point(s) as measured parallel to the direction of load. In ASTM E455 and ASAE EP484.1, the variable D_T is referred to as the *total* deflection, and is broken into shear and bending deflection components. The practice of dividing D_T into shear and bending deflection components has been abandoned in this EP because: (1) bending deflection components (as calculated according to ASTM E455 and ASAE EP484.1) were found to be relatively insignificant when compared to shear deflection components; (2) bending deflection calculations were based on the assumption of complete composite action between edge framing members in a diaphragm—a questionable assumption because of the significant slip between diaphragm components; and (3) current building design procedures (eg, ASAE EP484.2) generally ignore displacements attributable to bending moments within the plane of the diaphragm. When D_T is not broken into components, the shear stiffness calculated from D_T becomes an *effective* shear stiffness that should more accurately predict building diaphragm behavior when diaphragm flexural stiffness is ignored (ie, when displacements attributable to bending moments within the plane of the diaphragm are ignored). Displacements attributable to in-plane bending moments should not be ignored in buildings with high length-to-width ratios.

9.6 Test report

9.6.1 A test report is outlined to ensure that there is sufficient documentation of each test to enable a designer to verify that the actual building construction is functionally equivalent to the test assembly. The data collection specified in clause 8 represents the minimum data required. Research situations may require more data or more accurate data collection.

9.6.2 Wood member properties. The length, average actual size, moisture content, and mass at time of test assembly fabrication can be used to calculate the dry-weight dry-volume specific gravity of the wood. Dry-weight dry-volume specific gravity is a major predictor of other wood properties and connector behavior. For more detailed modeling of a test assembly, it is also beneficial to determine the modulus of elasticity of all wood members just prior to assembly fabrication.

Annex A
(informative)
Bibliography

Anderson, G. A. 1990. Diaphragm panel testing. *Frame Building Professional* 2(4):4, 7, 28–30.

ASAE Standards, 37th ed. 1990. EP484.1. Diaphragm design of metal-clad, post-frame rectangular buildings. St. Joseph, MI: American Society of Agricultural Engineers.

Woeste, F. E. and M. Townsend. 1991. Simple-beam diaphragm test considerations. *Appl. Eng. Agric.* 7(5):613–616.