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Timber structures — Static and cyclic lateral load test methods for shear walls

Structures en bois — Méthodes d'essai de charge latérale statique et cyclique sur murs de contreventement

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 21581 was prepared by Technical Committee ISO/TC 165, *Timber structures*.

Introduction

Evaluation of the structural performance of shear walls intended to resist forces generated during wind and seismic actions is based on static or reversed cyclic load testing in some regulatory jurisdictions. The objective of this International Standard is to provide test methods appropriate for static and cyclic lateral loading as a basis for determining the characteristics of shear walls for use in wind and seismic design. The cyclic displacement schedule in ISO 16670, which was developed in consultation with a group of international experts, was also used in this International Standard.

Supplementary information is given in Annex A to provide the rationale behind the cyclic displacement schedule, recommendations for cases for which a modified schedule would be more appropriate and typical test results obtained on a shear wall specimen by following this International Standard.

Timber structures — Static and cyclic lateral load test methods for shear walls

1 Scope

This International Standard specifies static and cyclic test methods as a basis for the derivation of lateral load resisting parameters which are required in the wind and seismic design of shear walls in timber buildings. This International Standard does not include criteria for parameters which are, at times, stipulated in national standards or building codes. This International Standard can be used to determine those parameters under the following conditions:

a) Method I: the boundary conditions are designed to produce mainly the shear response of the wall and ensure that the full shear capacity of the wall is achieved;

b) Method II: the boundary conditions are designed to produce mainly the rocking (rigid body rotation of the wall) or combined shear-rocking response of the wall reflecting the intended actual construction details of joints connecting the wall to bottom and top boundaries.

This International Standard specifies procedures to ascertain the envelope curves (backbone or skeleton curves) for shear walls subjected to a static or a cyclic displacement schedule.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 3131, *Wood — Determination of density for physical and mechanical tests*

3 Symbols and units

F Applied lateral load, in newtons

F_{max} Maximum lateral load, in newtons (for definition, see Figure 3)

F_v Applied vertical load, in newtons

H Height of wall specimen, in millimetres

K Displacement modulus, in newtons per millimetre

l Horizontal displacement of wall, in millimetres

l_u Ultimate horizontal displacement of wall, in millimetres (for definition, see Figure 3)

4 Test specimens

4.1 Conditioning

The specimens shall be conditioned at the controlled environment of (20 ± 2) °C and (65 ± 5) % relative humidity in accordance with ISO 554 as far as possible. The test laboratory shall normally be maintained at the controlled environment, but when other conditions apply, they shall be reported.

The density of the wood members in the wall specimen shall be determined in accordance with ISO 3131.

4.2 Form and dimension

The dimensions (e.g. height and length), configuration (e.g. openings) and fabrication details (e.g. elapsed time between the fabrication and test, tolerances, and conditioning details before and after fabrication) shall be representative of the intended end use.

Where panels are used, the wall specimen shall consist of a single or multiple panels of the representative dimensions.

Some wall configurations can have joints between wall units. Those joints should be considered for inclusion in test specimens.

4.3 Sampling

Sampling shall provide for selection of representative test material on an objective and unbiased basis, covering an appropriate range of physical and mechanical properties.

The number of replicates should be selected to achieve the specific objectives and desired reliability.

5 Apparatus

5.1 General

The test apparatus (Figure 1) shall be capable of producing the boundary conditions that are intended in Methods I and II.

NOTE 1 For further information, see A.2.

The testing machine shall be capable of applying and continuously recording load and displacement to an accuracy of ±1 % of the estimates of F_{max} and l_u or better.

Where the lateral loads, F, are applied along with the vertical loads, F_v, the test apparatus shall be capable of controlling the vertical loads and the lateral loads separately.

Where the lateral loads are applied along with the vertical loads, it is recommended that the frictional forces be taken into consideration. Vertical load should not produce horizontal component.

In Method I, the full shear capacity of the wall specimen is achieved through application of sufficient vertical loads and adequate vertical restraints (e.g. hold-down connectors) or tie-down rods (at both ends of the wall specimen in the cyclic test).

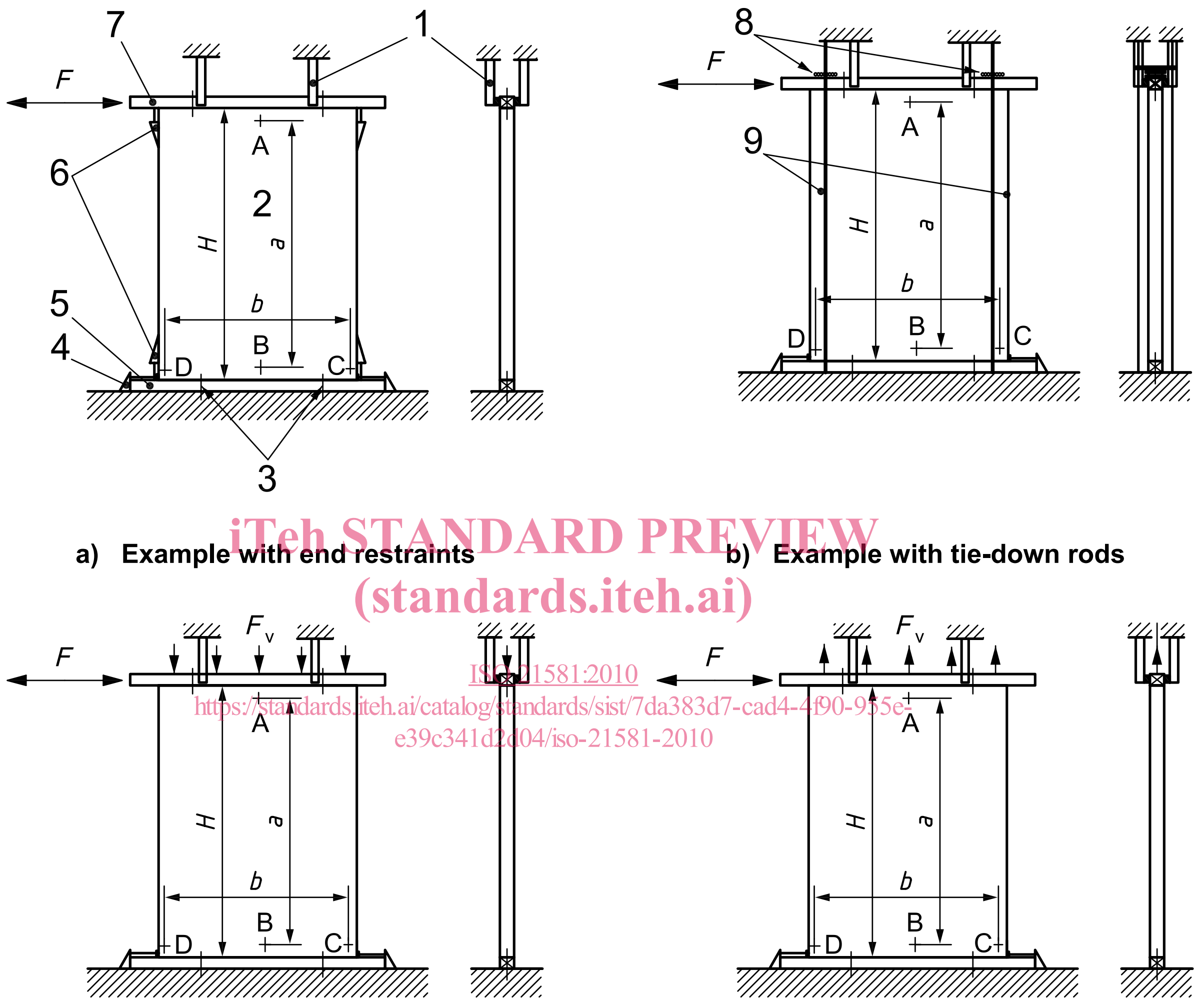
Where hold-down connectors are used, they shall be attached in such a way that they are effective primarily in resisting the up-lift forces, and the additional resistance that the wall gains due to hold-down connectors shall be determined.

Method I is intended to result in shear failure in the wall specimen. It is therefore recommended that, if so desired, the end members be designed in such a way as to avoid crushing and buckling failures. It is also recommended that hold-down connectors be used at the top of the wall if separation of horizontal and vertical members is not desired. Where tie-down rods are used, the frictional forces should be taken into account.

In Method II, the wall specimen shall be tested with representative boundary conditions (e.g. anchorage, hold-down connector details) and the vertical (compressive or tensile) loads that are expected in actual construction.

NOTE 2 Method II can result in failure in the wall or in anchorage or vertical restraints (hold-down connectors).

Measuring point A should be as close to the top of the wall as practicable.



a) Example with end restraints b) Example with tie-down rods

c) Example with combined compressive load d) Example with combined tensile load

Key

1	lateral restraint	*a*	distance between points A and B
2	wall specimen	*b*	distance between points C and D
3	anchor bolt	*F*	lateral load
4	horizontal restraint	F_v	applied vertical load
5	base beam	*H*	height of wall
6	vertical restraint		
7	loading beam		
8	roller		
9	tie-down rod		

Figure 1 — Examples of test apparatus

5.2 Base of test frame and loading beam

The base of the test frame shall provide a level foundation for the test specimen and shall be relatively stiff, such that its deflections are negligible. A rigid datum (independent of the test frame) shall be provided for the measurement of the deformation of the wall specimen.

The loading beam, if applicable, shall be firmly attached to the top of the wall specimen to ensure uniform distribution of lateral load. The actuator that is attached to the loading beam to apply the lateral load shall be installed in such a way that does not restrain up-lift. In all cases, the stiffness and the mass of the loading beam shall be determined. The cross-sectional dimensions and position of the beam shall allow the free movement of the panels during the test, unless otherwise specified by the test objectives.

A rigid or flexible loading beam may be used depending on the intended end use. In Method I, a rigid loading beam shall be used. In Method II, stiffness of loading beam may be chosen according to the intended actual construction.

5.3 Mounting of wall specimen

The wall specimen shall be connected to the base of the test frame with anchor bolts or other connectors according to the actual end use in structures.

In Method I, anchor bolts and vertical restraints (hold-down connectors) shall be designed in such a way as to allow the wall to fail in shear.

Lateral restraints shall be provided through the loading beam such that the top of the wall specimen deflects only in the plane of the wall.

6 Test procedure

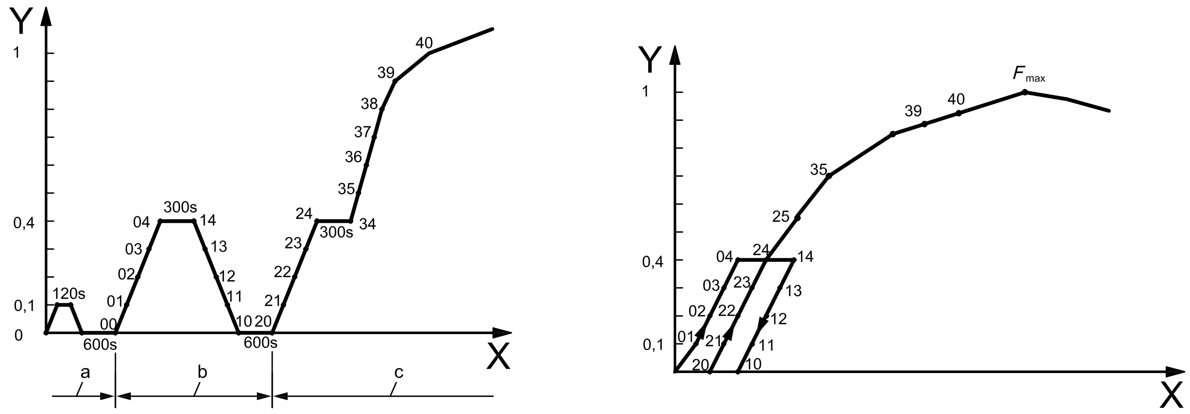
6.1 Static (monotonic) test

The lateral load, F, shall be applied as shown in Figure 1. The load shall be applied at a constant rate of movement related to the displacement at gauge A. For loading and unloading up to 0,4 F_{max} (estimated), the rate of loading shall be (0,000 8H ± 0,000 2H) mm per min (H: height of wall) . For loading above 0,4 F_{max} (estimated), the rate of loading shall be selected to achieve ultimate displacement between 5 min and 30 min. The procedure for the application of the lateral load is shown in Figure 2.

The displacements of the wall specimen shall be monitored at points A, B, C and D (see Figure 1). The deformations, l_{rel}, shall be taken as the displacement at A minus the displacement at B. The displacements at C and D shall be reported separately.

The mean value (where applicable) of the ultimate displacement l_u of the static tests will be determined by following the definition of l_u in Figure 3.

NOTE Static (monotonic) test procedure is adopted from EN 594.



Key

X time, in seconds

Y $\frac{F}{F_{max,est}}$

a Stabilizing load cycle.

b Stiffness load cycle.

c Strength test.

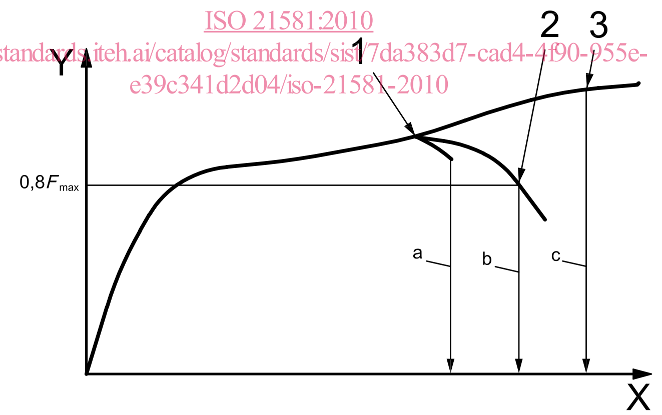
Key

X deformation, in millimetres

Y $\frac{F}{F_{max,est}}$

a) Lateral load versus time **b) Typical lateral load versus deformation**

Figure 2 — Static tests procedure



X displacement, l

Y load, F

1 F_{max} (case a, case b)

2 displacement at failure

3 F_{max} (case c)

a l_u (case a), displacement at failure.

b l_u (case b), displacement for 0,8 F_{max}.

c l_u (case c), displacement = H/15.

Definition of ultimate displacement: l_u corresponds to displacement at failure (case a), displacement at 0,8 F_{max} in the descending portion of the load-displacement curve (case b), or displacement reaching to H/15 (case c), whichever occurs first in the test.

Figure 3 — Ultimate displacement