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Timber structures — Test method — Static load tests for horizontal diaphragms including floors and roofs

Structures en bois — Méthode d'essai — Essais de chargement statique pour les diaphragmes horizontaux incluant planchers et toitures

PROOF/ÉPREUVE

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 165, *Timber structures*, based on ASTM E 455.

Introduction

Horizontal diaphragms including floors and roofs are integral parts of light-frame timber buildings to show resistance against horizontal forces such as winds and earthquakes. Their characteristics such as ultimate shear strength have great effects on the behaviour of timber buildings including horizontal diaphragms as floors and/or roofs under winds or seismic loads.

Horizontal diaphragms are those structures which are widely used for timber buildings to form floors and/or roofs. They behave as a simple beam or cantilever beams under horizontal loads caused by wind or earthquake to transmit forces to the structures or structural members supporting them. Horizontal diaphragms shall have enough stiffness and strength that they do not undergo large deflection or failures in parts of the structure.

The purpose of this International Standard is to measure the shear stiffness and strength of horizontal diaphragms as one of the basic parameters to interpret the behaviour of diaphragms under horizontal loads such as winds and earthquakes. The requirements are necessary to replicate the same conditions as those for timber structures in the field. Loads can be applied to the specimen either by compression or tension whichever is relevant.

Timber structures — Test method — Static load tests for horizontal diaphragms including floors and roofs

1 Scope

This International Standard defines the test method for horizontal diaphragms including floors and horizontal and sloped roofs under static loads. This test method is designated to evaluate the static shear capacity of a typical segment of a diaphragm under applied static loads, and to evaluate the stiffness of the diaphragm assembly.

2 Normative reference(s)

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

ISO 13061-2, *Physical and mechanical properties of wood — Test methods for small clear wood specimens — Part 2: Determination of density for physical and mechanical tests*[1)]

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1
diaphragm
horizontal and sloped assembly of materials designated to transmit lateral forces to vertical resisting elements or foundations through shear resistances in the plane of the construction

Note 1 to entry: A diaphragm is analogous to a horizontal deep beam composed of interconnected membrane elements such as panels, sheathings, or claddings acting as the deep beam web, intermediate elements such as joists or rafters acting as web stiffeners, and perimeter boundary elements such as girders or header joists acting as deep beam chords.

4 Symbols

E modulus of elasticity of flange or web material, depending upon which material is held constant in a transformed section analysis (MPa)

G' apparent shear stiffness, which is shear stiffness of the diaphragm obtained from test (N/mm)

I moment of inertia of the transformed section of the diaphragm based on webs or flanges (mm^4)

L total span of a simply supported diaphragm (mm)

P concentrated load (N)

R_u maximum diaphragm reaction (N)

S_u ultimate shear strength of the diaphragm (N/m)

a span length of cantilever diaphragm (mm)

1) Replaces ISO 3131:1975.

b depth of diaphragm (mm)

Δ_b bending deflection of diaphragm (mm)

Δ'_S apparent total shear deformation of the diaphragm based on test, which includes both the pure shear deformation and that contributed by distortion of the connection system (mm)

Δ_t total deflection of diaphragm (mm)

$\Delta_{1,2...}$ deformation measured at points 1, 2, ... (mm)

5 Requirements

The materials used to construct diaphragm such as timbers, panels, sheathings, claddings, and fasteners shall be, as far as possible, of the quality allowed by the relevant specification.

6 Test method

6.1 Principle

The lateral force applied to a horizontal diaphragm is resisted by in-plane shear capacity of the web material of the diaphragm and transmitted to the supporting structures such as shear walls, columns, beams, girders or foundations as shown in Figure 1. The diaphragm assembly, which is assumed to act as a deep beam, spans between shear walls, moment frames, or other constructions that can furnish the end or intermediate reactions to the system. The chord members of the assembly perpendicular to the direction of applied load act as flanges of the deep beam, and the panels covering the frames act as the web of the deep beam, and the framing members such as joists or rafters act as web stiffeners. The test methods evaluate the shear capacity and stiffness of the diaphragm by applying static bending loads to the simple beam or cantilever-type test specimens.

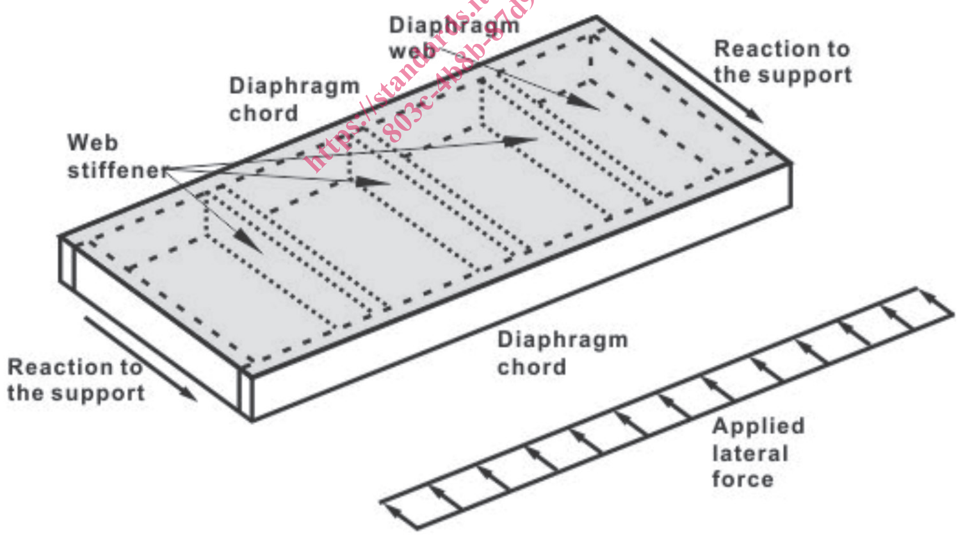

Figure 1 — Schematic drawing of simple span diaphragm

6.2 Apparatus

6.2.1 General

The test apparatus shown in Figures 2 and 3 shall be capable of producing the boundary conditions that are intended in the test method.

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

6.2.2 Test assembly

The diaphragm test assembly shall consist of a frame or framing system on which the elements comprising the web of the diaphragm are placed. The frame is a part of the test assembly and shall consist of members of the same or similar materials as those intended for use in the prototype construction. The frame shall be calibrated to establish its load-deformation characteristics before attaching the web elements. If the frame has a stiffness equal to or less than 2 % of the total diaphragm assembly, no adjustment of test results for frame resistance needs to be made. However, if the frame stiffness is greater than 2 % of the total assembly, the test results shall be adjusted to compensate for frame resistance.

The web elements shall be fastened to the frame in a manner equivalent to their attachment in the field. The assembly may be tested horizontally or vertically (for roof diaphragm, test with sloped position may be selected). Either a cantilever or a simple span diaphragm assembly shall be used, with concentrated or distributed loading.

When tested as a simple span diaphragm assembly in the vertical orientation, the self-weight of the diaphragm shall be taken account of in the calculation of strength and stiffness.

6.2.3 Deformation measurement

The base of the test frame shall provide a level foundation for the test specimen, and shall be relatively stiff so that its deflections shall be negligible. A rigid datum (independent of the test frame) shall be provided for the measurement of the deformation of the diaphragm specimen. Dial gages or other deformation measuring devices shall be attached to the specimen as shown in Figures 2 and 3, and shall record the displacement continuously with an accuracy of ±1 % of the displacement, or for displacement less than 2 mm with an accuracy of ±0,1 mm.

NOTE 1 Refer to ASTM E455 for deflection equation under various loading configurations.

NOTE 2 The required displacement measurement accuracy for displacement measurements less than 2 mm is reduced as this is not critical to the test and allows commonly available displacement gauges to be used.

6.2.4 Load measurement

Loads shall be applied by hydraulic jacks that have been previously calibrated, or by other suitable types of loading apparatus. Load measuring devices shall be accurate to within ±2 %.

6.3 Test specimens

6.3.1 Conditioning

The specimens shall be conditioned at the controlled environment of (20 ± 2) °C temperature and (65 ± 5) % relative humidity according to 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 wood materials in the diaphragm specimen shall be determined in accordance with ISO 13061-2.

6.3.2 Dimensions

The dimensions (e.g. width and length), configuration (e.g. openings), and fabrication details (e.g. member sizes and spacings, tolerances) shall be representative of the intended use.