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Timber structures — Joist hangers — Test methods

Structures en bois — Étriers à solive — Méthodes d'essai

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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 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Joist hangers are an integral part of timber constructions in that they provide a necessary means of connection between timber elements and also between timber elements and other materials such as metal, concrete and masonry. Hangers are made predominantly from light gauge steel sheet which is electrolytically or hot-dipped galvanised and which is bent into a formed three-dimensional element – mostly U-shaped to allow for a bearing seat and lateral support to the joist. For high corrosion zones, stainless steel is often used in lieu of galvanised steel sheet. Hangers may also be made from welded steel plates.

To provide a suitable connection, the joist hangers are capable of transferring forces in a range of directions depending on the make-up of the joint. Fasteners (e.g. nails, screws, bolts and dowels and proprietary fasteners) are inserted in the pre-punched or pre-drilled holes of the joist hanger plates (bearing seat, face and top plate) to secure the connection between the joint elements. The purpose of this document is to provide standard test procedures that can be used to determine the strength of a joint incorporating a joist hanger.

Timber structures — Joist hangers — Test methods

1 Scope

This document provides standard test methods for determining the vertical load, axial load and torsional moment capacity as well as deflection characteristics of preformed three-dimensional joist hangers that are used primarily for securing one timber member to another (the header can be concrete or masonry). The joist hangers primarily transfer vertical loads from the supported member to the supporting member, but they can also be required to transfer axial loads from the supported member to the supporting member.

NOTE 1 Structural steel sections can also be substituted as the header, but are not covered in this document.

NOTE 2 One secondary mechanism to be considered is the effect of rotation of the supported member about its longitudinal axis on the joist hanger.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1920-4, *Testing of concrete — Part 4: Strength of hardened concrete*

ISO 1920-6, *Testing of concrete — Part 6: Sampling, preparing and testing of concrete cores*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 8970, *Timber structures — Testing of joints made with mechanical fasteners — Requirements for wood density*

ISO 9652-4, *Masonry — Part 4: Test methods*

ISO 10984-1, *Timber structures — Dowel-type fasteners — Part 1: Determination of yield moment*

ISO 10984-2, *Timber structures — Dowel-type fasteners — Part 2: Determination of embedding strength*

ISO 13061-1, *Physical and mechanical properties of wood — Test methods for small clear wood specimens — Part 1: Determination of moisture content for physical and mechanical tests*

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*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
supporting member
header
member supporting a joist hanger

3.2
supported member
joist
bending or a tension member supported by a joist hanger

3.3
joist hanger
metal device, usually cold-formed from light-gauge steel sheet, used to transfer loads from a joist to a header member or wall in building construction

Note 1 to entry: Face-mounted joist hangers contact the side surface of the header and do not contact the top of the header. Top-mounted hangers are joist hangers that contact the side and top surface of the header.

Note 2 to entry: Joist hangers may also be constructed from welded steel plate. Joist hangers may also fit within a vertical recess in the joist (concealed). Joist hangers may also consist of two interacting brackets, one connected to the header and one connected to the end of the joist.

4 Symbols

P_t mean of the maximum loads achieved in the vertical load test

5 Materials

5.1 Timber

5.1.1 The timber shall be selected in accordance with ISO 8970.

NOTE When timber is selected in accordance with ISO 8970 the measured load carrying capacities need not be modified, provided that the coefficient of variation of the density of the selected timber reflects the natural variation of density.

5.1.2 For the determination of the vertical load strength, tensile strength (along the line of the supported member axis) and torsional strength of the joist hanger, the timber shall be sufficiently strong for failure to occur in the joist hanger and/or its fixings.

5.1.3 The supported member timber width shall match the manufacturer's specified width for the joist hanger being tested.

5.1.4 The timber used as joist and headers shall be consistent with the timber being used in construction, i.e. sawn timber or structural composite lumber (SCL) or glue laminated timber. Installation (including web stiffeners, filler blocks and backer blocks for I-joists) shall also replicate the manufacturer's specifications.

5.1.5 The joist and the header members for the specimens shall be cut so that the area where the joist hanger is located are free from knots, local grain disturbance, fissures (such as shakes, checks and splits) and wane. Elsewhere, the members shall be free from major defects that can lead to premature failure in the timber.

5.1.6 The moisture content of the timber shall be determined in accordance with ISO 13061-1, and its density in accordance with ISO 13061-2. When measuring the moisture content of manufactured wood products, care shall be taken to avoid the effect of adhesives or other non-wood material on readings.

5.1.7 The moisture content at the time of testing shall be greater than 11 %.

NOTE For certain investigations, other moisture conditions can be appropriate.

5.1.8 The identity of the species shall, if necessary, be confirmed by a botanical examination.

5.1.9 A minimum period of seven days shall elapse between the assembly and testing of the test specimens to allow for fibre relaxation.

5.2 Concrete or masonry

5.2.1 If the header is replaced with concrete, a minimum of three concrete test cylinders shall be prepared, stored and cured in accordance with ISO 1920-6 from the same batch of concrete used in the joist hanger test specimen. Cylinders shall be tested in accordance with ISO 1920-4 within 24 h of the test of the joist hanger.

5.2.2 If the header is replaced with masonry, the compressive strength of the masonry shall be determined by the prism test method in accordance with ISO 9652-4.

5.3 Fasteners

5.3.1 When nail and screw fasteners are used with the joist hanger, fasteners from the same manufacturer's lot as were used in the joist hanger test specimen shall be sampled to determine the fastener bending yield strength in accordance with ISO 10984-1.

5.3.2 When bolt and dowel fasteners are used with the joist hanger, fasteners from the same manufacturer's lot as were used in the joist hanger test specimen shall be sampled to determine the fastener embedding strength in accordance with ISO 10984-2.

5.3.3 Fasteners that secure the joist hanger to concrete or masonry header shall be appropriate for the header material and shall have sufficient strength to ensure that the failure under any of the loading conditions tested herein shall be in the joist hanger only. The fastener shall be selected so that the stiffness of the fastener does not affect the global evaluation of the stiffness of the joist hanger in any test.

5.4 Joist hangers

5.4.1 The sizes of joist hangers used for the various tests shall be selected from the range of sizes produced by the joist hanger manufacturer in such a way that the strength values for all sizes can be obtained by interpolation, provided the interpolation is based on at least three data points and where only one variable changes (such as the header depth and number of fasteners). Appropriate regression shall be used and reported.

5.4.2 When tested in accordance with ISO 5002 or an equivalent standard, the mechanical properties (tensile strength, yield stress, elongation and hardness) of the test coil metal shall meet the requirements for the specified structural grade of steel for the joist hanger manufacture.

5.4.3 If the manufacturer's installation instructions require that the joist hangers be free of oil or any substance that can alter the hanger performance in service, they shall be washed in solvent before they are used in the tests.

6 Sampling

The number of joist hangers tested shall be sufficient to fabricate a minimum of five test specimens for each combination of joist hanger size and load condition.

7 Test apparatus

7.1 Testing machine

The testing machine shall be capable of operation at a constant rate of motion of the movable crosshead or a constant rate of loading. The force-measuring device shall be calibrated in accordance with ISO 7500-1.

7.2 Displacement transducers

All tests shall use a displacement transducer on each side of the joist to measure the relative movements between the supported member and header. Devices used for this purpose shall be calibrated and have an accuracy of ±0,02 mm.

8 Tests

8.1 General

8.1.1 The support and restraint conditions shall be those specified by the manufacturer and shall reflect the declared intended use. In the absence of manufacturer-supplied support and restraint conditions the test specimens shall be supported and restrained as described in the test methods below.

8.1.2 The manufacturer shall specify any assumptions regarding the preparation of the supporting and supported members.

EXAMPLE Requirements for pre-drilling holes, tolerance on the hole diameter and any special installation/maintenance provisions (e.g. re-tightening bolts).

8.2 Vertical load test

8.2.1 Test setup

8.2.1.1 Test specimens consisting of a length of joist supported by a joist hanger attached to a header shall be constructed as shown in Figure 1.

NOTE The header can be either fully restrained against rotation or simply supported as specified by the manufacturer.

8.2.1.2 The header shall have a length sufficient to provide support against lateral translation at a distance of at least one and a half times the depth of the header or two times the depth of the joist hanger, whichever is the larger, from the centreline of the joist.

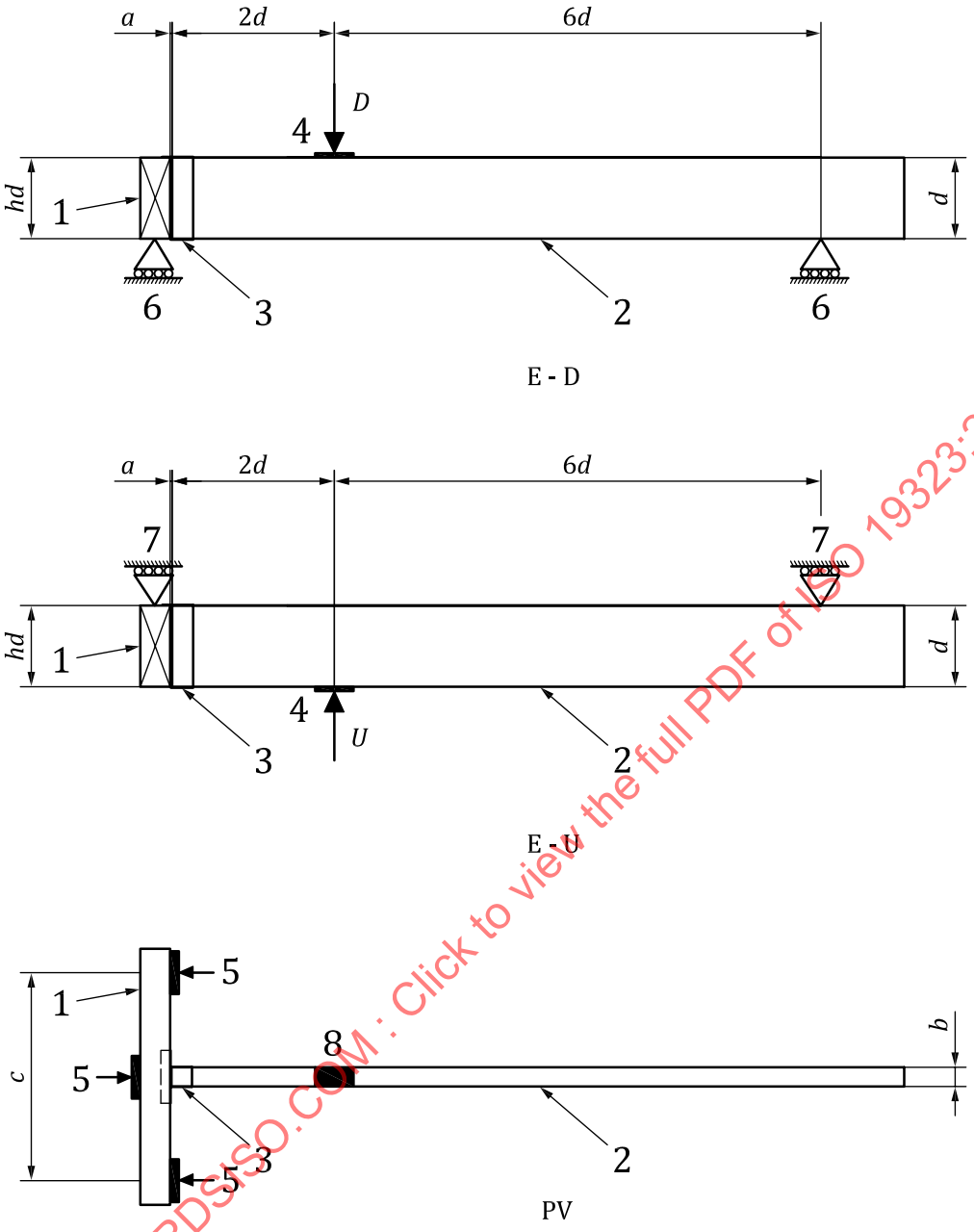
8.2.1.3 The joist length shall be sufficient to allow the application of the load at a distance of two times the depth of the joist from the front face of the header and the distance from the load application point to the remote support shall be six times the joist depth.

8.2.1.4 Reinforcement of the joist member in the area of the load application shall be permitted. Reinforcement may be required to prevent joist member failure in bending, shear or compression perpendicular to the grain at the applied load. Wood failure modes, such as joist bending failure and joist top surface crushing at the load transfer block are unrelated to the performance of the joist hanger and if such failures occur, the specimen shall be discarded and additional tests undertaken with appropriate reinforcement included.

8.2.1.5 A minimum clearance of 3 mm shall be provided between the end of the joist and abutting material, i.e. the header if no hanger section between the header and the joist or any hanger section between the header and the joist (see Figure 2). Prior to loading, the 3 mm gap shall be maintained between the joist and header by providing blocking or equivalent between the ends of the headers.

8.2.1.6 A low friction material with a thickness no greater than 1,5 mm shall be inserted into the 3 mm gap prior to loading.

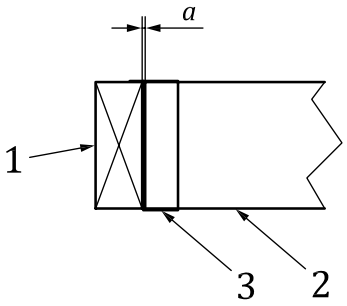
8.2.1.7 The seat of the hanger shall be prevented from direct contact with the header during the test unless provisions are made to prevent the hanger seat from gouging into the header or the hanger seat shall be at or below the bottom of the header.



Key

1	supporting member (header)	*b*	supported member width, expressed in mm
2	supported member (joist)	*c*	lesser of 3 *hd* or 4 times joist hanger depth, expressed in mm
3	joist hanger		
4	loading plate	*d*	supported member depth, expressed in mm
5	restraint (against lateral translation)	D	downward load, expressed in newtons
6	support (downward load)	E – D	elevation – downward load
7	support (upward load)	E – U	elevation – upward load
8	loading block	*hd*	supporting member depth, expressed in mm
a	3 mm gap between joist and header or between joist and hanger if hanger back plate is present	PV	plan view
		U	upward load, expressed in newtons

Figure 1 — Typical downward or upward test setup (vertical load test)



Key

1 supporting member (header)

2 supported member (joist)

3 joist hanger

a 3 mm gap between joist and header or between joist and hanger if hanger back plate is present

Figure 2 — Gap between joist and joist hanger

8.2.1.8 The header supports shall provide sufficient bearing to prevent excessive crushing.

8.2.1.9 No portion of the joist hanger shall bear on any support other than the header during the test. No portion of the joist shall bear on any support other than the joist hanger and the remote support.

8.2.1.10 Where a joist hanger device is of a design that is not adaptable to the test setup described above, necessary departures shall be permitted, provided that the altered setup will perform the essential function of testing the joist hanger devices, and that such departures are reported in the test report in detail.

8.2.2 Test procedure

8.2.2.1 Displacement transducers shall be fitted on both sides of the joist adjacent to the joist hanger to record the relative vertical movement between the joist and the header. For both the downward and upward load tests, the attachment points shall be to the bottom half of the header (i.e., the half furthest from the load application face of the joist) and to the joist at a point 40 mm from the end of the joist. Alternatively, the relative vertical movement may be recorded by placing a single displacement transducer targeting the top face of the joist and 40 mm from the end of the joist.

If the joist hanger prevents the attachment at 40 mm from the end of the joist, the gauges may be attached at a greater distance and the distance reported in the test report.

8.2.2.2 The load shall be centred over the joist and shall be applied over a sufficient joist length to prevent crushing under the loading head.

8.2.2.3 For downward load capacity tests, an initial load, or preload, of not more than 40 % of the ultimate load shall be applied to the joist to seat the test assembly. The load shall then be reduced to 10 % of the ultimate load and then re-applied. For upward load capacity tests the specimen shall not be preloaded.

NOTE The estimated ultimate capacity for the type of joint to be tested can be determined on the basis of experience, or by calculation or from preliminary tests.

8.2.2.4 A loading rate shall be used to give time to failure between 1 min and 5 min. Time to failure outside of this range shall be noted in the report. If the time to failure is longer than 10 min or shorter than 30 s, the test shall not be included in the analysis.

8.2.2.5 The load and displacement shall be continuously recorded over the duration of the test.

8.2.2.6 The load shall be recorded to a precision of 1 % for loads greater than 5 kN and 50 N for loads up to and including 5 kN. The deflections shall be recorded to ±1 % of the displacement gauge range. A sufficient number of readings shall be taken to permit the determination of the load at a relative vertical movement of 3 mm between the joist and the header.

8.2.3 Test report

The test report shall include:

a) the date of fabrication, date of test and date of report;

b) the test sponsor and test agency;

c) a description of the joist hangers tested including a drawing of the joist hangers, showing all pertinent dimensions and material specifications, including corrosion protection, and identification;

d) the details of the test specimen construction including a drawing showing actual dimensions, species, grades, including the name of the manufacturer of any proprietary products, a description of the load transfer block, other blocking, low-friction materials, reinforcement, and any deviations from the standard test setup as shown in Figure 1 and Figure 2;

e) the measured hanger steel properties including yield strength and tensile strength and evidence of the steel coil specified strength;

f) a description of the fasteners, including the finish, corrosion protection, head configuration, head diameter and markings; the measured length, diameter and strength properties from 5.3;

g) a description of the method of installation of the fasteners (e.g. gun-nailed) and the locations of the individual fasteners;

h) a description of the concrete or masonry properties, including measured properties as required in 5.2 if concrete or masonry was used;

i) the moisture contents and densities of the joist and header;

j) a complete description of the test method and loading procedure used, if there are any variations from this document;

k) data on load-deflection (a plot of the load-deflection curve), including the preload, the load at the 3 mm deflection point, the load at the commencement of the test and the maximum test load observed;

l) the type and location of failure of the specimen.

8.3 Tension load test

8.3.1 Test setup

8.3.1.1 Test specimens consisting of a length of joist supported by a joist hanger attached to a header shall be constructed as shown in Figure 3. The header shall be restrained to prevent translation or rotation of the header during the test.

NOTE The restraint is to force failure to occur in the joist hanger and/or its connections.

8.3.1.2 The header shall have a length sufficient to provide the intended joist hanger to header contact for the joist hanger, space for nailing and bearing as applicable.

NOTE The intention is to retain the header sufficiently while not affecting the performance of the joist hanger.

8.3.1.3 The header restraints shall be of a sufficient size to provide sufficient bearing to prevent excessive crushing of the header. The close edge of the restraint block shall be a minimum of 50 mm from the nearest point of the joist hanger.

8.3.1.4 A minimum horizontal clear distance of 200 mm or the joist depth, whichever is the larger, shall be provided between the tension load transfer bracket and the joist hanger.

8.3.1.5 The tension load transfer bracket shall be sufficiently strong to ensure that failure occurs in the joist hanger and/or its fixings.

8.3.2 Test procedure

8.3.2.1 Displacement transducers shall be fitted on both faces of the joist 50 mm from the nearest point of the joist hanger to record the relative movement between the joist and the header.

8.3.2.2 A loading rate shall be used to give time to failure between 1 min and 5 min. Time to failure outside of this range shall be noted in the report. If the time to failure is longer than 10 min or shorter than 30 s, the test shall not be included in the analysis.

8.3.2.3 The load and displacement shall be continuously recorded over the duration of the test.

8.3.2.4 The load shall be recorded to a precision of 1 % for loads greater than 5 kN and 50 N for loads up to and including 5 kN. The deflections shall be recorded to ±1 % of the displacement gauge range. A sufficient number of readings shall be taken to permit a load-displacement curve to be drawn and the determination of the load at a relative movement of 3 mm between the joist and the header.

8.3.3 Test report

The test report shall include:

a) the date of fabrication, date of test and date of report;

b) the test sponsor and test agency;

c) a description of the joist hangers tested including a drawing of the joist hangers, showing all pertinent dimensions and material specifications, including corrosion protection, and identification marking;

d) the details of the test specimen construction including a drawing showing actual dimensions, species, grades, including the name of the manufacturer of any proprietary products, a description of the load application rig, and any deviations from the standard test setup as shown in Figure 3;

e) the measured hanger steel properties including yield strength and tensile strength and evidence of the steel coil specified strength;

f) a description of the fasteners, including the finish, corrosion protection, head configuration, head diameter and markings; the measured length, diameter and strength properties from 5.3;

g) a description of the method of installation of the fasteners (e.g. gun-nailed) and the locations of the individual fasteners;

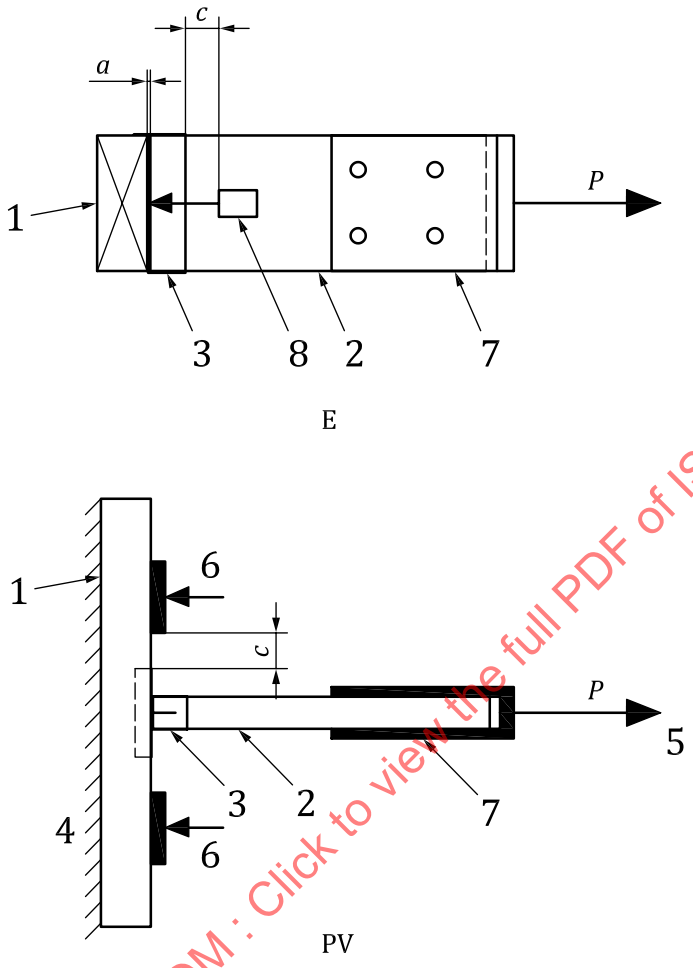
h) a description of the concrete or masonry properties, including measured properties as required in section 5.2 if concrete or masonry was used;

i) the moisture contents and densities of the joist and header;

j) a complete description of the test method and loading procedure used, if there are any variations from this document;

k) a plot of the load-displacement curve (axial to the joist), including the load at the 3 mm displacement limit and the maximum test load observed;

l) the type and location of failure of the specimen.



Key

1 supporting member (header)
2 supported member (joist)
3 joist hanger
4 platen
5 crosshead
6 restraint
7 tension load transfer bracket
8 displacement transducer each face
a 3 mm gap between joist and header
c 50 mm minimum
E elevation
P load, expressed in newtons
PV plan view

Figure 3 — Tension test specimen setup

8.4 Torsional load test

8.4.1 Test setup

8.4.1.1 A specimen shall consist of a joist supported between two headers by the joist hanger devices that are to be tested (see Figure 4).

8.4.1.2 The joist and headers shall have a length sufficient to permit loading of the joist hangers without excessive deformation of the test specimen. The minimum joist length shall be 450 mm. The header length shall be at least 450 mm. The header depth shall be a minimum of 50 mm deeper than the joist depth and the joist shall be attached to the headers with their top surfaces in the same horizontal plane.

8.4.1.3 A minimum clearance of 3 mm shall be provided between each end of the joist and abutting material, i.e. the header if no hanger section between the header and the joist or any hanger section between the header and the joist (see Figure 4). Prior to loading, the 3 mm gap shall be maintained between the joist and header.

8.4.1.4 A low friction material with a thickness no greater than 1,5 mm shall be inserted into the 3 mm gap prior to loading.

8.4.1.5 The headers shall be rigidly supported against uplift.

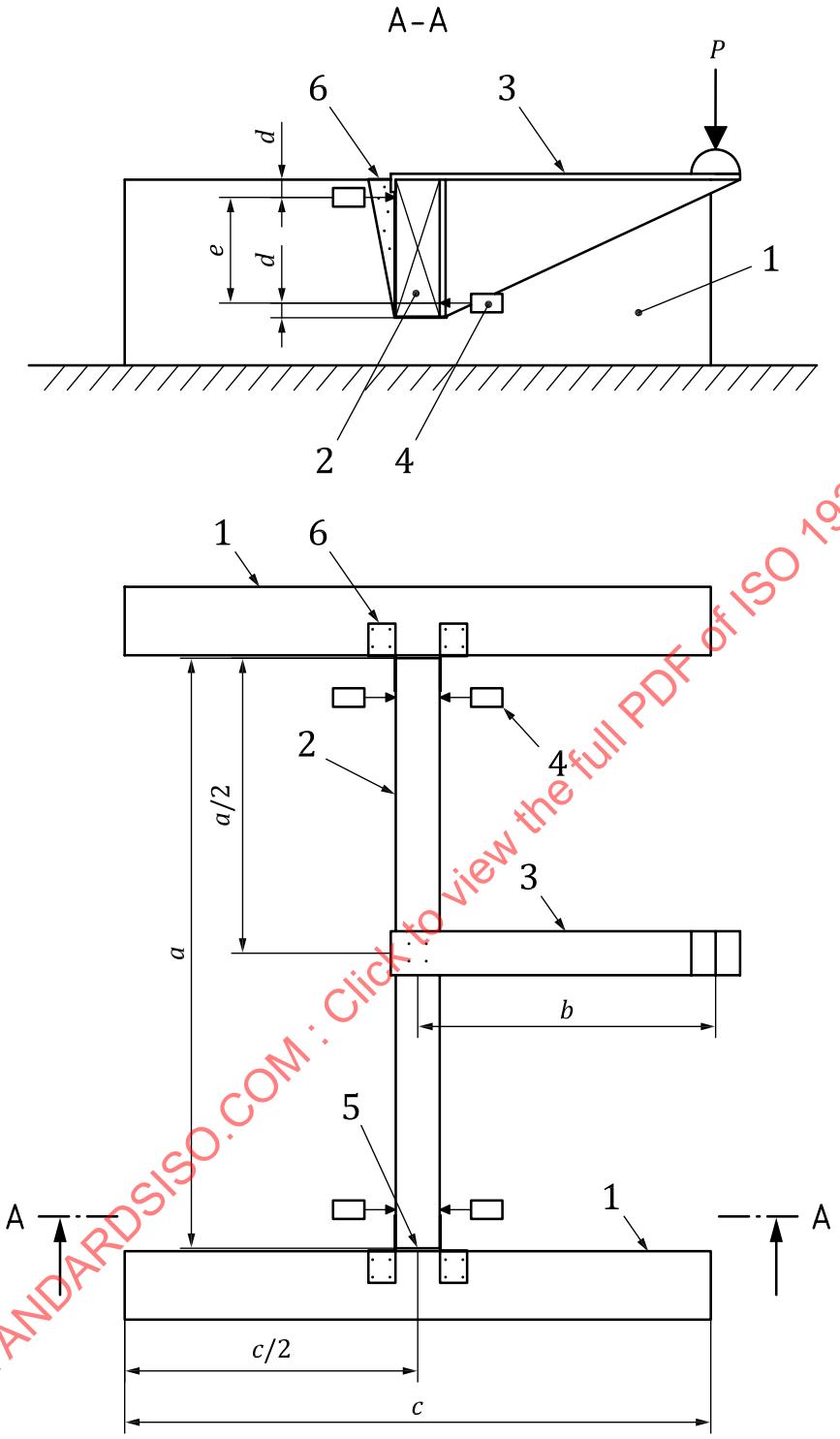
NOTE This can be achieved by clamping the headers to a rigid table or strong floor.

8.4.1.6 The header supports shall provide sufficient bearing to prevent excessive crushing of the headers.

8.4.1.7 A suitable steel bracket shall be attached to the mid-length of the joist to allow a vertical load to be applied at a point at least 300 mm offset from the centreline of the joist.

NOTE This bracket will introduce a torsional moment on the joist and the two supporting joist hangers.

8.4.1.8 Where a joist hanger device is of a design that is not adaptable to the test setup described above, necessary departures shall be permitted, provided that the altered setup will perform the essential function of testing the joist hanger devices, and that such departures are reported in the test report in detail.



Key

1 supporting member (header)
2 supported member (joist)
3 steel bracket
4 displacement transducer
5 3 mm gap each end – insert low friction material of <1,5 mm thickness in gap
6 joist hanger
a 450 to 600 mm
b ≥300 mm

c ≥450 mm

d ≤25 mm

e vertical distance between displacement transducers, expressed in mm

P load, expressed in newtons

Figure 4 — Torsional test specimen setup

8.4.2 Test procedure

8.4.2.1 Horizontal movement of the joist with respect to the headers shall be measured with displacement transducers at the top and bottom at each end of the joist (see Figure 4). The target points shall be within 10 mm of the joist hanger, or 40 mm from the joist end, and within 25 mm of the top and bottom of the joist.

8.4.2.2 The location of the displacement transducers and the distance between the upper and lower transducer at each end shall be recorded.

8.4.2.3 An initial load, or preload, of not more than 40 % of the ultimate load shall be applied to the joist to seat the test assembly. The load shall then be reduced to 10 % of the ultimate load and then re-applied.

NOTE The estimated ultimate capacity for the type of joint to be tested can be determined on the basis of experience, or by calculation or from preliminary tests.

8.4.2.4 A loading rate shall be used to give time to reach the ultimate load between 1 min and 5 min. Time to ultimate load outside of this range shall be noted in the report. If the time to ultimate load is longer than 10 min or shorter than 30 s, the test shall not be included in the analysis. All displacement transducer displacements shall be recorded during loading until one gauge has registered a movement of at least 10 mm, or failure of the specimen, whichever occurs first.

8.4.2.5 The load and displacement shall be continuously recorded over the duration of the test.

8.4.2.6 The load shall be recorded to a precision of 1 % for loads greater than 5 kN and 50 N for loads up to and including 5 kN. The deflections of the displacement transducers shall be recorded to ±1 % of the displacement gauge range. A sufficient number of readings shall be taken to permit the establishment of a load-deformation curve.

8.4.3 Calculation of torsional moment and rotation

8.4.3.1 The torsional moment applied to each joist hanger shall be calculated in accordance with:

$$M = (P \times d)/2$$

where

M is the torsional moment (Nm);

P is the applied load (kN);

d is the distance between the centreline of the joist and the point of load application (m).