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Hardware for furniture — Test methods for strength and overload tests of connectors for furniture constructed from panel material

bsi.

National foreword

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The UK participation in its preparation was entrusted to Technical Committee FW/0, Furniture.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Hardware for furniture - Test methods for strength and overload tests of connectors for furniture constructed from panel material

Quincaillerie d'ameublement - Méthodes d'essai pour détermination de la résistance mécanique et rigidité de ferrures d'assemblage de corps de meuble

Möbelbeschläge - Prüfverfahren zur Durchführung von Festigkeits- und Schwellbelastungstests von Korpuseckverbindern für Möbel aus Holzwerkstoffplatten

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EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents

European foreword

This document (EN 17869:2023) has been prepared by Technical Committee CEN/TC 207 "Furniture", the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2023, and conflicting national standards shall be withdrawn at the latest by September 2023.

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1 Scope

This document specifies test methods for the strength and overload tests of connectors for furniture constructed from panel material and procedures for evaluating test results.

This document is specifically intended for assessing cabinet connectors for carcases made of wood-based panel materials. The methods described can, however, be used to assess the relative performance of other types of connectors, e.g. some types of connectors for beds.

The strength and overload tests only apply to the connectors and their components, as well as the mounting to and in the cabinet carcase. They do not apply to additional functions that the connector can have, e.g. covering of the connector.

The tests described in this document are carried out according to a test setup with specified properties and characteristics.

The test results are only valid for the connector tested. The results can be used to represent the performance of production models, provided the tested model is representative of the production model.

Aging and the influences of temperature and humidity are not included. This document contains four informative annexes, providing additional methodologies for the detailed evaluation of the test results and a procedure for comparing the tested connector with a reference connector:

— Annex A (informative) Reference connector — Glued dowel;

— Annex B (informative) Ratio generation;

— Annex C (informative) Stiffness calculation for further evaluation of the overload;

— Annex D (informative) Evaluation by the characteristic value (5 % percentile).

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.

EN 312, *Particleboards — Specifications*

EN 320, *Particleboards and fibreboards — Determination of resistance to axial withdrawal of screws*

EN 323, *Wood-based panels — Determination of density*

3 Terms and definitions

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

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

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at https://www.electropedia.org/

3.1
clearance
L
force-free mobility of the connection, which occurs during the described tests due to repeated loading

Note 1 to entry: The clearance *L* is given in mm.

3.2
connector
connector for use in furniture constructed from panel materials, such as cabinet furniture and shelves

3.3
maximum torque
maximum achievable torque when screwing in the connectors without damaging the connector or the furniture

4 General test conditions

4.1 Preliminary preparation

The connectors(s) shall be mounted according to the instructions of the manufacturer.

If mounting or assembly instructions are not supplied, or if different mounting positions of the connector are possible, the most adverse configuration shall be used and the mounting or assembly method shall be recorded in the test report.

Connectors shall be tightened to the manufacturer's defined torque before testing and shall not be re-tightened unless specifically required in the manufacturer's instructions. In case the torque is not specified by the manufacturer, the connectors are tightened to 80 % of the maximum torque or to any other reasonable value. The torque value shall be recorded in the report. Even if the configuration is to be changed to produce the worst-case conditions this shall be recorded in the test report.

The design of the test specimens and test equipment shall not influence the test results and shall be adjusted if necessary. Adjustments of the test specimens or the test equipment shall be recorded in the test report.

The tests shall be carried out in indoor ambient conditions at a temperature between 15 °C and 25 °C. If during a test the temperature is outside the range of 15 °C to 25 °C, the maximum and/or minimum temperature shall be recorded in the test report.

Connectors which include structural hardware parts made of hygroscopic plastic materials, e.g. polyamide in load-bearing function shall be conditioned at (23 ± 5) °C and a relative humidity of (50 ± 5) % for at least seven days before testing. Panel materials used for the test setting shall be kept in the standard climate for at least seven days before testing.

Before beginning the testing, visually inspect the connector(s) thoroughly. Record any defects so that they are not assumed to have been caused by the tests. Carry out measurements when specified.

NOTE For accelerating the conditioning process, EN ISO 1110 [1] can be used.

4.2 Test equipment

4.2.1 Testing device

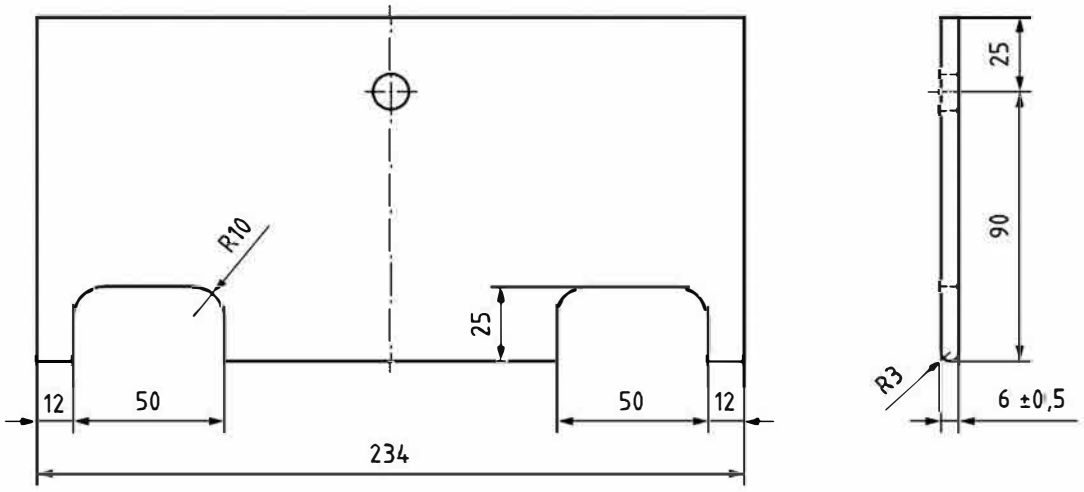
4.2.1.1 General

An apparatus which, by means of a loading device (Figure 1), allows the application of a compressive force at the force application points as shown in Figure 5.

4.2.1.2 Loading device

The loading device shall be rotatable and made of steel without any play as shown in Figure 1. The bearing shall be executed in such a way that the loading device can deflect by max. 0,1 mm transverse to the vertical plane of symmetry shown in Figure 1b). A schematic illustration of a suitable bearing is shown in Figure 2.

Dimensions in millimetres



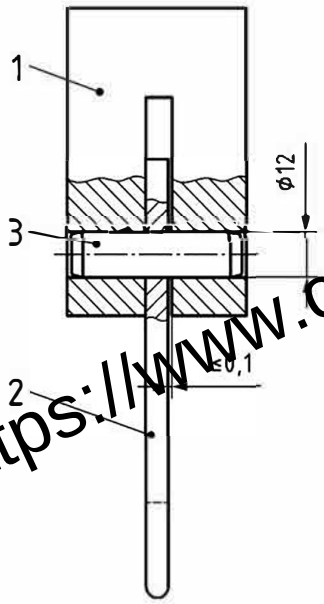
a) front view **b) side view**

Figure 1 — Loading device

The diameter of the mandrel for mounting the loading device should be at least 12 mm, the mandrel shall be made of steel.

The loading device shall not prevent deformation of the test specimen or breaking of the connectors. The two recesses of the loading device shall be enlarged as required. The dimension of any enlargement shall be recorded in the test report.

Dimensions in millimetres



Key

1 illustration, schematic
2 loading device
3 mandrel

Figure 2 — Schematic illustration for the bearing of the loading device

4.2.1.3 Clamping device

The clamping device shall hold the test specimens and shall be mounted in accordance with Figure 5 and shall extend over the entire depth/length of the test specimens.

Clamping device 1 shall be applied to test specimen 1.

Clamping device 2 shall be applied to test specimen 2.

4.2.2 Default particle board properties

If the manufacturer does not specify the panel board used for the tests in Clause 5, the particle board shall comply with type P2 according to EN 312. The properties of the particle board shall be as specified in Table 1.

Table 1 — Default particle board properties

Property	Referenced standard	Requirement
Axial withdrawal of screws	EN 320	(1 100 ± 100) N
Density	EN 323	(650 ± 50) kg/m^3

4.3 Application of forces

The forces shall be applied sufficiently slowly to ensure that negligible dynamic force is applied.

The forces may be replaced by masses. The relation 10 *N* = 1 kg shall be used for this purpose.

4.4 Tolerances

Unless otherwise stated, the following tolerances are applicable:

— Forces: ±5 % of the nominal force;

— Masses: ±1 % of the nominal mass;

— Dimensions: ±0,5 mm of the nominal dimension;

— Velocities: ±5 % of the nominal velocity.

NOTE For the purpose of uncertainty measurement, test results are not considered to be adversely affected when the above tolerances are met.

5 Test specimen

5.1 Test specimen 1 – perpendicular force

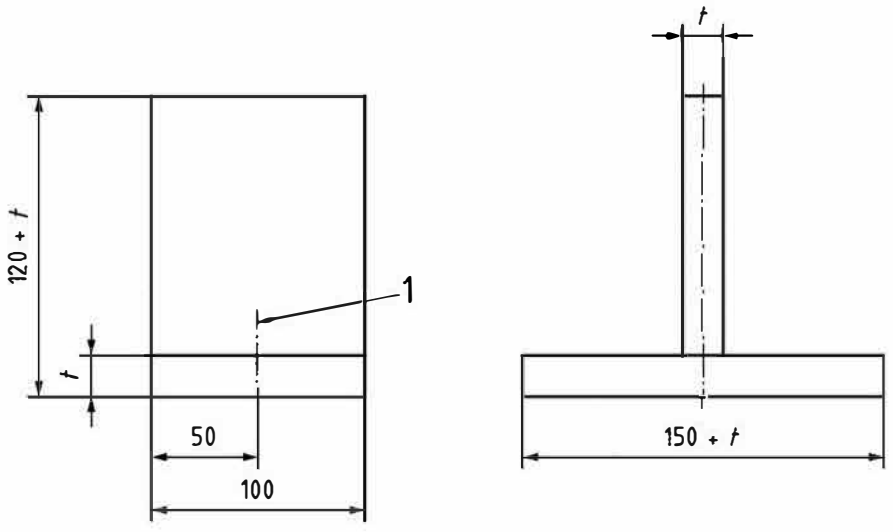
The test specimen consists of one horizontal test part, one vertical test part and a connector. The test parts shall be made of panel board with a thickness *t*. The dimensions of the test specimen shall be as given in Figure 3.

The type of panel board and the specifications shall be specified in the test report. If no specific panel board is defined by the manufacturer, a default particle board according to 4.2.2 can be used.

If the geometry of the connectors makes it necessary to adapt the test specimens, this shall be indicated in the report.

The test parts shall be connected by the connectors according to Figure 3.

Dimensions in millimetres



a) front view **b) side view**

Key

1 position of connector

t thickness of test part

Figure 3 — Test specimen 1

5.2 Test specimen 2 – lateral force and torque

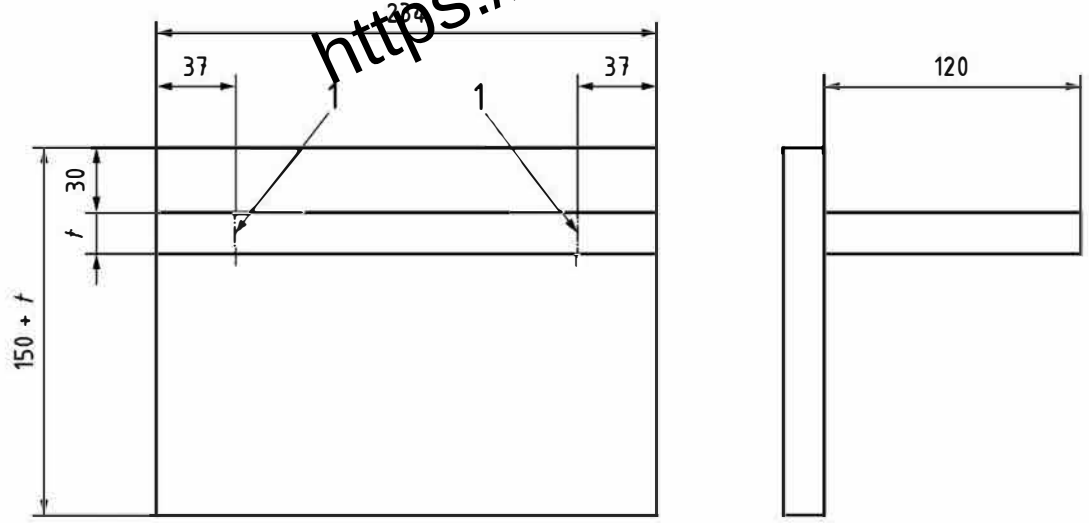
The test specimen consists of one horizontal test part, one vertical test part and two connectors. The test parts shall be made of a panel board with a thickness *t*. The dimensions of the test specimen shall be according to Figure 4.

If the geometry of the connectors makes it necessary to adapt the test specimens, this shall be indicated in the report.

The type of panel board and the specifications shall be specified in the test report. If no specific panel board is defined by the manufacturer, a default particle board according to 4.2.2 can be used.

The test parts shall be assembled using the connectors, according to Figure 4.

Dimensions in millimetres



a) front view **b) side view**

Key

1 position of connector

t thickness of test part

Figure 4 — Test specimen 2

6 Test procedures

6.1 General

For the tests according to 6.3 and 6.4, eight individual test specimens shall be used per test/connector.

The tests shall be carried out within one hour of the assembly of the test specimens. In the case of glued connections, the test is carried out after the adhesive has cured, in accordance with the manufacturer's instructions.

The test shall be carried out using a suitable displacement and force-controlled testing device for applying the force to the test specimens.

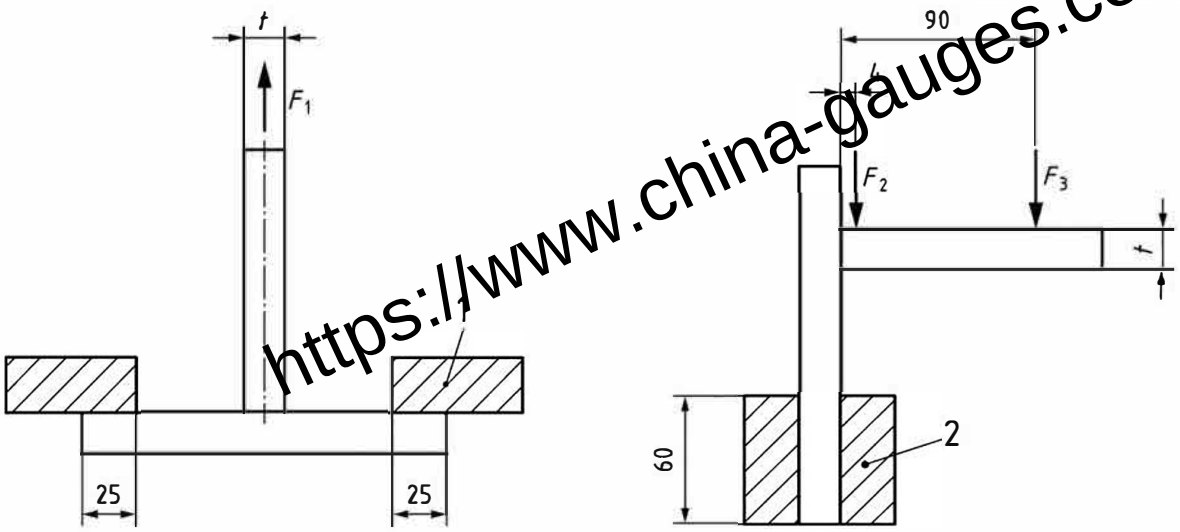
The test speed for all tests shall be between 10 mm/min and 25 mm/min.

The tolerance for the machine travel shall not exceed 0,1 mm.

6.2 Force application points, force directions and clamping devices

The force application points, force directions and clamping devices are shown in Figure 5.

Dimensions in millimetres



a) strength test of perpendicular force

b) strength test of lateral force, torque loading and overload test

Key

F_1	force at force application point 1
F_2	force at force application point 2
F_3	force at force application point 3
1	clamping device 1
2	clamping device 2
t	thickness of testpart

Figure 5 — Force application points, force directions and clamping devices

6.3 Strength tests

6.3.1 General

The strength of the connector is tested under the following load regimes: perpendicular force, lateral force and torque loading in accordance with 6.3.2 to 6.3.4.

6.3.2 Perpendicular force F_1

The perpendicular force test shall be carried out using the clamping device 1 and test specimen 1. Apply the force F_1 as shown in Figure 5. The maximum force before failure of the connection, in N, shall be measured and recorded.

NOTE Failure of the connection can be failure of the connector or failure of the panel board.

6.3.3 Lateral force F_2

The lateral force test shall be carried out using clamping device 2 and test specimen 2. Apply the force F_2 by means of the loading device as shown in Figure 5. The lateral force in N at a displacement of 2 mm from the loading device and the maximum force before failure of the connection, in N shall be measured and recorded.

NOTE Failure of the connection can be failure of the connector or failure of the panel board.

6.3.4 Torque loading F_3

The torque test shall be carried out using clamping device 2 and test specimen 2. Apply the force F_3 by means of the loading device as shown in Figure 5. The force in N at a displacement of 4 mm from the loading device and the maximum force before failure of the connection in N shall be measured and recorded.

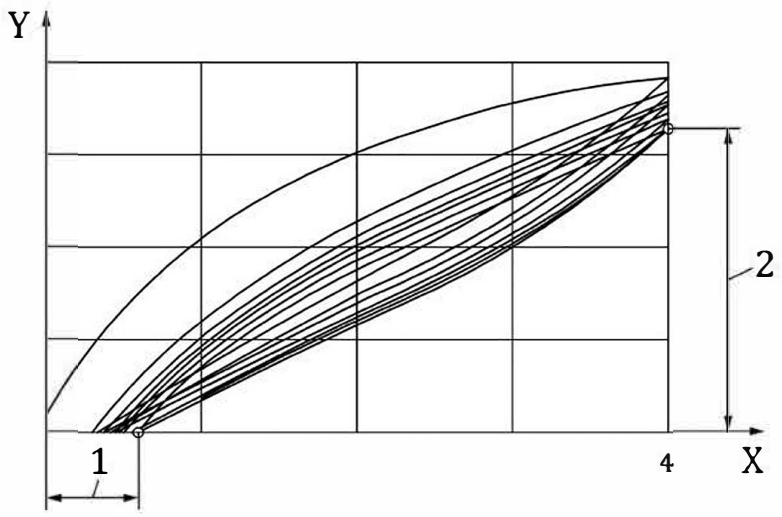
NOTE Failure of the connection can be failure of the connector or failure of the panel board.

The results are given as torque in Nm. A lever length of 0,09 m is used to calculate the torque (torque = recorded force in N*0,09 m).

6.4 Overload test

The overload test shall be performed using the clamping device 2 and the test specimen 2. Apply the force F_3 as overload by means of the loading device as shown in Figure 5. The displacement of the loading device at the initial state is in each case 4 mm (in the first cycle with a preliminary force of 1 N) without holding time. After the tenth stroke, the force in N at a displacement of 4 mm from the loading device and clearance L in millimetre (displacement of the loading device without force application) shall be measured and recorded.

Figure 6 shows the force profile at ten strokes. A stroke is the movement of the loading device from 0 mm to 4 mm at the force application point F_3 (Figure 5).



Key

1 clearance *L* in millimetre (mm)
2 force *F* in newton (N)
X displacement in millimetre (mm)
Y force in newton (N)

Figure 6 — Torque after 10th stroke

6.5 Evaluation of results

To evaluate the strength tests, the arithmetic mean values of the measured forces at the specified displacements from the loading device and at failure of the connection (maximum force) should be calculated and given together with the standard deviation.

To evaluate the overload test, the arithmetic mean values of the measured forces at a displacement of 4 mm from the loading device after the tenth stroke and of the clearance in millimetres be calculated and given together with the standard deviation.

For further evaluation the stiffness of the connection can be calculated using the measured force and the measured clearance in the overload test (see Annex C).

The evaluation of the measurement results can also be done by forming the characteristic values (5 % percentile) (see Annex D).

7 Test report

The test report shall contain at least the following information:

a) reference to this document (EN 17869);

b) exact description of the tested connector and its mounting position;

c) any defects observed before testing;

d) evaluation of results as per 6.5;

e) details of any deviations from this document;

f) name and address of the test facility;

g) date(s) of test.

Annex A
(informative)

Reference connector — Glued dowel

A.1 Background and explanation

To compare the test results, all tests can be carried out with a reference connection using glued dowels.

The test results can be used as reference values for the performance of the connectors in comparison to the commonly used glued dowel connection.

A.2 Test specimen for the test with wooden dowel

The test specimens for testing the reference connection should correspond to test specimens 1 and 2 (see Figure A.1) and should be made of wood-based materials from the same production batch.

A solid wooden dowel with a diameter of ($8^{0}_{-0,1}$) mm, 30 mm in length, made of beech without any grooves, mounted according to Figure A.1 shall be used to assemble the test specimens.

A suitable PVAC adhesive according to EN 204:2016 [3], class D2, should be applied to the walls of the dowel holes and the side of the dowel. The total quantity of the adhesive used should be approximately 0,3 g per dowel/hole.

First, the dowels should be inserted into the vertical arm and then joined with the horizontal arm and pressed together for at least 8 h until the adhesive has set at (23 ± 5) °C and a relative humidity of (50 ± 5) %.

Other connector types and glue quantities can also be used. Details of the connector and glue quantities should be stated in the test report.

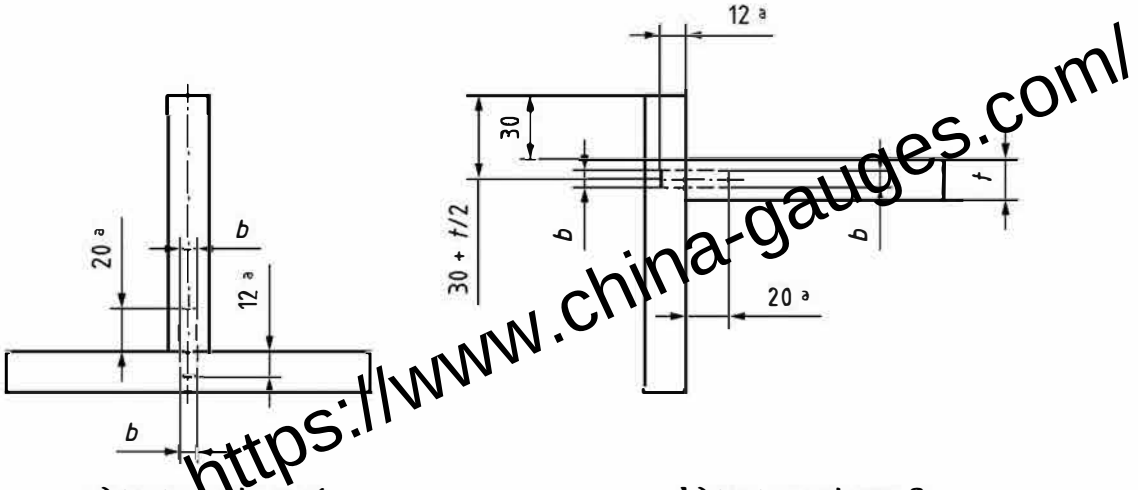
A.3 Test and evaluation

The test procedures used should be as described in 6.3 and 6.4.

Evaluation of the test results should be as described in 6.5.

To compare the performance of the dowel connector to other connectors tested, a ratio calculated according to Annex B can be calculated.

Dimensions in millimetres



a) test specimen 1 **b) test specimen 2**

Key

t depth of the test sample

a depth of the drilling

b diameter of the drilling hole ($8^{+0.2}_{0}$ mm)

Figure A.1 — Reference dowel connection

Annex B
(informative)

Ratio generation

B.1 Background and explanation

In order to compare the measurement results of different connectors, a ratio V can be calculated.

The ratio can be calculated, for example, to compare the connectors with a "reference connector" or to compare the connectors with a wooden dowel reference connector (see Annex A).

NOTE A ratio can only be established between the same reference values and for the same load types (e.g. mean values of the maximum force for the perpendicular force test, mean values of clearance for the overload test).

B.2 Formula

To form the ratio the following formula can be used:

$$V = \frac{a}{b} \tag{B.1}$$

where

- V is the ratio;
- a is the calculated mean value of the connector to be compared with the reference connection;
- b is the unchangeable reference value of the reference connection, e.g. the mean values of the connection with wooden dowels.

The calculated numeric value V is rounded to one decimal point.

Annex C
(informative)

Stiffness calculation for further evaluation of overload

C.1 Background and explanation

For further evaluation, the stiffness of the connection can be calculated from the force and the clearance L measured in the overload test (see 6.4).

A conversion to degrees is used to aid understanding. By specifying the angle, the deformation of a furniture carcase can be better estimated.

C.2 Conversion of the clearance L in clearance φ in degree of deviation

The conversion of the clearance L into degrees is done according to Figure C.1:

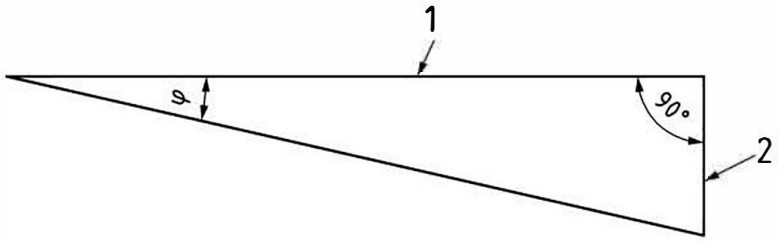
$$\varphi = \arctan\left(\frac{L}{A}\right) \tag{C.1}$$

where

- φ is the clearance in degrees (°);
- L is the clearance in millimetre (mm) (Travel distance of loading device without force application);
- A is the lever arm at the force application point 3, length 90 mm (corresponds to a length of 0,09 m).

NOTE If the lever arm length is not specified, there is not enough information to define the deformation angle.

The calculated numeric value φ is rounded off to one decimal points.



Key

1 length of the lever arm, 90 mm
2 clearance L (mm)
φ clearance (°)

Figure C.1 — Conversion of clearance L to degrees

C.3 Calculation of stiffness *S*

$$S = \frac{0{,}09\ \text{m} * F_{10}}{2{,}54° - \varphi} \qquad \text{(C.2)}$$

where

S is the stiffness, in newton meter/degree (Nm/°);

F_{10} is the force F, in newton (N), at 10th stroke;

φ is the clearance in degrees (°).

The lever arm corresponds to a length of 0,09 m at force application point 3. The angle resulting from a distance of 4 mm of the loading device corresponds to 2,54°.

Annex D
(informative)

Evaluation by the characteristic value (5 % percentile)

D.1 Background

The characteristic values determined within the framework of the standard test can, under certain circumstances, vary considerably, as the strength and stiffness of the connection is influenced by many factors, including the quality of the wood-based panel used and the manufacturing tolerances of the connectors and test specimens

Maximize the safety of a design, it can be important to take into account of the variation in the properties of a connection.

When comparing different connectors, the evaluation of the measured values obtained in the standard test can include calculating the characteristic values (5 % percentile). The 5 % percentile means the value obtained where less than 5 % of all potential test values are smaller than this value. If this quantile is used for the assessment of connectors it can be assumed that 95 % of all measured values will be greater than this value.

When the mean value, used in 6.3, is used half of all measured values are below the mean value.

The 5 % percentile is assumed and can give reassurance that the connection design is unlikely to fail.

This appendix therefore explains how the evaluation of the measured values of this document can be carried out by forming the 5 % percentile.

D.2 General information

The characteristic values can be determined according to EN 14358 [2].

D.3 Characteristic value for strength

D.3.1 Calculation

A characteristic value (5 % percentile) per test can be calculated for the individual measured values of strength determined in 6.3.

When determining the characteristic value for the strength, the logarithmic normal distribution should be used.

NOTE A normal distribution could also produce negative values under certain circumstances.

The calculated numeric value m_k should be rounded off to two decimal places.

The calculation should be made according to the following formula:

$$m_k = \exp\left(\bar{y} - k_s\left(n\right) s_y\right) \quad \text{(D.1)}$$

where

m_k is the characteristic value (5 % quantile) for strength;

s_y is the standard deviation;

$k_s\left(n\right)$ is the factor for the calculation of characteristic values within the framework of the initial test, for eight valid tests (n = 8) corresponds to $k_s\left(n\right)$ = 2,18;

$\bar{y}$ is the mean value of the logarithmic measurement results.

The calculations of the standard deviation and the mean values are made according to the following equations:

Mean value:

$$\bar{y} = \frac{1}{n}\sum_{i=1}^{n} \ln m_i$$

Standard deviation:

$$s_y = \max\left\{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(\ln m_i - \bar{y}\right)^2}\right.$$
$$\left. 0,05\right.$$

D.3.2 Example for calculation of the characteristic values of the strength tests according to 6.3

The mathematical evaluation for the strength tests is shown with an example which is based on the wooden dowel / PVAC - normal force in Table D.1 and Table D.2.

Table D.1 — Normal force test values for F_{max}

Test specimen	F_{max} N	$Ln\ F_{max}$ N
1	833,63	6,73
2	1 014,83	6,92
3	962,30	6,87
4	989,45	6,90
5	1 231,22	7,12
6	1 137,03	7,04
7	979,00	6,89
8		

Table D.2 — Calculation of the characteristic value for strength

Equations	Results
Mean value $\bar{y} = \frac{1}{n}\sum_{i=1}^{n} \ln m_i$	0,92
Standard deviation $s_y = \max\left\{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(\ln m_i - \bar{y}\right)^2}; 0{,}05\right\}$	0,12
Characteristic value $m_k = \exp\left(\bar{y} - k_s(n)\, s_y\right)$	788,72

D.4 Characteristic value for stiffness and clearance in degrees

D.4.1 Calculation

A characteristic value (5 % percentile) per test can be calculated for the individual measured stiffness values determined in 6.4.

When determining the characteristic value for the stiffness and clearance, the normal distribution should be used.

The calculated numeric value m_k is rounded off to two decimal places.

The calculation should be made according to the following equation:

$$m_k = \bar{y} - k_s(n)\, s_y \tag{D.2}$$

where

m_k is the characteristic value (5 % quantile) for stiffness and clearance;

s_y is the standard deviation;

$k_s(n)$ is factor for the calculation of characteristic values within the framework of the initial test, for eight valid tests (n = 8) corresponds to $k_s(n)$ = 0,259;

$\bar{y}$ is the mean value of the logarithmic measurement results.

The calculations of the standard deviation and the mean values should be made according to the following equations:

Mean value of clearance and stiffness *S*:

$$\bar{y} = \frac{1}{n}\sum_{i=1}^{n} m_i$$

Standard deviation of clearance and stiffness *S*:

$$s_y = \max\left\{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(m_i - \bar{y}\right)^2};\ 0{,}05\bar{y}\right\}$$

D.4.2 Example for calculation of the characteristic values of the stiffness and clearance in degrees after overload stress test according to Annex C

The mathematical evaluation of the stiffness and clearance is shown with an example which is based on the wooden dowel / PVAC – overload test in Tables D.3 to D6.

Firstly, the clearance is determined in degrees according to Table D.3 and Table D.4. Based on this, the stiffness *S* is determined according to Table D.5 and Table D.6.

Table D.3 — Equations

Equations	**Results** Degrees (°)
Conversion of clearance *L* (see C.2) $\arctan\left(\frac{L}{90}\right)$	See Table D.4
Mean value of clearance in degrees $\bar{y} = \frac{1}{n}\sum_{i=1}^{n} m_i$	0,96
Standard deviation of clearance in degrees $s_y = \max\left\{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(m_i - \bar{y}\right)^2};\ 0{,}05\bar{y}\right\}$	0,09
Characteristic value of clearance in degrees $m_k = \bar{y} - k_s(n)\,s_y$	0,94

Table D.4 — Conversion of clearance in degree

Test specimen	Clearance	
	L mm	φ degree (°) [a]
1	1,30	0,83
2	1,51	0,96
3	1,52	0,97
4	1,69	1,08
5	1,33	0,85
6	1,60	1,02
7	1,67	1,06
8	1,47	0,94

[a] Interim result is rounded to obtain a better overview.

Table D.5 — Calculation of characteristic value for the stiffness S

Formula	Results Nm/degree (°)
Calculation of stiffness S (see C.3) $S = \frac{0,09\ \mathrm{m}^* F_{10}}{2,54° - \varphi}$	See Table D.6
Mean value of stiffness S $\bar{y} = \frac{1}{n}\sum_{i=1}^{n} m_i$	8,66
Standard deviation of stiffness S $s_y = \max\left\{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(m_i - \bar{y}\right)^2};\ 0,05\bar{y}\right\}$	1,05
Characteristic value of stiffness S $m_k = \bar{y} - k_s(n)\,s_y$	8,38

Table D.6 — Values for stiffness S

Test specimen	Parameter		
	Force F_{10} N	φ degree (°) [a]	S Nm/degree (°) [a]
1	161,40	0,83	8,48
2	158,00	0,96	9,01
3	161,30	0,97	9,23
4	144,90	1,08	8,91
5	180,50	0,85	9,59
6	166,30	1,02	9,84
7	118,90	1,06	7,25
8	123,70	0,94	6,94

[a] Interim result is rounded to obtain a better overview.

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