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Authorised and notified according to Article 10 of the Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products

MEMBER OF EOTA

European Technical Approval ETA-09/0015

Trade name:	Gutzeit Joist Hangers Type A and B (Kombi and Innen)
Holder of approval:	Gutzeit Verbindungssysteme GmbH & Co. Rudolf-Diesel-Strasse 1 D-58730 Fröndenberg, Industriegebiet Tel. +49 2373 - 979261 Fax +49 2373 - 979266 Internet www.gutzeit-holzverbinder.de
Generic type and use of construction product:	Three-dimensional nailing plate (joist hanger for wood to wood connections and wood to concrete or steel connections)
Valid from: to:	2009-03-10 2014-03-10
Manufacturing plant:	Gutzeit Verbindungssysteme GmbH & Co. Rudolf-Diesel-Strasse 1 D-58730 Fröndenberg, Industriegebiet
This European Technical Approval contains:	21 pages including 4 annexes which form an integral part of the document

I LEGAL BASIS AND GENERAL CONDITIONS

1 This European Technical Approval is issued by ETA-Danmark A/S in accordance with:

- Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products[1)], as amended by Council Directive 93/68/EEC of 22 July 1993[2)].

- Bekendtgørelse 559 af 27-06-1994 (afløser bekendtgørelse 480 af 25-06-1991) om ikrafttræden af EF direktiv af 21. december 1988 om indbyrdes tilnærmelse af medlemsstaternes love og administrative bestemmelser om byggevarer.

- Common Procedural Rules for Requesting, Preparing and the Granting of European Technical Approvals set out in the Annex to Commission Decision 94/23/EC[3)].

- EOTA Guideline ETAG 015 *Three-dimensional nailing plates,* September 2002 edition.

2 ETA-Danmark A/S is authorized to check whether the provisions of this European Technical Approval are met. Checking may take place in the manufacturing plant. Nevertheless, the responsibility for the conformity of the products to the European Technical Approval and for their fitness for the intended use remains with the holder of the European Technical Approval.

3 This European Technical Approval is not to be transferred to manufacturers or agents of manufacturers other than those indicated on page 1, or manufacturing plants other than those indicated on page 1 of this European Technical Approval.

4 This European Technical Approval may be withdrawn by ETA-Danmark A/S pursuant to Article 5(1) of Council Directive89/106/EEC.

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6 This European Technical Approval is issued by ETA-Danmark A/S in English.
This version corresponds fully to the version circulated within EOTA. Translations into other languages have to be designated as such.

1) Official Journal of the European Communities N° L40, 11 Feb 1989, p 12.
2) Official Journal of the European Communities N° L220, 30 Aug 1993, p 1.
3) Official Journal of the European Communities N° L 17, 20 Jan 1994, p 34.

I SPECIAL CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1 Definition of product and intended use

Definition of the product
Gutzeit joist hangers type A and B are one-piece non-welded, face-fixed joist hangers to be used in timber to timber connections. Gutzeit joist hangers type A are also used for connections between a timber joist and a concrete structure or a steel member.

The joist hangers are made from pre-galvanized steel Grade DX51D + Z (min Z275) according to EN 10327:2004 with a minimum R_e of 250 MPa, a minimum tensile strength R_m of 330 MPa and a minimum ultimate strain A_{80} of 22 % with tolerances according to EN 10143:1993. Dimensions, hole positions, steel type and typical installations are shown in Annex A.

Intended use
The joist hangers are intended for use in making end-grain to side-grain connections in load bearing timber structures, as a connection between a wood based joist and a solid timber or wood based header, where requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 of Council Directive 89/106/EEC shall be fulfilled. They are also intended for use in making an end-grain connection between a timber joist and a concrete structure or a steel member.

The joist hangers can be installed as connections between wood based members such as:

- Structural solid timber classified to C14-C40 according to EN 338 / EN 14081,
- Glulam classified to GL24-GL36 according to EN 1194 / EN 14080,
- LVL according to EN 14374,
- Parallam PSL,
- Intrallam LSL,
- Duo- and Triobalken,
- Layered wood plates,
- I-beams with backer blocks on both sides of the web in the header and web stiffeners in the joist
- Plywood according to EN 636

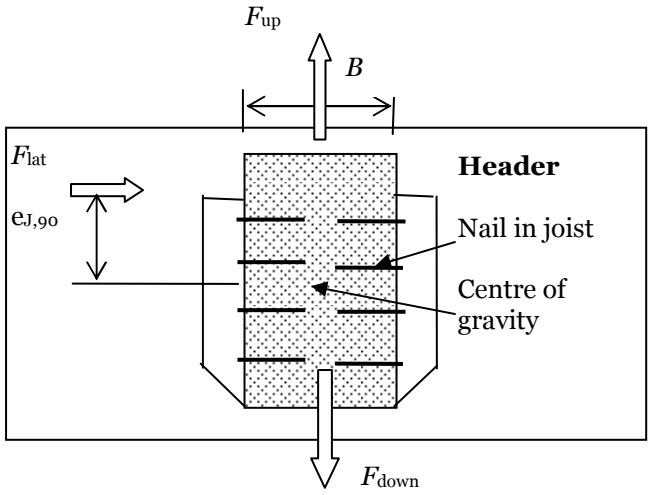
However, the calculation methods are only allowed for a characteristic wood density of up to 460 kg/m^3. Even though the wood based material may have a larger density, this must not be used when calculating the load-carrying capacities of the fasteners.

Annex B states the formulas for the characteristic load-carrying capacities of the joist hanger connections. The design of the connections shall be in accordance with Eurocode 5 or a similar national Timber Code.

It is assumed that the forces acting on the joist hanger connection are F_{up}, F_{down} and F_{lat}, as shown in the figure below. The forces F_{up} and F_{down} shall act in the middle of the joist hanger. The force F_{lat} is assumed to act $e_{J,90}$ above the centre of gravity of the nails in the joist. It is assumed that the forces are acting right at the end of the joist.

It is assumed that the header is prevented from rotating. Similarly it is assumed that the concrete structure or the steel member, to which the joist hanger is bolted, does not rotate. If the header beam only has installed a joist hanger on one side, the eccentricity moment $M_v = F_d \cdot (B_H / 2 + 30\text{mm})$ shall be considered. The same applies when the header has joist hanger connections on both sides, but with vertical forces which differ more than 20%.

It is a condition for a force F_{lat} perpendicular to the vertical symmetry line that the joist hanger is connected to a wood-based header with nails in all holes (full nailing) or in all holes marked for partial nailing.



The joist hangers are intended for use in connections subject to static or quasi static loading.

The zinc-coated hangers are for use in timber structures subject to dry, internal conditions defined by the service classes 1 and 2 of EN 1995-1-1:2004, (Eurocode 5).

Assumed working life

The assumed intended working life of the joist hangers for the intended use is 50 years, provided that they are subject to appropriate use and maintenance.

The information on the working life should not be regarded as a guarantee provided by the manufacturer or ETA Danmark. An "assumed intended working life" means that it is expected that, when this working life has elapsed, the real working life may be, in normal use conditions, considerably longer without major degradation affecting the essential requirements.

2 Characteristics of product and assessment

ETAG paragraph	Characteristic		Assessment of characteristic
	2.1	**Mechanical resistance and stability*)**	
6.1.1		Characteristic load-carrying capacity	See Annex B
6.1.2		Stiffness	No performance determined
6.1.3		Ductility in cyclic testing	No performance determined
	2.2	**Safety in case of fire**	
6.2.1		Reaction to fire	The joist hangers are made from steel classified as **Euroclass A1** in accordance with EN 1350-1 and EC decision 96/603/EC, amended by EC Decision 2000/605/EC
	2.3	**Hygiene, health and the environment**	
6.3.1		Influence on air quality	No dangerous materials **)
	2.4	**Safety in use**	Not relevant
	2.5	**Protection against noise**	Not relevant
	2.6	**Energy economy and heat retention**	Not relevant
	2.7	**Related aspects of serviceability**	
6.7.1		Durability	The joist hangers have been assessed as having satisfactory durability and serviceability when used in timber structures using the timber species described in Eurocode 5 and subject to the conditions defined by service class 1 and 2
6.7.2		Serviceability	
6.7.3		Identification	See Annex A

*) See page 5 of this ETA

**) In accordance with http://europa.eu.int-/comm/enterprise/construction/internal/dangsub/dangmain.htm In addition to the specific clauses relating to dangerous substances contained in this European Technical Approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.

Safety principles and partial factors

2.1 Mechanical resistance and stability

See annex B for characteristic load-carrying capacities of the joist hangers.

The characteristic capacities of the joist hangers are determined by calculation assisted by testing as described in the EOTA Guideline 015 clause 5.1.2. They should be used for designs in accordance with Eurocode 5 or a similar national Timber Code.

The design models allow the use of fasteners described in the table on page 12 in Annex A.

Threaded nails (ringed shank nails) in accordance to EN 14592
In the formulas in Annex B the capacities for threaded nails calculated from the formulas of Eurocode 5 are used assuming a thick steel plate when calculating the lateral nail load-carrying-capacity.

Further, the joist hangers may be fastened to a concrete structure or steel member by bolts with a diameter of 10 mm in holes with a diameter up to 2 mm larger than the bolt.

The load bearing capacities of the brackets has been determined based on the use of connector nails 4,0 x 40 mm in accordance with the German national approval for the nails.

The characteristic withdrawal capacity of the nails has to be determined by calculation in accordance with EN 1995-1-1: 2004, paragraph 8.3.2 (head pull-through is not relevant):

$$F_{ax,Rk} = f_{ax,k} \times d \times t_{pen}$$

Where:

$f_{ax,k}$	Characteristic value of the withdrawal parameter in N/mm^2
d	Nail diameter in mm
t_{pen}	Penetration depth of the profiles shank in mm

Based on tests by Versuchsanstalt für Stahl, Holz und Steine, University of Kalrsruhe, the characteristic value of the withdrawal resistance for the threaded nails used can be calculated as:

$$f_{ax,k} = 50 \times 10^{-6} \times \sigma_k^{\,2}$$

Where:

σ_k	Characteristic density of the timber in kg/m^3

The shape of the nail directly under the head shall be in the form of a truncated cone with a diameter under the nail head which exceeds the hole diameter.

The design models allow the use of fasteners described in the table on page 12 in Annex A

No performance has been determined in relation to ductility of a joint under cyclic testing. The contribution to the performance of structures in seismic zones, therefore, has not been assessed.

No performance has been determined in relation to the joint's stiffness properties - to be used for the analysis of the serviceability limit state.

2.7 Related aspects of serviceability

2.7.1 Corrosion protection in service class 1 and 2.
In accordance with ETAG 015 the angle brackets are made from pre-galvanized steel DX 51 D / Z 275 according to EN 10327:2004 with minimum yield strength R_e of 250 MPa, a minimum tensile strength R_m of 330 MPa and a minimum ultimate strain A_{80} of 22 %

3 Attestation of Conformity and CE marking

3.1 Attestation of Conformity system

The system of attestation of conformity is 2+ described in Council Directive 89/106/EEC (Construction Products Directive) Annex III.

a) Tasks for the manufacturer:

(1) Factory production control,
(2) Initial type testing of the product,

b) Tasks for the notified body:

(1) Initial inspection of the factory and the factory production control,
(2) Continuous surveillance

3.2 Responsibilities

3.2.1 Tasks of the manufacturer

3.2.1.1 Factory production control

The manufacturer has a factory production control system in the plant and exercises permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer are documented in a systematic manner in the form of written policies and procedures. This production control system ensures that the product is in conformity with the European Technical Approval.

The manufacturer shall only use raw materials supplied with the relevant inspection documents as laid down in the control plan[4]. The incoming raw materials shall be subject to controls and tests by the manufacturer before acceptance. Check of materials, such as sheet metal, shall include control of the inspection documents presented by suppliers (comparison with nominal values) by verifying dimension and determining material properties, e.g. chemical composition, mechanical properties and zinc coating thickness.

The manufactured components are checked visually and for dimensions.

The control plan, which is part of the technical documentation of this European Technical Approval, includes details of the extent, nature and frequency of testing and controls to be performed within the factory production control and has been agreed between the approval holder and ETA Danmark.

The results of factory production control are recorded and evaluated. The records include at least the following information:

- Designation of the product, basic material and components;
- Type of control or testing;
- Date of manufacture of the product and date of testing of the product or basic material and components;
- Result of control and testing and, if appropriate, comparison with requirements;
- Signature of person responsible for factory production control.

The records shall be presented to ETA Danmark on request.

3.2.1.1 Initial type testing of the product

For initial type-testing the results of the tests performed as part of the assessment for the European Technical Approval shall be used unless there are changes in the production line or plant. In such cases the necessary initial type testing has to be agreed between ETA Danmark and the notified body.

3.2.2. Tasks of notified bodies

3.2.2.1 Initial inspection of the factory and the factory production control

The approved body should ascertain that, in accordance with the control plan, the factory, in particular the staff and equipment, and the factory production control, are suitable to ensure a continuous and orderly manufacturing of the angle brackets with the specifications given in part 2.

3.2.2.2 Continuous surveillance

The approved body shall visit the factory at least twice a year for routine inspections. It shall be verified that the system of factory production control and the specified manufacturing processes are maintained, taking account of the control plan.

The results of product certification and continuous surveillance shall be made available on demand by the certification body to ETA Danmark. Where the provisions of the European Technical Approval and the control plan are no longer fulfilled, the certificate

4 The control plan has been deposited at ETA-Danmark and is only made available to the approved bodies involved in the conformity attestation procedure.

of conformity shall be withdrawn by the approved body.

3.3 CE marking

The CE marking shall be affixed on each packaging of angle brackets. The initials "CE" shall be followed by the identification number of the notified body and shall be accompanied by the following information:

- Name or identifying mark of the manufacturer
- The last two digits of the year in which the marking was affixed
- Number of the European Technical Approval
- Name and size of product
- Number of the ETA Guideline (ETAG no. 015)
- Number of the EC Certificate of Conformity

4 Assumptions under which the fitness of the product for the intended use was favourably assessed

4.1 Manufacturing

Gutzeit joist hangers types A and B are manufactured in accordance with the provisions of this European Technical Approval using the manufacturing processes as identified in the inspection of the plant by the notified inspection body and laid down in the technical documentation.

4.2 Installation

Joist hanger connections

A joist hanger connection is deemed fit for its intended use provided:

Header – support conditions

- The header beam shall be restrained against rotation and be free from wane under the joist hanger.

  If the header carries joists only on one side the eccentricity moment from the joists $M_{ec} = R_{joist}$ ($b_{header}/2+e_{J,0}$) shall be considered at the strength verification of the header.

R_{joist}	Reaction force from the joists
b_{header}	Width of header
$e_{J,0}$	Distance from the centroid of the nails in the joist to the surface of the header

- For a header with joists from both sides but with different reaction forces a similar consideration applies.

Wood to wood connections

- Joist hangers are fastened to wood-based members by nails.
- There shall be nails in all holes or a partial nailing pattern as prescribed in Annex A-D may be used.
- The characteristic capacity of the joist hanger connection is calculated according to the manufacturer's technical documentation, dated 2008-11-08.
- The joist hanger connection is designed in accordance with Eurocode 5 or an appropriate national code.
- The gap between the end of the joist and the surface, where contact stresses can occur during loading shall be limited. This means that for joist hangers with outward flaps the gap between the surface of the end of the joist and that of the header shall be maximum 3 mm.
- Joist hangers with inward flaps the gap between the surface of the nail heads in the inward flaps and the end of the joist shall be maximum 8 mm.
- For joist hangers A and B the width of the joist shall be at least l+4d, where l is the length of the fasteners and d is the fastener diameter in the joist, for full nailing and partial nailing without staggering the fasteners in the joist. For nailing with staggered fasteners in the joist the width shall be at least the penetration length of the fasteners.
- The cross section of the joist at the joist hanger connection shall have sharp edges at the lower side against the bottom plate, i.e. it shall be without wane.
- The cross section of the header shall have a plane surface against the whole joist hanger.
- The width B_J of the joist shall correspond to that of the joist hanger. B_J shall not be smaller than B-3 mm, where B is the inner width of the joist hanger.
- The depth of the joist shall be so large that the top of the joist is at least 20 mm above the upper fastener in the joist.
- Nails to be used shall have a diameter, which fits the holes of the joist hangers.

Wood to concrete or steel

The above mentioned rules for wood to wood connections are applicable also for the connection between the joist and the joist hanger.

- The joist hanger shall be in close contact with the concrete or steel over the whole face. There shall be no intermediate layers in between.
- The gap between the end of the joist and the surface, where contact stresses can occur during loading shall be limited. This means that the gap between the surface of the end of the joist and that of the concrete or steel shall be maximum 3 mm.
- The bolt shall have a diameter not less than the hole diameter minus 2 mm.
- The bolts shall be placed symmetrically about the vertical symmetry line. There shall always be bolts in the 2 upper holes.
- The upper bolts shall have washers according to EN ISO 7094.

4.3 Maintenance and repair

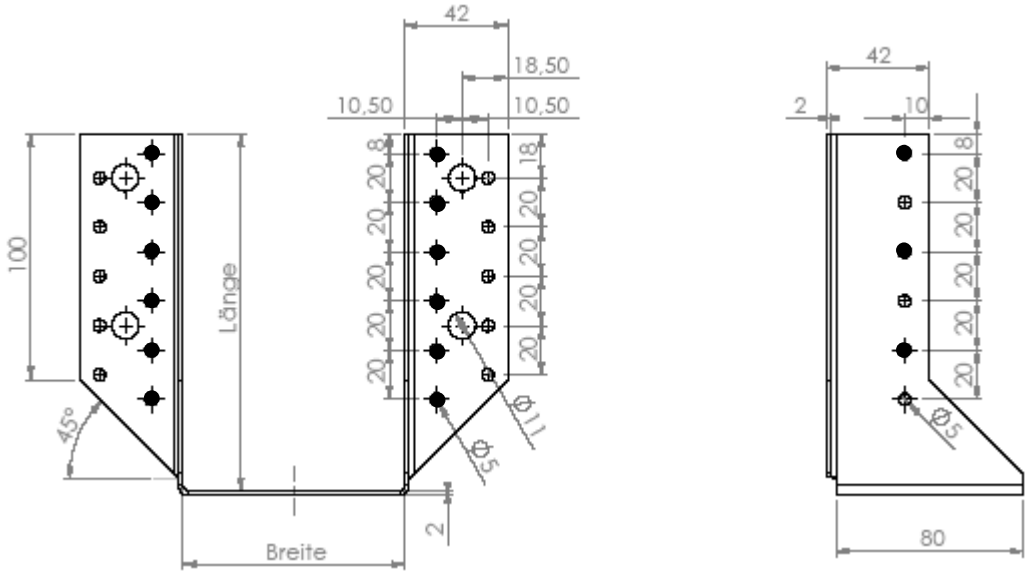
Maintenance is not required during the assumed intended working life. Should repair prove necessary, it is normal to replace the joist hanger.

Thomas Bruun
Manager, ETA-Danmark

Annex A
Product details and definitions

Joist hanger type A

Face mount hanger with external flanges. 2.0 mm thick pre-galvanized steel DX51D + Z (min Z275) according to EN 10327:2004 with a minimum R_e of 250 MPa, a minimum tensile strength R_m of 330 MPa and a minimum ultimate strain A_{80} of 22 % with tolerances according to EN 10143:1993.



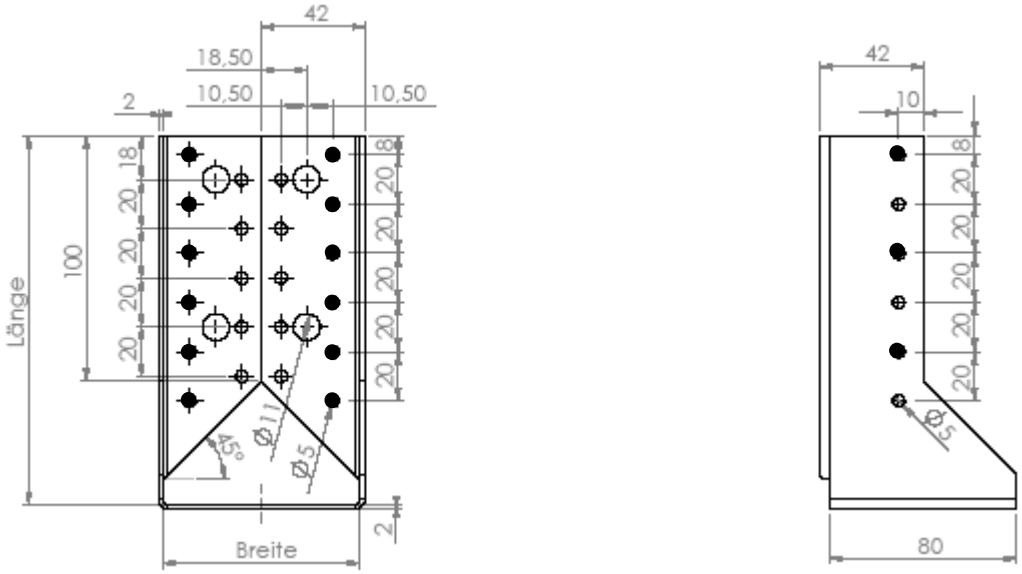
- Partial nailing; Drawing: Blank 380, 2,0 mm steel

Blank	Total n° of nail holes		Width interval		Height interval		Bolt holes		
	n_H	n_J	min	max	min	max	n°	d	A
230	10	6	51	64	83	90	2	11	= B + 84
260	14	8	25	70	95	118	4	11	= B + 84
300	18	10	60	64	118	120	4	11	= B + 84
320	18	10	40	80	120	140	4	11	= B + 84
360	20	10	80	80	140	140	4	11	= B + 84
380	22	12	60	100	140	160	4	11	= B + 84
420	24	14	100	100	160	160	4	11	= B + 84
440	26	14	40	120	160	200	4	11	= B + 84
480	28	16	120	120	180	180	4	11	= B + 84
500	30	16	60	140	180	220	6	11	= B + 84

Joist hanger's height = (blank – width)/2

Joist hanger type B

Face mount hanger with interior flanges. 2.0 mm thick pre-galvanized steel DX51D + Z (min Z275) according to EN 10327:2004 with a minimum R_e of 250 MPa, a minimum tensile strength R_m of 330 MPa and a minimum ultimate strain A_{80} of 22 % with tolerances according to EN 10143:1993.



- Partial nailing; Drawing: Blank 380, 2,0 mm steel

Blank	Total n° of nail holes		Width interval		Height interval	
	n_H	n_J	min	max	min	max
260	8	8	60	60	100	100
320	18	10	80	80	120	120
380	22	12	70	100	140	155
420	24	14	140	140	140	140
440	26	14	80	120	160	180
500	30	16	100	140	180	200

Joist hanger's height = (blank – width)/2

Fastener types and sizes

NAIL diameter	Length Min – max	Nail type
4.0	25 - 100	Ringed shank nails according to EN 14592

In the formulas in Annex B the capacities for threaded nails calculated from the formulas of Eurocode 5 are used assuming a thick steel plate when calculating the lateral nail load-carrying-capacity. The load bearing capacities of the joist hangers has been determined based on the use of connector nails 4,0 x L mm in accordance with the German national approval for the nails. The characteristic withdrawal capacity of the nails has to be determined by calculation in accordance with EN 1995-1-1: 2004, paragraph 8.3.2 (head pull-through is not relevant):

$F_{ax,Rk} = f_{1,k} \times d \times t_{pen}$

Where:

$f_{1,k}$ Characteristic value of the withdrawal parameter in N/mm^2
d Nail diameter in mm
t_{pen} Penetration depth of the profiled shank in mm

Based on tests by Versuchsanstalt für Stahl, Holz und Steine, University of Karlsruhe, the characteristic value of the withdrawal resistance for the threaded nails used can be calculated as:

$f_{1,k} = 50 \times 10^{-6} \times \rho_k^{\,2}$

Where:

ρ_k Characteristic density of the timber in kg/m^3

The shape of the nail directly under the head shall be in the form of a truncated cone with a diameter under the nail head which exceeds the hole diameter.

BOLTS diameter	Correspondence Hole diameter	Bolts type
10.0	Max. 2 mm. larger than the bolt diameter	See specification of the manufacturer

Annex B
Characteristic values of load-carrying-capacities

Characteristic capacities of the joist hanger connections with nails only

The downward and the upward directed forces are assumed to act in the middle of the joist. The lateral force is assumed to act at an distance $e_{J,90}$ above the centre of gravity of the nails in the joist.

Two nails patterns are specified. A full nailing pattern, where there are nails in all the holes and a partial nailing pattern, where the number of nails in the joist and the header are at least half the numbers specified for full nailing. The nails in the joist may be staggered. The nails in the header shall be put in the holes closest to the bend line.

For Gutzeit joist hangers the width of the joist shall be at least l+4d, where l is the length of the nails and d is the diameter of the nails in the joist, for full nailing and partial nailing without staggering the nails in the joist. For partial nailing with staggered nails in the joist the width shall be at least the penetration length of the nails.

B.1 Joist hangers types A and B fastened with nails

Force downward toward the bottom plate:

$$F_{Z,Rd} = \min \begin{cases} (n_J + 2) \cdot F_{v,J,Rd} \\ \dfrac{1}{\sqrt{\left(\dfrac{1}{n_H \cdot F_{v,H,Rd}}\right)^2 + \left(\dfrac{1}{k_{H,1} \cdot F_{ax,H,Rd}}\right)^2}} \end{cases} \qquad \text{(B.1.1.1)}$$

Force upward away from the bottom plate:

$$F_{Z,Rd} = \min \begin{cases} n_J \cdot F_{v,J,Rd} \\ \dfrac{1}{\sqrt{\left(\dfrac{1}{n_H \cdot F_{v,H,Rd}}\right)^2 + \left(\dfrac{1}{k_{H,2} \cdot F_{ax,H,Rd}}\right)^2}} \end{cases} \qquad \text{(B.1.1.2)}$$

Lateral force:

$$F_{Y,Rd} = \min \begin{cases} \dfrac{n_J \cdot F_{v,J,Rd}}{\sqrt{\left(\dfrac{2 \cdot \sqrt{e_{J,0}^2 + e_{J,90}^2}}{b_J}\right)^2 + \left(\dfrac{F_{v,J,Rd}}{F_{ax,J,Rd}}\right)^2}} \\ \dfrac{F_{v,H,Rd}}{\sqrt{\left(\dfrac{1}{n_H} + \dfrac{e_H}{e_1}\right)^2 + \left(\dfrac{e_H}{e_2}\right)^2}} \end{cases} \qquad \text{(B.1.1.3)}$$

n_J total number of nails in both sides of the joist

n_H total number of nails in the side of the header

$F_{v,Rd}$ Characteristic lateral load-carrying capacity of the fasteners in the joist or in the header indicated by the indices J or H

$F_{ax,Rd}$ Characteristic axial load-carrying capacity of the fasteners in the joist or in the header indicated by the indices J or H

b_J width of the joist hanger, see figure B1.

$e_{J,90}$ distance of the lateral force above the centre of gravity of the nails in the joist, see figure B1.

$e_{J,0}$ distance from the nails in the joist to the surface of the header, see figure B1.

e_H distance of the lateral force above the centre of gravity of the nails in the header.

e_1 joist hanger dimension, see Annex C

e_2 joist hanger dimension, see Annex C

$k_{H,1}$ form factor, see Annex C

$k_{H,2}$ form factor, see Annex C

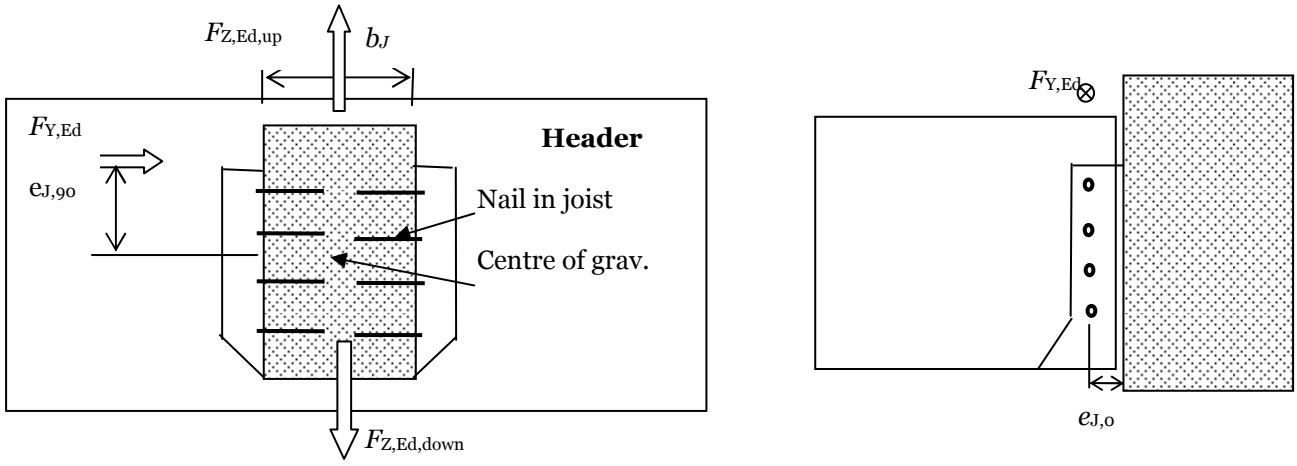


Figure B1: Definition of $e_{J,90}$ and $e_{J,0}$

B.1.2 Combined forces

In case of combined forces shall the following inequality be fulfilled:

$$\left(\frac{F_{Y,Ed}}{F_{Y,Rd}}\right)^2 + \left(\frac{F_{Z,Ed}}{F_{Z,Rd}}\right)^2 \leq 1 \qquad \text{(B.1.2.1)}$$

B.2 Characteristic capacities of the joist hanger type A connections with bolts

For joist hangers type A connected to a wall of concrete, lightweight concrete or to a steel member the assumptions for the calculation of the load-carrying capacity of the connection are:

- The transfer of force from the joist to the joist hanger is as for a wood-wood connection, see clause B.1;
- The bolts shall always be positioned symmetrically about the vertical axis of the joist hanger;
- Washers according to EN ISO 7094 shall be installed at least under the upper 2 bolt heads or nuts.

Description of the static model

For a downward directed force toward the bottom plate the static behavior is basically the same as for a wood-wood connection with nails.

The nails in the joist are subjected to a lateral force, which is equally distributed over all nails in the joist.

Since the concrete and steel have a larger compressive strength than timber subjected perpendicular to the grain the rotation point may be assumed positioned at the top of the bottom plate.

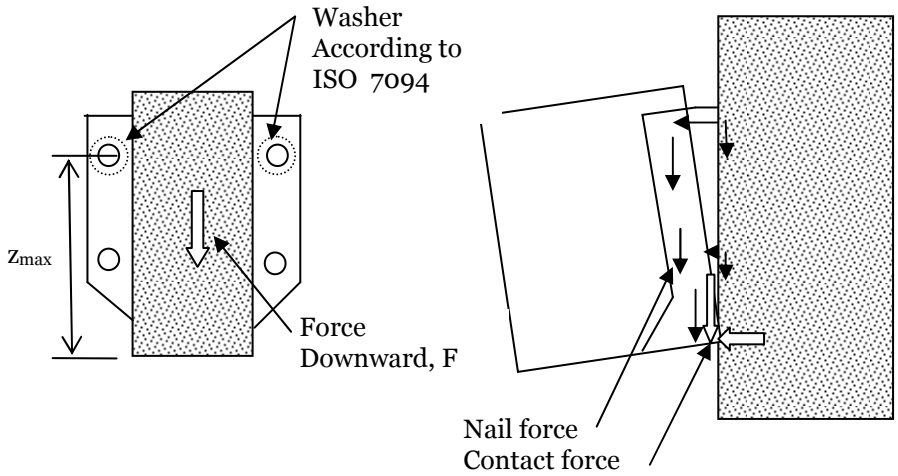


Figure B2 Left: Cross section in joist. Right: The joist will deflect and rotate, at the bottom a contact force will occur at the bottom plate, and the withdrawal forces in the bolts in the wall will vary linearly as assumed for nailed connections in the header.

The forces in the bolts will be partly lateral forces, partly withdrawal forces. The lateral forces are distributed evenly over all bolts. The withdrawal forces are on the safe side assumed to be taken by the 2 upper bolts with washers. The maximum withdrawal force in a upper bolt can be calculated from

$$F_{ax,bolt} = \frac{F \cdot e_{J,0}}{2 \cdot z_{max}} \qquad (B.2.1)$$

Where

F downward directed force toward the bottom plate;

$e_{J,0}$ eccentricity = distance from the nail column in the joist to the surface of the header;

z_{max} max distance from upper bolt to the bottom plate (rotation point).

The upper 2 bolts are critical. They are subjected to a lateral force and a withdrawal force. The lateral force is determined assuming an even distribution of the downward force F.

$$F_{lat,bolt} = F / n_{bolt} \qquad (B.2.2)$$

Characteristic capacities of a bolted joist hanger connection

The Characteristic capacity of the connection between the joist and the joist hanger may be calculated from the same assumptions and formulas as for joist hangers nailed to a wooden header beam.

$$F_{Z,Rk} = (n_J + 2) \cdot F_{v,J,Rk} \quad \text{for threaded nails} \qquad \text{(B.2.3)}$$

The upper 2 bolts are critical. They are subjected to a lateral force calculated from formula (B.2.2).

The withdrawal force in an upper bolt is calculated from (B.2.1).

Where

F downward directed force toward the bottom plate

n_{bolt} total number of bolts in the joist hanger

$e_{J,0}$ eccentricity = distance from the nail column in the joist to the surface of the header

z_{max} max distance from the upper bolt to the bottom plate (rotation point)

It shall be verified by the design of the bolted connection that the upper bolts have sufficient load-carrying capacity to carry the combined lateral and axial forces.

From the characteristic load-carrying-capacity of the bearing resistance between the bolt and the plate of the joist hanger the following maximum characteristic capacity of the joist hanger connection can be determined.

$$F_{bear,Rk} = n_{bolt} \cdot f_{u,k} \cdot d \cdot t \qquad \text{(B.2.4)}$$

where

n_{bolt} total number of bolts in the 2 flaps

$f_{u,k}$ characteristic ultimate tensile strength of the steel

d diameter of the bolt

t thickness of the steel plate of the joist hanger

The characteristic load-carrying capacity of the joist hanger connections is the minimum of:

- The capacity determined from (B.2.3) from the fasteners in the joist;
- The capacity determined from (B.2.4) from the embedding strength of the steel plate against the bolt;
- The capacity controlled by the bolt forces given by (B.2.1) and (B.2.2).

Annex C
Form factors $k_{H,1}$ and $k_{H,2}$ and dimensions e_1, e_2 and $e_{J,0}$

Table C1: Gutzeit Joist hanger type A with external flanges:
Form factors $k_{H,1}$ and $k_{H,2}$ and dimensions e_1, e_2 and $e_{J,0}$

B [mm]	H [mm]	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 [mm]	e_2 [mm]	$e_{J,0}$ [mm]	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 [mm]	e_2 [mm]	$e_{J,0}$ [mm]
		Full nailing							Partial nailing						
51	90	10	6	11,1	2,82	1253	421	32	6	4	6,85	1,88	525	273	32
60	85	10	6	9,90	3,02	1474	461	32	6	4	6,14	2,02	635	295	32
64	83	10	6	9,38	3,13	1579	478	32	6	4	5,83	2,08	688	306	32
25	118	14	8	23,0	5,72	793	511	32	8	4	13,3	3,54	307	361	32
32	114	14	8	21,7	5,92	911	547	32	8	4	12,6	3,65	358	370	32
38	111	14	8	20,6	6,12	1022	578	32	8	4	12,0	3,76	406	381	32
40	110	14	8	20,2	6,18	1060	589	32	8	4	11,8	3,80	424	385	32
50	105	14	8	18,3	6,54	1268	645	32	8	4	10,8	4,02	518	409	32
60	100	14	8	16,6	6,94	1499	703	32	8	4	9,77	4,27	626	437	32
63	99	14	8	16,0	7,07	1573	720	32	8	4	9,47	4,35	661	446	32
70	95	14	8	14,8	7,39	1753	762	32	8	4	8,80	4,55	748	467	32
60	120	18	10	24,9	12,5	1581	988	32	10	6	14,2	7,35	662	616	32
64	118	18	10	24,0	12,8	1677	1017	32	10	6	13,8	7,50	706	628	32
40	140	18	10	34,1	10,5	1027	856	32	10	6	19,3	6,15	420	572	32
51	135	18	10	31,5	10,9	1225	927	32	10	6	17,8	6,44	507	593	32
60	130	18	10	29,4	11,4	1406	988	32	10	6	16,7	6,70	589	616	32
63	129	18	10	28,7	11,5	1469	1010	32	10	6	16,3	6,79	618	625	32
64	128	18	10	28,5	11,6	1491	1017	32	10	6	16,2	6,82	628	628	32
70	125	18	10	27,1	11,9	1625	1060	32	10	6	15,4	7,01	690	647	32
75	123	18	10	26,0	12,2	1742	1097	32	10	6	14,8	7,18	745	663	32
80	120	18	10	24,9	12,5	1864	1134	32	10	6	14,2	7,35	802	681	32
80	140	20	10	34,6	14,6	2208	1343	32	10	6	19,3	6,15	802	681	32
60	160	22	12	45,8	16,9	1703	1330	32	12	6	25,4	9,68	724	842	32
63	159	22	12	45,0	17,1	1773	1354	32	12	6	25,0	9,79	755	849	32
70	155	22	12	43,0	17,6	1945	1410	32	12	6	23,9	10,0	833	868	32
71	155	22	12	42,7	17,6	1971	1418	32	12	6	23,8	10,1	845	871	32
75	153	22	12	41,6	17,9	2075	1451	32	12	6	23,2	10,2	892	883	32
76	152	22	12	41,3	18,0	2101	1459	32	12	6	23,0	10,3	904	887	32
80	150	22	12	40,2	18,2	2209	1493	32	12	6	22,4	10,4	954	900	32
90	145	22	12	37,5	18,9	2496	1579	32	12	6	21,0	10,8	1087	937	32
100	140	22	12	34,8	19,7	2804	1669	32	12	6	19,5	11,3	1233	978	32
100	160	24	14	46,0	23,3	2618	1870	32	14	8	25,6	16,0	1299	1238	32
40	200	26	14	72,7	22,3	1333	1604	32	14	8	39,6	12,5	579	1141	32
60	190	26	14	65,9	23,6	1714	1741	32	14	8	36,0	13,2	743	1123	32
63	189	26	14	64,9	23,8	1779	1765	32	14	8	35,4	13,3	771	1126	32
71	185	26	14	62,2	24,4	1958	1832	32	14	8	34,0	13,7	851	1141	32
75	183	26	14	60,9	24,7	2053	1866	32	14	8	33,3	13,8	894	1151	32
80	180	26	14	59,2	25,1	2176	1911	32	14	8	32,4	14,0	950	1165	32
100	170	26	14	52,7	26,7	2718	2103	32	14	8	29,0	15,0	1199	1238	32
120	160	26	14	46,5	28,6	3339	2309	32	14	8	25,6	16,0	1492	1329	32
120	180	28	16	59,6	31,6	3751	2594	32	14	8	32,4	14,0	1492	1329	32
60	220	30	16	89,5	31,4	2042	2233	32	16	8	48,3	17,3	903	1469	32
75	213	30	16	83,7	32,6	2405	2355	32	16	8	45,2	18,0	1063	1473	32

Table C1 (contd.): Gutzeit Joist hanger type A with external flanges:
Form factors $k_{H,1}$ and $k_{H,2}$ and dimensions e_1, e_2 and $e_{J,0}$

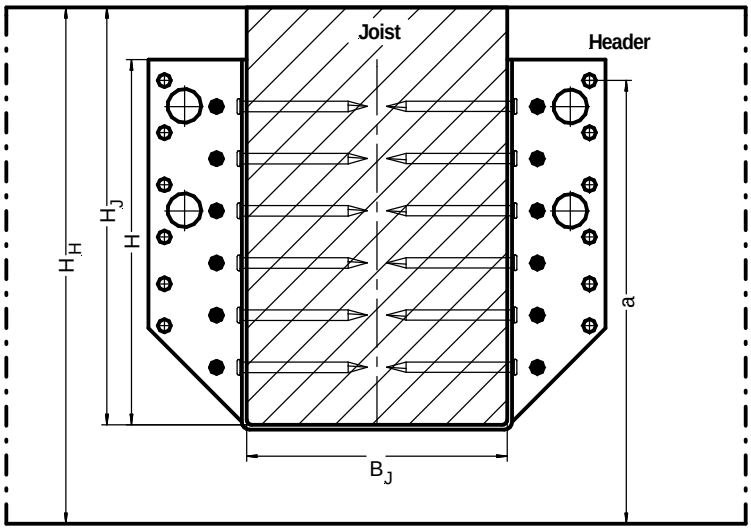
B [mm]	**H [mm]**	**n_H**	**n_J**	**$k_{H,1}$**	**$k_{H,2}$**	**e_1 [mm]**	**e_2 [mm]**	**$e_{J,0}$ [mm]**	**n_H**	**n_J**	**$k_{H,1}$**	**$k_{H,2}$**	**e_1 [mm]**	**e_2 [mm]**	**$e_{J,0}$ [mm]**
		Full nailing							Partial nailing						
80	210	30	16	81,8	33,0	2537	2400	32	16	8	44,2	18,2	1122	1482	32
100	200	30	16	74,2	34,9	3118	2599	32	16	8	40,2	19,2	1387	1541	32
120	190	30	16	66,9	36,9	3785	2819	32	16	8	36,3	20,3	1698	1628	32
140	180	30	16	59,8	39,2	4538	3054	32	16	8	32,6	21,6	2055	1733	32

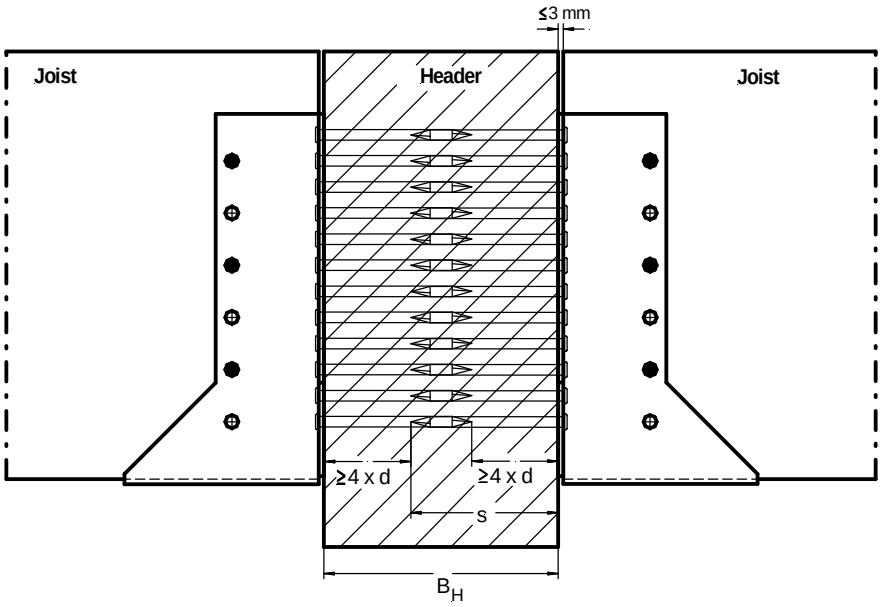
Table C2: Joist hanger type B with interior flanges:
Form factors $k_{H,1}$ and $k_{H,2}$ and dimensions e_1, e_2 and $e_{J,0}$

B [mm]	**H [mm]**	**n_H**	**n_J**	**$k_{H,1}$**	**$k_{H,2}$**	**e_1 [mm]**	**e_2 [mm]**	**$e_{J,0}$ [mm]**	**n_H**	**n_J**	**$k_{H,1}$**	**$k_{H,2}$**	**e_1 [mm]**	**e_2 [mm]**	**$e_{J,0}$ [mm]**
		Full nailing							Partial nailing						
60	100	8	8	9,77	4,27	197	363	32	8	4	9,77	4,27	197	363	32
80	120	18	10	24,9	12,5	465	721	32	10	6	14,2	7,35	365	566	32
70	155	22	12	37,2	15,2	655	1129	32	12	6	20,7	8,68	482	831	32
76	152	22	12	35,7	15,5	710	1109	32	12	6	19,9	8,87	526	822	32
80	150	22	12	40,2	18,2	655	1129	32	12	6	22,4	10,4	482	831	32
100	140	22	12	34,8	19,7	870	1115	32	12	6	19,5	11,3	645	827	32
140	140	24	14	34,9	27,1	1569	1596	32	14	8	19,5	18,6	1186	1206	32
80	180	26	14	59,2	25,1	753	1688	32	14	8	32,4	14,0	526	1178	32
100	170	26	14	52,7	26,7	947	1579	32	14	8	29,0	15,0	672	1120	32
120	160	26	14	46,5	28,6	1222	1621	32	14	8	25,6	16,0	862	1143	32
100	200	30	16	74,0	35,9	1424	2191	32	14	8	39,6	12,5	728	1120	32
120	190	30	16	66,7	37,9	1752	2146	32	14	8	36,0	13,2	934	1143	32
140	180	30	16	59,7	40,3	2180	2217	32	14	8	32,4	14,0	1186	1206	32

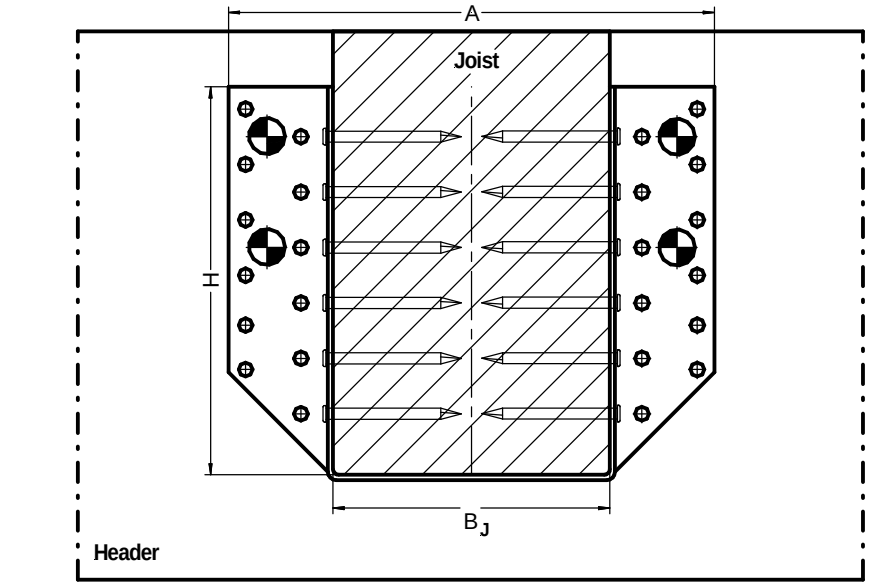
Annex D
Installation of joist hangers

Joist hanger in wood/wood connection





Joist hanger connected to concrete, lightweight concrete or a steel member by bolts



Bolts M10
Washer according to EN ISO 7094