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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-08/0171

This ETA replaces the previous ETA with the same number and validity from 2008-11-11 to 2013-11-11

Trade name:	GAH Joist Hangers Type A, 1,5 mm and 2,0 mm and type B
Holder of approval:	Gust. Alberts GmbH & Co KG Gewerbegebiet Grünenthal D-55845 Herscheid Tel. +49 2357 907 0 Fax +49 2357 907 189 Internet www.gah.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:	2009-08-12 2014-08-12
Manufacturing plant:	Gust. Alberts GmbH & Co KG Gewerbegebiet Grünenthal D-55845 Herscheid
This European Technical Approval contains:	32 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.

5 Reproduction of this European Technical Approval including transmission by electronic means shall be in full. However, partial reproduction can be made with the written consent of ETA-Danmark A/S. In this case partial reproduction has to be designated as such. Texts and drawings of advertising brochures shall not contradict or misuse the European Technical Approval.

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
GAH joist hangers type A, 1,5 mm and 2,0 mm and type B are one-piece non-welded, face-fixed joist hangers to be used in timber to timber connections as well as connections between a timber joist and a concrete structure or a steel member. Type B is for timber to timber connections only.

The joist hangers are made from 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.

Additionally, all the joist hangers can be made from stainless steel 1.4016, 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 provided that the yield strength f_y for these steel grades is at least the same as the minimum yield strength of the zinc coated steel normally used for the brackets. The ultimate strength f_u and the ultimate strain A_{80} shall exceed the corresponding minimum values for the zinc coated steel.

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

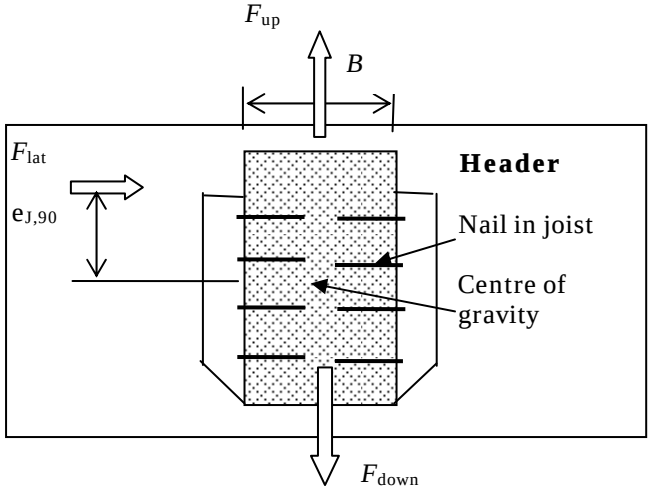
However, the calculation methods are only allowed for a characteristic wood density of up to 460 kg/m^3. Even though the wood based material may have a larger density, this must not be used when calculating the load-carrying capacities of the fasteners.

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_{up}, F_{down} and F_{lat} that the joist hanger is connected to a wood-based header with nails either 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) the joist hangers made of stainless steel in service class 3. The fasteners to be used shall be made from suitable stainless material.

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 14 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 type A 2,0 mm may be fastened to a concrete structure or steel member by bolts with a diameter of 8 mm in holes with a diameter of 10mm and by bolts with a diameter of 10 mm in holes with a diameter of 11 mm, respectively. The joist hangers type A 1,5 mm can 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
$t_{pen} \geq 31$ mm for 2,0 mm brackets and $t_{pen} \geq 25$ mm for 1,5 mm brackets

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 9 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 %

2.7.2 Corrosion protection in service class 3.
In accordance with Eurocode 5 the joist hangers are made from stainless steel 1.4016, 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 and the nails shall be produced from stainless steel.

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

GAH joist hangers type A 1,5 mm and 2,0 mm and type 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 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 $M_{ec} = R_{joist}$ ($b_{header}/2+e_{nail}$) shall be considered at the strength verification of the header.

  R_{joist} Reaction force from the joists,
  b_{header} Width of header,
  e_{nail} Distance from 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 may be 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 2008-07-15 and 2009-05-02.
- 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 the gap between the surface of the end of the joist and that of the header shall not exceed 3 mm.
- For GAH joist hangers type A 2,0 mm with overlapping nails in the joist (see figure 8.5 in EN 1995-1-1) 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 joist hangers with staggered nails in the joist the width shall be at least the penetration length of the nails.
- For joist hangers type A 1.5 mm and type B the width of the joist 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 fit the holes of the joist hangers. Nails shall have a diameter which is not smaller than the diameter of the hole minus 1 mm.

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 not exceed 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

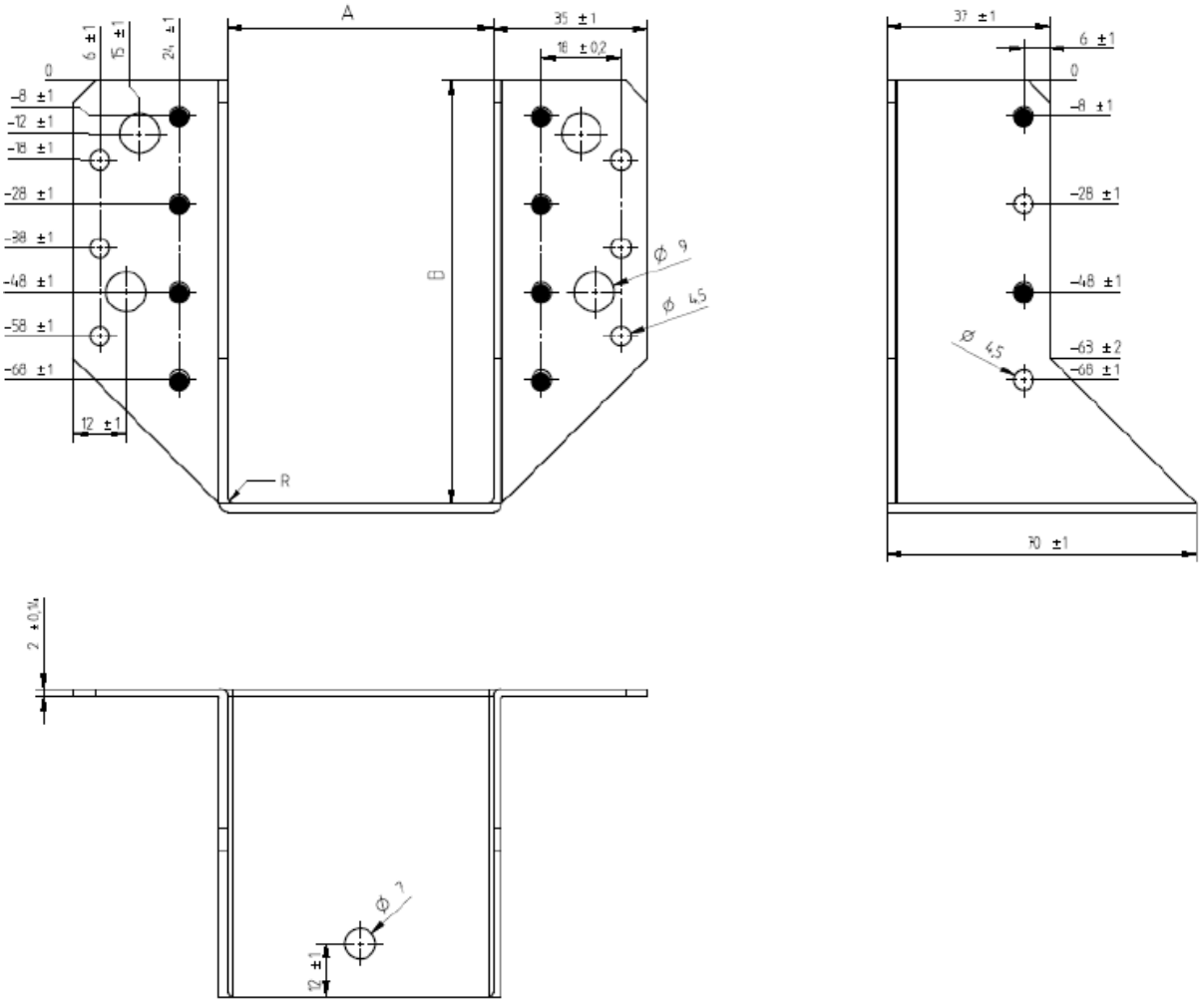
Maintenance is not required during the assumed intended working life. Should repair prove necessary, it is normal to replace the joist hanger.

Thomas Bruun
Manager, ETA-Danmark

Annex A
Product details and definitions

GAH Joist hanger type A 2,0 mm Blank 260
Face mount hanger with external flanges
2,0 mm thick pre-galvanised 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.

Additionally, the joist hanger can be made from stainless steel 1.4016, 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 provided that the yield strength f_y for these steel grades is at least the same as the minimum yield strength of the zinc coated steel normally used for the brackets. The ultimate strength f_u and the ultimate strain A_{80} shall exceed the corresponding minimum values for the zinc coated steel.

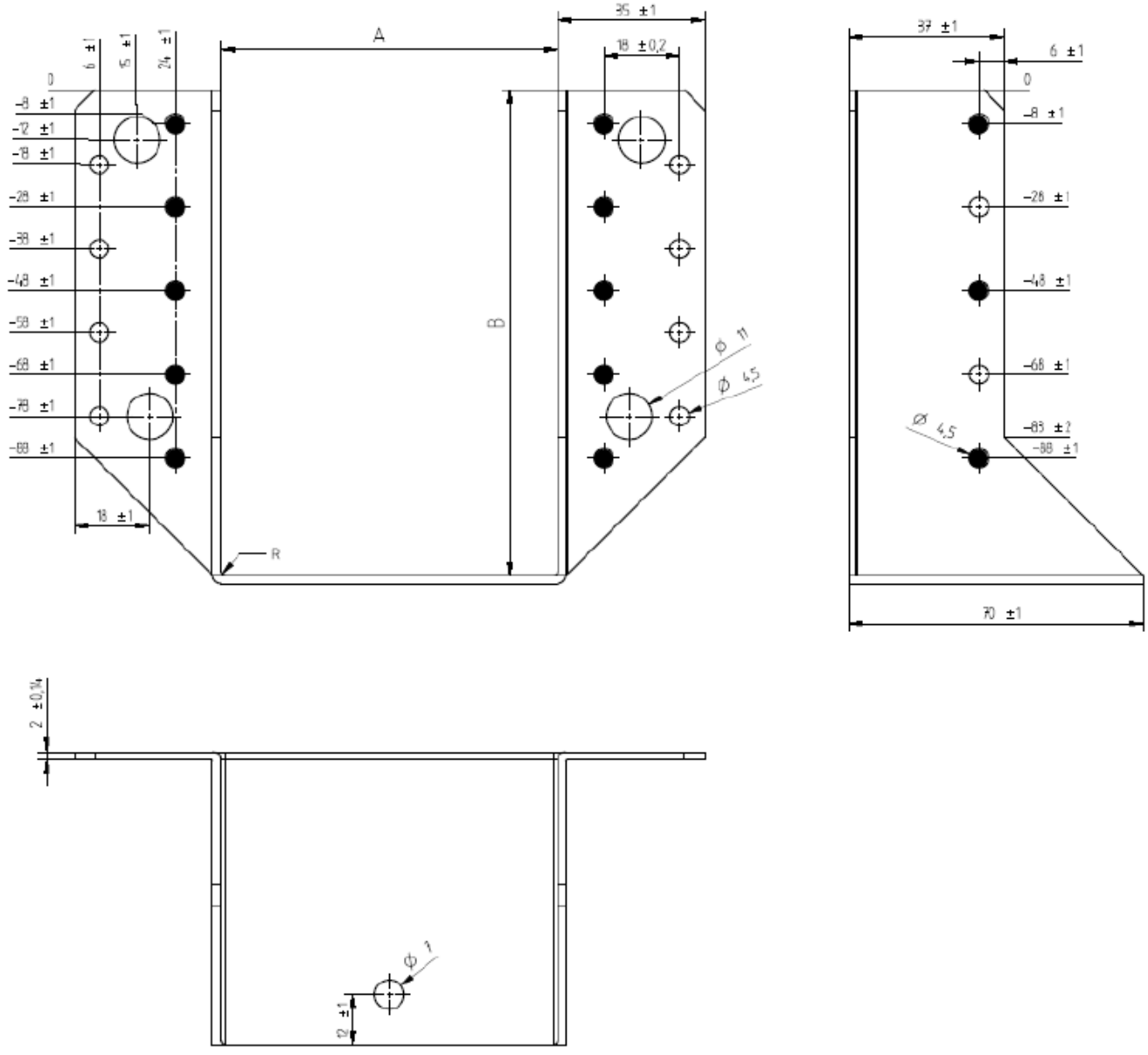


- Partial nailing

Blank	Total n° of holes		Width interval		Height interval	
	n_H	n_J	min	max	min	max
260	14	8	32	65	96	114
320	18	10	32	80	120	143
380	22	12	54	100	140	163

GAH Joist hanger type A 2,0 mm Blank 320
Face mount hanger with external flanges
2,0 mm thick pre-galvanised 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.

Additionally, the joist hanger can be made from stainless steel 1.4016, 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 provided that the yield strength f_y for these steel grades is at least the same as the minimum yield strength of the zinc coated steel normally used for the brackets. The ultimate strength f_u and the ultimate strain A_{80} shall exceed the corresponding minimum values for the zinc coated steel.

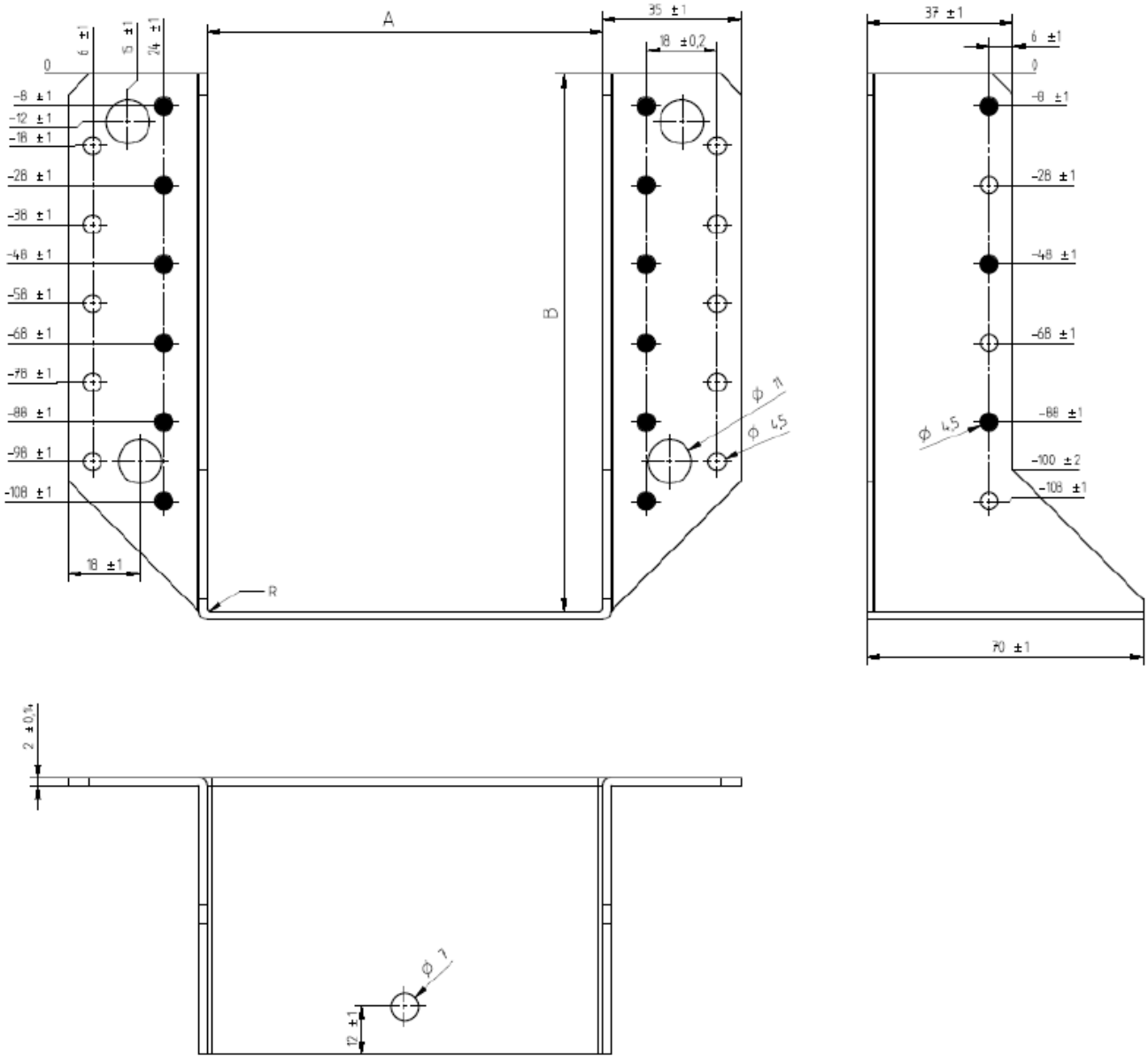


- Partial nailing

Blank	Total n° of holes		Width interval		Height interval	
	n_H	n_J	min	max	min	max
260	14	8	32	65	96	114
320	18	10	32	80	120	143
380	22	12	54	100	140	163

GAH Joist hanger type A 2,0 mm Blank 380
Face mount hanger with external flanges
2,0 mm thick pre-galvanised 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.

Additionally, the joist hanger can be made from stainless steel 1.4016, 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 provided that the yield strength f_y for these steel grades is at least the same as the minimum yield strength of the zinc coated steel normally used for the brackets. The ultimate strength f_u and the ultimate strain A_{80} shall exceed the corresponding minimum values for the zinc coated steel.

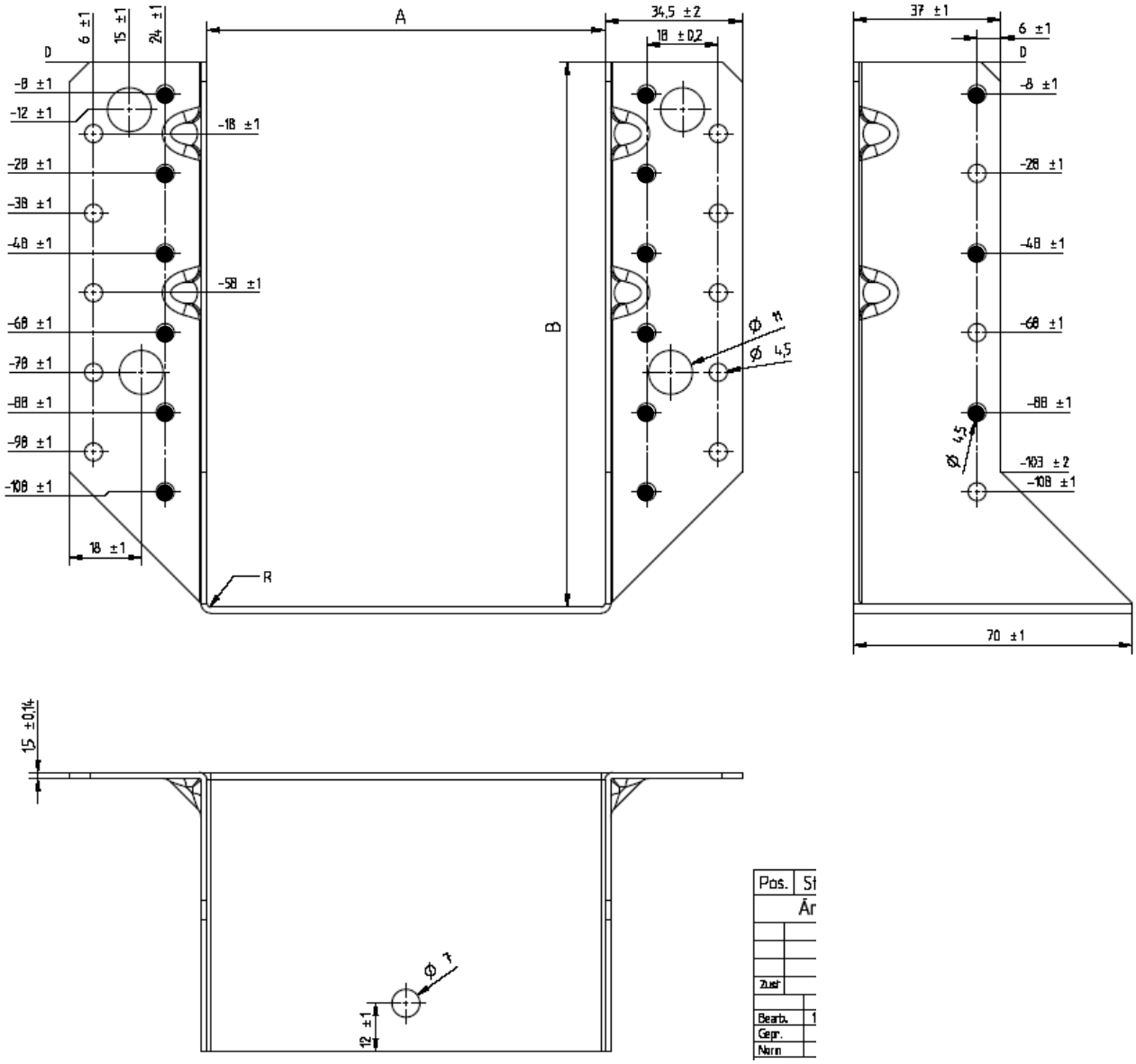


- Partial nailing

Blank	Total n° of holes		Width interval		Height interval	
	n_H	n_J	min	max	min	max
260	14	8	32	65	96	114
320	18	10	32	80	120	143
380	22	12	54	100	140	163

Joist hanger type A 1.5 mm: Face mount hanger with external flanges
1,5 mm thick pre-galvanised steel DX51D + Z (min Z275) according to EN 10327:2004 with a minimum yield strength R_{eH} 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.

Additionally, the joist hanger can be made from stainless steel 1.4016, 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 provided that the yield strength f_y for these steel grades is at least the same as the minimum yield strength of the zinc coated steel normally used for the brackets. The ultimate strength f_u and the ultimate strain A_{80} shall exceed the corresponding minimum values for the zinc coated steel.



- Partial nailing; Drawing: blank 380;

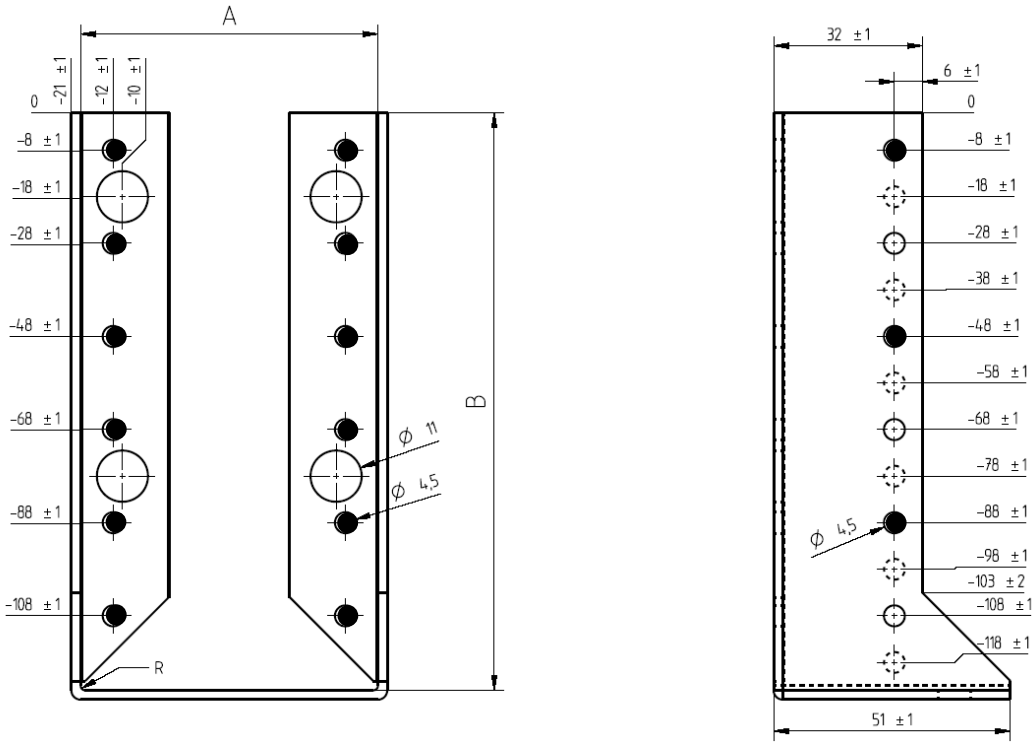
Blank	Total n° of holes		Width interval		Height interval		A
	n_H	n_J	min	max	min	max	
260	14	8	32	65	98	114	= B + 69
320	18	10	32	80	120	144	= B + 69
380	22	12	60	100	140	160	= B + 69

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

Joist hangers 238 B, 260 B and 320 1B1

Face mount hanger with interior flanges

2.0 mm thick pre-galvanized steel DX51D according to EN 10327:2004 with a minimum yield strength R_e of 295 MPa, a minimum tensile strength R_m of 360 MPa and a minimum ultimate strain A80 of 22 % or stainless steel 1.4016, 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 with tolerances according to EN 10143:1993.



- Partial nailing; Drawing: Blank 320 1B1

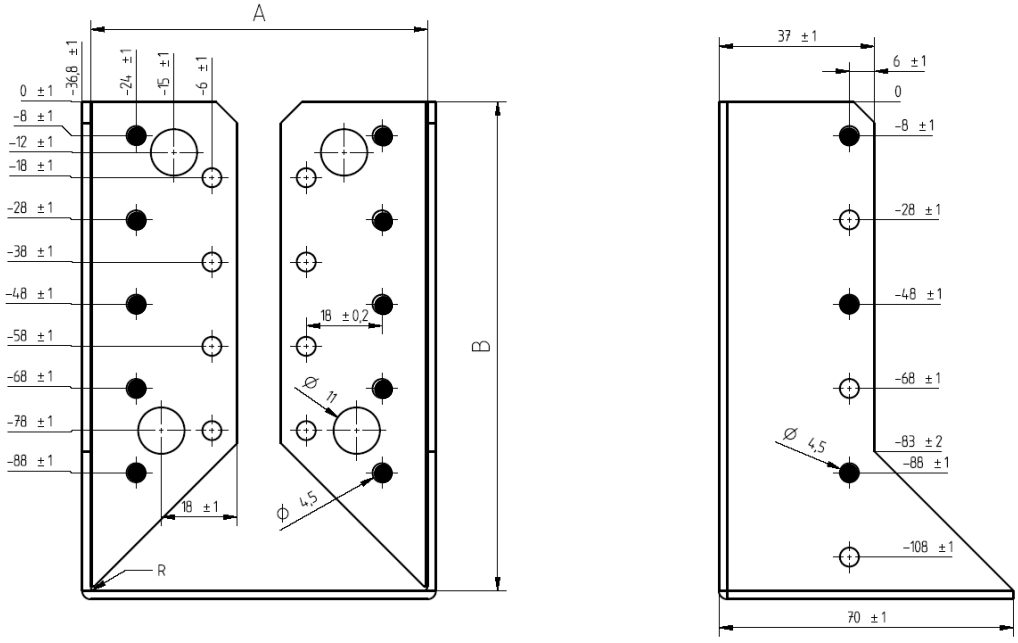
Blank	Total n° of nail holes		Width interval		Height interval	
	n_H	n_J	min	max	min	max
238	8	8	45	51	93	96
260	8	8	40	64	98	110
320	12	12	48	64	128	136

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

Joist hangers 320 B, 380 B, 440 B and 500 B

Face mount hanger with interior flanges

2.0 mm thick pre-galvanized steel DX51D according to EN 10327:2004 with a minimum yield strength R_e of 295 MPa, a minimum tensile strength R_m of 360 MPa and a minimum ultimate strain A80 of 22 % or stainless steel 1.4016, 1.4301, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 with tolerances according to EN 10143:1993.



- Partial nailing; Drawing: Blank 320

Blank	Total n° of nail holes		Width interval		Height interval	
	n_H	n_J	min	max	min	max
320	18	12	70	80	120	125
380	22	12	70	100	140	155
440	26	14	80	120	160	180
500	30	16	80	140	180	210

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

Fastener types and sizes

Nail type	Nail size (mm)		Finish
According to prEN 14592	Diameter	Length	
Threaded nail	4,0	35 - 100	Electroplated zinc

In the load-carrying-capacities of the nailed connection 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-carrying-capacities of the joist hangers are 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):

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

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 profiled shank including the nail point in mm, $t_{pen} \geq 31$ mm for 2,0 mm brackets and $t_{pen} \geq 25$ mm for 1,5 mm brackets

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:

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

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.

SCREW Diameter	Length Min – max	Screw type
5,0	30 – 60 for 2,0 mm brackets 25 – 50 for 1,5 mm brackets	Screw according to prEN 14592

BOLT Diameter	Corresponding hole diameter	Bolt type
8,0	9,0	See specification of the manufacturer
10,0	11,0 for 2 mm brackets Max. 2 mm larger than the bolt diameter for 1,5 mm brackets	See specification of the manufacturer

Annex B
Characteristic load-carrying-capacities

Characteristic capacities of the joist hanger connections with nails or screws

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 a distance $e_{J,90}$ above the centre of gravity of the nails in the joist. The axial force is assumed to act in the centre of gravity of the header connection.

Two nail 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 and there shall always be a nail in the upper and the lower holes. The other nails are distributed evenly over the height. The nails and screws respectively in the header shall be put in the holes closest to the bend line.

For joist hangers type A 2, 0 mm with overlapping nails or screws in the joist (see figure 8.5 in EN 1995-1-1) 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 joist hangers with staggered nails in the joist the width shall be at least the penetration length of the nails.

For joist hangers type A 1,5 mm and type B the width of the joist shall be at least the penetration length of the nails.

B.1. Joist hangers with outward flaps and fastened with nails or screws

B.1.1 Joist hangers fastened with nails or screws

Force downward toward the bottom plate:

$$F_{Z,Rk} = \min \begin{cases} (n_J + 2) \cdot F_{v,J,Rk} \\ \dfrac{1}{\sqrt{\left(\dfrac{1}{n_H \cdot F_{v,H,Rk}}\right)^2 + \left(\dfrac{1}{k_{H,1} \cdot F_{ax,H,Rk}}\right)^2}} \end{cases} \quad \text{(B.1.1)}$$

Force upward away from the bottom plate:

$$F_{Z,Rk} = \min \begin{cases} n_J \cdot F_{v,J,Rk} \\ \dfrac{1}{\sqrt{\left(\dfrac{1}{n_H \cdot F_{v,H,Rk}}\right)^2 + \left(\dfrac{1}{k_{H,2} \cdot F_{ax,H,Rk}}\right)^2}} \end{cases} \quad \text{(B.1.2)}$$

Lateral force:

$$F_{Y,Rd} = \min \begin{cases} \dfrac{n_J \cdot F_{v,J,Rd}}{\sqrt{\left(\dfrac{2 \cdot \sqrt{e_{J,0}^2 + e_{J,90}^2}}{b_J}\right)^2 + \left(\dfrac{F_{v,J,Rd}}{F_{ax,J,Rd}}\right)^2}} \\ \dfrac{F_{v,H,Rd}}{\sqrt{\left(\dfrac{1}{n_H} + \dfrac{e_H}{e_1}\right)^2 + \left(\dfrac{e_H}{e_2}\right)^2}} \end{cases} \quad \text{(B.1.3)}$$

n_J total number of fasteners in the joist

n_H total number of fasteners in the header

$F_{v,Rk}$ characteristic lateral load-carrying capacity of a fastener in the joist or in the header indicated by the indices J or H in N

$F_{ax,Rk}$ characteristic axial load-carrying capacity of a fastener in the joist or in the header indicated by the indices J or H in N

b_J width of the joist hanger in mm, see B in figure B1

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

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

$e_{J,0}$ joist hanger dimension in mm, see Table B1

e_1 joist hanger dimension in mm, see Table B1

e_2 joist hanger dimension in mm, see Table B1

$k_{H,1}$ form factor, see Tables C1 to C2

$k_{H,2}$ form factor, see Tables C1 to C2

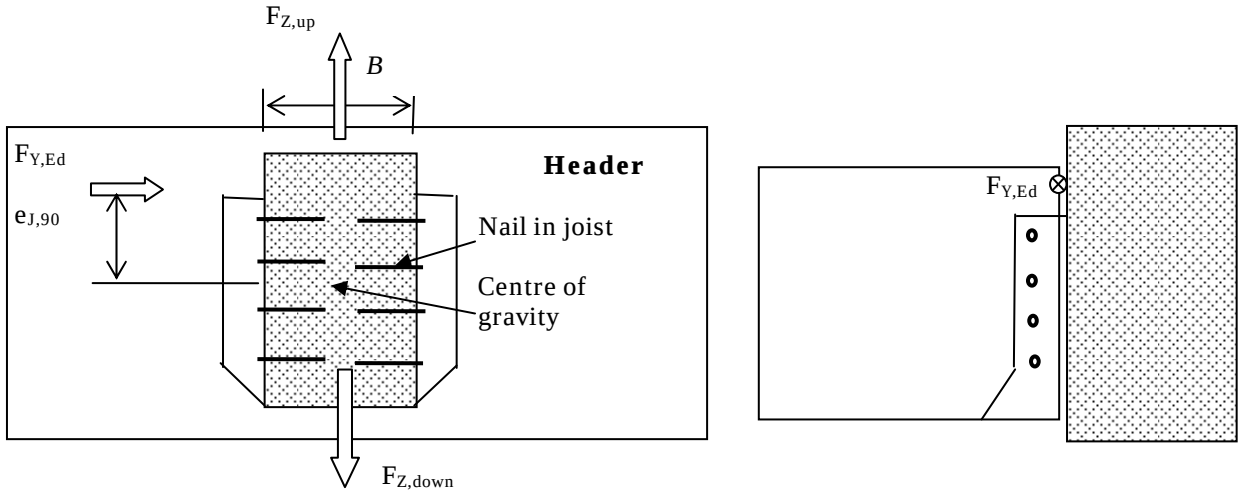


Figure B1: Definition of $e_{J,90}$

B.1.2 Combined forces

In case of combined forces the relevant of the following inequalities shall be fulfilled:

Force downward toward the bottom plate:
$$\left(\frac{F_{Z,Down,Ed}}{F_{Z,Down,Rk}}\right)^2 + \left(\frac{F_{Y,Ed}}{F_{Y,Rk}}\right)^2 \le 1,0 \qquad \text{(B.1.4)}$$

Force upward away from the bottom plate:
$$\left(\frac{F_{Z,Up,Ed}}{F_{Z,Up,Rk}}\right)^2 + \left(\frac{F_{Y,Ed}}{F_{Y,Rk}}\right)^2 \le 1,0 \qquad \text{(B.1.5)}$$

B.2 Joist hangers with inward flaps and fastened with nails in torsionally restrained timber header beams

Force downward toward the bottom plate:

$$F_{Z,Rd} = \min \begin{cases} (n_J + n_p) \cdot F_{v,J,Rd} \\ \dfrac{1}{\sqrt{\left(\dfrac{1}{n_H \cdot F_{v,H,Rd}}\right)^2 + \left(\dfrac{1}{k_{H,1} \cdot F_{ax,H,Rd}}\right)^2}} \end{cases} \quad \text{(B.2.1)}$$

Force upward away from the bottom plate:

$$F_{Z,Rd} = \min \begin{cases} n_J \cdot F_{v,J,Rd} \\ \dfrac{1}{\sqrt{\left(\dfrac{1}{n_H \cdot F_{v,H,Rd}}\right)^2 + \left(\dfrac{1}{k_{H,2} \cdot F_{ax,H,Rd}}\right)^2}} \end{cases} \quad \text{(B.2.2)}$$

Lateral force:

$$F_{Y,Rd} = \min \begin{cases} \dfrac{n_J \cdot F_{v,J,Rd}}{\sqrt{\left(\dfrac{2 \cdot \sqrt{e_{J,0}^2 + e_{J,90}^2}}{b_J}\right)^2 + \left(\dfrac{F_{v,J,Rd}}{F_{ax,J,Rd}}\right)^2}} \\ \dfrac{F_{v,H,Rd}}{\sqrt{\left(\dfrac{1}{n_H} + \dfrac{e_H}{e_1}\right)^2 + \left(\dfrac{e_H}{e_2}\right)^2}} \end{cases} \quad \text{(B.2.3)}$$

n_J total number of nails in both sides of the joist

n_H total number of nails in the side of the header

n_p fictitious number of fastener shear planes to account for the bottom plate (see Table B.2)

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

$F_{ax,Rd}$ Design 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 B2.

$e_{J,90}$ distance of the lateral force above the centre of gravity of the nails in the joist, see figure B2.

$e_{J,0}$ distance from the nails in the joist to the surface of the header, see figure B2.

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

e_1 joist hanger dimension

e_2 joist hanger dimension

$k_{H,1}$ form factor, see tables C3 to C4

$k_{H,2}$ form factor, see tables C3 to C4

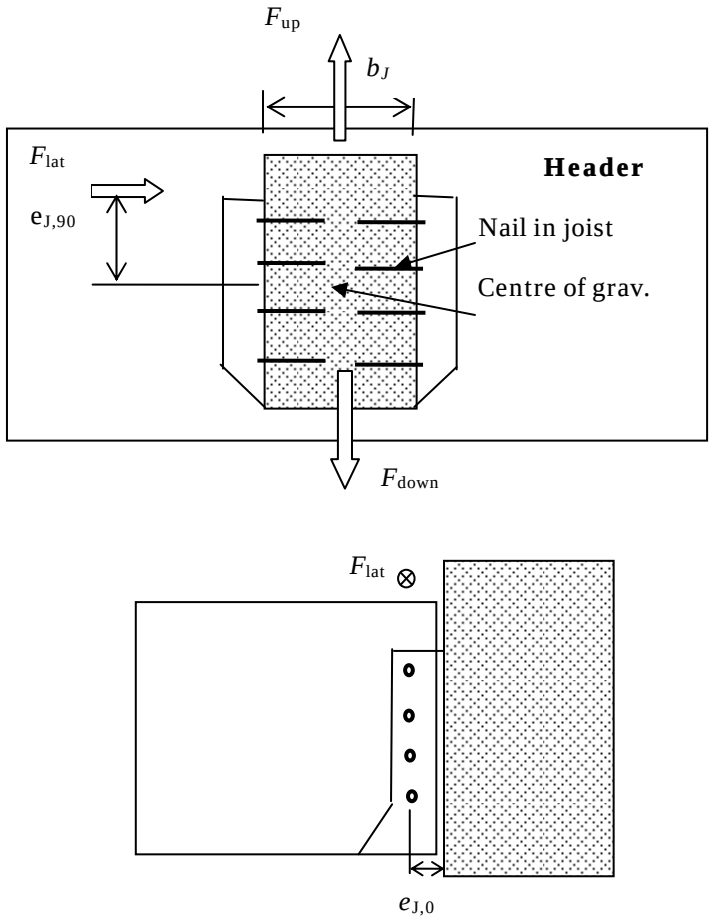


Figure B.2: Definition of $e_{J,90}$ and $e_{J,0}$

Table B.2: Number n_p of additional nails in equation B.1.1

Joist hanger GAH	Bottom plate length ℓ [mm]	n_p
238 B, 260 B, 320 1B1	51	3
320 B, 380 B, 440 B, 500 B	70	4

Combined forces

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

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

B.3 Characteristic load-carrying-capacities of the joist hanger connections with bolts

For joist hangers 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 force transfer 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 under the bolt heads or nuts.

Description of the static model

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

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

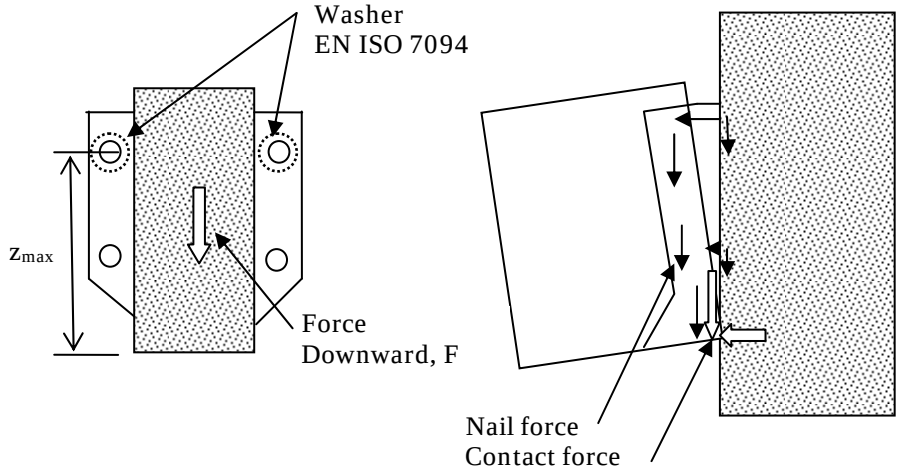


Figure B2 Left: Cross section in joist. Right: The joist will deflect and rotate, at the bottom a contact force will occur at the bottom plate, and the withdrawal forces in the bolts in the wall will vary linearly as assumed for a nailed connection in the header.

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

$$F_{ax,bolt} = \frac{F \cdot e_{J,0}}{2 \cdot z_{max}} \qquad (B.3.1)$$

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*.

$$F_{lat,bolt} = F_{Z,Ed} / n_{bolt} \quad \text{(B.3.2)}$$

Characteristic capacities of a bolted joist hanger connection

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

$$F_{Z,J,Rk} = (n_J + 2) \cdot F_{v,J,Rk} \quad \text{(B.3.3)}$$

The upper 2 bolts are critical. They are subjected to a lateral force calculated from formula (B.3.2).

The withdrawal force in an upper bolt is calculated from (B.3.1).

Where

$F_{Z,Ed}$ 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 design capacity to carry the combined lateral and axial forces.

From the characteristic 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.

$$F_{bear,Rk} = n_{bolt} \cdot f_{u,k} \cdot d \cdot t \quad \text{(B.3.4)}$$

Where

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

$f_{u,k}$ characteristic ultimate tensile strength of the steel, 330 MPa

d diameter of the bolt

t thickness of the steel plate of the joist hanger

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

- The capacity determined from (B.3.3) from the nails in the joist
- The capacity determined from (B.3.4) from the embedding strength of the steel plate against the bolt
- The capacity controlled by the bolt forces given by (B.3.1) and (B.3.2).

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

Table C1: GAH Joist hanger type A 2 mm with external flanges:
Form factors kH,1 and kH,2 and dimensions e1, e2; eJ,0 = 31 mm

B [mm]	H [mm]	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 [mm]	e_2 [mm]	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 [mm]	e_2 [mm]
		Full nailing						Partial nailing					
40	73	8	5	8,78	3,01	963	295	4	3	4,15	1,29	424	137
42	72	8	5	8,55	3,01	1006	302	4	3	4,03	1,29	450	141
44	71	8	5	8,32	3,01	1051	309	4	3	3,92	1,29	476	144
46	70	8	5	8,09	3,01	1096	316	4	3	3,80	1,29	502	148
48	69	8	5	7,87	3,01	1142	323	4	3	3,68	1,29	530	151
50	68	8	5	7,64	3,01	1190	331	4	3	3,57	1,29	558	155
40	77	8	5	9,13	2,88	1027	293	4	3	4,39	1,29	424	137
42	76	8	5	8,90	2,88	1073	300	4	3	4,27	1,29	450	141
44	75	8	5	8,66	2,88	1121	308	4	3	4,15	1,29	476	144
46	74	8	5	8,43	2,88	1169	315	4	3	4,03	1,29	502	148
48	73	8	5	8,20	2,88	1219	322	4	3	3,92	1,29	530	151
50	72	8	5	7,97	2,88	1270	329	4	3	3,80	1,29	558	155
52	71	8	5	7,74	2,88	1322	336	4	3	3,68	1,29	588	159
54	70	8	5	7,51	2,88	1375	344	4	3	3,57	1,29	618	163
56	69	8	5	7,29	2,88	1429	351	4	3	3,45	1,29	648	166
58	68	8	5	7,06	2,88	1485	358	4	3	3,34	1,29	680	170
60	67	8	5	6,84	2,88	1541	366	4	3	3,23	1,29	712	174
62	66	8	5	6,62	2,88	1599	373	4	3	3,11	1,29	746	178
64	65	8	5	6,40	2,88	1658	380	4	3	3,00	1,29	780	181
40	85	10	6	11,9	4,84	869	354	6	4	7,32	3,23	368	238
42	84	10	6	11,6	4,84	907	363	6	4	7,15	3,23	387	242
44	83	10	6	11,3	4,84	947	371	6	4	6,99	3,23	407	246
46	82	10	6	11,0	4,84	988	380	6	4	6,82	3,23	427	251
48	81	10	6	10,8	4,84	1029	388	6	4	6,66	3,23	448	256
50	80	10	6	10,5	4,84	1072	397	6	4	6,50	3,23	469	260
52	79	10	6	10,2	4,84	1116	406	6	4	6,34	3,23	491	265
54	78	10	6	9,95	4,84	1160	414	6	4	6,18	3,23	513	270
56	77	10	6	9,68	4,84	1206	423	6	4	6,02	3,23	536	275
58	76	10	6	9,41	4,84	1253	432	6	4	5,86	3,23	560	280
60	75	10	6	9,14	4,84	1301	441	6	4	5,71	3,23	584	285

Table C1 (cont) GAH Joist hanger type A 2 mm with external flanges:
Form factors kH,1 and kH,2 and dimensions e1, e2; eJ,0 = 31 mm

B [mm]	H [mm]	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 [mm]	e_2 [mm]	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 [mm]	e_2 [mm]
		Full nailing						Partial nailing					
32	114	14	8	22,4	9,78	786	524	8	4	13,1	6,02	328	364
34	113	14	8	22,0	9,78	819	534	8	4	12,8	6,02	342	367
36	112	14	8	21,6	9,78	853	544	8	4	12,6	6,02	358	370
38	111	14	8	21,2	9,78	887	555	8	4	12,4	6,02	373	373
40	110	14	8	20,8	9,78	923	565	8	4	12,2	6,02	390	377
42	109	14	8	20,5	9,78	960	576	8	4	12,0	6,02	406	381
44	108	14	8	20,1	9,78	997	587	8	4	11,8	6,02	424	385
46	107	14	8	19,7	9,78	1036	598	8	4	11,5	6,02	442	390
48	106	14	8	19,3	9,78	1075	609	8	4	11,3	6,02	460	394
50	105	14	8	18,9	9,78	1115	620	8	4	11,1	6,02	479	399
52	104	14	8	18,6	9,78	1157	631	8	4	10,9	6,02	498	404
54	103	14	8	18,2	9,78	1199	642	8	4	10,7	6,02	518	409
56	102	14	8	17,8	9,78	1242	654	8	4	10,5	6,02	539	415
58	101	14	8	17,5	9,78	1286	665	8	4	10,3	6,02	560	420
60	100	14	8	17,1	9,78	1331	677	8	4	10,1	6,02	582	426
62	99	14	8	16,7	9,78	1377	689	8	4	9,88	6,02	604	431
64	98	14	8	16,4	9,78	1424	700	8	4	9,68	6,02	626	437
65	97,5	14	8	16,2	9,78	1448	706	8	4	9,58	6,02	638	440
32	144	18	10	37,2	16,5	887	789	10	6	21,0	9,68	382	566
34	143	18	10	36,7	16,5	919	799	10	6	20,7	9,68	396	566
36	142	18	10	36,2	16,5	952	810	10	6	20,4	9,68	410	566
38	141	18	10	35,7	16,5	986	822	10	6	20,2	9,68	425	567
40	140	18	10	35,2	16,5	1020	833	10	6	19,9	9,68	440	568
42	139	18	10	34,7	16,5	1056	845	10	6	19,6	9,68	456	570
44	138	18	10	34,2	16,5	1092	857	10	6	19,4	9,68	472	572
46	137	18	10	33,7	16,5	1130	869	10	6	19,1	9,68	489	575
48	136	18	10	33,2	16,5	1168	882	10	6	18,8	9,68	506	579
50	135	18	10	32,7	16,5	1207	894	10	6	18,6	9,68	524	582
52	134	18	10	32,2	16,5	1247	907	10	6	18,3	9,68	542	586
54	133	18	10	31,8	16,5	1288	920	10	6	18,0	9,68	561	591
56	132	18	10	31,3	16,5	1330	933	10	6	17,8	9,68	580	595
58	131	18	10	30,8	16,5	1373	947	10	6	17,5	9,68	600	600
60	130	18	10	30,3	16,5	1416	960	10	6	17,2	9,68	620	605
62	129	18	10	29,9	16,5	1461	974	10	6	17,0	9,68	641	610
64	128	18	10	29,4	16,5	1506	988	10	6	16,7	9,68	662	616
66	127	18	10	28,9	16,5	1553	1002	10	6	16,5	9,68	684	622
68	126	18	10	28,4	16,5	1600	1016	10	6	16,2	9,68	706	628
70	125	18	10	28,0	16,5	1648	1030	10	6	15,9	9,68	729	634
72	124	18	10	27,5	16,5	1697	1044	10	6	15,7	9,68	752	640
74	123	18	10	27,1	16,5	1747	1059	10	6	15,4	9,68	776	647
76	122	18	10	26,6	16,5	1798	1073	10	6	15,2	9,68	800	653
78	121	18	10	26,1	16,5	1850	1088	10	6	14,9	9,68	825	660
80	120	18	10	25,7	16,5	1902	1103	10	6	14,7	9,68	850	667

Table C1 (cont.): GAH Joist hanger type A 2 mm with external flanges:
Form factors kH,1 and kH,2 and dimensions e1, e2; eJ,0 = 31 mm

B [mm]	**H [mm]**	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 **[mm]**	e_2 **[mm]**	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 **[mm]**	e_2 **[mm]**
		Full nailing						Partial nailing					
54	163	22	12	49,1	24,8	1414	1262	12	6	27,2	14,2	627	824
56	162	22	12	48,5	24,8	1455	1276	12	6	26,9	14,2	645	827
58	161	22	12	47,9	24,8	1497	1290	12	6	26,6	14,2	664	830
60	160	22	12	47,3	24,8	1540	1305	12	6	26,3	14,2	683	833
62	159	22	12	46,7	24,8	1583	1319	12	6	25,9	14,2	703	837
64	158	22	12	46,1	24,8	1628	1334	12	6	25,6	14,2	724	842
66	157	22	12	45,5	24,8	1673	1350	12	6	25,3	14,2	745	846
68	156	22	12	45,0	24,8	1720	1365	12	6	25,0	14,2	766	851
70	155	22	12	44,4	24,8	1767	1381	12	6	24,7	14,2	788	856
72	154	22	12	43,8	24,8	1815	1396	12	6	24,4	14,2	810	862
74	153	22	12	43,2	24,8	1864	1412	12	6	24,1	14,2	833	868
76	152	22	12	42,7	24,8	1914	1428	12	6	23,8	14,2	856	874
78	151	22	12	42,1	24,8	1965	1445	12	6	23,4	14,2	880	880
80	150	22	12	41,5	24,8	2016	1461	12	6	23,1	14,2	904	887
82	149	22	12	41,0	24,8	2069	1478	12	6	22,8	14,2	929	893
84	148	22	12	40,4	24,8	2122	1495	12	6	22,5	14,2	954	900
86	147	22	12	39,8	24,8	2177	1512	12	6	22,2	14,2	980	907
88	146	22	12	39,3	24,8	2232	1529	12	6	21,9	14,2	1006	915
90	145	22	12	38,7	24,8	2288	1546	12	6	21,6	14,2	1033	922
92	144	22	12	38,2	24,8	2345	1563	12	6	21,3	14,2	1060	930
94	143	22	12	37,6	24,8	2403	1581	12	6	21,0	14,2	1087	937
96	142	22	12	37,1	24,8	2461	1598	12	6	20,7	14,2	1115	945
98	141	22	12	36,5	24,8	2521	1616	12	6	20,4	14,2	1144	953
100	140	22	12	36,0	24,8	2581	1634	12	6	20,2	14,2	1173	962

Table C2: Joist hanger type A 1.5 mm with external flanges:
Form factors $k_{H,1}$ and $k_{H,2}$ and dimensions e_1, e_2; $e_{J,0}$ = 31 mm

B [mm]	**H [mm]**	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 [mm]	e_2 [mm]	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 [mm]	e_2 [mm]
		Full nailing						Partial nailing					
32	114	14	8	22,4	6,12	770	519	8	4	13,1	3,76	321	393
34	113	14	8	22,0	6,18	802	529	8	4	12,8	3,80	335	394
36	112	14	8	21,6	6,25	836	539	8	4	12,6	3,84	350	396
38	111	14	8	21,2	6,31	870	549	8	4	12,4	3,88	365	399
40	110	14	8	20,8	6,38	905	560	8	4	12,2	3,93	381	401
42	109	14	8	20,5	6,45	941	570	8	4	12,0	3,97	398	405
44	108	14	8	20,1	6,52	978	581	8	4	11,8	4,01	415	408
46	107	14	8	19,7	6,60	1016	592	8	4	11,5	4,06	433	412
48	106	14	8	19,3	6,67	1055	603	8	4	11,3	4,11	451	416
50	105	14	8	18,9	6,75	1095	614	8	4	11,1	4,15	469	420
52	104	14	8	18,6	6,83	1136	625	8	4	10,9	4,20	489	425
54	103	14	8	18,2	6,91	1178	637	8	4	10,7	4,25	508	430
56	102	14	8	17,8	7,0	1220	648	8	4	10,5	4,30	529	434
58	101	14	8	17,5	7,1	1264	659	8	4	10,3	4,35	549	440
60	100	14	8	17,1	7,2	1309	671	8	4	10,1	4,41	571	445
62	99	14	8	16,7	7,2	1354	683	8	4	9,88	4,46	593	450
64	98	14	8	16,4	7,3	1400	694	8	4	9,68	4,52	615	456
65	98	14	8	16,2	7,4	1424	700	8	4	9,58	4,54	626	458
32	144	18	10	37,2	10,4	872	783	10	6	21,0	6,14	376	613
34	143	18	10	36,7	10,5	903	794	10	6	20,7	6,19	389	610
36	142	18	10	36,2	10,6	936	805	10	6	20,4	6,24	403	608
38	141	18	10	35,7	10,7	969	816	10	6	20,2	6,29	418	607
40	140	18	10	35,2	10,8	1003	827	10	6	19,9	6,35	433	607
42	139	18	10	34,7	10,9	1038	839	10	6	19,6	6,40	448	608
44	138	18	10	34,2	11,0	1074	851	10	6	19,4	6,45	464	609
46	137	18	10	33,7	11,1	1111	863	10	6	19,1	6,51	481	610
48	136	18	10	33,2	11,2	1149	875	10	6	18,8	6,56	498	612
50	135	18	10	32,7	11,2	1188	888	10	6	18,6	6,62	515	615
52	134	18	10	32,2	11,3	1227	901	10	6	18,3	6,67	533	618
54	133	18	10	31,8	11,4	1268	914	10	6	18,0	6,73	552	621
56	132	18	10	31,3	11,5	1309	927	10	6	17,8	6,79	571	625
58	131	18	10	30,8	11,6	1351	940	10	6	17,5	6,85	590	629
60	130	18	10	30,3	11,8	1395	954	10	6	17,2	6,91	610	634
62	129	18	10	29,9	11,9	1439	967	10	6	17,0	6,97	631	639
64	128	18	10	29,4	12,0	1484	981	10	6	16,7	7,04	652	644
66	127	18	10	28,9	12,1	1530	995	10	6	16,5	7,10	673	649
68	126	18	10	28,4	12,2	1576	1009	10	6	16,2	7,17	695	654
70	125	18	10	28,0	12,3	1624	1023	10	6	15,9	7,24	718	660
72	124	18	10	27,5	12,4	1673	1037	10	6	15,7	7,30	741	666
74	123	18	10	27,1	12,5	1722	1052	10	6	15,4	7,37	764	672
76	122	18	10	26,6	12,7	1773	1066	10	6	15,2	7,44	788	678
78	121	18	10	26,1	12,8	1824	1081	10	6	14,9	7,52	813	684
80	120	18	10	25,7	12,9	1876	1095	10	6	14,7	7,59	838	691

Table C2 (cont.): Joist hanger type A 1.5 mm with external flanges:
Form factors $k_{H,1}$ and $k_{H,2}$ and dimensions e_1, e_2; $e_{J,0}$ = 31 mm

B [mm]	**H [mm]**	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 [mm]	e_2 [mm]	n_H	n_J	$k_{H,1}$	$k_{H,2}$	e_1 [mm]	e_2 [mm]
		Full nailing						Partial nailing					
60	160	22	12	47,3	17,5	1518	1298	12	6	26,3	10,0	674	875
62	159	22	12	46,7	17,6	1561	1312	12	6	25,9	10,1	693	878
64	158	22	12	46,1	17,7	1606	1327	12	6	25,6	10,1	714	881
66	157	22	12	45,5	17,9	1651	1342	12	6	25,3	10,2	734	885
68	156	22	12	45,0	18,0	1697	1357	12	6	25,0	10,3	755	889
70	155	22	12	44,4	18,1	1743	1373	12	6	24,7	10,4	777	893
72	154	22	12	43,8	18,3	1791	1388	12	6	24,4	10,4	799	898
74	153	22	12	43,2	18,4	1840	1404	12	6	24,1	10,5	822	903
76	152	22	12	42,7	18,5	1889	1420	12	6	23,8	10,6	845	908
78	151	22	12	42,1	18,7	1939	1437	12	6	23,4	10,7	868	914
80	150	22	12	41,5	18,8	1991	1453	12	6	23,1	10,8	892	920
82	149	22	12	41,0	19,0	2043	1469	12	6	22,8	10,8	917	926
84	148	22	12	40,4	19,1	2096	1486	12	6	22,5	10,9	942	932
86	147	22	12	39,8	19,3	2149	1503	12	6	22,2	11,0	967	939
88	146	22	12	39,3	19,4	2204	1520	12	6	21,9	11,1	993	946
90	145	22	12	38,7	19,6	2260	1537	12	6	21,6	11,2	1019	953
92	144	22	12	38,2	19,7	2316	1554	12	6	21,3	11,3	1046	960
94	143	22	12	37,6	19,9	2374	1572	12	6	21,0	11,4	1074	967
96	142	22	12	37,1	20,0	2432	1589	12	6	20,7	11,4	1101	975
98	141	22	12	36,5	20,2	2491	1607	12	6	20,4	11,5	1130	982
100	140	22	12	36,0	20,4	2551	1625	12	6	20,2	11,6	1158	990

Table C3: Joist hanger 238 B, 260 B and 320 1B1 with interior flanges:
Form factors $k_{H,1}$ and $k_{H,2}$ and dimensions e_1, e_2; $e_{J,0}$ = 26 mm

B [mm]	**H [mm]**	$\mathbf{n_H}$	$\mathbf{n_J}$	$\mathbf{k_{H,1}}$	$\mathbf{k_{H,2}}$	$\mathbf{e_1}$ **[mm]**	$\mathbf{e_2}$ **[mm]**	$\mathbf{n_H}$	$\mathbf{n_J}$	$\mathbf{k_{H,1}}$	$\mathbf{k_{H,2}}$	$\mathbf{e_1}$ **[mm]**	$\mathbf{e_2}$ **[mm]**
		Full nailing						Partial nailing					
45	96	8	8	11,1	7,18	197	382	8	4	11,1	7,18	197	382
47	95	8	8	10,8	7,18	206	374	8	4	10,8	7,18	206	374
49	94	8	8	10,6	7,18	215	369	8	4	10,6	7,18	215	369
51	93	8	8	10,4	7,18	225	364	8	4	10,4	7,18	225	364
40	110	8	8	11,5	7,18	178	412	8	4	11,5	7,18	178	412
42	109	8	8	11,3	7,18	186	398	8	4	11,3	7,18	186	398
44	108	8	8	11,1	7,18	193	387	8	4	11,1	7,18	193	387
46	107	8	8	10,8	7,18	202	378	8	4	10,8	7,18	202	378
48	106	8	8	10,6	7,18	210	371	8	4	10,6	7,18	210	371
50	105	8	8	10,4	7,18	220	366	8	4	10,4	7,18	220	366
52	104	8	8	10,1	7,18	230	363	8	4	10,1	7,18	230	363
54	103	8	8	9,90	7,18	240	360	8	4	9,90	7,18	240	360
56	102	8	8	9,68	7,18	251	358	8	4	9,68	7,18	251	358
58	101	8	8	9,45	7,18	262	358	8	4	9,45	7,18	262	358
60	100	8	8	9,23	7,18	274	358	8	4	9,23	7,18	274	358
62	99	8	8	9,01	7,18	287	359	8	4	9,01	7,18	287	359
64	98	8	8	8,80	7,18	300	360	8	4	8,80	7,18	300	360
48	136	12	12	22,6	16,9	349	1028	12	6	22,6	16,9	349	1028
50	135	12	12	22,3	16,9	358	994	12	6	22,3	16,9	358	994
52	134	12	12	22,0	16,9	367	965	12	6	22,0	16,9	367	965
54	133	12	12	21,6	16,9	376	940	12	6	21,6	16,9	376	940
56	132	12	12	21,3	16,9	386	919	12	6	21,3	16,9	386	919
58	131	12	12	21,0	16,9	396	900	12	6	21,0	16,9	396	900
60	130	12	12	20,6	16,9	407	885	12	6	20,6	16,9	407	885
62	129	12	12	20,3	16,9	418	871	12	6	20,3	16,9	418	871
64	128	12	12	20,0	16,9	430	860	12	6	20,0	16,9	430	860

Table C4: Joist hanger 320 B, 380 B, 440 B and 500 B with interior flanges: Form factors $k_{H,1}$ and $k_{H,2}$ and dimensions e_1, e_2; $e_{J,0}$ = 31 mm

B [mm]	**H [mm]**	$\mathbf{n_H}$	$\mathbf{n_J}$	$\mathbf{k_{H,1}}$	$\mathbf{k_{H,2}}$	$\mathbf{e_1}$ **[mm]**	$\mathbf{e_2}$ **[mm]**	$\mathbf{n_H}$	$\mathbf{n_J}$	$\mathbf{k_{H,1}}$	$\mathbf{k_{H,2}}$	$\mathbf{e_1}$ **[mm]**	$\mathbf{e_2}$ **[mm]**
		Full nailing						Partial nailing					
70	125	18	12	28,0	16,5	454	751	10	6	15,9	9,68	346	573
72	124	18	12	27,5	16,5	469	745	10	6	15,7	9,68	359	569
74	123	18	12	27,1	16,5	485	741	10	6	15,4	9,68	372	567
76	122	18	12	26,6	16,5	502	738	10	6	15,2	9,68	385	566
78	121	18	12	26,1	16,5	520	737	10	6	14,9	9,68	399	566
80	120	18	12	25,7	16,5	538	737	10	6	14,7	9,68	413	566
70	155	22	12	44,4	24,8	585	1220	12	6	24,7	14,2	418	871
72	154	22	12	43,8	24,8	600	1200	12	6	24,4	14,2	430	860
74	153	22	12	43,2	24,8	615	1183	12	6	24,1	14,2	442	850
76	152	22	12	42,7	24,8	631	1169	12	6	23,8	14,2	455	843
78	151	22	12	42,1	24,8	648	1157	12	6	23,4	14,2	468	836
80	150	22	12	41,5	24,8	666	1148	12	6	23,1	14,2	482	831
82	149	22	12	41,0	24,8	685	1141	12	6	22,8	14,2	496	827
84	148	22	12	40,4	24,8	704	1136	12	6	22,5	14,2	511	824
86	147	22	12	39,8	24,8	725	1133	12	6	22,2	14,2	526	822
88	146	22	12	39,3	24,8	746	1131	12	6	21,9	14,2	541	820
90	145	22	12	38,7	24,8	769	1130	12	6	21,6	14,2	557	820
92	144	22	12	38,2	24,8	792	1131	12	6	21,3	14,2	574	820
94	143	22	12	37,6	24,8	816	1133	12	6	21,0	14,2	591	821
96	142	22	12	37,1	24,8	841	1136	12	6	20,7	14,2	609	822
98	141	22	12	36,5	24,8	867	1140	12	6	20,4	14,2	627	824
100	140	22	12	36,0	24,8	893	1145	12	6	20,2	14,2	645	827
80	180	26	14	61,1	34,9	827	1711	14	8	33,5	19,6	570	1178
82	179	26	14	60,4	34,9	845	1691	14	8	33,1	19,6	583	1167
84	178	26	14	59,8	34,9	865	1674	14	8	32,7	19,6	598	1157
86	177	26	14	59,1	34,9	885	1659	14	8	32,4	19,6	612	1148
88	176	26	14	58,4	34,9	906	1647	14	8	32,0	19,6	627	1141
90	175	26	14	57,7	34,9	928	1637	14	8	31,7	19,6	643	1135
92	174	26	14	57,1	34,9	950	1629	14	8	31,3	19,6	659	1130
94	173	26	14	56,4	34,9	974	1623	14	8	31,0	19,6	676	1126
96	172	26	14	55,7	34,9	998	1619	14	8	30,6	19,6	693	1123
98	171	26	14	55,1	34,9	1024	1616	14	8	30,3	19,6	710	1121
100	170	26	14	54,4	34,9	1050	1615	14	8	29,9	19,6	728	1120
102	169	26	14	53,8	34,9	1077	1615	14	8	29,6	19,6	747	1120
104	168	26	14	53,1	34,9	1105	1617	14	8	29,2	19,6	766	1120
106	167	26	14	52,5	34,9	1133	1619	14	8	28,9	19,6	785	1121
108	166	26	14	51,8	34,9	1163	1623	14	8	28,5	19,6	805	1123
110	165	26	14	51,2	34,9	1194	1628	14	8	28,2	19,6	825	1125
112	164	26	14	50,5	34,9	1225	1633	14	8	27,8	19,6	846	1128
114	163	26	14	49,9	34,9	1257	1640	14	8	27,5	19,6	867	1131
116	162	26	14	49,3	34,9	1290	1647	14	8	27,1	19,6	889	1135
118	161	26	14	48,6	34,9	1324	1655	14	8	26,8	19,6	911	1139
120	160	26	14	48,0	34,9	1359	1664	14	8	26,5	19,6	934	1143

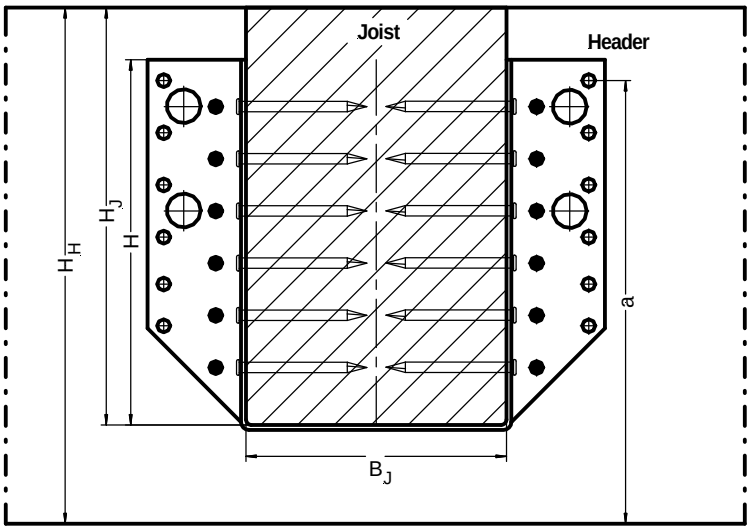
Table C4 (cont.): Joist hanger 320 B, 380 B, 440 B and 500 B with interior flanges: Form factors $k_{H,1}$ and $k_{H,2}$ and dimensions e_1, e_2; $e_{J,0}$ = 31 mm

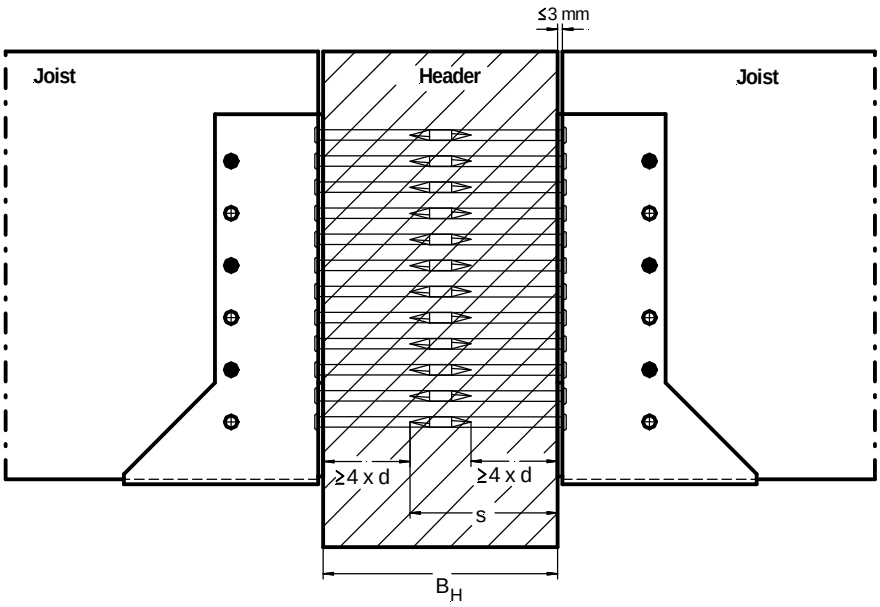
B [mm]	**H [mm]**	**n_H**	**n_J**	**$k_{H,1}$**	**$k_{H,2}$**	**e_1 [mm]**	**e_2 [mm]**	**n_H**	**n_J**	**$k_{H,1}$**	**$k_{H,2}$**	**e_1 [mm]**	**e_2 [mm]**
		Full nailing						Partial nailing					
80	210	30	16	84,4	46,8	1016	2453	16	8	45,7	25,8	672	1623
82	209	30	16	83,6	46,8	1035	2414	16	8	45,2	25,8	686	1600
84	208	30	16	82,9	46,8	1053	2379	16	8	44,8	25,8	700	1580
86	207	30	16	82,1	46,8	1073	2348	16	8	44,4	25,8	714	1562
88	206	30	16	81,3	46,8	1094	2320	16	8	44,0	25,8	729	1546
90	205	30	16	80,5	46,8	1115	2296	16	8	43,6	25,8	744	1532
92	204	30	16	79,7	46,8	1138	2276	16	8	43,2	25,8	760	1520
94	203	30	16	78,9	46,8	1161	2258	16	8	42,8	25,8	776	1509
96	202	30	16	78,2	46,8	1185	2242	16	8	42,3	25,8	793	1500
98	201	30	16	77,4	46,8	1210	2229	16	8	41,9	25,8	810	1492
100	200	30	16	76,6	46,8	1236	2218	16	8	41,5	25,8	828	1486
102	199	30	16	75,9	46,8	1263	2209	16	8	41,1	25,8	846	1480
104	198	30	16	75,1	46,8	1290	2202	16	8	40,7	25,8	864	1476
106	197	30	16	74,3	46,8	1318	2197	16	8	40,3	25,8	883	1472
108	196	30	16	73,6	46,8	1348	2194	16	8	39,9	25,8	903	1469
110	195	30	16	72,8	46,8	1378	2192	16	8	39,5	25,8	923	1468
112	194	30	16	72,0	46,8	1409	2191	16	8	39,1	25,8	943	1467
114	193	30	16	71,3	46,8	1440	2192	16	8	38,7	25,8	964	1466
116	192	30	16	70,5	46,8	1473	2194	16	8	38,3	25,8	985	1467
118	191	30	16	69,8	46,8	1507	2197	16	8	37,9	25,8	1007	1468
120	190	30	16	69,0	46,8	1541	2201	16	8	37,5	25,8	1029	1470
122	189	30	16	68,3	46,8	1576	2207	16	8	37,1	25,8	1051	1472
124	188	30	16	67,6	46,8	1612	2213	16	8	36,7	25,8	1075	1475
126	187	30	16	66,8	46,8	1649	2220	16	8	36,5	25,8	1098	1478
128	186	30	16	66,1	46,8	1687	2228	16	8	36,2	25,8	1122	1482
130	185	30	16	65,3	46,8	1726	2237	16	8	35,8	25,8	1147	1486
132	184	30	16	64,6	46,8	1765	2247	16	8	35,4	25,8	1171	1491
134	183	30	16	63,9	46,8	1806	2257	16	8	35,0	25,8	1197	1496
136	182	30	16	63,2	46,8	1847	2268	16	8	34,6	25,8	1223	1501
138	181	30	16	62,4	46,8	1889	2280	16	8	34,2	25,8	1249	1507
140	180	30	16	61,7	46,8	1932	2292	16	8	33,8	25,8	1276	1513

Annex D

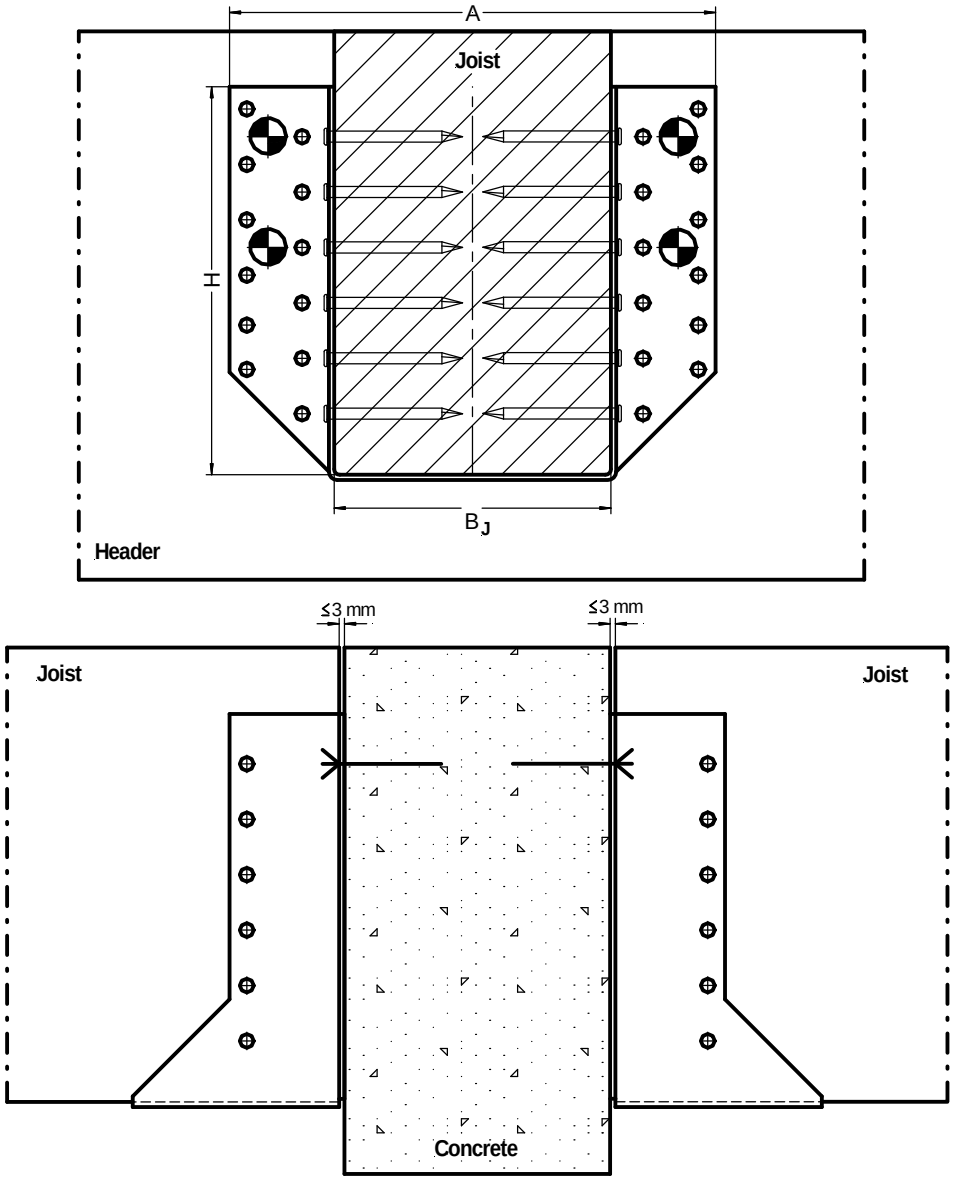
Installation of joist hangers

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