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Authorised and notified according to Article 29 of the Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011

MEMBER OF EOTA

European Technical Assessment ETA-08/0007 of 2015-08-11

I General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: ETA-Danmark A/S

Trade name of the construction product:	SIMA Beam Shoe type 220-65 U PL, 290-65 U PL, 380-65 U PL, 230-65 U/I, 240-65 U/I, 250-65 U/I, 260-65 U/I, 320-90 U/I, 380-90 U/I, 380-120 U/I, 440-130 U/I, 500-155 U/I and 550-155 U/I
Product family to which the above construction product belongs:	Three-dimensional nailing plate (Joist hanger for wood to wood connections and wood to concrete or steel connections)
Manufacturer:	Sima Industri ApS Industrivej Nord 40 DK-7490 Aulum Tel. +45 97 47 26 11 Fax +45 97 47 37 11 Internet www.simaindustri.dk
Manufacturing plant:	Sima Industri ApS Industrivej Nord 40 DK-7490 Aulum
This European Technical Assessment contains:	37 pages including 3 annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	Guideline for European Technical Approval (ETAG) No. 015 Three Dimensional Nailing Plates, April 2013, used as European Assessment Document (EAD).
This version replaces:	The previous ETA with the same number issued on 2012-01-23 and expiry on 2017-01-23

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product and intended use

Technical description of the product

Sima Industri Beam Shoe type 220-65 U PL, 290-65 U PL, 380-65 U PL, 230-65 U/I, 240-65 U/I, 250-65 U/I, 260-65 U/I, 320-90 U/I, 380-90 U/I, 380-120 U/I, 440-130 U/I, 500-155 U/I and 550-155 U/I are one-piece, non-welded joist hangers. They are face mounted timber-to-timber joist hangers connected to the header beam, the steel member or the concrete structure and the joist with a range of nails or bolts.

The joist hangers are made from pre-galvanized steel Grade S250GD + min. Z275 according to EN10346. Dimensions, hole positions, steel type and typical installations are shown in Annex B.

All joist hangers can also be produced from stainless steel number 1.4401, 1.4404, 1.4521, 1.4301 or 1.4509 according to EN 10088-2 or a stainless steel with a minimum characteristic 0.2% yield stress of 240 MPa, a minimum 1.0% yield stress of 270 MPa and a minimum ultimate tensile strength of 530 MPa.

2 Specification of the intended use in accordance with the applicable EAD

The joist hangers are intended for use in making end-grain to side-grain connections in load bearing timber structures, and 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 Basic Works Requirements 1 and 4 of Regulation (EU) 305/2011 shall be fulfilled.

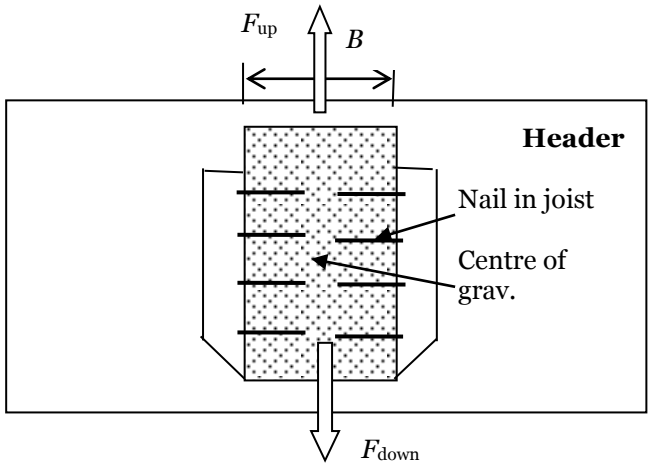
The joist hangers can be installed as connections between wood based members such as:

- 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,
- Kreuzbalken with minimum thickness of 80 mm
- 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 350 kg/m^3. Even though the wood based material may have a larger density, this must not be used in the formulas for the load-carrying capacities of the fasteners.

Annex C gives the tables 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 the following F_{up} and F_{down} as shown in the figure below. The forces F_{up} and F_{down} shall act in the middle of the joist hanger. 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. Similar it is assumed that the concrete structure or the steel member to which the joist hanger is bolted does not rotate. The joist hangers are intended for use for 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 (Eurocode 5).

The stainless steel hangers are intended for use in service class 1, 2 and 3 according to EN 1995 (Eurocode 5).

The scope of the brackets regarding resistance to corrosion shall be defined according to national provisions that apply at the installation site considering environmental conditions.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the connectors of 50 years.

The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability*) (BWR1)	
Characteristic load-carrying capacity	See Annex C
Stiffness	No performance determined
Ductility in cyclic testing	No performance determined
3.2 Safety in case of fire (BWR2)	
Reaction to fire	The 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
3.3 Hygiene, health and the environment (BWR3)	
Influence on air quality	The product does not contain/release dangerous substances specified in TR 034, dated March 2012 0**)
3.7 Sustainable use of natural resources (BWR7)	No Performance Determined
3.8 General aspects related to the performance of the product	The 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, 2 and 3
Identification	See Annex B

*) See additional information in section 3.8 – 3.9.

**) In addition to the specific clauses relating to dangerous substances contained in this European technical Assessment, 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 Construction Products Regulation, these requirements need also to be complied with, when and where they apply.

3.9 Methods of verification

The characteristic load-carrying capacities have been calculated without considering different ratios between the partial factors for timber connections and steel cross sections. Therefore, in the end use calculation based on this ETA, this shall be considered.

The values in annex C have been determined by multiplying the calculated resistance of the connection by k_{mod} to consider load duration and service classes in accordance with EC 5.

Additionally, the capacities indicated for the upward force F_{up} takes into account the national partial safety factor γ_M.

3.10 Mechanical resistance and stability

See annex C for characteristic load-carrying capacity in the directions F_{down} and $F_{up.}$

The characteristic capacities of the joist hangers are determined by calculation 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 15 in Annex B.

Connector nails in accordance to ETA-09/0273
The load bearing capacities of the joist hangers has been determined based on the use of Paslode connector nails 4,0 x 40 mm in accordance with ETA-09/0273 for nails. The fastener can be replaced by fastener mentioned in the ETA-09/0273 with the same or higher performance. The capacity of the connection may not be higher than the load mentioned in this ETA.
The capacities of the nails used in calculations are:

$F_{ax,Rk}$ = 0,998kN
$F_{V,Rk}$ = 1,885kN

The joist hangers are mounted using either full or half nailing.

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.

Further, the joist hangers 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.

3.11 Aspects related to the performance of the product

3.11.1 Corrosion protection in service class 1 and 2.
In accordance with ETAG 015 the joist hanger have a zinc coating weight of min. Z275. The steel employed is S250GD with min. Z275 according to EN 10346.

3.11.2 Corrosion protection in service class 3
In accordance with ETAG 015 stainless steel number 1.4401, 1.4404, 1.4521, 1.4301 or 1.4509 according to EN 10088-2 or a stainless steel with a minimum characteristic 0.2% yield stress of 240 MPa, a minimum 1.0% yield stress of 270 MPa and a minimum ultimate tensile strength of 530 MPa fulfill the requirements.

3.12 General aspects related to the fitness for use of the product

SIMA Industri Beam Shoe are manufactured in accordance with the provisions of this European Technical Assessment using the manufacturing processes as identified in the inspection of the plant by the notified inspection body and laid down in the technical documentation.

Joist hanger connections

A joist hanger connection is deemed fit for use provided:

Header – support conditions

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

Wood to wood connections

- Joist hangers can be fastened to wood-based members by nails.
- There shall be nails in all holes or a partial nailing pattern as prescribed in Annex B can be used.
- The characteristic capacity of the joist hanger connection is calculated according to the manufacturer's technical documentation, dated 2006-12-18.
- 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 shall the gap between the surface of the end of the joist and that of the header be maximum 3 mm.
- The width of the joist shall be at least the penetration length of the nails, 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.
- 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 nail in the joist.
- Nails to be used shall have a diameter, which fits the holes of the joist hangers. Round 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 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 30x30x3,0 mm.

4 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

According to the decision 97/638/EC of the European Commission1, as amended, the system(s) of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) is 2+.

5 Technical details necessary for the implementation of the AVCP system, as foreseen in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at ETA-Danmark

Issued in Copenhagen on 2015-08-11 by

Thomas Bruun
Managing Director, ETA-Danmark

Annex A

Changes from last ETA

Additions and modifications for this ETA	
Pages	**Update**
9	Annex A added
6, 26-31	Revision of values due to new Paslode Connector nails
3	Addition of stainless beam shoes
13	235-65 U/I edited to 230/65 U/I
11, 26, 32	220-65 U PL added
11, 26, 32	290-65 U PL added
12, 27, 33	380-65 U PL added

Additions and modifications for the ETA valid from 2012-01-23 to 2017-01-23	
Pages	**Update**
	ETA extended 5 years
13	Beam shoe 235-65 U-I added
32-37	Values for forces upwards added

Annex B

Product details and definitions

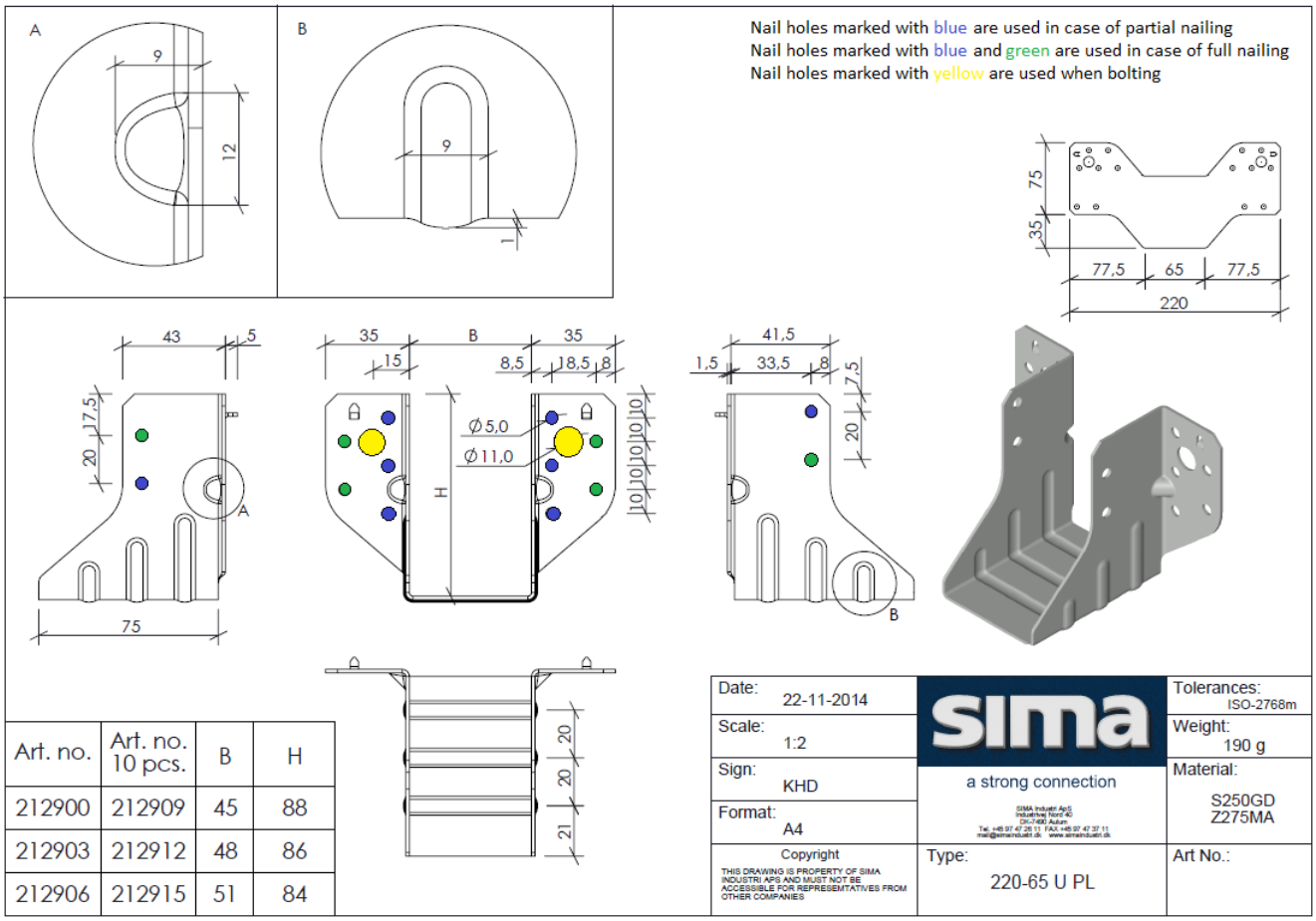
Fastener specification

Fastener type	Fastener dimension (mm)		Finish	ETA
	Diameter	Length		
Paslode Connector nail	4,0	40	Electroplated zinc	09/0273
Bolt M8	8		For relevant joist hangers see the assumed characteristic capacities of the bolt connection and compare with the specification of the manufacturer	
Bolt M10	10			
Spit TAPCON	8	70/5	Mechanical galvanized	11/0073

Joist hanger specification:

Holes marked blue are used in case of partial nailing
Holes marked green and blue are used in case of full nailing
Holes marked yellow are used for bolts
Holes marked red are never used

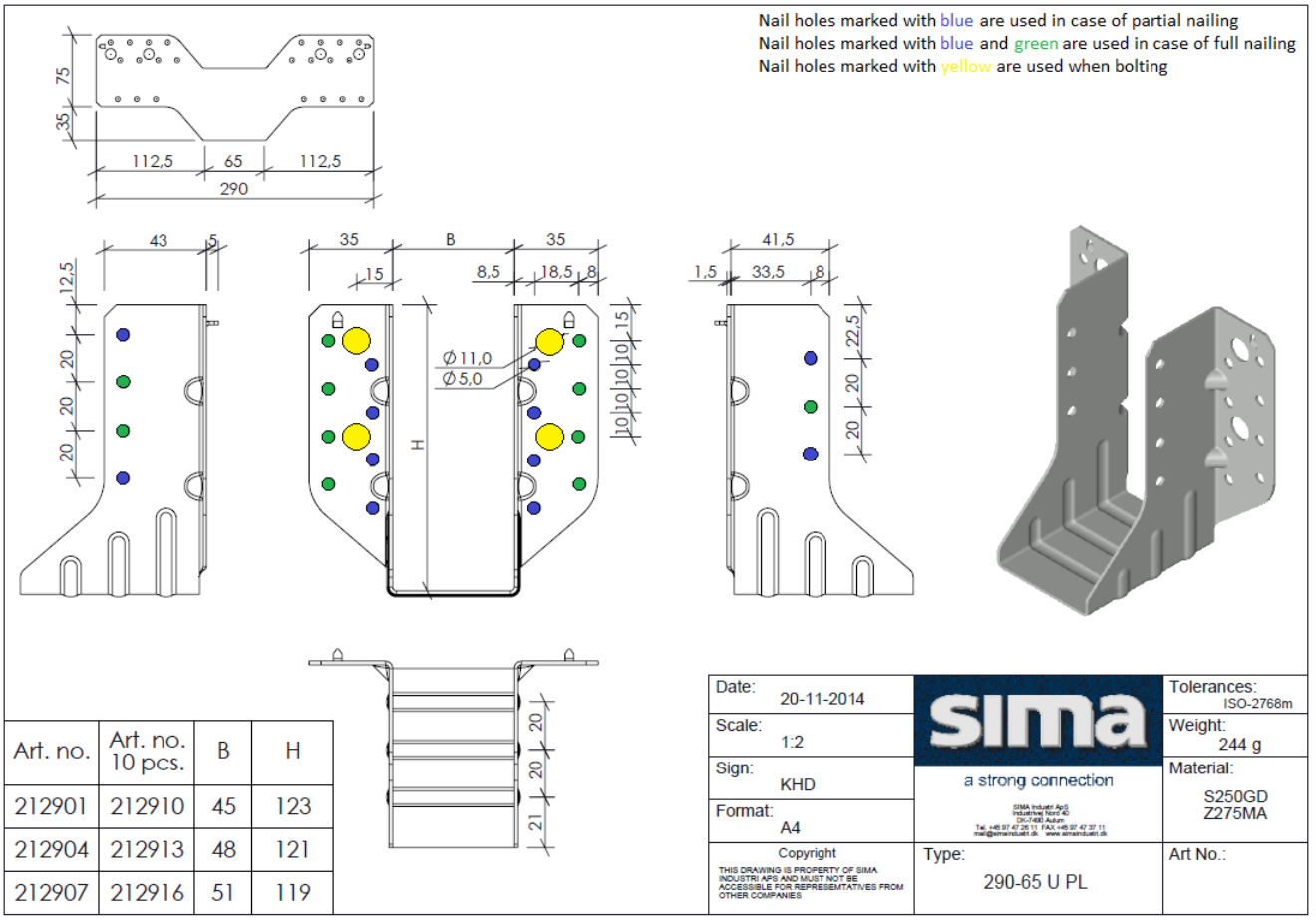
220-65 U PL



Art. no.	Art. no. 10 pcs.	B	H
212900	212909	45	88
212903	212912	48	86
212906	212915	51	84

Date: 22-11-2014	SIMA a strong connection	Tolerances: ISO-2768m
Scale: 1:2		Weight: 190 g
Sign: KHD		Material: S250GD Z275MA
Format: A4		
Copyright THIS DRAWING IS PROPERTY OF SIMA INDUSTRI APS AND MUST NOT BE ACCESSIBLE FOR REPRESENTATIVES FROM OTHER COMPANIES	Type: 220-65 U PL	Art No.:

290-65 U PL



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212904	212913	48	121
212907	212916	51	119

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Format: A4		
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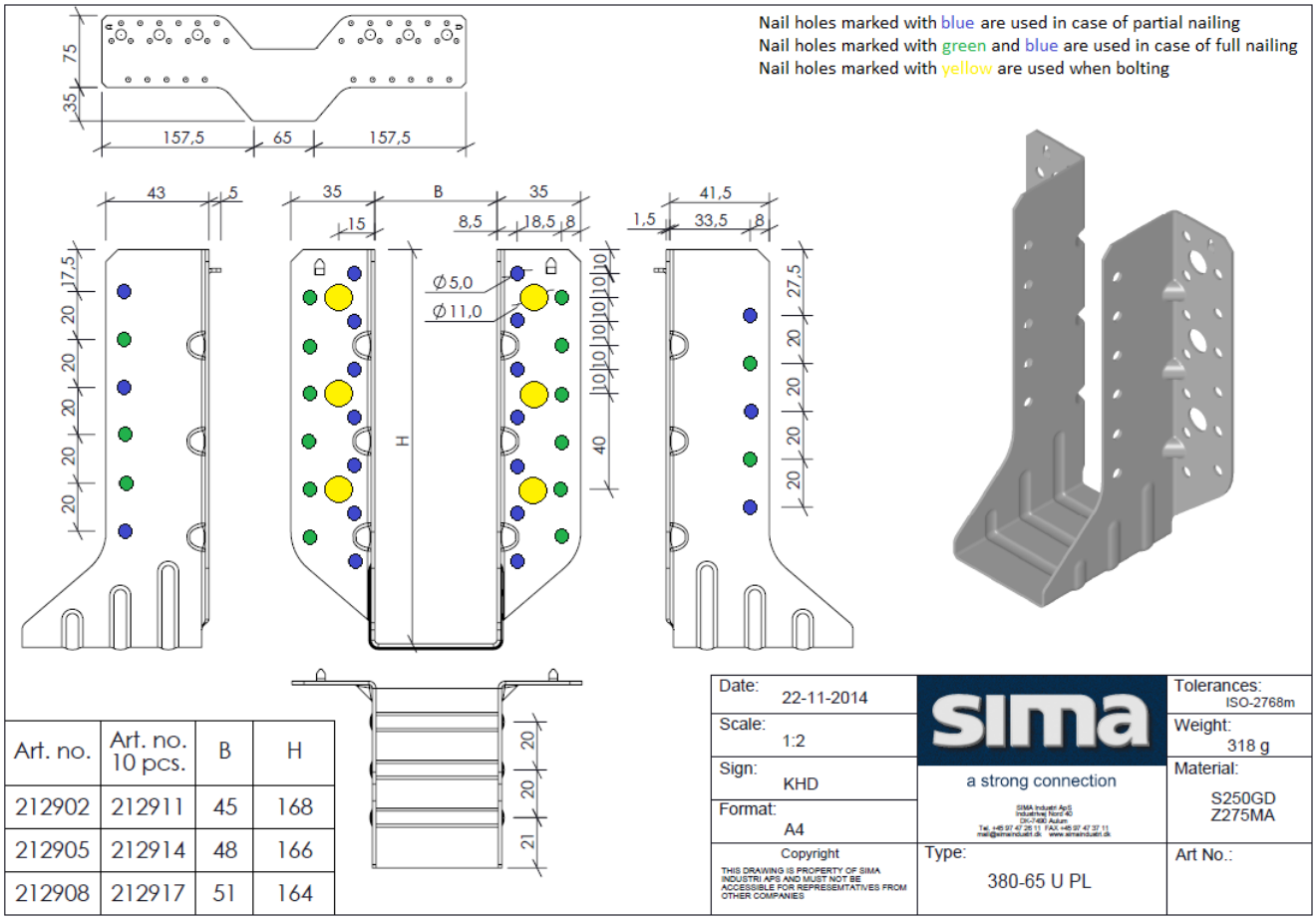
380-65 U PL



Art. no.	Art. no. 10 pcs.	B	H
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212905	212914	48	166
212908	212917	51	164

Date: 22-11-2014	SIMA a strong connection	Tolerances: ISO-2768m
Scale: 1:2		Weight: 318 g
Sign: KHD		Material: S250GD Z275MA
Format: A4		
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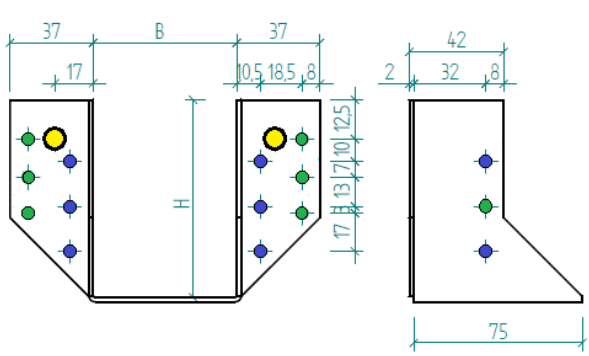
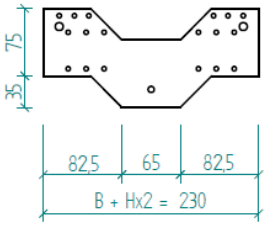
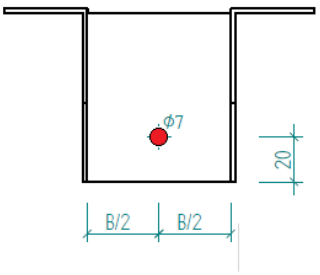
230-65 U/I







Nail holes marked with blue are used in case of partial nailing
Nail holes marked with green and blue are used in case of full nailing
Nail holes marked with yellow are used when bolting
Nail holes marked with red are never used

Art. no. 10 pcs.	ART. NO.	B	H
212417	212317	45	93

Date: 06-07-2013	SIMA	Customer:
Scale: 1:2		T.No:
Sign.: KHD	SIMA Industri ApS Industrivej Nord 40 DK-7490 Aulum Tel. +45 97 47 26 11 Fax +45 97 47 37 11 Mail@simaindustri.dk www.simaindustri.dk	Material: S 250GD Z275 MA EN 10346
Format: A4	Type: 230-65 U	Art Nr.:
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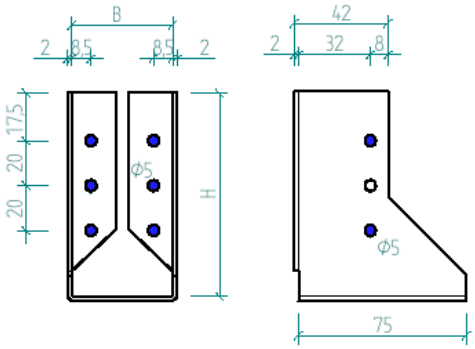

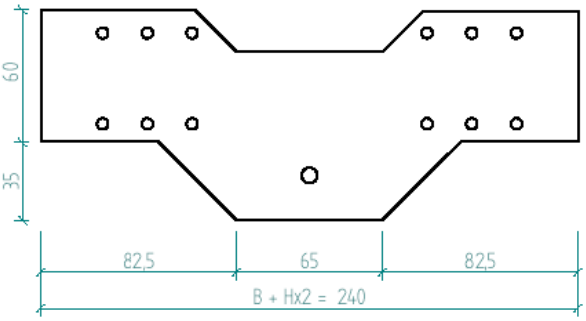

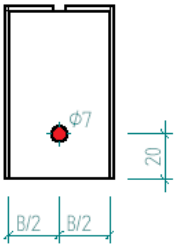

Nail holes marked with red are never used
Nail holes marked with blue are used

ART. NO.	B	H
212375	45	93

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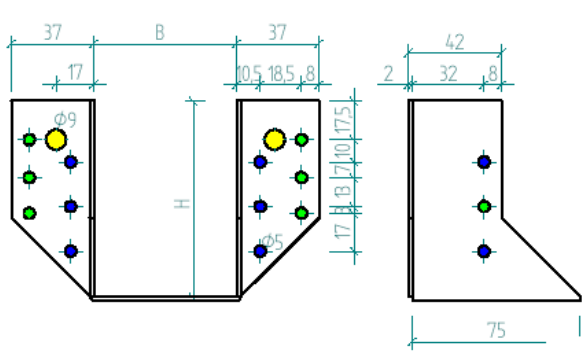
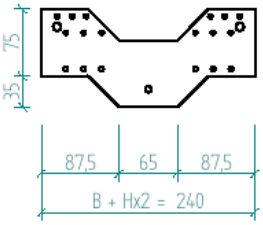
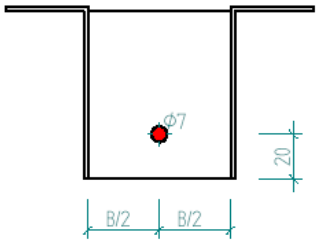
240-65 U/I







Nail holes marked with blue are used in case of partial nailing
Nail holes marked with green and blue are used in case of full nailing
Nail holes marked with yellow are used when bolting
Nail holes marked with red are never used

ART. NO.	B	H
212316	40	100
212318	45	97
212325	48	96
212333	51	94

Rev. No.	Date	Correction	Sign.

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Sign.: MG		Material: S 250GD Z275 MA EN 10326 : 2004
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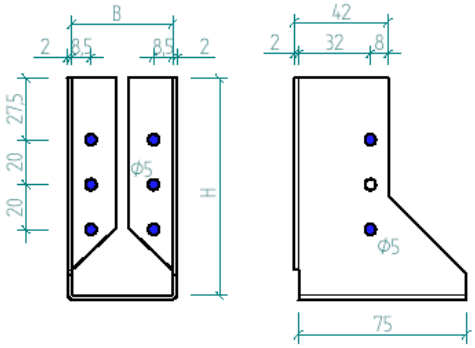

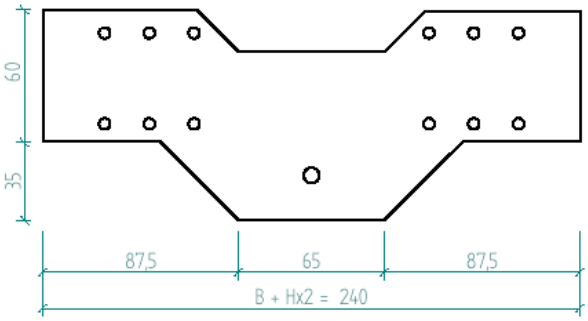

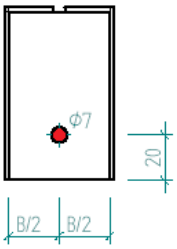

Nail holes marked with red are never used
Nail holes marked with blue are used in case of partial nailing

ART. NO.	B	H
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212378	48	96
212382	51	94

Rev. No.	Date	Correction	Sign.

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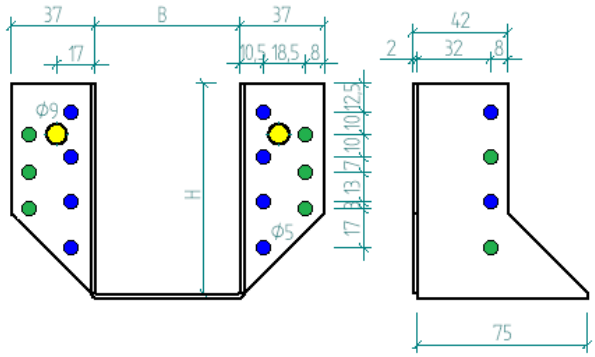
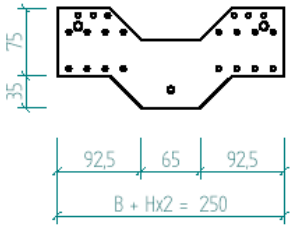
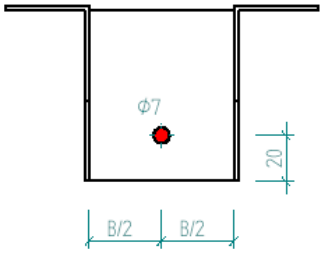
250-65 U/I







Nail holes marked with blue are used in case of partial nailing
Nail holes marked with green and blue are used in case of full nailing
Nail holes marked with yellow are used when bolting
Nail holes marked with red are never used

ART. NO.	B	H
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212332	50	100

Rev. No.	Date	Correction	Sign.

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Scale: 1:2		T.No:
Sign.: MG		Material: S 250GD Z275 MA EN 10326 : 2004
Format: A4		
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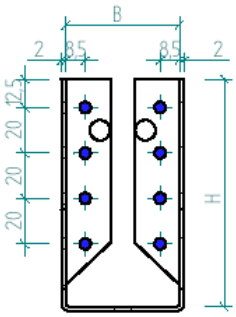

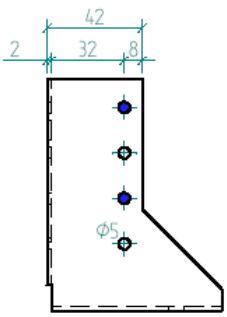

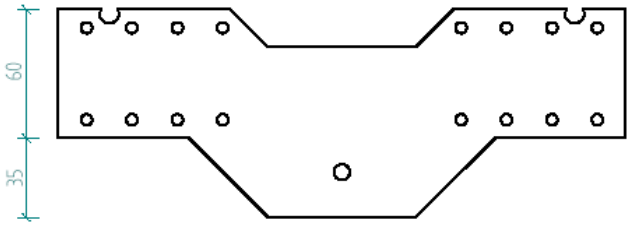

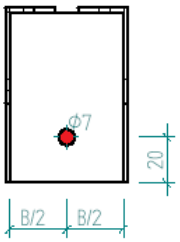

Nail holes marked with red are never used
Nail holes marked with blue are used in case of partial nailing

ART. NO.	B	H
212381	50	100

Rev. No.	Date	Correction	Sign.

Date: 12-04-2006	SIMA Industri ApS Industrivej Nord 40 DK-7490 Aulum Tel. +45 97 47 26 11 Fax +45 97 47 37 11 Mail@simaindustri.dk www.simaindustri.dk	Customer:
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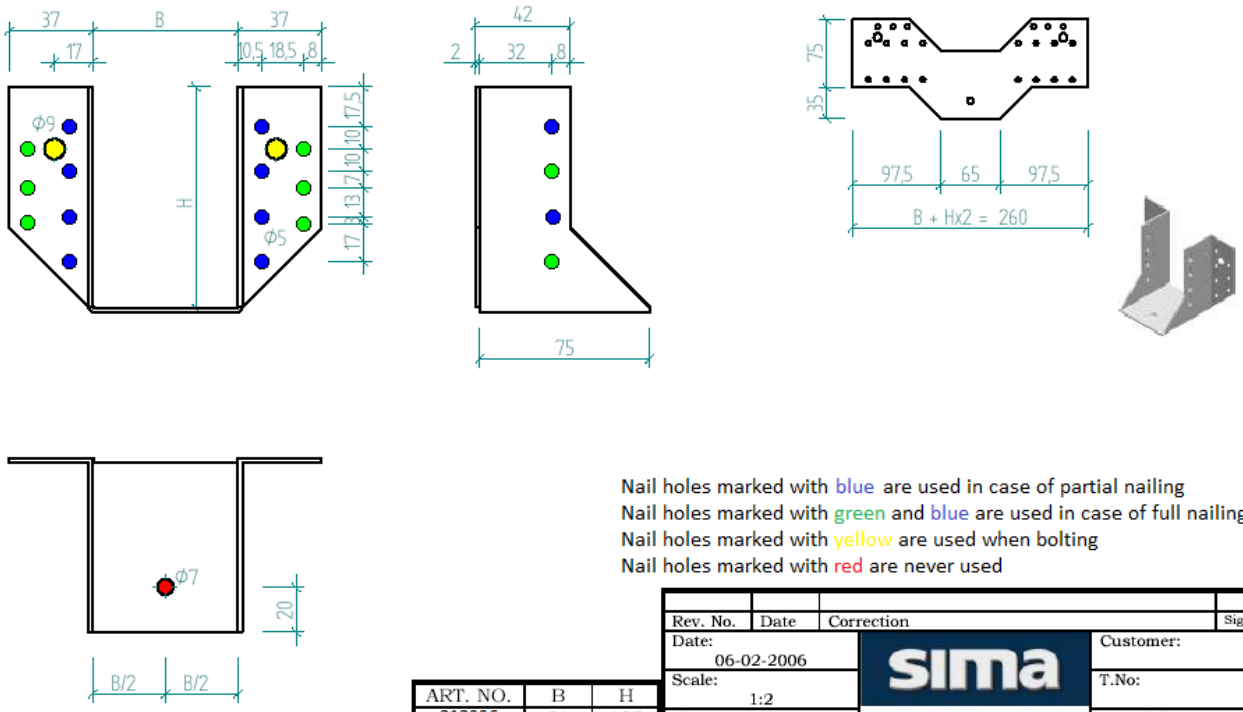
260-65 U/I



Nail holes marked with blue are used in case of partial nailing
Nail holes marked with green and blue are used in case of full nailing
Nail holes marked with yellow are used when bolting
Nail holes marked with red are never used

ART. NO.	B	H
212336	51	105
212341	60	100
212346	63	100
212347	64	98

Rev. No.	Date	Correction	Sign.

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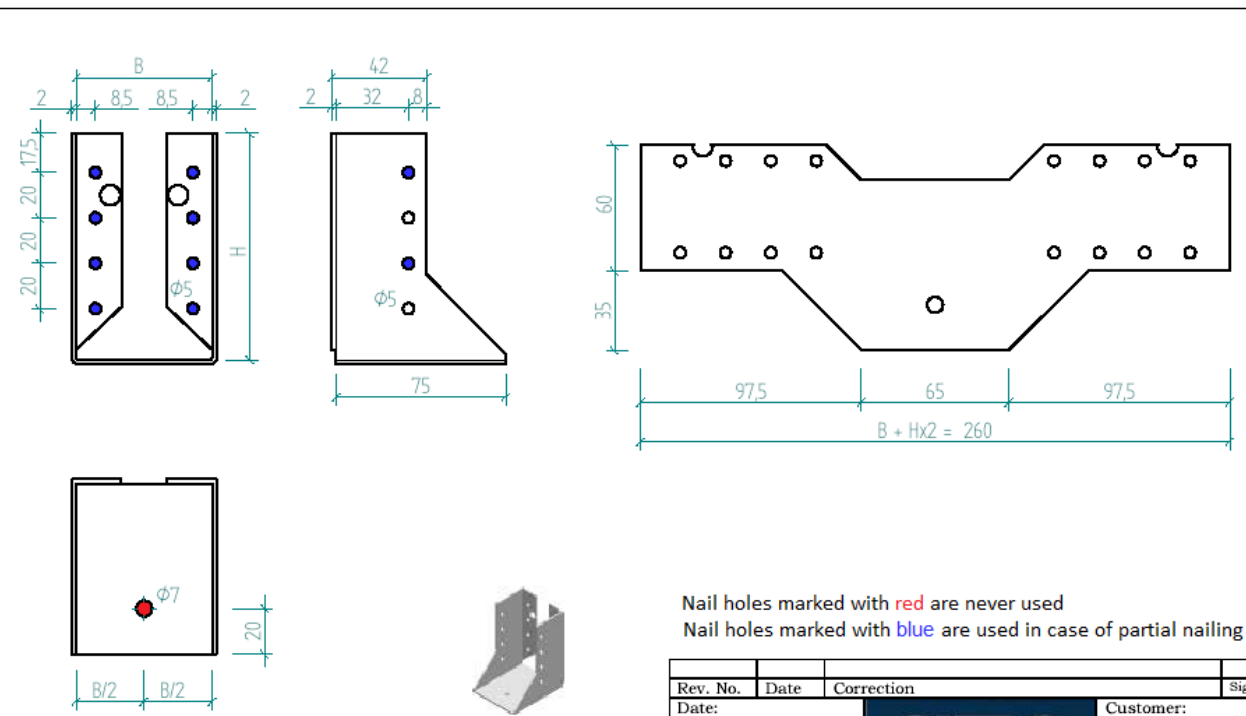
Material: S 250GD Z275 MA EN 10326 : 2004
Type: 260-65 U
Art Nr.:



Nail holes marked with red are never used
Nail holes marked with blue are used in case of partial nailing

ART. NO.	B	H
212383	51	105
212385	60	100
212387	64	98

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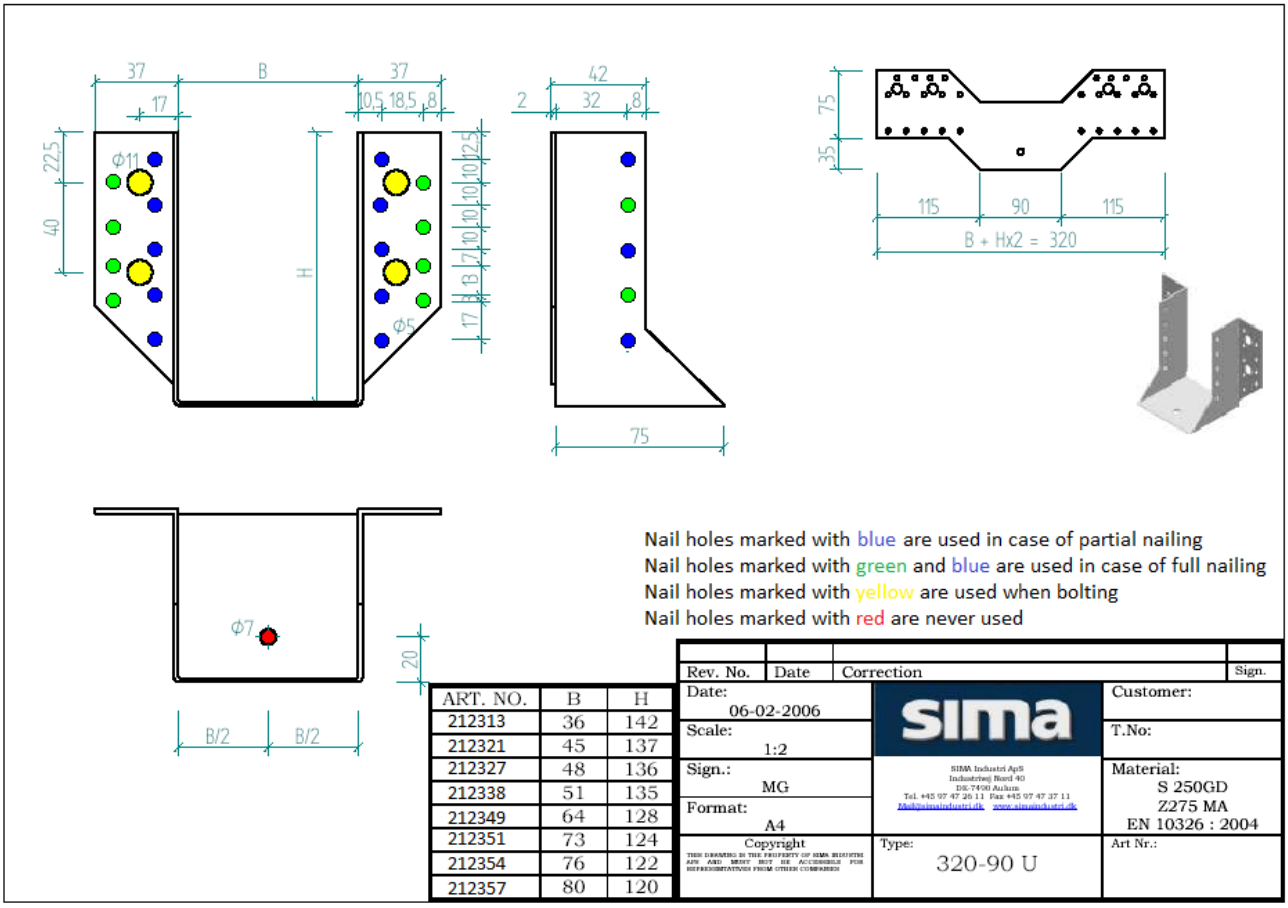
Type: 260-65 I
Art Nr.:

320-90 U/I



Nail holes marked with blue are used in case of partial nailing
Nail holes marked with green and blue are used in case of full nailing
Nail holes marked with yellow are used when bolting
Nail holes marked with red are never used

ART. NO.	B	H
212313	36	142
212321	45	137
212327	48	136
212338	51	135
212349	64	128
212351	73	124
212354	76	122
212357	80	120

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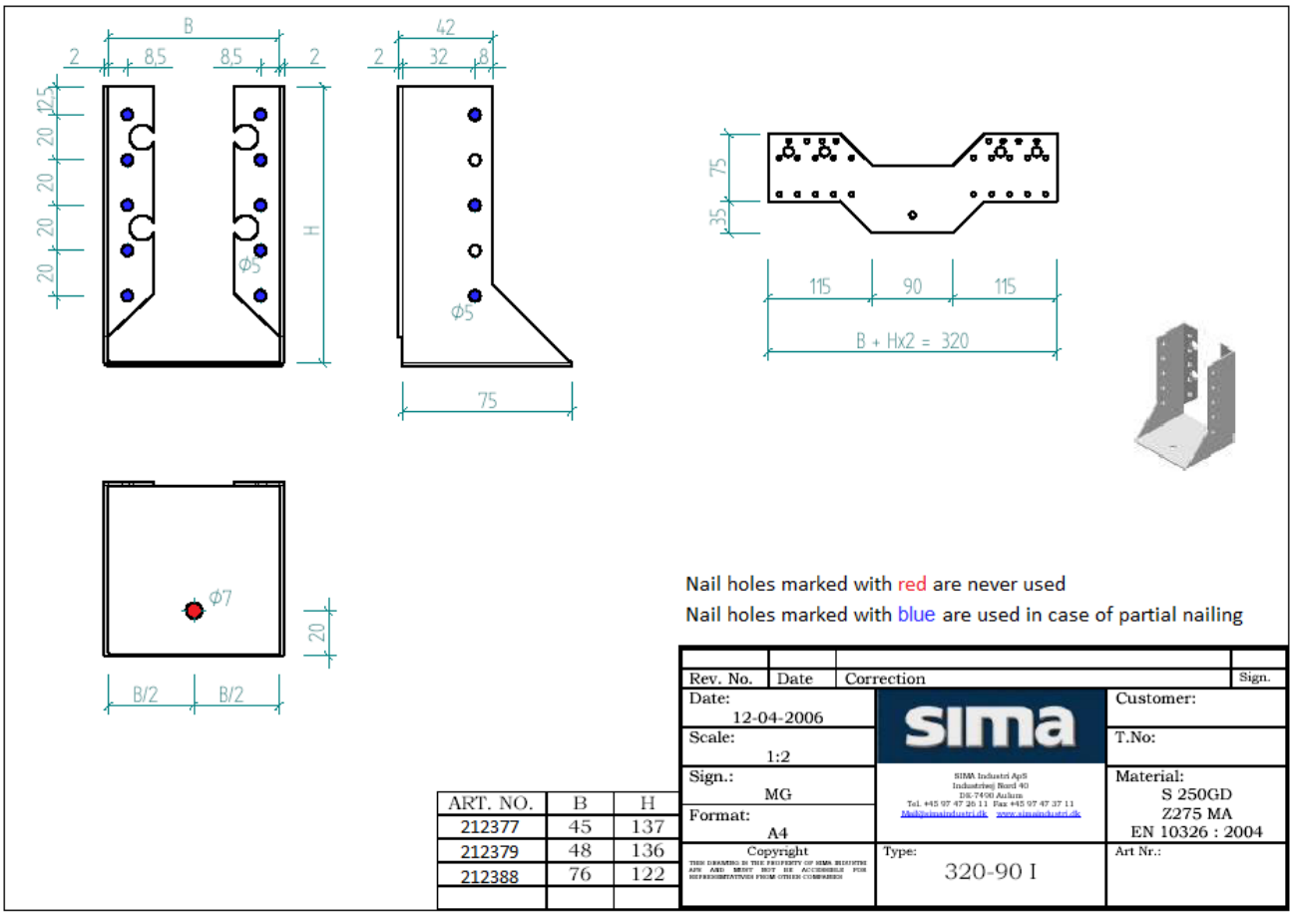

Nail holes marked with red are never used
Nail holes marked with blue are used in case of partial nailing

ART. NO.	B	H
212377	45	137
212379	48	136
212388	76	122

Rev. No.	Date	Correction	Sign.

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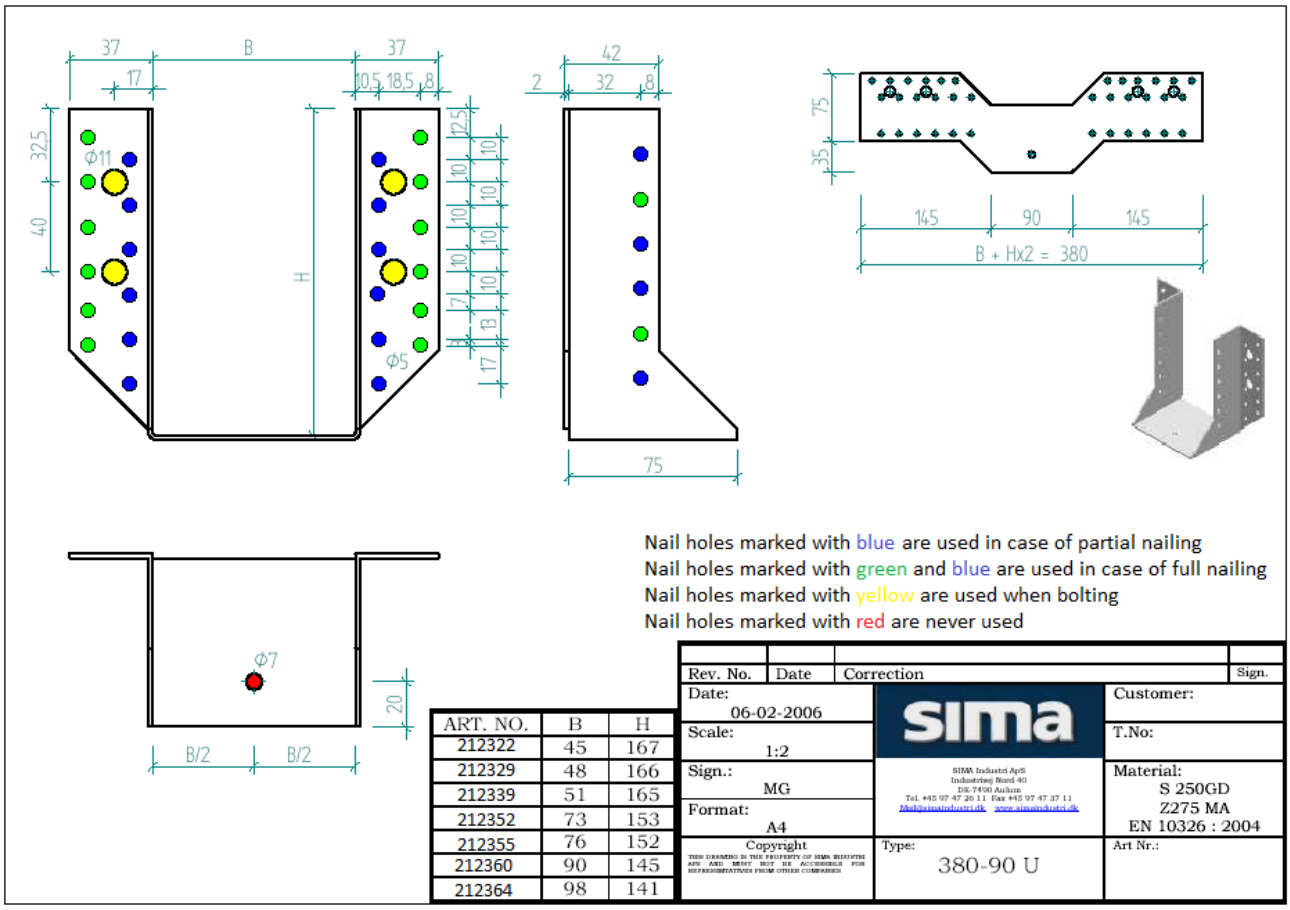
Type: 320-90 I
Art Nr.:

380-90 U/I



Nail holes marked with blue are used in case of partial nailing
Nail holes marked with green and blue are used in case of full nailing
Nail holes marked with yellow are used when bolting
Nail holes marked with red are never used

ART. NO.	B	H
212322	45	167
212329	48	166
212339	51	165
212352	73	153
212355	76	152
212360	90	145
212364	98	141

Rev. No.	Date	Correction	Sign.

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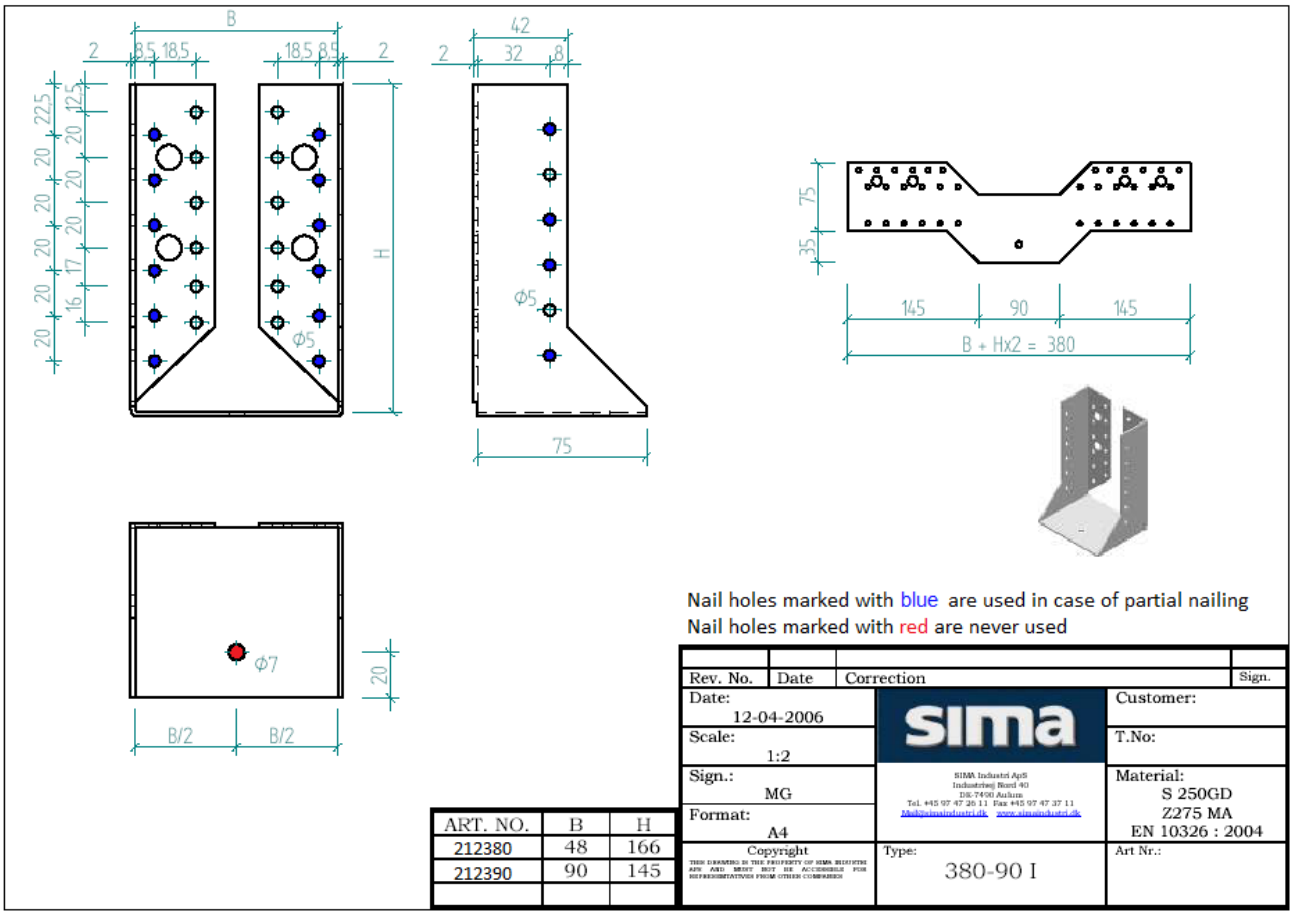
Type: 380-90 U
Art Nr.:



Nail holes marked with blue are used in case of partial nailing
Nail holes marked with red are never used

ART. NO.	B	H
212380	48	166
212390	90	145

Rev. No.	Date	Correction	Sign.

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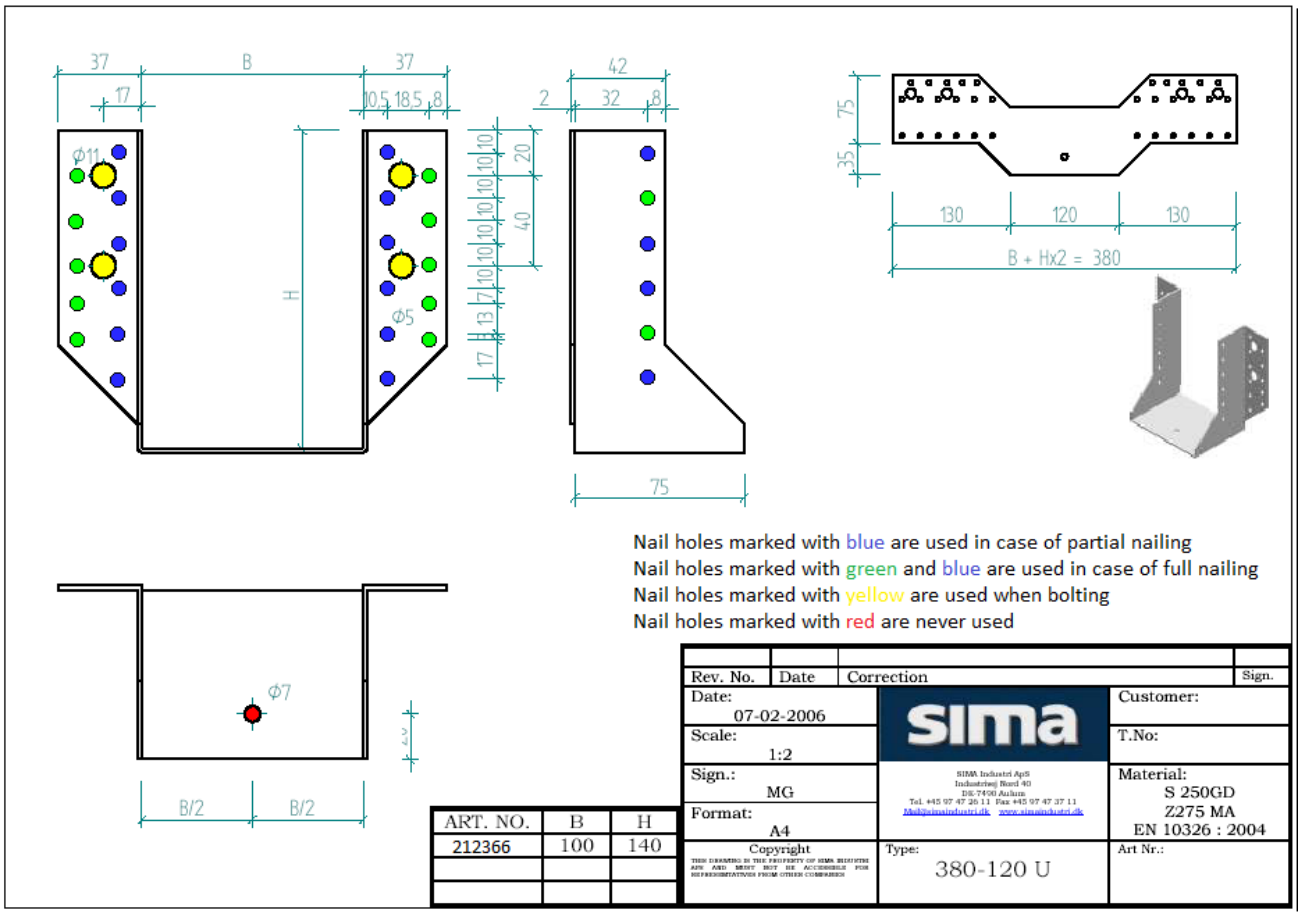
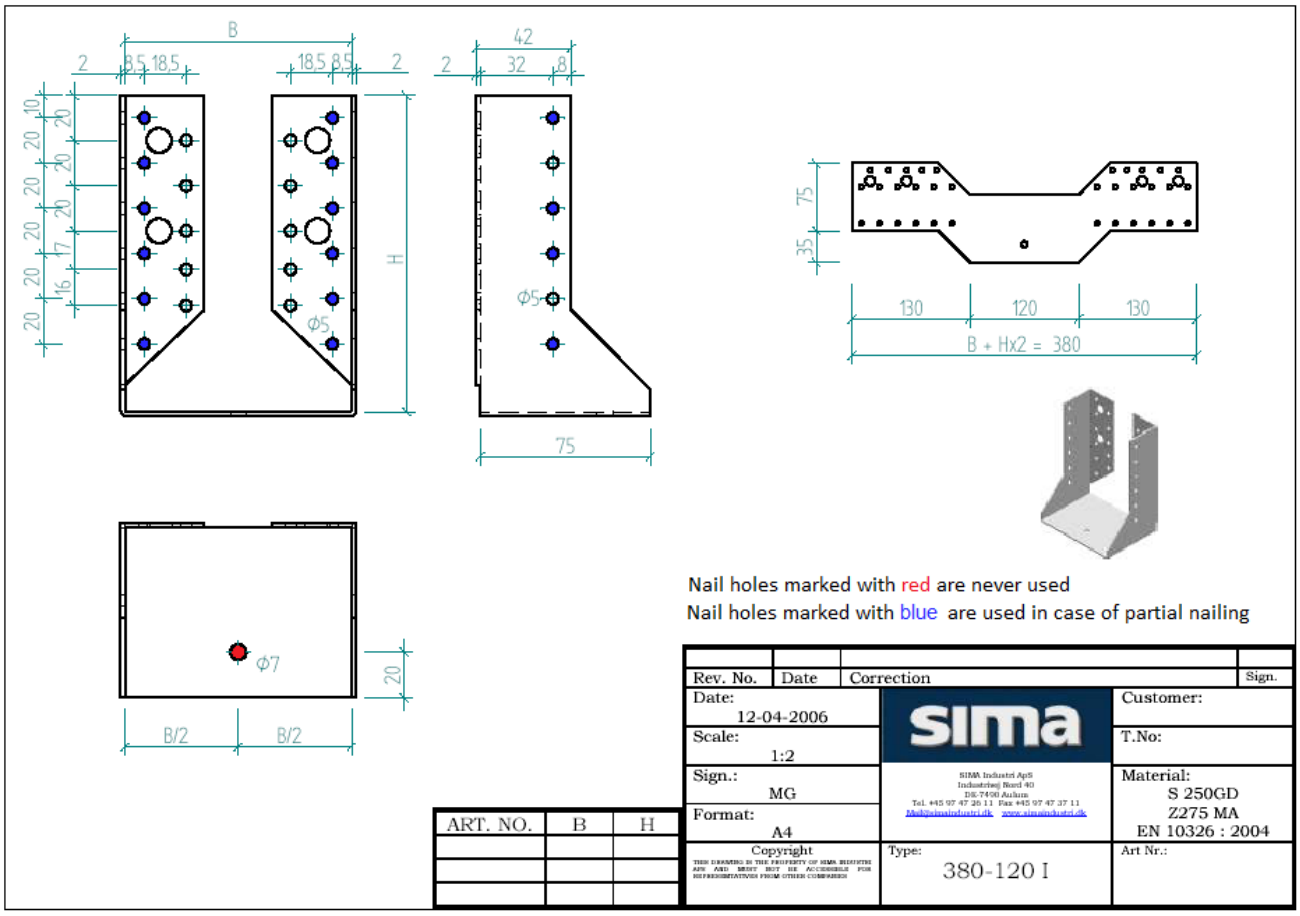
Type: 380-90 I
Art Nr.:

380-120 U/I

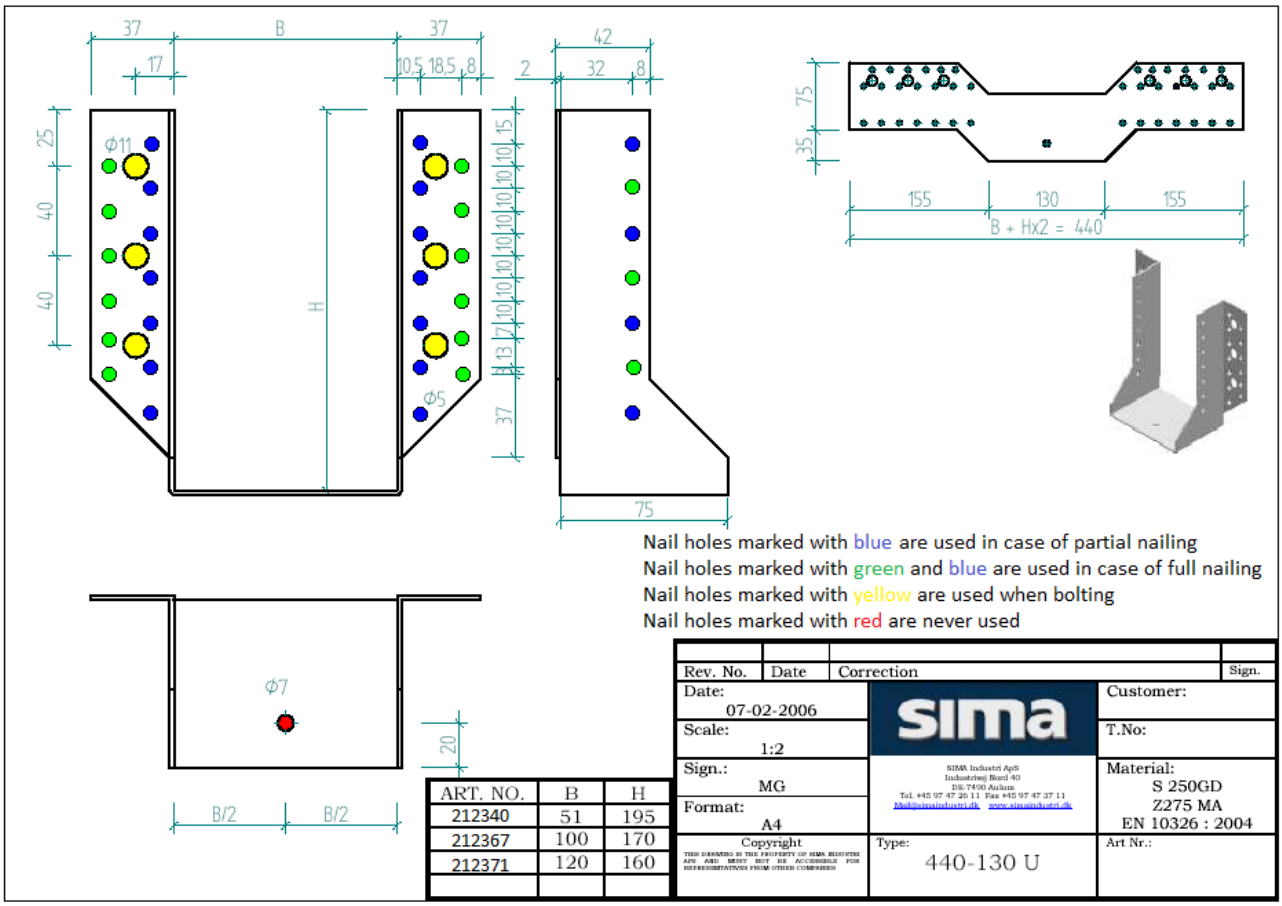


ART. NO.	B	H
212366	100	140

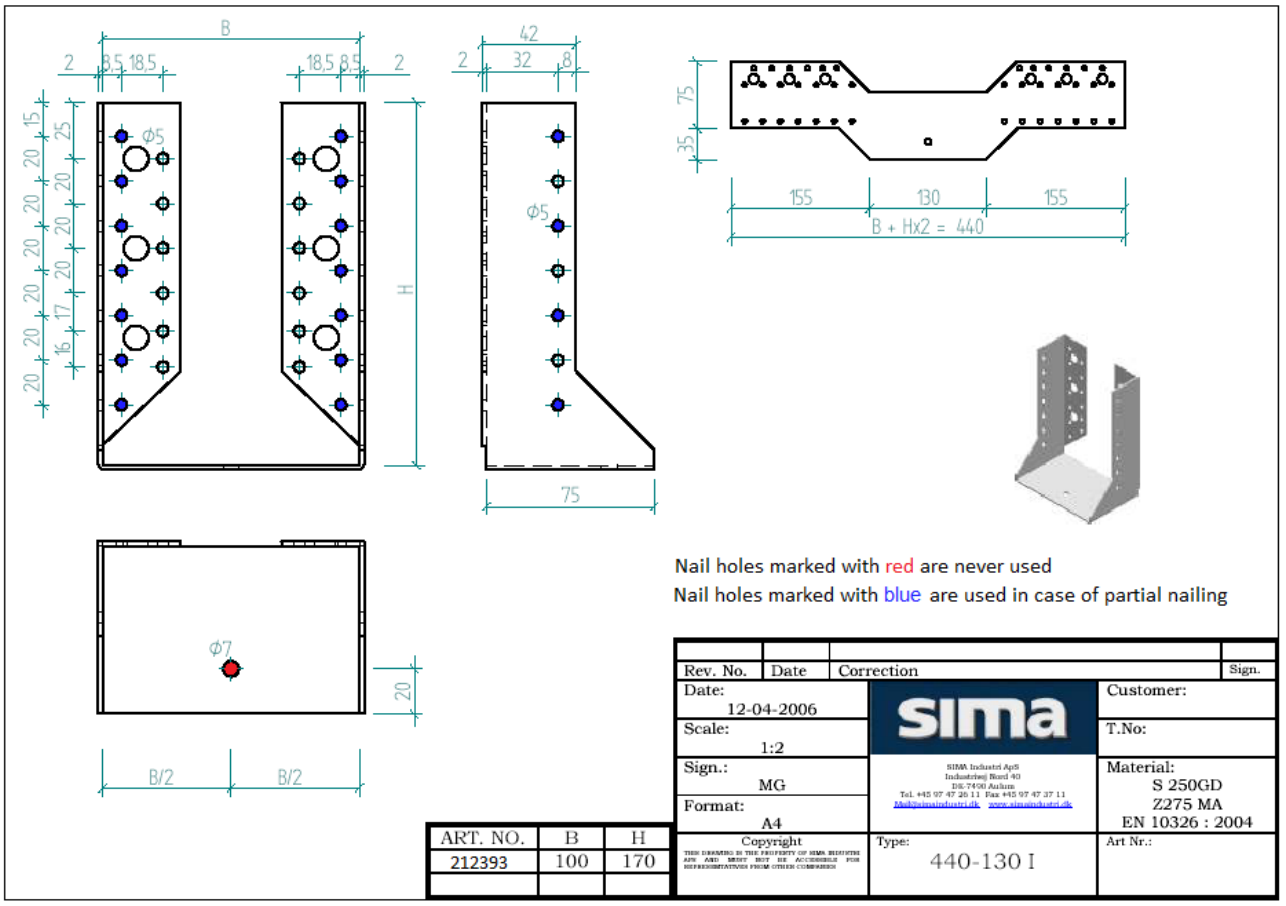


ART. NO.	B	H

440-130 U/I

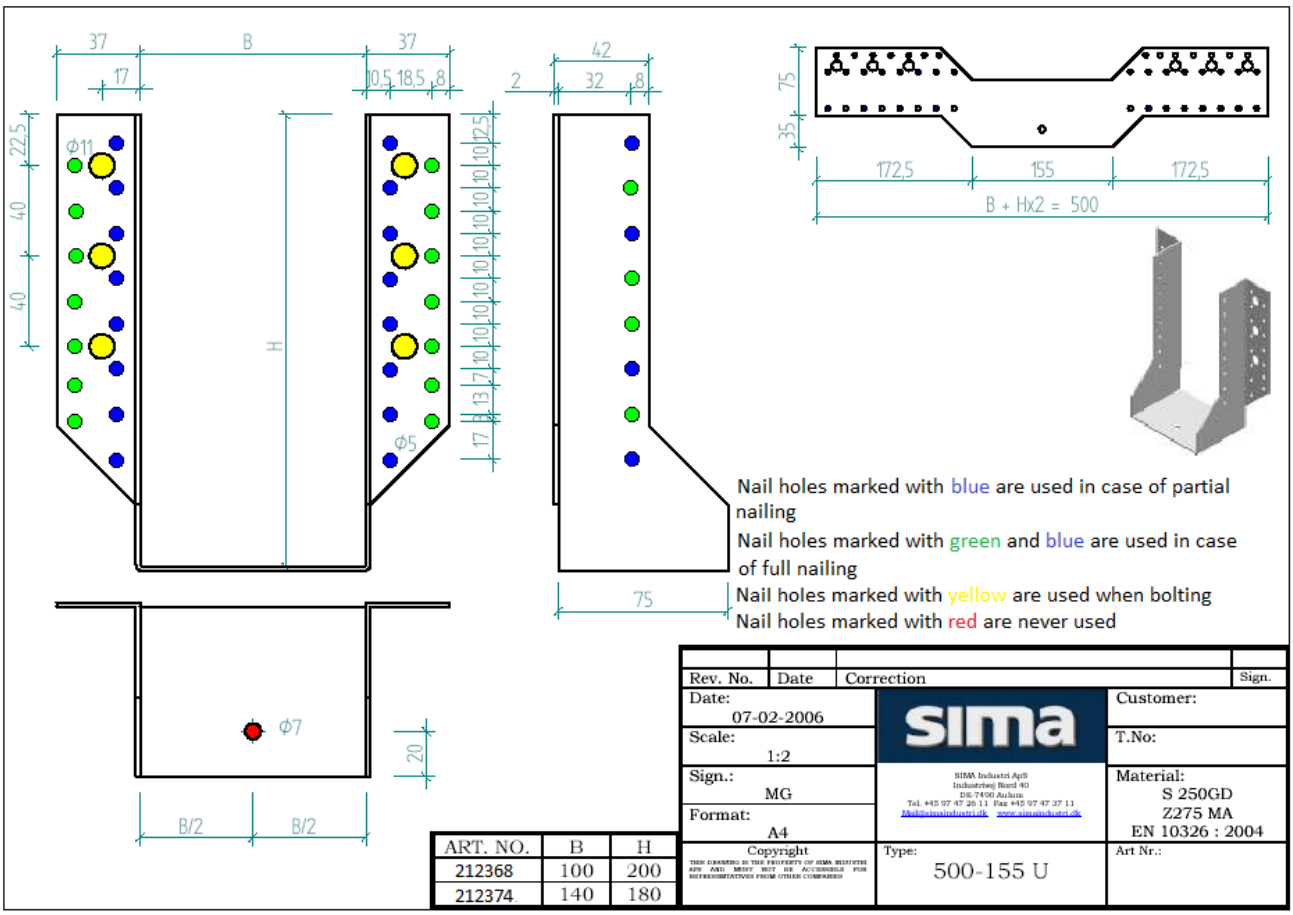


ART. NO.	B	H
212340	51	195
212367	100	170
212371	120	160



ART. NO.	B	H
212393	100	170

500-155 U/I



ART. NO.	B	H
212368	100	200
212374	140	180

Rev. No.	Date	Correction	Sign.

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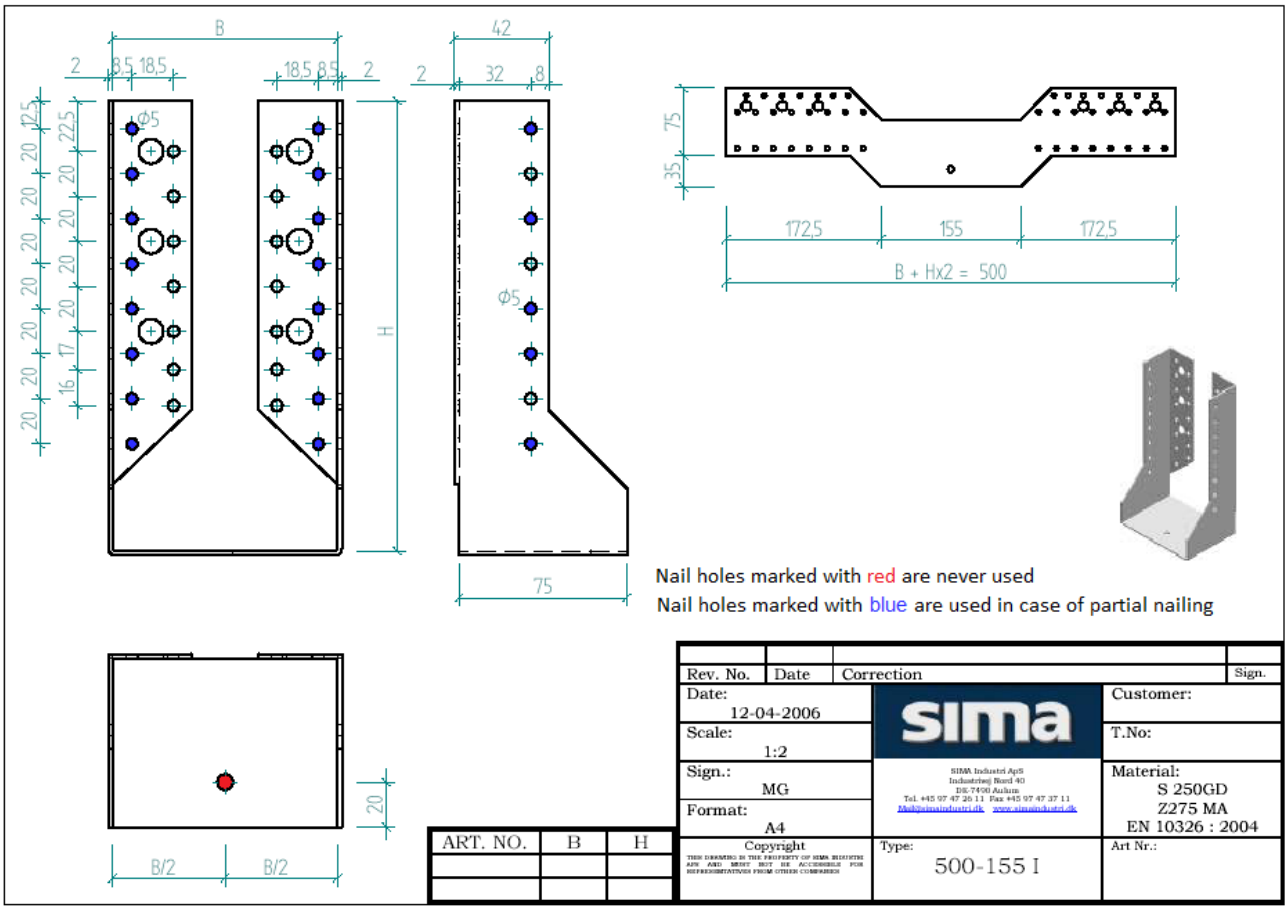

ART. NO.	B	H

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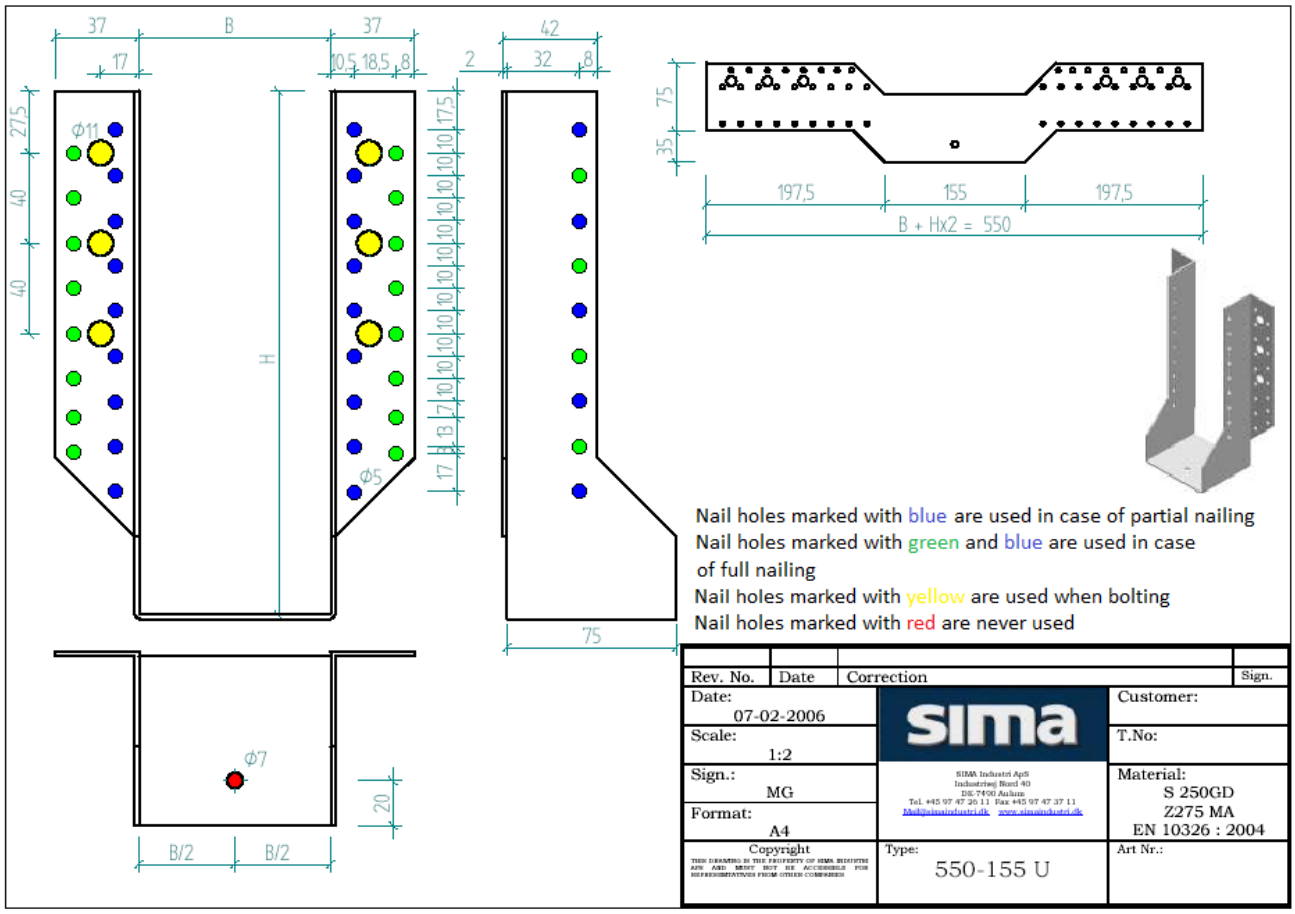
550-155 U/I


37
B
37
17
10,5
18,5
8
42
2
32
8
275
40
40
Φ11
H
Φ5
175
10
10
10
10
10
10
10
10
10
7
13
8
17
75
35
197,5
155
197,5
B + Hx2 = 550
Φ7
20
B/2
B/2
75
Nail holes marked with blue are used in case of partial nailing
Nail holes marked with green and blue are used in case of full nailing
Nail holes marked with yellow are used when bolting
Nail holes marked with red are never used
Rev. No.
Date
Correction
Sign.
Date:
07-02-2006
Scale:
1:2
Sign.:
MG
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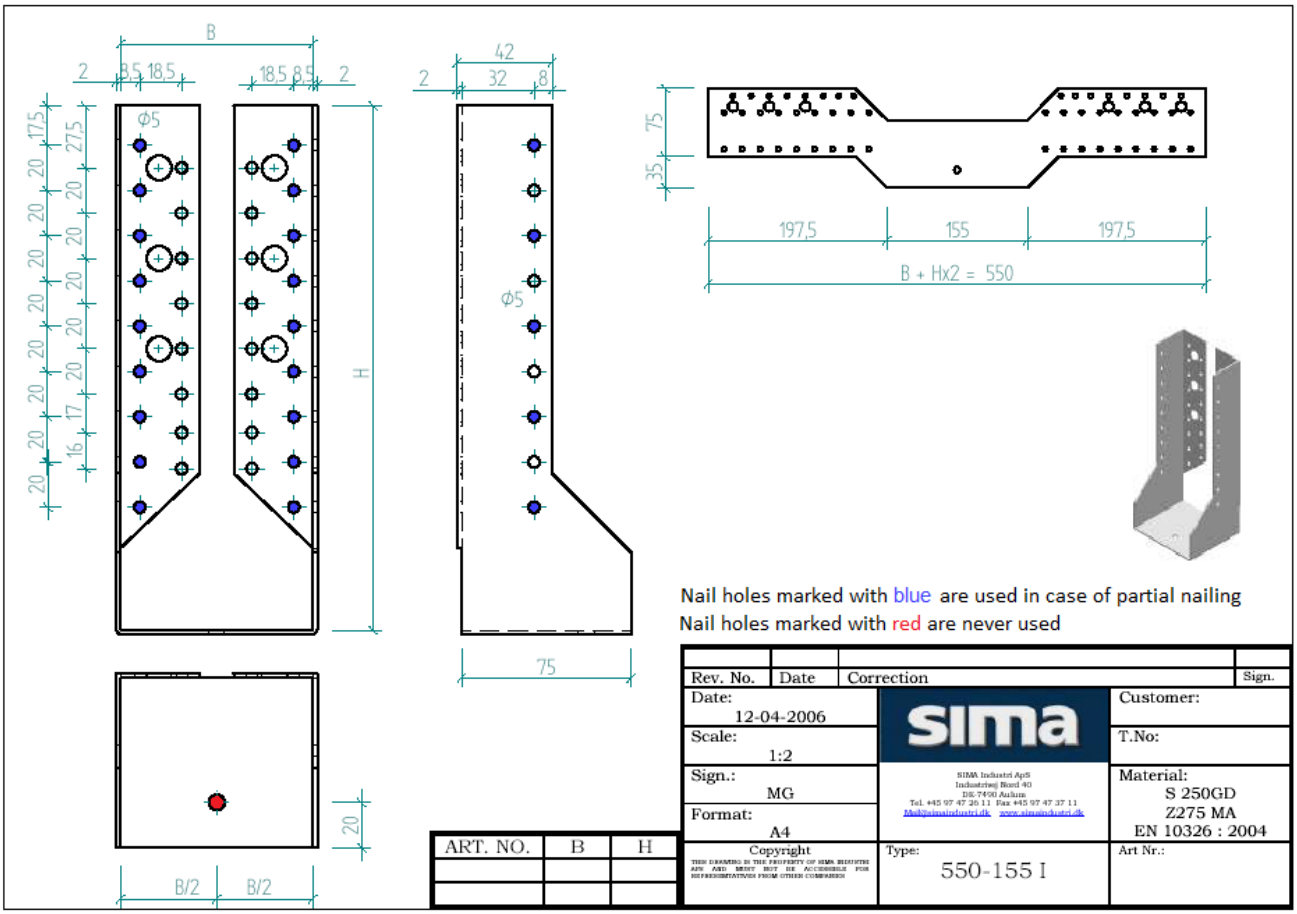
Z275 MA
EN 10326 : 2004
Type:
550-155 U
Art Nr.:


B
2
18,5
18,5
2
42
2
32
8
Φ5
175
275
20
H
16
75
35
197,5
155
197,5
B + Hx2 = 550
20
B/2
B/2
75
Nail holes marked with blue are used in case of partial nailing
Nail holes marked with red are never used
ART. NO.
B
H
Rev. No.
Date
Correction
Sign.
Date:
12-04-2006
Scale:
1:2
Sign.:
MG
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Z275 MA
EN 10326 : 2004
Type:
550-155 I
Art Nr.:

Characteristic capacities of the joist hanger connections with nails.

The downward and the upward directed forces are assumed to act in the middle of the joist.

Two nails patterns are specified. A full nailing pattern, where there are nails in all the holes. 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 in the header shall be put in the holes closest to the bend line.

The width of the joist shall be at least the penetration length of the nails, 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.

A.1 Joist hangers with outward and inward flaps and fastened with nails

Force downward toward the bottom plate:

$$R_{Down,k} = \min\left\{n_{J,ef,1} \cdot R_{lat,J,k}; n_H \cdot R_{lat,H,k}\right\}$$

Force upward away from the bottom plate:

$$R_{Up,k} = \min\left\{n_{J,ef,2} \cdot R_{lat,J,k}; n_H \cdot R_{lat,H,k}\right\}$$

where the following symbols are:

$n_{J,ef,1}$ effective number of nails in the side of the joist

$n_{J,ef,2}$ effective number of nails in the side of the joist

n_H total number of nails in the side of the header

$R_{lat,k}$ characteristic lateral load-carrying capacity of the nails in the joist or in the header indicated by the indices J or H

$R_{ax,k}$ characteristic axial load-carrying capacity of the nails in the joist or in the header indicated by the indices J or H

A.2 Characteristic 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 Transfer of force from the joist to the joist hanger is as for a wood-wood connection, se clause A.1.
- The bolts shall always be positioned symmetrically about the vertical axis of the joist hanger.
- Washers, 30x30x3 mm shall be installed 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 or screws.

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

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

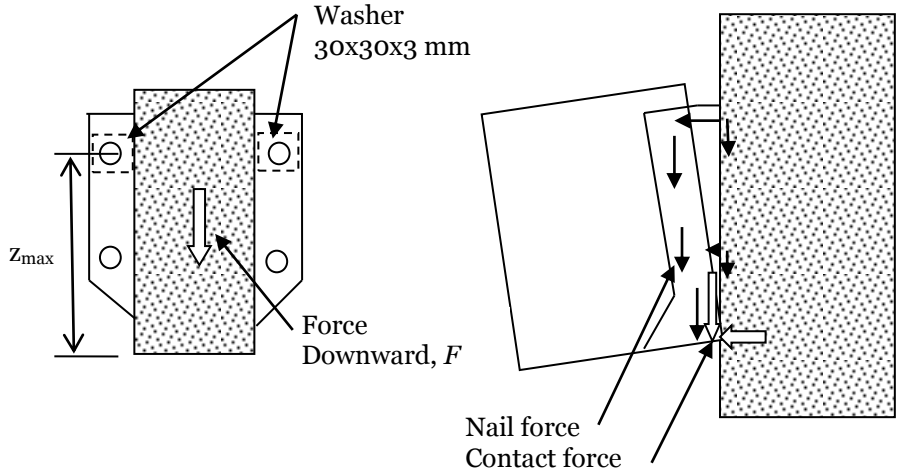

Figure B2 Left: Cross section in joist. Right: The joist will deflect and rotate, at the bottom a contact force will occur at the bottom plate, and the withdrawal forces in the bolts in the wall will vary linearly as assumed for nailed connections in the header.

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

$$F_{ax,bolt} = \frac{F \cdot e}{2 \cdot z_{max}} \qquad \text{(A.2.1)}$$

where

F downward directed force toward the bottom plate

e 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*.

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

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 or screwed to a wooden header.

$$R_{nail,k} = (n_J + 2) \cdot R_{lat,J,k} \qquad \text{(A.2.3)}$$

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

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

where

F downward directed force toward the bottom plate

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

e 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.

$$R_{bear,k} = n_{bolt} f_{u,k} dt \qquad \text{(A.2.4)}$$

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 connections is the minimum of:

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

Annex C.1

Characteristic capacities of the downward force F_{down}

For inwards beam shoes widths that are smaller than 80mm only the blue nail holes can be used. The load carrying values have only been assessed in accordance with EC 5 Table 3.1- "Values of K_{mod}"

Beam shoe 220-65 U PL

Paslode Connector nails 4,0 x 40 pr connection or Spit Tapcon 8x70/5 , F_{down}, [kN]				
Load Duration	8 nails Holes: Blue	14 nails Holes: Green + Blue	2 nails + 2 bolts Holes: Blue + Yellow	4 nails + 2 bolts Holes: Green + Blue + Yellow
P	5,11	7,58	5,29	7,93
L	5,96	8,84	6,17	9,25
M	6,81	10,10	7,05	10,57
S	7,66	11,37	7,93	11,89
I	9,36	13,89	9,69	14,53
Characteristic values found by calculation	8,51	12,63	8,81	13,21

Beam shoe 290-65 U PL

Paslode Connector nails 4,0 x 40 pr connection or Spit Tapcon 8x70/5, F_{down}, [kN]				
Load Duration	12 nails Holes: Blue	23 nails Holes: Green + Blue	4 nails + 2 bolts Holes: Blue + Yellow	7 nails + 4 bolts Holes: Green + Blue + Yellow
P	7,93	11,89	7,93	11,89
L	9,25	13,87	9,25	13,87
M	10,57	15,86	10,57	15,86
S	11,89	17,84	11,89	17,84
I	14,53	21,80	14,53	21,80
Characteristic values found by calculation	13,21	19,82	13,21	19,82

Beam shoe 380-65 U PL

Paslode Connector nails 4,0 x 40 pr connection or Spit Tapcon 8x70/5, F_{down}, [kN]				
Load Duration	20 nails Holes: Blue	37 nails Holes: Green + Blue	6 nails + 2 bolts Holes: Blue + Yellow	11 nails + 6 bolts Holes: Green + Blue + Yellow
P	10,57	17,17	10,57	17,17
L	12,33	20,03	12,33	20,03
M	14,09	22,90	14,09	22,90
S	15,85	25,76	15,85	25,76
I	19,37	31,48	19,37	31,48
Characteristic values found by calculation	17,61	28,62	17,61	28,62

Beam shoe 230-65 U/I and 240-65 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{down}, [kN]				
Load Duration	10 nails Holes: Blue	18 nails Holes: Green + Blue	4 nails + 2 bolts Holes: Blue + Yellow	6 nails + 2 bolts Holes: Green + Blue + Yellow
P	6,79	6,79	9,85	10,27
L	7,92	7,92	11,49	11,98
M	9,05	9,05	13,13	13,69
S	10,18	10,18	14,77	15,40
I	12,44	12,44	18,05	18,82
Characteristic values found by calculation	11,31	11,31	16,41	17,11

Beam shoe 250-65 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{down}, [kN]				
Load Duration	12 nails Holes: Blue	22 nails Holes: Green + Blue	4 nails + 2 bolts Holes: Blue + Yellow	8 nails + 2 bolts Holes: Green + Blue + Yellow
P	9,05	9,05	9,85	13,20
L	10,56	10,56	11,49	15,40
M	12,06	12,06	13,13	17,60
S	13,57	13,57	14,77	19,80
I	16,59	16,59	18,05	24,20
Characteristic values found by calculation	15,08	15,08	16,41	22,00

Beam Shoe 260-65 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{down}, [kN]				
Load Duration	12 nails Holes: Blue	22 nails Holes: Green + Blue	4 nails + 2 bolts Holes: Blue + Yellow	8 nails + 2 bolts Holes: Green + Blue + Yellow
P	9,05	9,05	9,85	14,37
L	10,56	10,56	11,49	16,77
M	12,06	12,06	13,13	19,16
S	13,57	13,57	14,77	21,56
I	16,59	16,59	18,05	26,35
Characteristic values found by calculation	15,08	15,08	16,41	23,95

Beam Shoe 320-90 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{down}, [kN]				
Load Duration	16 nails Holes: Blue	28 nails Holes: Green + Blue	6 nails + 4 bolts Holes: Blue + Yellow	10 nails + 4 bolts Holes: Green + Blue + Yellow
P	11,31	11,31	9,94	11,74
L	13,20	13,20	11,59	13,69
M	15,08	15,08	13,25	15,65
S	16,97	16,97	14,90	17,60
I	20,74	20,74	18,22	21,52
Characteristic values found by calculation	18,85	18,85	16,56	19,56

Beam Shoe 380-90 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{down}, [kN]				
Load Duration	20 nails Holes: Blue	36 nails Holes: Green + Blue	8 nails + 4 bolts Holes: Blue + Yellow	12 nails + 4 bolts Holes: Green + Blue + Yellow
P	12,11	13,57	12,11	18,89
L	14,13	15,83	14,13	22,04
M	16,14	18,10	16,14	25,19
S	18,16	20,36	18,16	28,34
I	22,20	24,88	22,20	34,64
Characteristic values found by calculation	20,18	22,62	20,18	31,49

Beam Shoe 380-120 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{down}, [kN]				
Load Duration	20 nails Holes: Blue	36 nails Holes: Green + Blue	8 nails + 4 bolts Holes: Blue + Yellow	12 nails + 4 bolts Holes: Green + Blue + Yellow
P	12,11	13,57	16,63	18,89
L	14,13	15,83	19,40	22,04
M	16,14	18,10	22,18	25,19
S	18,16	20,36	24,95	28,34
I	22,20	24,88	30,49	34,64
Characteristic values found by calculation	20,18	22,62	27,72	31,49

Beam Shoe 440-130 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{down}, [kN]				
Load Duration	22 nails Holes: Blue	40 nails Holes: Green + Blue	8 nails + 6 bolts Holes: Blue + Yellow	14 nails + 6 bolts Holes: Green + Blue + Yellow
P	14,37	15,83	14,37	21,16
L	16,77	18,47	16,77	24,68e
M	19,16	21,11	19,16	28,21
S	21,56	23,75	21,56	31,73
I	26,35	29,03	26,35	38,79
Characteristic values found by calculation	23,95	26,39	23,95	35,26

Beam Shoe 500-155 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{down}, [kN]				
Load Duration	26 nails Holes: Blue	46 nails Holes: Green + Blue	10 nails + 6 bolts Holes: Blue + Yellow	16 nails + 6 bolts Holes: Green + Blue + Yellow
P	14,37	18,10	14,38	23,42
L	16,77	21,11	16,77	27,32
M	19,16	24,13	19,17	31,22
S	21,56	27,14	21,56	35,13
I	26,35	33,18	26,36	42,93
Characteristic values found by calculation	23,95	30,16	23,96	39,03

Beam Shoe 550-155 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{down}, [kN]				
Load Duration	28 nails Holes: Blue	52 nails Holes: Green + Blue	10 nails + 6 bolts Holes: Blue + Yellow	18 nails + 6 bolts Holes: Green + Blue + Yellow
P	16,63	20,36	16,63	25,68
L	19,40	23,75	19,40	29,96
M	22,18	27,14	22,18	34,24
S	24,95	30,54	24,95	38,52
I	30,49	37,32	30,49	47,08
Characteristic values found by calculation	27,72	33,93	27,72	42,80

Annex C.2

Characteristic capacities of the upward force F_{up} for beam shoes with outward (U) or inwards (I) flaps
For beam shoes widths (B) smaller than 80mm only partial nailing can be used. The load carrying values have only been assessed in accordance with EC 5 Table 3.1- "Values of K_{mod}"

Beam shoe 220-65 U PL

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	8 nails Holes: Blue	14 nails Holes: Green + Blue	2 nails + 2 bolts Holes: Blue + Yellow	4 nails + 2 bolts Holes: Green + Blue + Yellow
P	2,64	5,20	2,64	5,29
L	3,08	6,07	3,08	6,17
M	3,52	6,94	3,52	7,05
S	3,96	7,80	3,96	7,93
I	4,84	9,54	4,84	9,69
Characteristic values found by calculation	4,40	8,67	4,40	8,81

Beam shoe 290-65 U PL

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	12 nails Holes: Blue	23 nails Holes: Green + Blue	4 nails + 2 bolts Holes: Blue + Yellow	7 nails + 4 bolts Holes: Green + Blue + Yellow
P	5,29	6,15	5,29	6,15
L	6,17	7,18	6,17	7,18
M	7,05	8,20	7,05	8,20
S	7,93	9,23	7,93	9,23
I	9,69	11,28	9,69	11,28
Characteristic values found by calculation	8,81	10,25	8,81	10,25

Beam shoe 380-65 U PL

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	19 nails Holes: Blue	37 nails Holes: Green + Blue	6 nails + 2 bolts Holes: Blue + Yellow	11 nails + 6 bolts Holes: Green + Blue + Yellow
P	7,93	10,76	7,93	10,76
L	9,25	12,56	9,25	12,56
M	10,57	14,35	10,57	14,35
S	11,89	16,15	11,89	16,15
I	14,53	19,73	14,53	19,73
Characteristic values found by calculation	13,21	17,94	13,21	17,94

Beam shoe 230-65 or 240-65 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	10 nails Holes: Blue	18 nails Holes: Green + Blue	4 nails + 2 bolts Holes: Blue + Yellow	6 nails + 2 bolts Holes: Green + Blue + Yellow
P	1,38	2,77	1,38	2,77
L	1,61	3,23	1,61	3,23
M	1,84	3,69	1,84	3,69
S	2,07	4,15	2,07	4,15
I	2,53	5,07	2,53	5,07
Characteristic values found by calculation	2,30	4,61	2,30	4,61

Beam shoe 250-65 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	12 nails Holes: Blue	22 nails Holes: Green + Blue	4 nails + 2 bolts Holes: Blue + Yellow	8 nails + 2 bolts Holes: Green + Blue + Yellow
P	2,77	4,15	2,77	4,15
L	3,23	4,84	3,23	4,84
M	3,69	5,53	3,69	5,53
S	4,15	6,22	4,15	6,22
I	5,07	7,60	5,07	7,60
Characteristic values found by calculation	4,61	6,91	4,61	6,91

Beam Shoe 260-65 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	12 nails Holes: Blue	22 nails Holes: Green + Blue	4 nails + 2 bolts Holes: Blue + Yellow	8 nails + 2 bolts Holes: Green + Blue + Yellow
P	2,77	4,15	2,77	4,15
L	3,23	4,84	3,23	4,84
M	3,69	5,53	3,69	5,53
S	4,15	6,22	4,15	6,22
I	5,07	7,60	5,07	7,60
Characteristic values found by calculation	4,61	6,91	4,61	6,91

Beam Shoe 320-90 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	16 nails Holes: Blue	28 nails Holes: Green + Blue	6 nails + 4 bolts Holes: Blue + Yellow	10 nails + 4 bolts Holes: Green + Blue + Yellow
P	2,77	5,52	2,77	5,52
L	3,23	6,44	3,23	6,44
M	3,69	7,36	3,69	7,36
S	4,15	8,28	4,15	8,28
I	5,07	10,12	5,07	10,12
Characteristic values found by calculation	4,61	9,20	4,61	9,20

Beam Shoe 380-90 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	20 nails Holes: Blue	36 nails Holes: Green + Blue	8 nails + 4 bolts Holes: Blue + Yellow	12 nails + 4 bolts Holes: Green + Blue + Yellow
P	4,15	6,91	4,15	6,91
L	4,84	8,06	4,84	8,06
M	5,53	9,22	5,53	9,22
S	6,22	10,37	6,22	10,37
I	7,60	12,67	7,60	12,67
Characteristic values found by calculation	6,91	11,52	6,91	11,52

Beam Shoe 380-120 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	20 nails Holes: Blue	36 nails Holes: Green + Blue	8 nails + 4 bolts Holes: Blue + Yellow	12 nails + 4 bolts Holes: Green + Blue + Yellow
P	4,15	6,91	4,15	6,91
L	4,84	8,06	4,84	8,06
M	5,53	9,22	5,53	9,22
S	6,22	10,37	6,22	10,37
I	7,60	12,67	7,60	12,67
Characteristic values found by calculation	6,91	11,52	6,91	11,52

Beam Shoe 440-130 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	22 nails Holes: Blue	40 nails Holes: Green + Blue	8 nails + 6 bolts Holes: Blue + Yellow	14 nails + 6 bolts Holes: Green + Blue + Yellow
P	4,15	8,29	4,15	8,29
L	4,84	9,67	4,84	9,67
M	5,53	11,06	5,53	11,06
S	6,22	12,44	6,22	12,44
I	7,60	15,20	7,60	15,20
Characteristic values found by calculation	6,91	13,82	6,91	13,82

Beam Shoe 500-155 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	26 nails Holes: Blue	46 nails Holes: Green + Blue	10 nails + 6 bolts Holes: Blue + Yellow	16 nails + 6 bolts Holes: Green + Blue + Yellow
P	5,52	9,67	5,52	9,67
L	6,44	11,28	6,44	11,28
M	7,36	12,90	7,36	12,90
S	8,28	14,51	8,28	14,51
I	10,12	17,73	10,12	17,73
Characteristic values found by calculation	9,20	16,12	9,20	16,12

Beam Shoe 550-155 U/I

Paslode Connector nails 4,0 x 40 pr connection or bolts, F_{up}, [kN]				
Load Duration	28 nails Holes: Blue	52 nails Holes: Green + Blue	10 nails + 6 bolts Holes: Blue + Yellow	18 nails + 6 bolts Holes: Green + Blue + Yellow
P	6,91	12,43	6,91	12,43
L	8,06	14,50	8,06	14,50
M	9,22	16,58	9,22	16,58
S	10,37	18,65	10,37	18,65
I	12,67	22,79	12,67	22,79
Characteristic values found by calculation	11,52	20,72	11,52	20,72