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Anstalt des öffentlichen Rechts

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

DIBt

Mitglied der EOTA
Member of EOTA

European Technical Approval ETA-10/0302

English translation prepared by DIBt - Original version in German language

Handelsbezeichnung *Trade name*	BiLO-Winkel
Zulassungsinhaber *Holder of approval*	BiERBACH® GmbH & Co. KG Befestigungstechnik Industriegebiet West Rudolf-Diesel-Straße 59425 Unna DEUTSCHLAND
Zulassungsgegenstand und Verwendungszweck *Generic type and use of construction product*	Blechformteile (Winkel für Holz-Holz-Verbindungen) *Three-dimensional nailing plates (Angle brackets for timber to timber connections)*
Geltungsdauer: vom *Validity: from* bis *to*	16 September 2010 16 September 2015
Herstellwerk *Manufacturing plant*	BiERBACH® GmbH & Co. KG Befestigungstechnik Industriegebiet West Rudolf-Diesel-Straße 59425 Unna DEUTSCHLAND

Diese Zulassung umfasst *This Approval contains*	17 Seiten einschließlich 2 Anhänge *17 pages including 2 annexes*

I LEGAL BASES AND GENERAL CONDITIONS

1 This European technical approval is issued by Deutsches Institut für Bautechnik 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], modified by Council Directive 93/68/EEC[2] and Regulation (EC) N° 1882/2003 of the European Parliament and of the Council[3];
- Gesetz über das In-Verkehr-Bringen von und den freien Warenverkehr mit Bauprodukten zur Umsetzung der Richtlinie 89/106/EWG des Rates vom 21. Dezember 1988 zur Angleichung der Rechts- und Verwaltungsvorschriften der Mitgliedstaaten über Bauprodukte und anderer Rechtsakte der Europäischen Gemeinschaften (Bauproduktengesetz - BauPG) vom 28. April 1998[4], as amended by law of 31 October 2006[5];
- Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC[6];
- Guideline for European technical approval of "Three-dimensional nailing plates", ETAG 015.

2 Deutsches Institut für Bautechnik 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 Deutsches Institut für Bautechnik, in particular pursuant to information by the Commission according to Article 5(1) of Council Directive 89/106/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 Deutsches Institut für Bautechnik. 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 The European technical approval is issued by the approval body in its official language. 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 L 40, 11 February 1989, p. 12
2 Official Journal of the European Communities L 220, 30 August 1993, p. 1
3 Official Journal of the European Union L 284, 31 October 2003, p. 25
4 *Bundesgesetzblatt Teil I 1998*, p. 812
5 *Bundesgesetzblatt Teil I 2006*, p. 2407, 2416
6 Official Journal of the European Communities L 17, 20 January 1994, p. 34

II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1 Definition of the product and of the intended use

1.1 Definition of the construction product

BiLO-Winkel are one-piece non-welded timber connectors which are fastened to timber members with nails. They are made by cold forming from galvanized steel sheet or stainless steel.

The brackets are made from galvanized steel sheet S250GD+Z275 according to EN 10346:2009 or from stainless steel 1.4301, 1.4303, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005. The brackets Type 70, 90 and 100 are available with rib or without rib.

Design, dimensions, hole positions, steel grade and a typical installation are given in Annex A and in Annex B. Brackets are produced from steel sheets with dimensions according to the standard EN 10143:2006.

1.2 Intended use

The brackets are used for load-carrying timber to timber connections in timber constructions, where the requirements "Mechanical resistance and stability" within the meaning of the Essential Requirement 1 of Council Directive 89/106/EEC has to be fulfilled. The brackets may also be used for connections between a timber member and a member of concrete or steel.

The connection is manufactured with one or two brackets (see Annex B).

The structural behaviour of the construction elements and the support conditions shall correspond to the indications given in Annex B. The brackets may only be used in service classes 1 and 2 according to Eurocode 5 and for connections exposed to predominantly quasi static loads.

The brackets can also be used in timber structures, service class 3 when stainless steel with equal or higher yield strength and tensile strength is employed compared to steel sheet S250GD+Z275 according to EN 10346:2009.

The timber members can be of solid timber, glued laminated timber or wood-based material. Requirements applicable to the timber construction elements are fulfilled by timber or wood-based material with a characteristic density between 290 kg/m³ and 420 kg/m³. The following softwood materials are suitable for connections with *BiLO-Winkel*.

- Solid timber of softwood according to EN 338-2003 / EN 14081-1:2005,
- Glued laminated timber according to EN 1194:1999 / EN 14080:2005,
- Glued laminated solid timber Duo- and Triobalken,
- Solid wood panels SWP according to EN 13353:2008 / EN 13986:2004,
- Laminated veneer lumber LVL according to EN 14374:2004, connection only perpendicular to the plane of the veneers,
- Plywood according to EN 636:2003 / EN 13986:2004,
- Parallel strand lumber Parallam PSL, connection only perpendicular to the plane of the veneers,
- Laminated strand lumber Intrallam LSL, connection only perpendicular to the plane of the veneers.

Annex B includes characteristic values of the load-carrying capacity for connections with brackets for a characteristic density of 350 kg/m³. For timber and wood-based materials with a characteristic density lower than 350 kg/m³ the characteristic values of the load-carrying capacity shall be reduced by the factor k_{dens}:

$$k_{dens} = \left(\frac{\rho_k}{350} \right)^2$$

Where ρ_k is the characteristic timber density in kg/m³.

The design of the connections shall be carried out according to national provisions that apply at the installation site of the certified object in line with the partial safety factor format, e.g. in accordance with Eurocode 5.

The provisions made in this European technical approval are based on an assumed working life of the brackets of 50 years, provided that the brackets are subject to appropriate use and maintenance. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded as a means for choosing the right products in relation to the expected economically reasonable working life of the construction.

2 Characteristics of product and methods of verification

2.1 Characteristics

ETAG para-graph	Characteristic	Assessment of characteristic
6.1	**Mechanical resistance and stability*)**	
6.1.1	Load-carrying capacities	See Annex B
6.1.2	Stiffness	No performance determined
6.1.3	Ductility in cyclic testing	No performance determined
6.2	**Safety in case of fire**	
	Reaction to fire	Brackets are made from steel classified as **Euroclass A1** in accordance with EC decision 96/603/EC, amended by EC Decision 2000/605/EC.
	Resistance to fire	Performance in relation to fire resistance would be determined for the complete structural element with any associated finishes, however not for a single connector. Therefore there is no performance determined to this Essential Requirement.
6.3	**Hygiene, health and the environment**	
6.3.1	Release of dangerous substances	No dangerous substances**)
6.4	**Safety in use**	Not relevant
6.5	**Protection against noise**	Not relevant
6.6	**Energy economy and heat retention**	Not relevant
6.7	**Related aspects of serviceability***)**	
6.7.1	Durability	Brackets have been assessed as having satisfactory durability and serviceability provided they are used in timber structures using the timber species described in Eurocode 5 and are subject to the conditions defined by service classes 1 and 2.
6.7.2	Serviceability	
6.7.3	Identification	See Annex A

*) See section 2.2 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.

***) See section 2.3 of this ETA

2.2 Mechanical resistance and stability

The characteristic load-carrying capacities of a connection with *BiLO-Winkel* are based on the characteristic values of the nail connection and the steel sheet. To calculate the design values, the characteristic load-carrying capacities given in Annex B have to be divided by partial safety factors for the material property and multiplied by the coefficient k_{mod} for the nail connection and the timber component with regard to the load duration and the service class defined in Eurocode 5.

According to the standard EN 1990:2002 (Eurocode - Basis of design) paragraph 6.3.5 the design value of load-carrying capacity can be determined by reducing the characteristic values of the load-carrying capacity with different partial safety factors.

Thus, the characteristic values of the load-carrying capacity were determined for the failure of timber or wood-based material $F_{Rk,H}$ (obtaining the embedment strength of nails subjected to shear or the withdrawal capacity of the most loaded nail, respectively) as well as for the steel sheet failure $F_{Rk,S}$. The design value of the load-carrying capacity F_{Rd} is the smaller value of:

$$F_{Rd} = \min\left\{\frac{k_{mod} \cdot F_{Rk,H}}{\gamma_{M,H}}; \frac{F_{Rk,S}}{\gamma_{M,S}}\right\}$$

Therefore, for timber or wood-based material failure the load duration class and the service class are taken into account. The various partial safety factors γ_M for steel and timber or wood-based material, respectively, are also taken into account.

Annex B states characteristic values of the load-carrying capacity for the direction of the load F_1 to F_5. The characteristic values of the load-carrying capacity of the angle brackets are determined by calculation according to the guideline ETAG 015. They are used for the design according to national provisions that apply at the installation site in line with the partial safety factor format, e.g. in accordance with Eurocode 5.

For ductility of a connection under cyclic load no performance was determined. Therefore, the contribution of the connections as to the structural behaviour under seismic load is not being assessed. For the stiffness of a connection in order to verify the limit state of serviceability no performance was determined.

2.3 Aspects of serviceability

2.3.1 Corrosion protection

In line with ETAG 015, the brackets are made of zinc-coated steel grade S250GD+Z275 in accordance with EN 10346 in service classes 1 and 2 or from stainless steel 1.4301, 1.4303, 1.4401, 1.4541 or 1.4571 according to EN 10088-2:2005 in service class 3.

2.3.2 In relation to the required corrosion protection for the nails to be used with the brackets national provisions that apply at the installation site of the certified object shall be considered e.g. Eurocode 5. In accordance with Eurocode 5 - Table 4.1 - the nails to be used may be of uncoated steel for service class 1 and require corrosion protection Fe/Zn 12c or Z275 for service class 2. Nails to be used in service class 3 are made of the same stainless steel like the angle brackets.

2.3.3 If preservative treatment of timber is used, national regulations apply.

3 Evaluation and attestation of conformity and CE marking

3.1 System of attestation of conformity

According to the Decision 97/638/EC of the European Commission[7] system 2+ of the attestation of conformity applies.

This system of attestation of conformity is defined as follows:

System 2+: Declaration of conformity of the product by the manufacturer on the basis of:

a) Tasks for the manufacturer:
   (1) initial type-testing of the product;
   (2) factory production control;
   (3) testing of samples taken at the factory in accordance with a prescribed test plan.

b) Tasks for the approved body:
   (4) certification of factory production control on the basis of:
      – initial inspection of factory and of factory production control;
      – continuous surveillance, assessment and approval of factory production control.

Note: Approved body are also named "notified body"

3.2 Responsibilities

3.2.1 Tasks of the manufacturer

3.2.1.1 Factory production control

The manufacturer shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures, including records of results performed. This production control system shall insure that the product is in conformity with this European technical approval.

The manufacturer may only use raw materials stated in the technical documentation of this European technical approval.

The factory production control shall be in accordance with the "Control plan relating to the European technical approval ETA-10/0302 issued on 16 September 2010" which is part of the technical documentation of this European technical approval. The control plan is laid down in the context of the factory production control system operated by the manufacturer and deposited with *Deutsches Institut für Bautechnik*[8].

The incoming raw materials shall be subject to controls and tests by the manufacturer before acceptance. Check of materials, such as steel sheet, 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 shall be checked visually and for dimension accuracy. The control plan includes details of the extent, nature and frequency of testing and controls to be performed within the factory production control.

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7 Official Journal of European Communities L 268/36 of 01.10.1997

8 The control plan is a confidential part of the European technical approval and only handed over to the approved body involved in the procedure of attestation of conformity. See section 3.2.2.

The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan. At least the following data shall be recorded:

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

The records shall be presented to the approved body involved in the continuous surveillance and shall be presented to *Deutsches Institut für Bautechnik* on request.

3.2.1.2 Other tasks for the manufacturer

The manufacturer shall, on the basis of a contract, involve a body which is approved for the tasks referred to in section 3.1 in the field of brackets in order to undertake the actions laid down in section 3.2.2. For this purpose, the control plan referred to in sections 3.2.1.1 and 3.2.2 shall be handed over by the manufacturer to the approved body involved.

For initial type-testing the results of the tests performed as part of the assessment for the European technical approval may be used unless there are changes in the production line or plant. In such cases the necessary initial type-testing shall be agreed on between *Deutsches Institut für Bautechnik* and the notified body.

The manufacturer shall make a declaration of conformity, stating that the construction product is in conformity with the provisions of the European technical approval ETA-10/0302 issued on16 September 2010.

3.2.2 Tasks for the approved body

The approved body shall perform the following tasks in accordance with the provisions of the control plan:

- initial inspection of factory and of factory production control and
- continuous surveillance, assessment and approval of factory production control.

3.2.2.1 Initial inspection of factory and factory production control

The approved body shall 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 brackets with this European technical approval.

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 factory production control system and the specified manufacturing processes are maintained in accordance with the control plan.

3.2.2.3 Other tasks of the approved body

The approved body shall retain the essential points of its actions referred to above and state the results obtained and conclusions drawn in a written report.

The results of the continuous surveillance shall be made available on demand by the certification body to *Deutsches Institut für Bautechnik*.

The approved certification body appointed by the manufacturer shall issue an EC certificate of conformity of the factory production control stating the conformity with the provisions of this European technical approval.

In cases where the provisions of the European technical approval and its control plan are no longer fulfilled the certification body shall withdraw the certificate of conformity and inform *Deutsches Institut für Bautechnik* without delay.

3.3 CE marking

The CE marking shall be affixed on each packaging of brackets. The letters "CE" shall be followed by the identification number of the approved certification body, where relevant, and be accompanied by the following additional information:

- the name and address of the producer (legal entity responsible for the manufacture),
- the last two digits of the year in which the CE marking was affixed,
- the number of the EC certificate for the factory production control,
- the number of the European technical approval,
- the number of the guideline for European Technical Approval (ETAG no. 015),
- the name and size of product.

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

4.1 Manufacturing

The brackets shall be manufactured in accordance with the provisions of the 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.

This European technical approval is issued for the product on the basis of agreed data/information, deposited with *Deutsches Institut für Bautechnik*, which identifies the product that has been assessed and judged. Changes to the product or production process, which could result in this deposited data/information being incorrect, should be notified to *Deutsches Institut für Bautechnik* before the changes are introduced. *Deutsches Institut für Bautechnik* will decide whether or not such changes affect the ETA and consequently the validity of the CE marking on the basis of the ETA and if so whether further assessment or alterations to the ETA, shall be necessary.

4.2 Installation

The connection of timber components among themselves or timber members to concrete resp steel members with brackets is considered to be suitable for the intended use, provided:

- Nail arrangement

The nailing pattern is shown in Annex B in Tables 1 to 9 in combination with the product drawings. Nails to be used shall have a diameter which matches the holes of the brackets. The minimum distances between the nails meet Eurocode 5.

- Wane

A wane is not allowed, the brackets shall lay on the entire surface of the timber

-Support and restraint conditions

The construction elements connected by brackets shall be secured against rotation.

- Connection to concrete or steel

The connection of the angle bracket to a concrete or steel member has to be verified. The verification of the connection is not subject of this European technical approval.

- Others

Installation is carried out by qualified personnel under the direction of a supervisor. The qualified personnel is appropriately qualified for this work. The installation is performed in accordance with the manufacturer's technical documentation.

The construction elements shall have a thickness exceeding the penetration depth of the nails in the construction element.

5 Recommendations

5.1 Packaging, transport and storage

BiLO-Winkel are packed in boxes bearing the manufacturer's name, product type, dimensions, quantity, data of manufacture and details of the delivery batch.

In relation to transportation and storage *BiLO-Winkel* should be treated as conventional metallic building products.

5.2 Use, maintenance, repair

The assessment of the fitness for use is based on the assumption that maintenance is not required during the assumed intended working life. Should repair prove necessary, this is normally done by the replacement of the bracket.

Georg Feistel
Head of Department

beglaubigt
Niebur

ANNEX A

Product details and definitions

Table A.1 Materials specification

BiLO-Winkel (Bracket type)	Thickness (mm)	Steel specification	Coating specification
70 without rib	2.5	S250GD	Z275
		1.4301, 1.4303, 1.4401, 1.4541 or 1.4571	-
70 with rib	2.5	S250GD	Z275
		1.4301, 1.4303, 1.4401, 1.4541 or 1.4571	-
90 without rib	2.5	S250GD	Z275
		1.4301, 1.4303, 1.4401, 1.4541 or 1.4571	-
90 with rib	2.5	S250GD	Z275
		1.4301, 1.4303, 1.4401, 1.4541 or 1.4571	-
100 without rib	3.0	S250GD	Z275
		1.4301, 1.4303, 1.4401, 1.4541 or 1.4571	-
100 with rib	3.0	S250GD	Z275
		1.4301, 1.4303, 1.4401, 1.4541 or 1.4571	-

Table A.2 Range of sizes

BiLO-Winkel (Bracket type)	Height (mm)		Length (mm)		Width (mm)	
70 without rib	67	69	67	69	52	54
70 with rib	67	69	67	69	52	54
90 without rib	90	92	90	92	62	64
90 with rib	90	92	90	92	62	64
100 without rib	97	99	97	99	87	89
100 with rib	97	99	97	99	87	89

Nail type	**Nail size (mm)**		**Finish**
According to EN 14592	Diameter	Length	
Threaded nail	4.0	40 Profiled length ≥ 30 mm	Corrosion protection according to national provisions e.g. electroplated zinc or stainless steel
Threaded nail	4.0	60 Profiled length ≥ 50 mm	Corrosion protection according to national provisions e.g. electroplated zinc or sstainless steel

The characteristic value of the withdrawal parameter has to fulfil the requirement:

$f_{ax,k} \geq 50 \times 10^{-6} \times \rho_k^2$ (N/mm^2)

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

Annex B
Characteristic load-carrying capacities

Table 1: Load F_1 Column, 2 angle brackets / connection

Type	Nail no. n_V	Nail no. n_H	$F_{1,Rk}$ [kN] (Column)	
			Timber	Steel
70 without rib	1,2,3	6,7,8,9,10,11,12,13	3.29	1.86
70 with rib	1,2,3	6,7,8,9,10,11,12	2.19	3.45
90 without rib	1,2,3,4	9,10,11,12,13,14,15,16, 17,18,19,20,21	6.07	2.50
90 with rib	1,2,3,4	10,11,12,13,14,15,16,17,18,19	4.10	8.05
100 without rib	1,2,3,4,5,6	11,12,13,14,15,16,17,18,19,20,21,22,23	10.3	4.73
100 with rib	1,2,3,4,5,6	11,12,13,14,15,16,17,18,19,20,21,22	8.22	15.3
Type 70 without rib and 70 with rib are connected with nails ø4.0x40				
Type 90 without rib, 100 without rib, 90 with rib and 100 with rib are connected with nails ø4.0x60				

Table 2: Load F_1, Column, 1 angle bracket / connection

Type	Nail no. n_V	Nail no. n_H	$F_{1,Rk}$ [kN] (Column)	
			Timber	Steel
70 without rib	1,2,3	6,7,8,9,10,11,12,13	1.65	0.93
70 with rib	1,2,3	6,7,8,9,10,11,12	1.10	1.73
90 without rib	1,2,3,4	9,10,11,12,13,14,15,16,17,18,19,20,21	3.03	1.25
90 with rib	1,2,3,4	10,11,12,13,14,15,16,17,18,19	2.05	4.02
100 without rib	1,2,3,4,5,6	11,12,13,14,15,16,17,18,19,20,21,22,23	5.14	2.36
100 with rib	1,2,3,4,5,6	11,12,13,14,15,16,17,18,19,20,21,22	4.11	7.63
Type70 without rib and 70 with rib are connected with nails ø4.0x40				
Type 90 without rib, 100 without rib, 90 with rib and 100 with rib are connected with nails ø4.0x60				

Table 3: Load F_1 Purlin, 2 angle brackets / connection

Type	Nail no. n_V	Nail no. n_H	$F_{1,Rk}$ [kN] (Purlin)	
			Timber	Steel
70 without rib	1,2,3,4,5	6,7,8,9,10,11,12,13	3.29	1.86
70 with rib	1,2,3,4,5	6,7,8,9,10,11,12	2.19	3.45
90 without rib	1,2,3,4,5,6,7,8	9,10,11,12,13,14,15,16, 17,18,19,20,21	6.07	2.50
90 with rib	1,2,3,4,5,6,7,8	10,11,12,13,14,15,16,17,18,19	4.10	8.05
100 without rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22,23	10.3	4.73
100 with rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22	8.22	15.3
Type 70 without rib and 70 with rib are connected with nails ø4.0x40				
Type 90 without rib, 100 without rib, 90 with rib and 100 with rib are connected with nails ø4.0x60				

Table 4: Load F_1 Purlin, 1 angle bracket / connection

Type	Nail no. n_V	Nail no. n_H	$F_{1,Rk}$ [kN] (Purlin)	
			Timber	Steel
70 without rib	1,2,3,4,5	6,7,8,9,10,11,12,13	1.65	0.93
70 with rib	1,2,3,4,5	6,7,8,9,10,11,12	1.10	1.73
90 without rib	1,2,3,4,5,6,7,8	9,10,11,12,13,14,15,16,17,18,19,20,21	3.03	1.25
90 with rib	1,2,3,4,5,6,7,8	10,11,12,13,14,15,16,17,18,19	2.05	4.02
100 without rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22,23	5.14	2.36
100 with rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22	4.11	7.63
Type 70 without rib and 70 with rib are connected with nails ø4.0x40				
Type 90 without rib, 100 without rib, 90 with rib and 100 with rib are connected with nails ø4.0x60				

Table 5: Load $F_{2,3}$, 2 angle brackets / connection

Type	Nail no. n_V	Nail no. n_H	e_1 [mm]	$F_{2,3Rk}$ [kN]
				Timber
70 without rib	1,2,3,4,5	6,7,8,9,10,11,12,13	29.4	5.92
70 with rib	1,2,3,4,5	6,7,8,9,10,11,12	30.5	5.78
90 without rib	1,2,3,4,5,6,7,8	9,10,11,12,13,14,15,16,17,18,19,20,21	35.6	12.4
90 with rib	1,2,3,4,5,6,7,8	10,11,12,13,14,15,16,17,18,19	42.5	11.0
100 without rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22,23	39.5	15.6
100 with rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22	41.1	15.2
Type 70 without rib and 70 with rib are connected with nails ø4.0x40				
Type 90 without rib, 100 without rib, 90 with rib and 100 with rib are connected with nails ø4.0x60				

Table 6: Load $F_{2,3}$, 1 angle bracket / connection

Type	Nail no. n_V	Nail no. n_H	e_1 [mm]	$F_{2,3Rk}$ [kN]
				Timber
70 without rib	1,2,3,4,5	6,7,8,9,10,11,12,13	29.4	2.96
70 with rib	1,2,3,4,5	6,7,8,9,10,11,12	30.5	2.89
90 without rib	1,2,3,4,5,6,7,8	9,10,11,12,13,14,15,16,17,18,19,20,21	35.6	6.22
90 with rib	1,2,3,4,5,6,7,8	10,11,12,13,14,15,16,17,18,19	42.5	5.52
100 without rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22,23	39.5	7.81
100 with rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22	41.1	7.61
Type 70 without rib and 70 with rib are connected with nails ø4.0x40				
Type 90 without rib, 100 without rib, 90 with rib and 100 with rib are connected with nails ø4.0x60				

Table 7: Load $F_{4,5}$, 2 angle brackets / connection

Type	Nail no. n_V	Nail no. n_H	$F_{4,Rk}$ [kN]	
			Timber	Steel
70 without rib	1,2,3,4,5	6,7,8,9,10,11,12,13	5.37	4.18
70 with rib	1,2,3,4,5	6,7,8,9,10,11,12	5.50	4.71
90 without rib	1,2,3,4,5,6,7,8	9,10,11,12,13,14,15,16,17,18,19,20,21	10.2	5.50
90 with rib	1,2,3,4,5,6,7,8	10,11,12,13,14,15,16,17,18,19	10.2	6.69
100 without rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22,23	18.0	7.62
100 with rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22	17.9	8.60
Type 70 without rib and 70 with rib are connected with nails ø4.0x40				
Type 90 without rib, 100 without rib, 90 with rib and 100 with rib are connected with nails ø4.0x60				

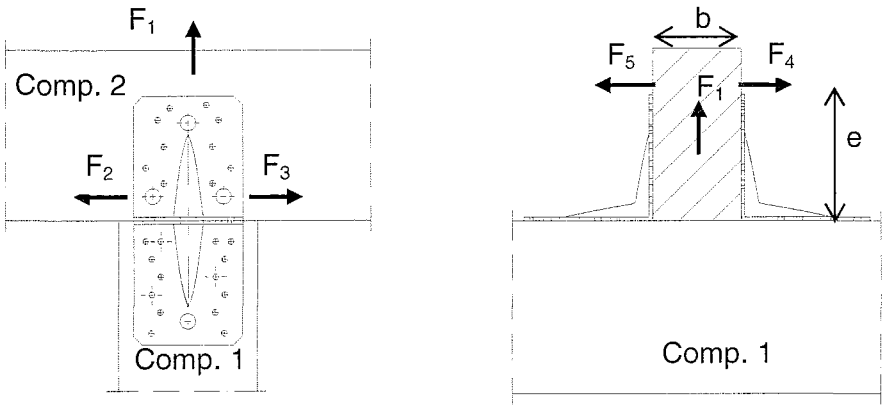
Table 8: Load F_4, 1 angle bracket / connection (Force towards the bracket)

Type	Nail no. n_V	Nail no. n_H	$F_{4,Rk}$ [kN]	
			Timber	Steel
70 with rib	1,2,3,4,5	6,7,8,9,10,11,12	5.50	3.43
90 with rib	1,2,3,4,5,6,7,8	10,11,12,13,14,15,16,17,18,19	10.2	5.07
100 with rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22	17.9	6.36
Type 70 with rib are connected with nails ø4.0x40				
Type 90 with rib and 100 with rib are connected with nails ø4.0x60				

Table 9: Load F_5, 1 angle bracket / connection (Force off the bracket)

Type	Nail no. n_V	Nail no. n_H	$F_{5,Rk}$ [kN]	
			Timber	Steel
70 with rib	1,2,3,4,5	6,7,8,9,10,11,12	1.49	1.31
90 with rib	1,2,3,4,5,6,7,8	10,11,12,13,14,15,16,17,18,19	2.98	1.96
100 with rib	1,2,3,4,5,6,7,8,9,10	11,12,13,14,15,16,17,18,19,20,21,22	5.24	2.52
Type 70 with rib are connected with nails ø 4.0x40				
Type 90 with rib and 100 with rib are connected with nails ø4.0x60				

Definitions of forces, their directions and eccentricity for beam to beam connection



Nailing pattern

The numbers of holes to be nailed are given in Table 1-9 in Annex B.

Double angle bracket per connection

The angle bracket must be placed symmetrically to the component axis.

Acting forces

F_1	Lifting force acting along the central axis of the joint
F_2 and F_3	Lateral force acting in the joint between the component 2 and component 1 in the component 2 direction
F_4 and F_5	Lateral force acting in the component 1 direction along the central axis of the joint. If the load is applied with an eccentricity e, a design for combined loading is required.

Single angle bracket per connection

Acting forces

F_1	Lifting force acting along the central axis of the joint. The component 2 shall be prevented from rotation. The load-carrying capacity will be half of a connection with double angle brackets.
F_2 and F_3	Lateral force acting in the joint between the component 2 and component 1 in the component 2 direction. The component 2 shall be prevented from rotation. The load-carrying capacity will be half of a connection with double angle brackets.
F_4 and F_5	Lateral force acting in the component 1 direction in the height of the top edge of component 2. F_4 is the force towards the angle bracket, F_5 is the force away from the angle bracket. Only the characteristic load-carrying capacities for angle brackets with ribs are given.

Wane

Wane is not allowed, the timber has to be sharp edged in the area of the angle brackets.

Splitting

For the lifting force F_1 tensile stress perpendicular to the grain in component 1 is to be verified if necessary.

Combined forces

If the forces F1 and F2/F3 or F4/F5 act at the same time, the following inequality shall be fulfilled:

$$\left(\frac{F_{1,d}}{F_{Rd,1}}\right)^2+\left(\frac{F_{2,d}}{F_{Rd,2}}\right)^2+\left(\frac{F_{3,d}}{F_{Rd,3}}\right)^2+\left(\frac{F_{4,d}}{F_{Rd,4}}\right)^2+\left(\frac{F_{5,d}}{F_{Rd,5}}\right)^2 \le 1$$

The forces F_2 and F_3 resp F_4 and F_5 are forces with opposite direction. Therefore only one force F_2 or F_3 resp F_4 or F_5 is able to act simultaneously with F_1, while the other force F_2 or F_3 resp F_4 or F_5 shall be set to zero.

If the load F_4/F_5 is applied with an eccentricity e, a design for combined loading for connections with double angle brackets is required. Here, an additional force ΔF_1 has to be added to the existing force F_1

$$\Delta F_{1,d} = F_{4,d} / F_{5,d} \cdot \frac{e}{B}$$

B is the width of component 2.

Connection to concrete or steel

The connection of the angle bracket to a concrete or steel member has to be verified. The verification of the connection is not subject of this European technical approval.

BiLO-Winkel (Angle brackets)

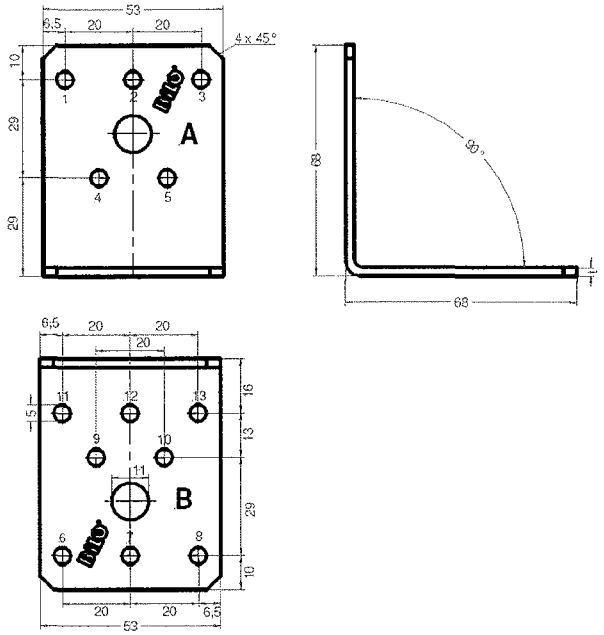


Figure A. 1 Dimensions of angle bracket 70 without rib

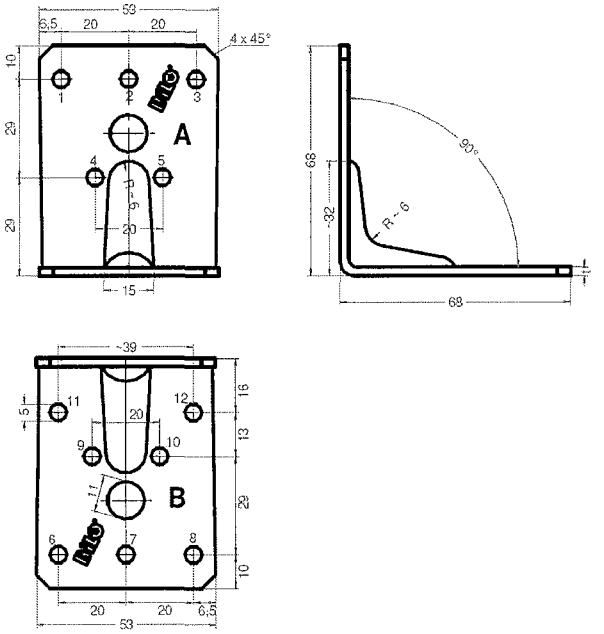


Figure A. 2 Dimensions of angle bracket 70 with rib

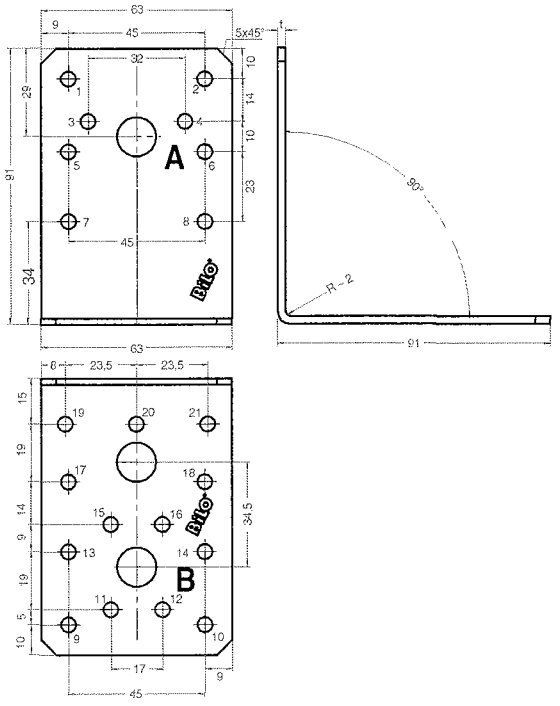


Figure A. 3 Dimensions of angle bracket 90 without rib

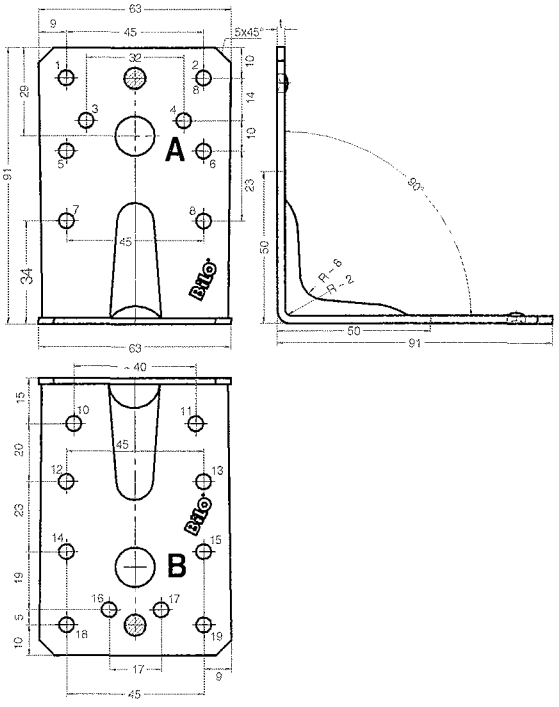


Figure A. 4 Dimensions of angle bracket 90 with rib

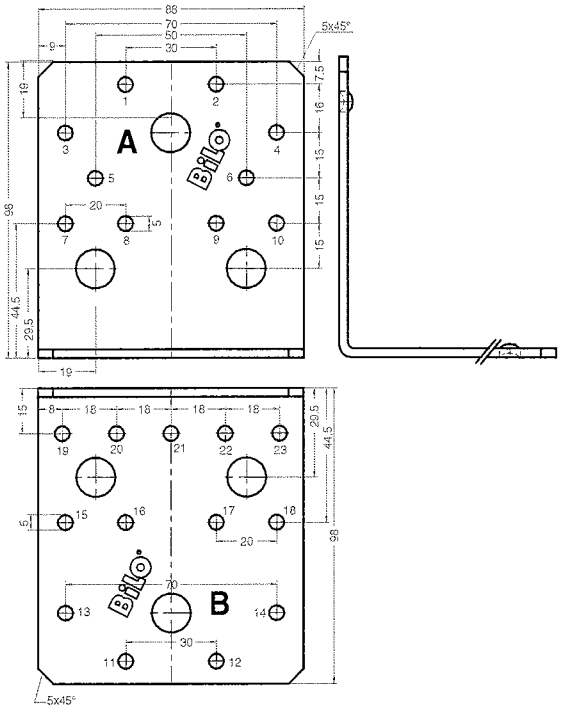


Figure A. 5 Dimensions of angle bracket 100 without rib

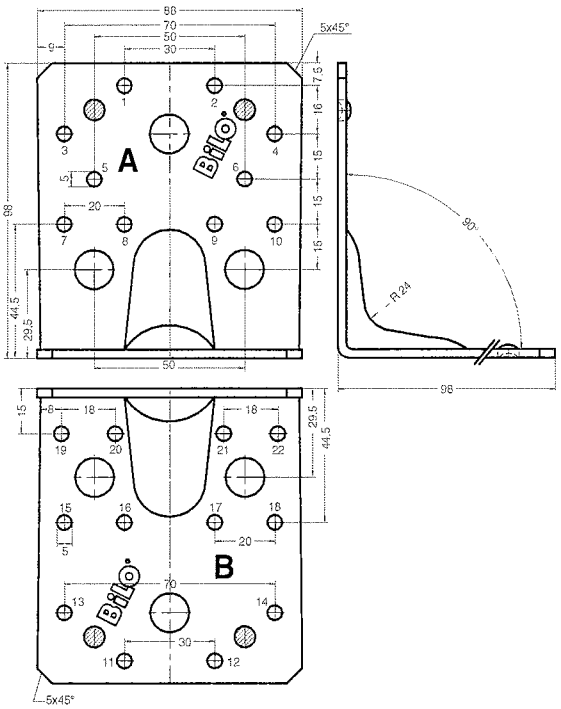


Figure A. 6 Dimensions of angle bracket 100 with rib

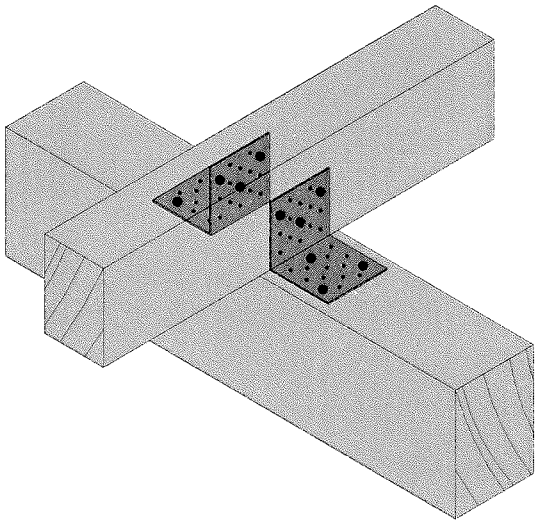


Figure A. 7 Typical installation