WELDA®

Fastening Plates for Welded Connections between Steel and Concrete Structures

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Calculation Basis: EC

MANAGEMENT SYSTEM CERTIFICATION
ISO 9001 · ISO 14001 · OHSAS 18001 · ISO 3834-2
DNV

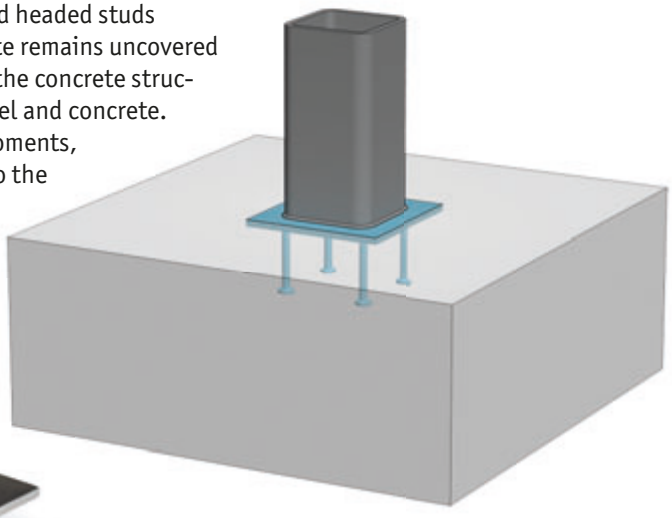
Technical Manual

WELDA® Fastening Plates

For welded connections between steel and concrete structures

- Fluent, effective and reliable design work thanks to free Peikko Designer®: Fastening Plate software
- Wide range of standard solutions to thin and shallow constructions
- Optimized solution even for the most demanding cases e.g. in industrial applications and maritime atmosphere enabled by a multitude of material options and dimensions for modification
- Increased resistances enable better optimization of fastening plate to the project
- Shorter installation time e.g. in heavily reinforced constructions thanks to the light weight and easy assembly
- WELDA® Fastening Plates make design work and assembly easier making the whole construction process faster and more effective

WELDA® Fastening Plates are purpose-designed building products used to create a welded connection between steel and concrete members. WELDA® Fastening Plates consist of a steel plate and headed studs embedded in concrete. The surface of the steel plate remains uncovered by concrete and thus creates a welding surface for the concrete structure, allowing structural welded joints between steel and concrete. The headed studs anchor forces such as bending moments, normal and shear actions from other structures into the concrete members.



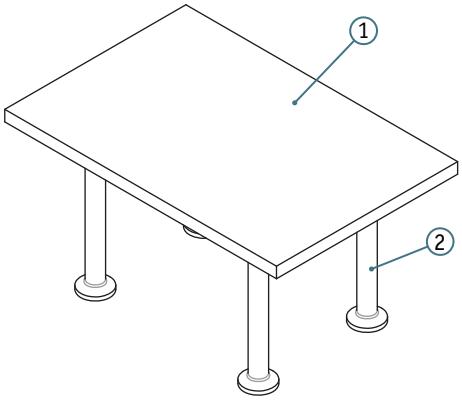
Contents

1. Product Properties

WELDA® Fastening Plates are constructional elements that are embedded in concrete. Structural joints to the steel plate are made by welding. The plates transfer the loads from steel structures into the base concrete structure.

WELDA® always includes a steel plate (1) onto which headed studs (2) are welded. Headed studs are also commonly known as headed anchors, headed fasteners or cast-in fasteners. WELDA® Fastening Plates are available in several sizes and materials.

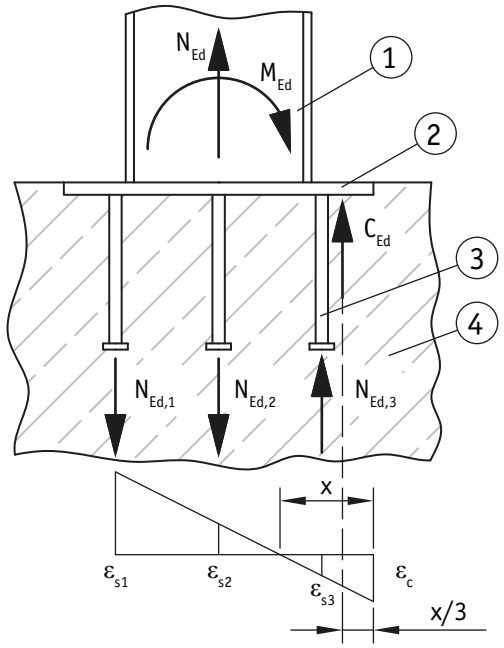
Figure 1. WELDA® consists of a steel plate and welded headed studs.



1.1 Structural behavior

WELDA® Fastening Plates are designed to transfer bending and torsional moments, as well as normal and shear forces, into concrete. The calculations assume that the steel plate is fully rigid and remains as a plane in the loading. The steel plate transfers forces from the attached profile to the headed studs.

Figure 2. Load distribution model under bending moment and normal force.

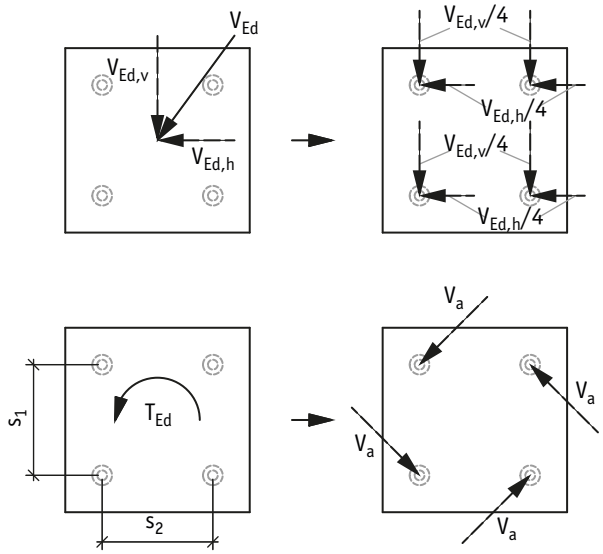


Legend:
1. Attached steel profile/member
2. Steel plate
3. Headed stud
4. Base concrete structure

The forces in fastenings (N) and concrete (C) are:

$$N_{Ed,i} = A_s \cdot \varepsilon_{s,i} \cdot E_s$$
$$C_{Ed} = 0{,}5 \cdot b \cdot x \cdot \varepsilon_c \cdot E_c$$

Figure 3. Determination of shear loads on four anchors, inclined shear load V_{Ed} and torsion moment T_{Ed}.



$$V_a = \frac{T_{Ed}}{I_p}\left[\left(\frac{s_1}{2}\right)^2 + \left(\frac{s_1}{2}\right)^2\right]^{0,5} \quad \text{ja} \quad I_p = {s_1}^2 + {s_2}^2$$

1.2 Limitations for application

The resistances of the fastening plates have been calculated for static loads. For dynamic and fatigue loads, greater safety factors must be used individually for each case.

The pre-calculated resistances (tables 5 and 6) assume that the fastening plates are far away from the edge. In practice, close edge distances can limit the resistances of the fastening plates and may require supplementary reinforcement.

Eccentricity (10 % from the plate side length, max 20 mm) caused by manufacturing tolerances and installation tolerance has been taken into account in the resistances. Larger eccentricities of fastening must be taken into account by design.

Peikko supplies the Peikko Designer® software to facilitate the design of WELDA® Fastening Plates. It can be downloaded free of charge from Peikko's website.

1.2.1 Loading and environmental conditions

WELDA® Fastening Plates are designed to be used indoors and in dry conditions. The designed lifetime for WELDA® Fastening Plates in dry internal conditions (exposure class X0) is 50 years. When using WELDA® Fastening Plates in other conditions, the surface treatment or raw materials must be adequate according to the environmental exposure class and intended operating life. WELDA® Fastening Plates are also manufactured in stainless steel materials (see section 1.3).

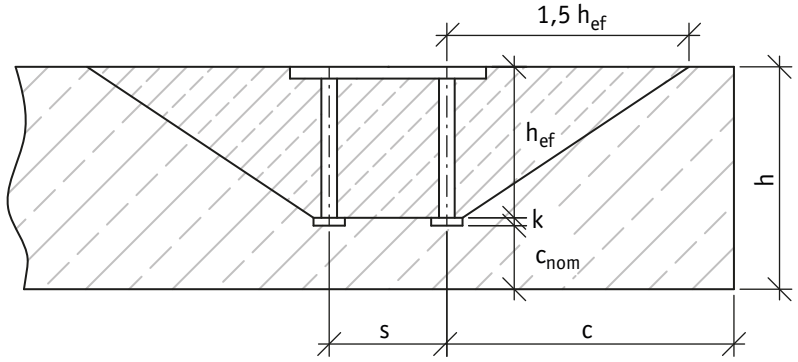
1.2.2 Positioning of the WELDA® Fastening Plates

The precise position of the fastening plate is indicated in the design drawings. Fastening Plates are to be fixed so that they cannot be displaced during the casting. Fastening plates can be fixed to reinforcement or on the formwork/mold by nails, glue, screws, double-sided tape, clamps, or magnets. The fastening plates can be supplied upon request with nail holes for easy fixing.

Table 1. Installation parameters for headed studs.

Nominal size d [mm]		10	12	13	16	19	20
Minimum spacing	s_{min} [mm]	50	70	70	80	100	100
Minimum edge distance	c_{min} [mm]	50	50	50	50	70	70
Minimum thickness of concrete member	h_{min} [mm]	$h_{ef} + k + c_{nom} = H + c_{nom}$					
c_{nom} = required concrete cover according to national regulations							

Figure 4. Parameters h_{ef}, k, c_{nom}, h, c, s.



1.3 Materials and dimensions

Table 2. Materials.

Types:	plate material	standard	anchor material	standard
WELDA	S355J2+N	EN 10025-2	SD1 (black steel)	EN ISO 13918
WELDA R	1.4301	EN 10088-2	SD1 (black steel)	EN ISO 13918
WELDA Rr	1.4301	EN 10088-2	SD3 (stainless steel)	EN ISO 13918
WELDA A	1.4401	EN 10088-2	SD1 (black steel)	EN ISO 13918
WELDA Ar	1.4401	EN 10088-2	SD3 (stainless steel)	EN ISO 13918

SD1: $f_{yk} \geq 350$ N/mm², $f_{uk} \geq 450$ N/mm², $A_5 \geq 15$ %;
SD3: $f_{p0,2} \geq 350$ N/mm², $f_{uk} \geq 500$ N/mm², $A_5 \geq 25$ %;

WELDA® Fastening Plates are also available in other material grades on special request as modified fastening plate (see Section 1.3.1.). Please contact Peikko Sales to inquire about other material grades.

Naming of WELDA® Fastening Plates:

WELDA BxL-H [type: -/R/Rr/A/Ar]

Examples of naming:

WELDA 100x100-68
WELDA 100x100-68 R
WELDA 100x100-68 Rr
WELDA 100x100-68 A
WELDA 100x100-68 Ar

Surface treatment for the standard WELDA® Fastening Plate: protection painting 40 µm. Epoxy painting or galvanizing on request. Fastening plates that are made of stainless steel (WELDA R/Rr/A/Ar) are not painted.

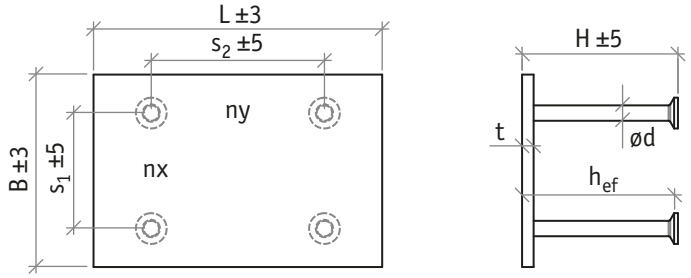


Table 3. Dimensions [mm], number of studs (nx, ny) and weight [kg] of WELDA® Fastening Plates.

WELDA B x L - H	B	L	H	t	h_{ef}	s_1	s_2	Ød	nx	ny	Weight
	[mm]										[kg]
WELDA 50x100-68	50	100	68	8	61	0	60	10	1	2	0.4
WELDA 100x100-68	100	100	68	8	61	60	60	10	2	2	0.8
WELDA 100x150-70	100	150	70	10	63	60	90	10	2	2	1.4
WELDA 100x200-72	100	200	72	12	64	70	120	13	2	2	2.2
WELDA 100x200-162	100	200	162	12	154	70	120	13	2	2	2.6
WELDA 100x300-162	100	300	162	12	154	70	100	13	2	3	3.9
WELDA 150x150-70	150	150	70	10	63	90	90	10	2	2	2.0
WELDA 150x150-160	150	150	160	10	153	90	90	10	2	2	2.2
WELDA 150x150-162	150	150	162	12	154	90	90	13	2	2	2.8
WELDA 200x200-72	200	200	72	12	64	120	120	13	2	2	4.1
WELDA 200x200-162	200	200	162	12	154	120	120	16	2	2	4.9
WELDA 200x300-165	200	300	165	15	157	120	180	16	2	2	8.2
WELDA 250x250-165	250	250	165	15	157	170	170	16	2	2	8.5
WELDA 300x300-165	300	300	165	15	157	180	180	16	2	2	11.7

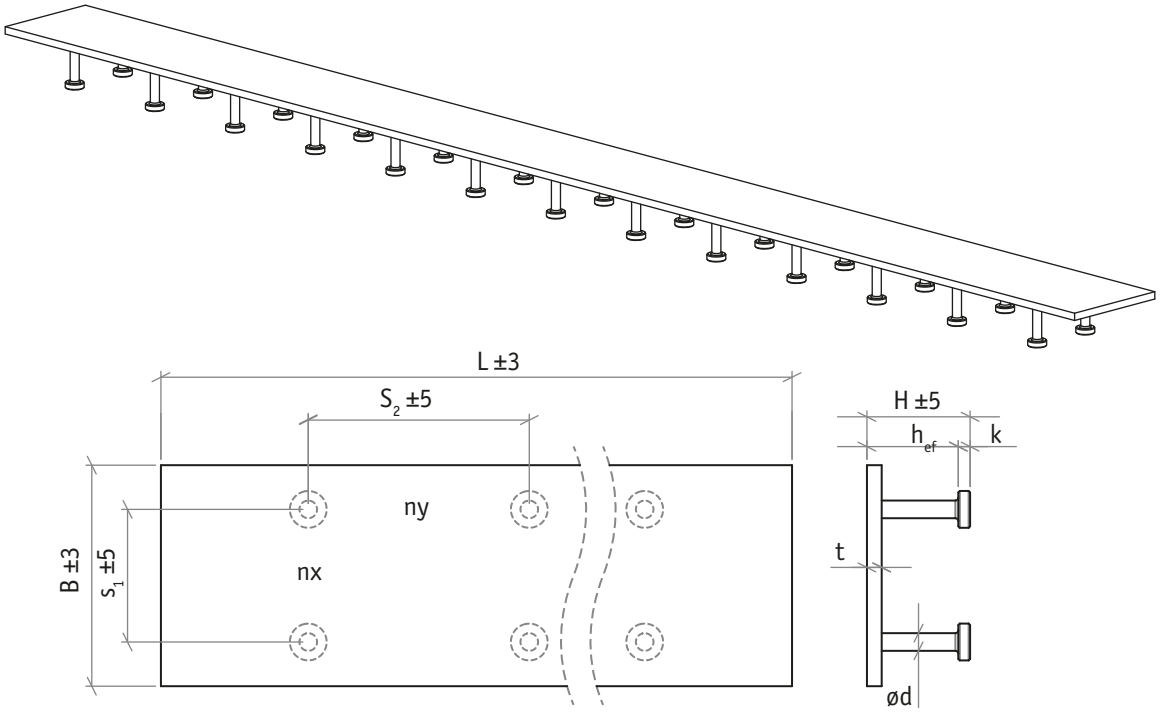


Table 4. Dimensions [mm], number of studs (nx, ny) and weight [kg/m] of WELDA® Fastening Plates.

WELDA B x L - H	B	L	H	t	h_{ef}	s_1	s_2	Ød	nx	ny	Weight
	[mm]										[~kg/m]
WELDA 100xL1-70	100	L1	70	10	62	70	150	13	2	3...13	8.9
WELDA 150xL1-70	150	L1	70	10	62	90	150	13	2	3...13	12.8
WELDA 200xL1-70	200	L1	70	10	62	100	150	13	2	3...13	16.8
WELDA 150xL2-115	150	L2	115	15	107	90	200	16	2	3...10	19.6
WELDA 200xL2-115	200	L2	115	15	107	100	200	16	2	3...10	25.5
WELDA 300xL2-115	300	L2	115	15	107	200	200	16	2	3...10	37.3
WELDA 400xL2-120	400	L2	120	20	112	200	200	16	2	3...10	64.8

L1 = 450/600/750/900/1050/1200/1350/1500/1650/1800/1950/2000 mm
L2 = 600/800/1000/1200/1400/1600/1800/2000 mm

1.3.1 Modified WELDA® Fastening Plates

WELDA® Fastening Plates can be modified to offer an optimized solution for different needs. Resistances can be verified by using Peikko Designer®: Fastening Plate software.

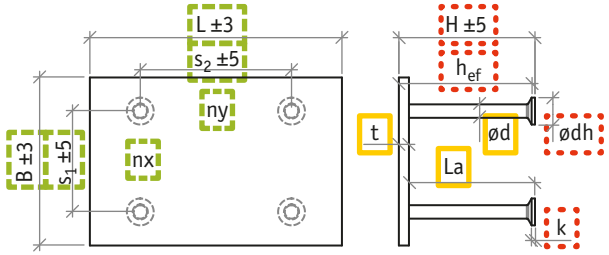
The elements that can be modified are:
1) Plate dimensions
- Thickness **t**: 8/10/12/15/20/25/30 mm
- Width **B**: 50...2000 mm
- Length **L**: 100...6000 mm

2) Headed anchors
- Number and position of anchors
- Diameters **Ød**: 10/12/13/16/19/20(/22/25) mm
- length **La**: 50...600 mm

3) Holes
- Number and position of holes
- Diameter of holes

4) Steel grade
- Generally available steel grades

= according to selected stud
= can be selected from list
= can be changed



PSS Peikko Smooth Stud (Black, SD1, EN ISO 13918)
PSS-type headed studs for modified fastening plates

Type	PSS 10	PSS 13	PSS 16	PSS 19	PSS 20
Ød [mm]	10	13	16	19	20
Ødh [mm]	19	25	32	32	40
s_{min} [mm]	50	70	80	100	100
Possible lengths of anchors **La** [mm]	50	50	50	75	75
	60	60	75	80	100
	75	75	100	90	125
	100	100	125	100	150
	125	125	150	125	175
	150	150	175	150	195
	175	175	200	175	200
		200	225	200	250
			250	225	300
			275	250	350
			300	275	
			350	300	
				350	

Modified WELDA® Fastening Plates must be named so that they will not be confused with standard WELDA® Fastening Plates. Additionally, the manufacturing parameters on the drawing must show the plate dimensions, size, and placing of studs and materials, etc. Further information about modification possibilities is available at Peikko Sales.

Naming the product: **WELDA MODIFIED** [project specific unique number or name]

Examples:
WELDA MODIFIED 1234
WELDA MODIFIED 25x600x2000+30d16-150

1.4 Manufacturing

Plates are cut mechanically or by flame cutting. The dimensional tolerances correspond to EN ISO 9013-442. For standard fastening plates, the maximum tolerance for the B and L dimensions is ± 3 mm. The anchors are welded by arc stud welding, MAG welding, or automatic stud welding. Arc stud welding is done by drawn arc stud welding with ceramic ferrule or shielding gas. The location tolerance for anchors is ± 5 mm and the tolerance for straightness ± 3°. The tolerance for total height H is ± 5 mm.

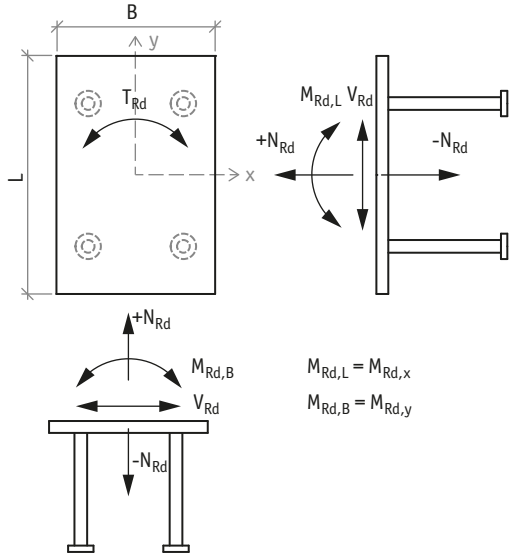
Peikko Group's production units are externally controlled and periodically audited on the basis of production certifications and product approvals by various organizations, including Inspecta Certification, VTT Expert Services, Nordcert, SLV, TSUS, and SPSC, among others. Products are marked with the mark of Inspecta, the emblem of Peikko Group, the type of the product, and the year and week of manufacturing.

2. Resistances

The resistances of WELDA® Fastening Plates are determined by a design concept that makes reference to the following standards:

- CEN/TS 1992-4-1:2009, Design of fastenings for use in concrete. Part 4-1: General
- CEN/TS 1992-4-2:2009, Design of fastenings for use in concrete. Part 4-2: Headed fasteners
- EN 1992-1-1:2004, Design of concrete structures : General rules and rules for buildings
- EN 1993-1-1:2005, Design of steel structures : General rules and rules for buildings
- EN 1993-1-8:2005, Design of steel structures. Part 1-8: Design of joints

Figure 5. Symbols and direction of the actions.



Assumptions for pre-calculated resistances (Tables 5 and 6):

- Concrete C25/30, cracked, without supplementary reinforcement
- Manufacturing and installation tolerances (10 % from plate side dimension, max 20 mm) have been taken into account
- The plate is far enough away from the edges so the edge does not fail
- Calculations have been made for static loads according to CEN/TS 1992-4-1...2
- Minimum fastening areas are calculated for steel plate material S355J2+N

The resistances of the fastening plates can be verified using Peikko Designer®. This is particularly recommended if:

- There are interactions of forces
- The edge distances might limit resistances
- The installation tolerances are greater than 10 % from the plate side dimension (max 20 mm)
- The fastening plate is modified

Table 5. Maximum resistances and minimum fastening area when only one single action is active.

WELDA B x L – H	Tension resistance $+N_{Rd}$ [kN]	Shear resistance V_{Rd} [kN]	Moment resistance $M_{Rd,L}$ [kNm]	Moment resistance $M_{Rd,B}$ [kNm]	Torsion resistance T_{Rd} [kNm]	Min fast. area (S355) for M_{Rd} [mm x mm]
WELDA 50x100-68	7.8	19.0	0.8	0.3	0.9	5 x 67
WELDA 100x100-68	17.2	30.5	1.1	1.1	1.8	48 x 48
WELDA 100x150-70	20.3	37.2	1.8	1.3	2.7	34 x 84
WELDA 100x200-72	23.9	46.0	2.5	1.6	4.0	20 x 105
WELDA 100x200-162	79.2	89.0	6.4	5.4	7.7	50 x 160
WELDA 100x300-162	90.1	94.9	11.0	5.4	10.3	46 x 260
WELDA 150x150-70	22.7	44.4	2.0	2.0	3.5	55 x 55
WELDA 150x150-160	62.9	52.8	4.8	4.8	4.2	116 x 116
WELDA 150x150-162	77.9	90.6	7.5	7.5	7.1	115 x 115
WELDA 200x200-72	28.5	58.4	3.1	3.1	5.8	40 x 40
WELDA 200x200-162	86.6	143.2	10.4	10.4	14.3	157 x 157
WELDA 200x300-165	97.6	145.7	15.9	12.0	18.3	108 x 217
WELDA 250x250-165	104.2	150.2	15.7	15.7	20.3	169 x 169
WELDA 300x300-165	107.5	151.1	18.2	18.2	21.5	201 x 201

Note:

- When many actions are active at the same time, interaction have to take into account.
- The fastening area depends on the direction and magnitude of loading.
- Welds can be taken into account when calculating the minimum fastening area (see Figure 6. Welds can be taken into account
- The compression resistance can be calculated using Peikko Designer®.

Figure 6. Welds can be taken into account in minimum fastening areas.

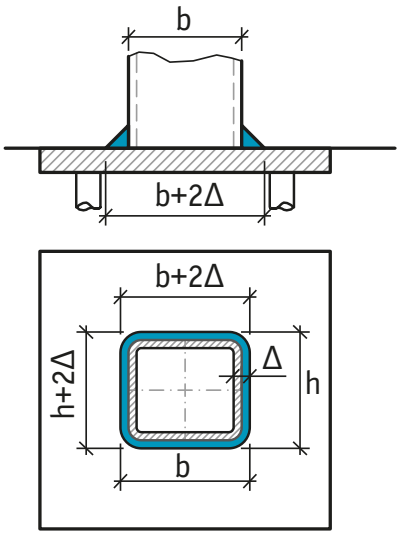


Table 6. Maximum resistances per stud row.

WELDA B x L – H	Tension with 20 mm eccentricity N_{Rd} [kN]	Shear without eccentricity V_{Rd} [kN]	Minimum fast. area (directions: B x L) [mm x mm]
WELDA 100xL1-70	11.2	25.1	10x110
WELDA 150xL1-70	12.1	29.4	50x80
WELDA 200xL1-70	12.5	30.4	40x50
WELDA 150xL2-115	24.4	54.8	50x120
WELDA 200xL2-115	25.0	56.1	50x80
WELDA 300xL2-115	30.9	69.5	50x50
WELDA 400xL2-120	31.2	69.9	50x50

Figure 7. Maximum number (ny-1) of pre-calculated resistances (see Table 6), where ny = number of stud rows.

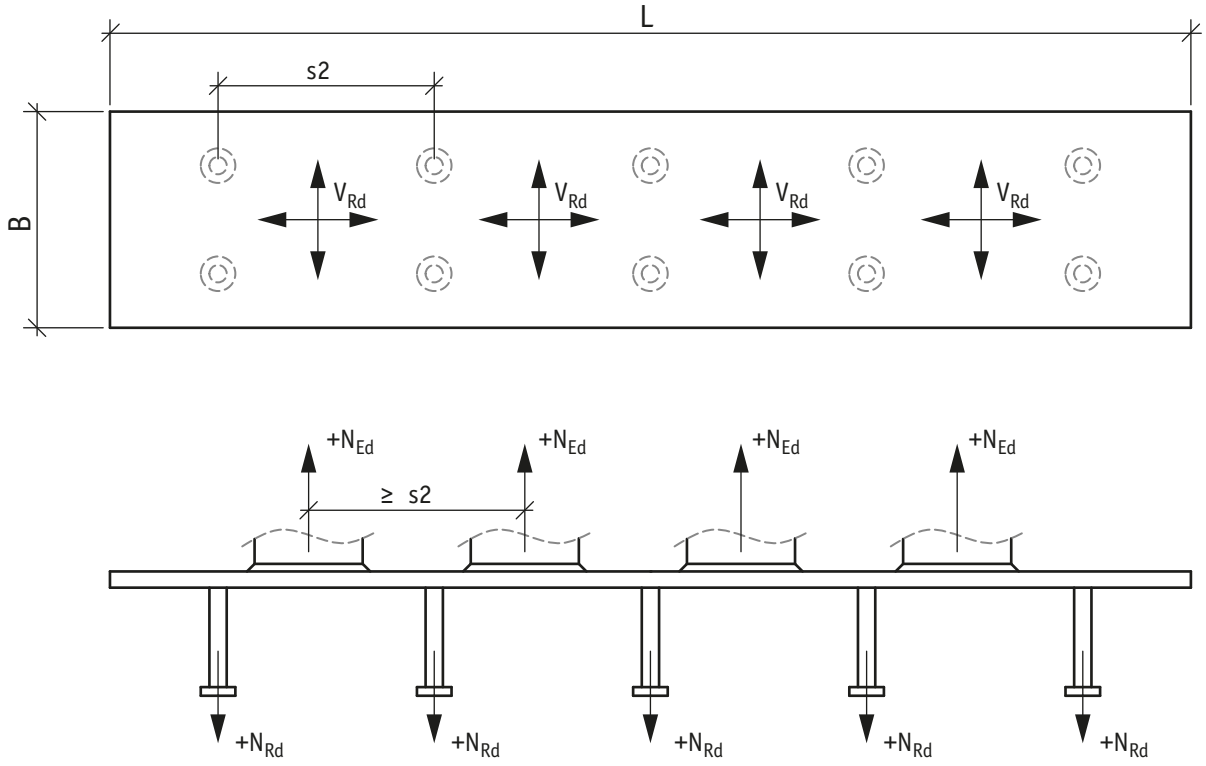
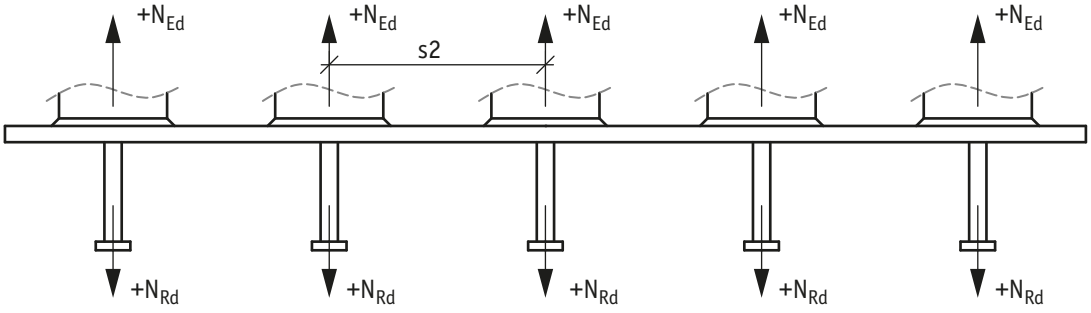


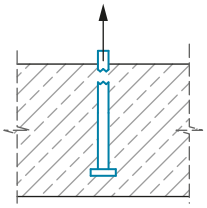
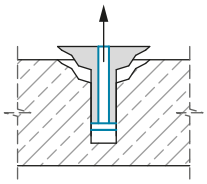
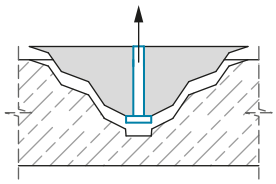
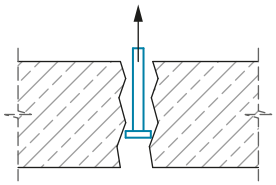
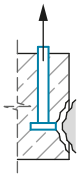
Figure 8. Maximum number (ny) of pre-calculated resistances (see Table 6) if the load goes directly to the anchors..



2.1 Required verification for WELDA® anchors loaded in tension

The Peikko Designer® software can be used to prove the resistance of the following verifications.

Table 7. Required verifications for headed anchors loaded in tension.

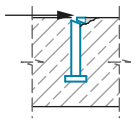
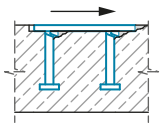
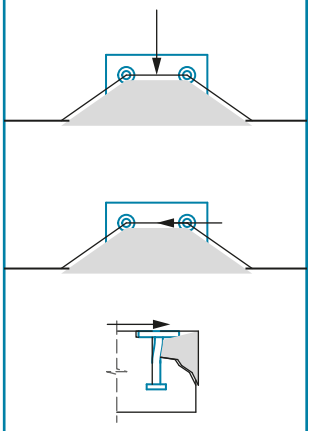
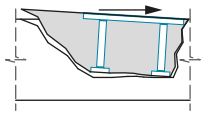
Failure mode	Example	Most loaded anchor	Anchor group
Steel strength of anchor		$N_{Ed}^{h} \leq N_{Rd,s} = \frac{N_{Rk,s}}{\gamma_{Ms}}$	
Pull-out strength of anchor		$N_{Ed}^{h} \leq N_{Rd,p} = \frac{N_{Rk,p}}{\gamma_{Mp}}$	
Concrete cone strength [1]			$N_{Ed}^{g} \leq N_{Rd,c} = \frac{N_{Rk,c}}{\gamma_{Mc}}$
Splitting strength [2]			$N_{Ed}^{g} \leq N_{Rd,sp} = \frac{N_{Rk,sp}}{\gamma_{Msp}}$
Blow-out strength [3]			$N_{Ed}^{g} \leq N_{Rd,cb} = \frac{N_{Rk,cb}}{\gamma_{Mc}}$

[1] Not required if supplementary reinforcement is provided according to Appendix A1
[2] Not required if the edge distance in all directions $c \geq 1{,}5\ h_{ef}$ for groups with one anchor and $c \geq 1{,}8\ h_{ef}$ for groups with more than one anchor or if supplementary reinforcement provided according to Appendix A2
[3] Not required if the edge distance in all directions $c \geq 0{,}5\ h_{ef}$

2.2 Required verification for WELDA® headed anchors loaded in shear

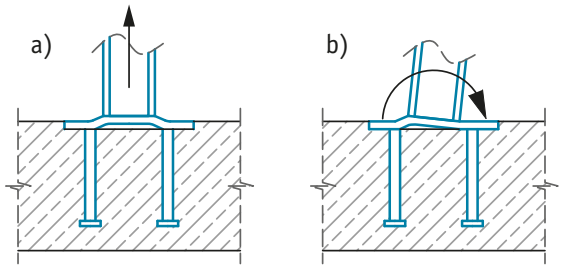
The Peikko Designer® software can be used to prove the resistance of the following verifications.

Table 8. Required verifications for headed anchors loaded in shear.

Failure mode	Example	Most loaded anchor	Anchor group
Steel strength of anchor		$V_{Ed}^{h} \leq V_{Rd,s} = \frac{V_{Rk,s}}{\gamma_{Ms}}$	
Concrete edge strength [1)] • Shear perpendicular to the edge • Shear parallel to the edge • Inclined shear			$V_{Ed}^{g} \leq V_{Rd,c} = \frac{V_{Rk,c}}{\gamma_{Mc}}$
Concrete pry-out strength			$V_{Ed}^{g} \leq V_{Rd,cp} = \frac{V_{Rk,cp}}{\gamma_{Mc}}$

[1)] Not required if the edge distances in all directions c ≥ min (10 h_{ef}; 60Ø) or if supplementary reinforcement is provided according to Appendix B1

Figure 9. Plate verification for a) tension force and b) bending moment.



2.3 Combined axial and shear load

When axial and shear forces strain the headed stud simultaneously the interaction should be checked by satisfying the following equations for different failure modes. The combined axial and shear load can be easily checked using the Peikko Designer® Fastening Plate software.

WITH RESPECT TO STEEL VERIFICATIONS

Headed Anchors
The simultaneous **tensile** force and **shear** force in each headed stud shall satisfy the condition:

$$|\beta_N|^2 + |\beta_V|^2 \leq 1 \qquad \text{CEN/TS 1992-4-2, Eq. (46)}$$

where

$$\beta_N = \frac{|N_{Ed}^1|}{N_{Rd}} \leq 1 \quad \text{ja} \quad \beta_V = \frac{|V_{Ed}^1|}{V_{Rd}} \leq 1$$

where

N_{Ed}^1 = axial tension force in the most loaded headed stud
V_{Ed}^1 = shear force in the most loaded headed stud
N_{Rd} = axial resistance of headed stud
V_{Rd} = shear resistance of headed stud

WITH RESPECT TO CONCRETE VERIFICATIONS

Anchors without supplementary reinforcement
The simultaneous **tensile** force and **shear** force shall satisfy the condition:

$$|\beta_N|^{1,5} + |\beta_V|^{1,5} \leq 1 \qquad \text{CEN/TS 1992-4-2, Eq. (48)}$$

Anchors with supplementary reinforcement
The simultaneous tensile force and shear force shall satisfy the condition:

$$|\beta_N|^{2/3} + |\beta_V|^{2/3} \leq 1 \qquad \text{CEN/TS 1992-4-2, Eq. (49)}$$

where

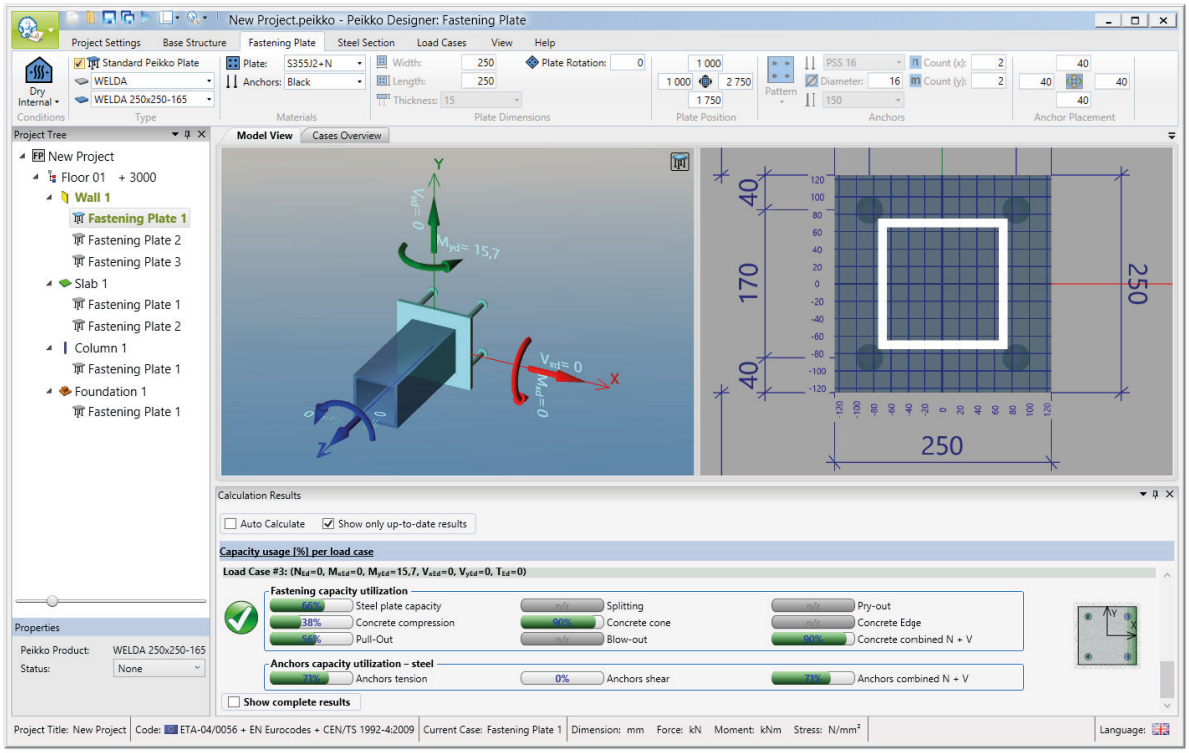
β_N = largest degree of utilization from concrete verifications under tensile force
β_V = largest degree of utilization from concrete verifications under shear force
NOTE: Failure modes β_N and β_V are those not covered by supplementary reinforcement

Selecting of WELDA® Fastening Plate

The following aspects must be considered when selecting the appropriate type of WELDA® Fastening Plate:

1. Type of loading and load cases: N_{Ed}, M_{xEd}, M_{yEd}, V_{xEd}, V_{yEd}, T_{Ed}. In the case of seismic, dynamic and fatigue loads, greater safety factors have to be used individually for each case
2. Direction of loading
3. Dimensions of steel profile or member
4. Eccentricity of the steel profile: ex, ey
5. Dimensions and edge distances of base structure
6. Concrete class of base structure
7. Cracked/uncracked concrete
8. Existing and supplementary reinforcement
9. Environmental conditions and exposure class: Dry internal/External atmospheric

Figure 10. Peikko Designer: Fastening Plate.

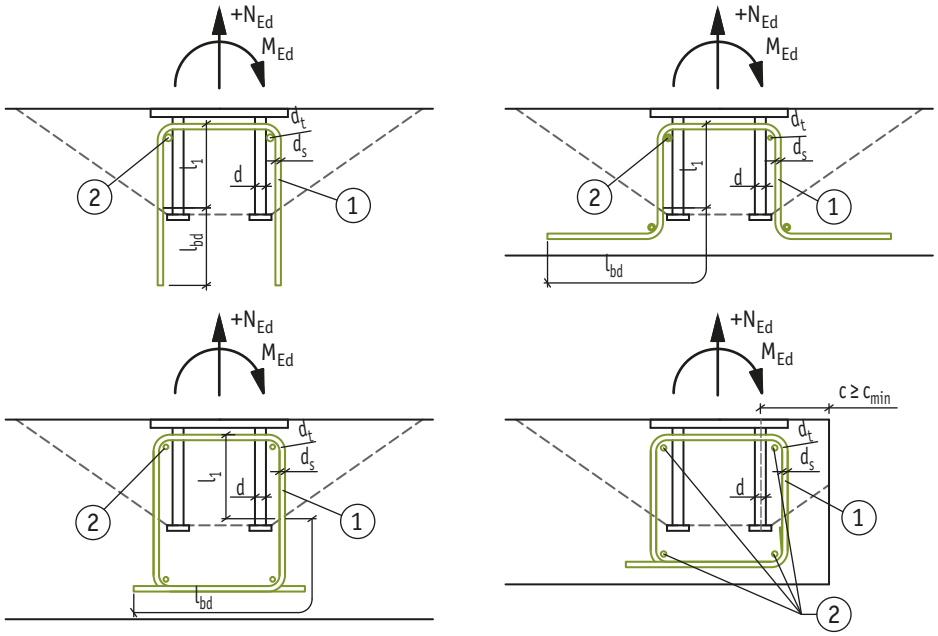


Annex A – Supplementary reinforcement to resist tension load

A1: Concrete cone reinforcement

If the concrete cone resistance is exceeded, supplementary reinforcement for the tension load should be provided. The principles of hanger reinforcement to prevent concrete cone failure for WELDA® Fastening Plates are shown in the following figures.

Figure 11. Supplementary hanger reinforcement alternatives for concrete cone reinforcement.

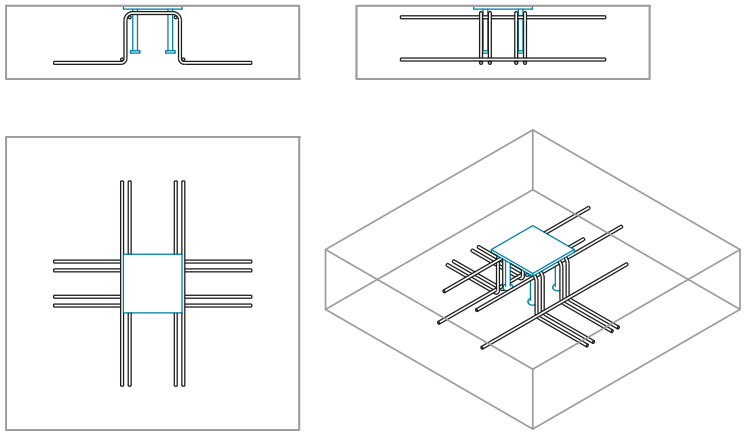


Where ① = supplementary hanger reinforcement, diameter d_s
② = transverse/main reinforcement of concrete structure, diameter d_t ($d_t \geq d_s$)
l_1 = anchorage length of supplementary reinforcement in the concrete failure cone, $l_1 \geq 4d_s$
l_{bd} = design anchorage length of supplementary reinforcement in base structure
Minimum bending radius of supplementary reinforcement = $2d_s$, when $d_s \leq 16$ mm.

Table 9. Hanger reinforcement (B500B) per anchor based on steel tension resistance of headed stud.

Diameter of the headed stud	**d**	**[mm]**	**10**	**12**	**13**	**16**	**19**	**20**
Tension resistance of headed stud	$N_{Rd,s}$	[kN]	23	33	39	59	83	92
Required cross-section area of hanger reinforcement	A_s	[mm²]	53	76	89	135	190	211
Selected reinforcement (legs/stud)	**n x d_s**	**[mm]**	**1 x 10**	**1 x 10**	**1 x 12**	**1 x 14**	**1 x 16**	**2 x 12**
Alternative reinforcement (legs/stud)	**n x d_s**	**[mm]**	**2 x 6**	**2 x 8**	**2 x 8**	**2 x 10**	**2 x 12**	**3 x 10**

Figure 12. Supplementary hanger reinforcement when fastening is far from the edges ($c \geq 1{,}5\ h_{ef}$).



A2: Splitting reinforcement

If the splitting resistance is exceeded, supplementary reinforcement near the concrete side and top face surface should be provided to resist the splitting forces and to limit cracks. Details of the reinforcement for WELDA® Fastening Plates are shown in the following figure. The required numbers of reinforcement bars are given in Table 10. Existing surface reinforcement can be used as splitting reinforcement if it is not used fully for other purposes and the total utilization ratio is ≤ 1.

The required cross-section A_s of the splitting reinforcement may be determined as follows:

$$A_s = 0{,}5\frac{\sum N_{Ed}}{f_{yk}/\gamma_{Ms,re}} \quad [mm^2] \qquad \text{CEN/TS 1992-4-2, Eq. (17)}$$

where,

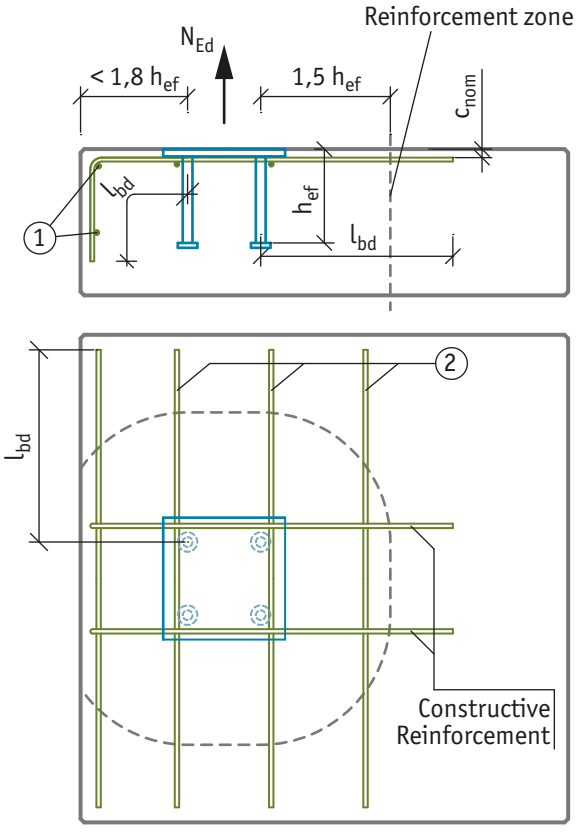
$\sum N_{Ed}$ = sum of the design tensile forces of the anchors in tension under the design value of the actions [N]
f_{yk} = nominal yield strength of the reinforcing steel ≤ 500 N/mm²
$\gamma_{Ms,re}$ = partial safety factor for steel failure of supplementary reinforcement = 1,15

Table 10. Splitting reinforcement per anchor row (B500B).

Headed stud diameter [mm]	A_s ① + ② [mm²]	Selected reinforcement
10	26,3	1 Ø 6
12	37,9	1 Ø 8
13	44,5	1 Ø 8
16	67,4	1 Ø 10
19	95,1	1 Ø 12
20	105,4	1 Ø 12

Placement of reinforcement:

- Splitting reinforcement must be evenly placed along the **critical edge(s)*** on the side and top faces of concrete member.
  *** The distance from the edge of the concrete surface to the center of the nearest anchor in tension smaller than < 1,8 h_{ef}.**
- Bars against splitting must be located inside the effective reinforcement zone (i.e. within a distance ≤1,5 h_{ef} from the anchor in tension).
- Pos.① is the **side-face reinforcement** of the critical edge or edges of the same direction.
- Pos.② is the top-face reinforcement of the critical edge or edges of the same direction.
- **NOTE:** Perpendicular edges should be considered independently (i.e. A_s per direction).



Annex B – Supplementary reinforcement to resist shear load

B1: Edge reinforcement

If the edge failure verification under shear load shows insufficient resistance, supplementary reinforcement should be provided. Details of hanger reinforcement to prevent edge failure for WELDA® Fastening Plates are shown in the following figures. The required numbers of U-stirrups are given in Table 11.

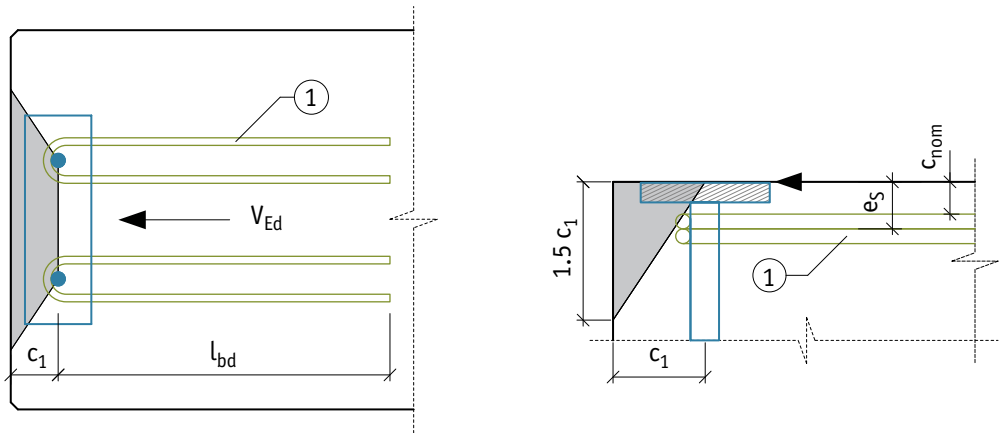
Table 11. Concrete edge reinforcement (B500B).

Headed stud diameter [mm]	U-Stirrups (per stud) ①	c_1	c_{nom} [mm]	e_s
10	1 Ø 10	50	35	40
12	1 Ø 12	70	35	41
13	1 Ø 12	70	35	41
16	1 Ø 16	80	35	43
19	2 Ø 14	100	35	49
20	2 Ø 14	100	35	49

Reinforcement from Table 11 can be directly applied if the following conditions exist:

- The distance between the reinforcement and the shear force acting on a base plate is equal to or smaller than e_s
- The edge distance is equal or greater than c_1
- The bending radius of supplementary reinforcement ≥ 2Ø (Ø ≤ 16 mm)

Figure 14. Illustration of detailing of the supplementary reinforcement in the form of loops (①).



Installation of WELDA® Fastening Plate

INSTALLATION OF WELDA® FASTENING PLATES AT THE PRECAST FACTORY OR ON THE CONSTRUCTION SITE

WELDA® Fastening Plates are installed to the planned positions before or during casting of concrete.

The precise position of the fastening plate is indicated on the design drawings. Fastening plates can be fixed on the formwork or on the reinforcement by nails, glue, double-sided tape, or clamps. If steel mould is used fixing using magnets is possible. Upon request, WELDA® Fastening Plates can also be supplied with nail holes for easy fixing.

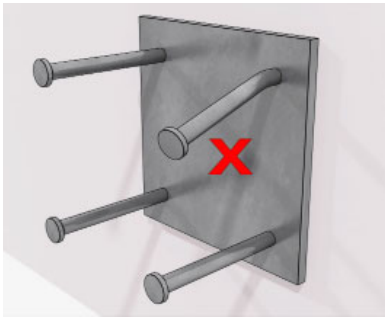
The anchoring of WELDA® Fastening Plates is based on the concrete cone, which is due to the headed studs. Bending or cutting the anchors reduces the tension capacities and the moment of the fastening plates because it downsizes the concrete cone. If any of the anchors are bent or cut, the resistances of the fastening plate must be rechecked.

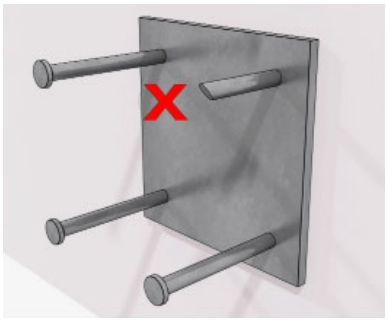
It is not recommended to bend or cut the headed studs or anchors to make the plate fit the reinforcement. This may have a negative effect on the resistances and design values of the plate, leading to non-performance of the plate under load.

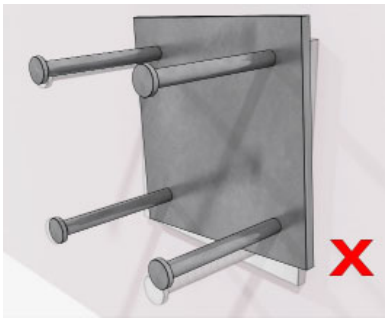
In casting, the dropping height of the concrete should be kept as small as possible. This ensures that the mass stays even and the fastening plate is not exposed to great impelling forces. Close attention should be paid during casting and compacting to ensure that the position of fastening plates stays unchanged.

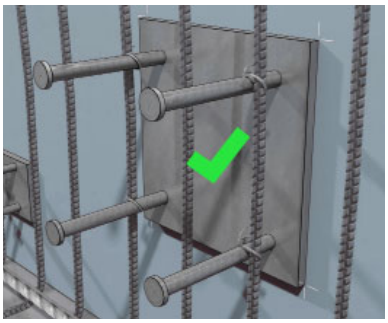
The concrete under the heads of headed studs or anchors, as well as under the base plate, should be properly compacted. If a vibrator is used for compacting, contact between the fastening plate and the vibrator is to be avoided. Bigger fastening plates are to be provided with air holes to enable adequate compacting under the plate area.

Only when the concrete has been hardened and reached the design strength can the fastening plate be loaded.









WELDING TO WELDA® FASTENING PLATES AND TO ANCHORS

In general, the steel profile or member is welded to the WELDA® Fastening Plate after casting. Upon request, welding can be done in the Peikko workshop before casting if the formwork permits welding.

It is recommended that the designer makes a welding plan, which includes the welding orders, welder qualification, and the welding fillet, particularly for demanding welding work.

All impurities such as oil, grease, dirt, paint, and zinc coating must be removed from the surface before welding. These can have a degenerative effect on welding and, in the worst case, can result in the failure of the welded connection.

The method of welding must be chosen so that a sufficient welding quality for the required welding class is achieved. The following procedures, for example, aid in this:

- The welds and the welding must be done symmetrically with relation to the cross-section's centre of gravity
- Welding must be done in the direction from the structure's centre point towards the sides, unless other actions are taken
- Separate structural elements should be allowed to move freely as long as possible during the welding procedure
- If different heating needs are required, preheating should be done separately
- If the temperature is below 0°C preheating is recommended in any case

Table 12. Normative recommendations for welding fillet with common steel grades.

MATERIAL OF THE STEEL PART	MATERIAL WELDED ON THE STEEL PART		
	S235, S355	**1.4301**	**1.4401**
S235, S355	GMAW: G3Si1 FCAW: T 42 4 M M 1 H10 SMAW: E 42 4 B 42 H5	GMAW: G 23 12 LSi SMAW: E23 12 L R 3 2	GMAW: G 23 12 2 L SMAW: E 23 12 2 L R 3 2
1.4301	GMAW: G 23 12 LSi SMAW: E23 12 L R 3 2	GMAW: SS308LSi SMAW: E19 9 L R 1 2	GMAW: G 23 12 2 L SMAW: E 23 12 2 L R 3 2
1.4401	GMAW: G 23 12 2 L SMAW: E 23 12 2 L R 3 2	GMAW: G 23 12 2 L SMAW: E 23 12 2 L R 3 2	GMAW: SS316LSi SMAW: E19 12 3 L R 1 1

GMAW = Gas Metal Arc Welding (MIG/MAG)
SMAW = Shielded Metal Arc Welding (Stick welding)
FCAW = Flux Core Arc Welding

For structural and assembly welding, the following issues must be considered:

- In the event of moisture or low temperature (below -5 °C), the steel must be preheated to min. +50 °C. Heating is more important for bars of greater diameters.
- The steel parts to be welded must be cleaned of ice, snow, moisture, rust, paint, grease, and other impurities
- Sufficient welding current should be used and, for pin welding, the diameter of the pin must be large enough in relation to the bar
- The welder must be qualified

When welding on-site, standards EN 1090-2 and EN 13670 must be complied with as well as national annexes or application standards.

PEIKKO GROUP CORPORATION

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Peikko is a family-owned and run company with over 1200 professionals. Peikko was founded in 1965 and is headquartered in Lahti, Finland.