SBKL FASTENING PLATES

TECHNICAL MANUAL
EUROCODE DESIGN

27.1.2021

Contents:

1 FASTENING PLATE PRINCIPLE

SBKL fastening plates are steel plates equipped with resistance welded stud head anchors. The fastening plates are cast into concrete. SBKL fastening plates are intended to be used as base plates to which steel profiles are welded. The fastening plates transfer loads from structures welded on it to concrete structures. The loads are transferred through rebar anchors.

SBKL fastening plates consist of a steel on which stud head anchors are welded. Multiple sizes of plates are manufactured with different material options.

The resistances of SBKL fastening plates are calculated for static loads.

Minimum reinforcement according to SFS-EN 1992-1-1 is always to be used in the location of the fastening plates to guarantee ductility of the structure in ultimate limit state. If in this manual the resistance is given without additional reinforcement, the minimum reinforcement is not contributing to the resistance given. When in this manual the resistance is presented with additional reinforcement, in addition to the minimum reinforcement, the structure has additional reinforcement according to section 4.10.

2 DIMENSIONS AND MATERIALS OF SBKL FASTENING PLATES

2.1 MATERIALS AND STANDARDS

1	2	3	4
Type	Part	Material	Standard
SBKL	Steel plate	S355J2+N	SFS-EN 10025
	Anchor	S355J2+N	SFS-EN 10025
SBKLR	Steel plate	1.4301	SFS-EN 10088
	Anchor	S355J2+N	SFS-EN 10025
SBKLH	Steel plate	1.4401	SFS-EN 10088
	Anchor	S355J2+N	SFS-EN 10025
SBKLRr	Steel plate	1.4301	SFS-EN 10088
	Anchor	1.4301	SFS-EN 10088

2.2 SBKL DIMENSIONS

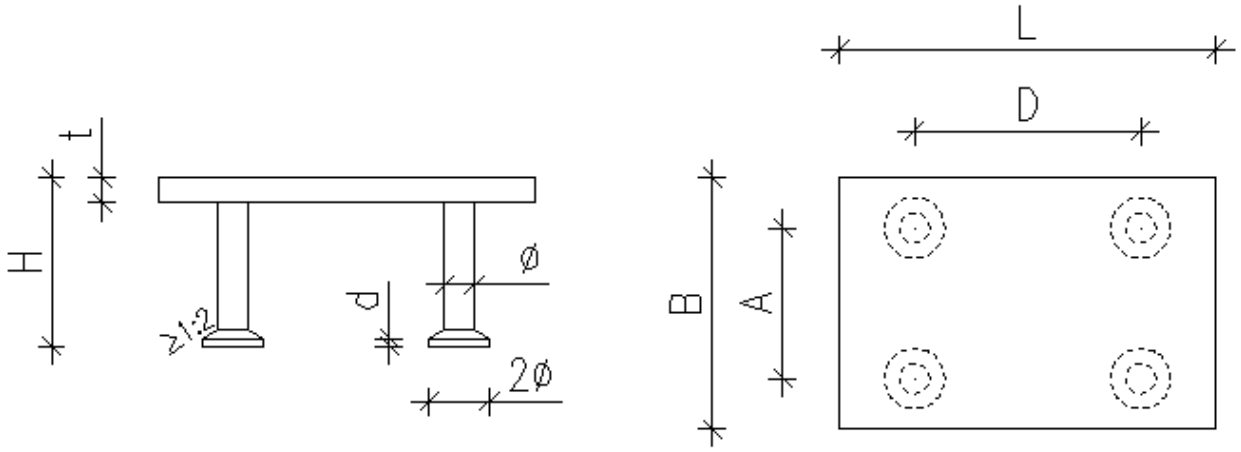

Figure 1. SBKL fastening plate dimensions

Table 1. SBKL fastening plate dimensions

1				2	3	4	5	6	7
SBKL fastening plate				H	A	D	t	Ø	d
	B	x	L	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
SBKL	50	x	100	68	-	60	8	12	3
	50	x	100	108	-	60	8	12	3
	100	x	100	68	60	60	8	12	3
	100	x	100	108	60	60	8	12	3
	100	x	150	70	60	90	10	12	3
	100	x	150	110	60	90	10	12	3
	100	x	200	72	60	120	12	12	3
	100	x	200	112	60	120	12	14	3
	100	x	200	162	60	120	12	14	3
	100	x	300	165	60	180	15	16	4
	150	x	150	70	90	90	10	12	3
	150	x	150	110	90	90	10	12	3
	150	x	150	162	90	90	12	14	3
	200	x	200	72	120	120	12	14	3
	200	x	200	112	120	120	12	14	3
	200	x	200	162	120	120	12	16	4
	200	x	300	165	120	180	15	16	4
	250	x	250	165	170	170	15	16	4
	300	x	300	165	180	180	15	16	4

3 MANUFACTURING AND TOLERANCES

3.1 MANUFACTURING METHOD AND EXECUTION CLASS

Steel plates: Thermal or mechanical cutting
Steel bars: Mechanical cutting, heading (cold/hot)
Welding: MAG welding, manual or robotic, resistance welding or arc stud welding
Welding class: C (SFS-EN ISO 5817), EXC2 (SFS-EN 1090-2 section 7.6)

Execution class: EXC2 (SFS-EN 1090-2) [more demanding classes according to a separate guideline]

3.2 MANUFACTURING TOLERANCES

Plate side lengths:

	± 4 mm	150 mm < L ≤ 600 mm
Plate straightness:	L/150	
Plate cut edge surface roughness:	SFS-EN 1090-2	
Squareness of cut edges:	SFS-EN 1090-2	
Steel part height:	± 5 mm	
Anchor location:	± 5 mm	
Anchor spacing:	± 5 mm	
Anchor inclination:	± 5°	

3.3 SURFACE TREATMENT

Protective painting shall be applied to the visible surfaces of the fastening plates. The fastening plates are delivered with an approximately 40 µm shop priming. Upon request the fastening plates are delivered with a 60 µm epoxy painting or hot dip galvanized according to galvanizing standard. Stainless and acid-proof fastening plates are delivered without protective painting.

3.4 QUALITY CONTROL

Demands of product standards are to be applied in quality control. The manufacturer of the fastening plates has a valid quality control agreement for the quality control of steel part manufacturing.

4 RESISTANCES

4.1 BASIS OF STRUCTURAL DESIGN

The resistances of JKL fastening plates have been calculated according to the following norms, rules, and regulations:

SFS-EN 1992 Eurocode 2 Design of concrete structures
SFS-EN 1993 Eurocode 3 Design of steel structures

The resistances have been calculated with respect to static loads. For dynamic and fatigue loads the resistances need to be separately checked on a case-by-case basis.

4.2 RESISTANCES WITHOUT EFFECTS OF ADDITIONAL REINFORCEMENT AND EDGE DISTANCE

Tables 2 and 3 present the resistances of SBKL fastening plates when only one loading acts at a time. The resistance of SBKL fastening plates with respect to combinations of load effects shall be checked according to 4.7.

The resistances given in table 2 and 3 have been calculated using the following assumptions:

- Concrete strength C25/30
- Cracking can occur in the location of the fastening plate.
- No additional reinforcement at the location of the fastening plate. Structure only reinforced with minimum reinforcement and splitting reinforcement in section 4.6. The resistances of fastening plate with additional reinforcement are presented in section 4.10.
- Concrete structure has been designed to withstand all applied loads.
- The fastening plate is located so far from the edge that the breakage of the edge of concrete structure is not a governing failure mechanism (the required edge distances are given in section 4.4). If the edge distance is smaller than what given in 4.4, the resistances need to be reduced or additional reinforcement according to section 4.10 needs to be used at the location of the fastening plate.
- The thickness of the member on which the fastening plate is mounted is according to section 4.5.
- The tolerance for the location of a load is smaller of 10 % plate side dimension or 15 mm (In addition the manufacturing tolerance ± 5 mm has been considered in the calculations).
- The fastening surface of the steel component to be mounted on the fastening plate shall have minimum area according to section 4.3.
- Shear force V_{Ed} can act in both directions of the plate but in one direction at a time. Shear force acting in both directions need to be considered according to section 4.7.
- Bending moment M_{Ed} can act in both plate directions but only in one direction at a time. Bending moment acting in both directions simultaneously shall be considered according to section 4.7.

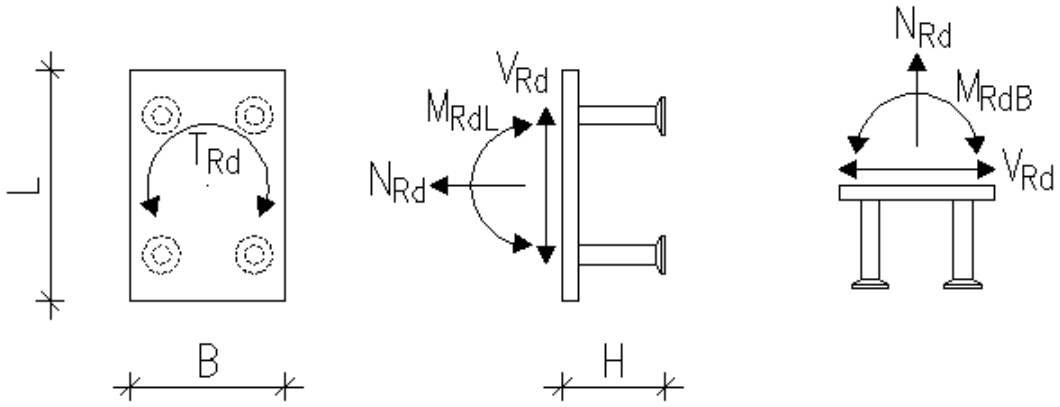

Figure 2. Notation for force directions in SBKL fastening plates

Table 2. Resistances of SBKL, SBKLR and SBKLH fastening plates for single load effects for cracked C25/30 concrete without additional reinforcement and without considering the effect of edge distances.

1				2	3	4	5	6	7
Fastening plate				H	N_{Rd}	V_{Rd}	M_{RdL}	M_{RdB}	T_{Rd}
	B	x	L	[mm]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
	50	x	100	68	14,3	28,5	0,8	0,3	1,0
	50	x	100	108	26,8	38,5	2,0	0,6	2,3
	100	x	100	68	18,7	37,3	1,1	1,1	1,8
	100	x	100	108	41,3	71,2	2,8	2,8	3,8
	100	x	150	70	20,9	41,8	1,8	1,3	2,7
	100	x	150	110	44,4	70,3	4,3	3,1	5,2
	100	x	200	72	24,1	48,2	2,6	1,6	3,9
	100	x	200	112	48,7	97,3	5,9	3,2	7,3
SBKL	100	x	200	162	77,3	101,0	9,9	5,5	8,8
SBKLR	100	x	300	165	86,4	141,5	14,1	5,5	16,3
SBKLH	150	x	150	70	23,3	46,6	1,9	1,9	3,6
	150	x	150	110	47,9	73,3	4,6	4,6	6,1
	150	x	150	162	77,5	99,8	7,9	7,9	8,3
	200	x	200	72	23,1	23,1	1,9	1,9	2,4
	200	x	200	112	56,2	106,1	6,8	6,8	10,7
	200	x	200	162	85,3	138,6	10,4	10,4	14,5
	200	x	300	165	95,9	144,6	16,8	12,2	18,5
	250	x	250	165	102,3	146,9	15,8	15,8	20,6
	300	x	300	165	105,5	148,0	18,6	18,6	21,8

The values in table 2 are maximum resistances of SBKL, SBKLR and SBKLH fastening plates for individual load effects. The maximum resistances given are values for concrete structures with minimum reinforcement and fastening plate locations according to tables 5 and 6 without additional reinforcement.

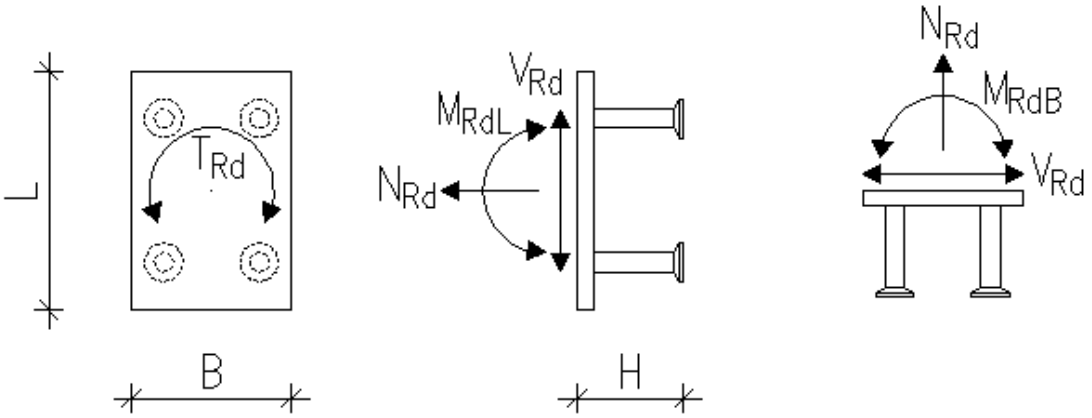

Figure 3. Notation for force directions in SBKL fastening plates

Table 3. Resistances of SBKLRr fastening plates for single load effects for cracked C25/30 concrete without additional reinforcement and without considering the effect of edge distances.

1				2	3	4	5	6	7
Fastening plate				H	N_{Rd}	V_{Rd}	M_{RdL}	M_{RdB}	T_{Rd}
	B	x	L	[mm]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
SBKLRr	50	x	100	68	14,3	19,0	0,8	0,3	1,0
	50	x	100	108	15,8	19,0	2,0	0,6	1,4
	100	x	100	68	18,7	35,1	1,1	1,1	1,8
	100	x	100	108	41,3	35,1	2,8	2,8	2,0
	100	x	150	70	20,9	34,7	1,8	1,3	2,6
	100	x	150	110	44,4	34,7	4,3	2,9	2,6
	100	x	200	72	24,1	36,6	2,6	1,6	3,2
	100	x	200	112	48,7	49,8	5,9	3,3	4,3
	100	x	200	162	77,3	49,8	8,1	4,1	4,3
	100	x	300	165	86,4	69,7	14,1	4,8	8,0
	150	x	150	70	23,3	36,1	1,9	1,9	3,0
	150	x	150	110	47,9	36,1	4,4	4,4	3,0
	150	x	150	162	77,5	49,2	6,1	6,1	4,1
	200	x	200	72	23,1	23,1	1,9	1,9	2,4
	200	x	200	112	56,2	52,3	6,8	6,8	5,5
	200	x	200	162	85,3	68,3	9,9	9,9	7,2
	200	x	300	165	95,9	71,3	15,8	10,5	9,1
	250	x	250	165	102,3	72,4	13,7	13,7	10,2
	300	x	300	165	105,5	73,0	15,9	15,9	10,7

The values in table 3 are maximum resistances of SBKLRr fastening plates for individual load effects. The maximum resistances given are values for concrete structures with minimum reinforcement and fastening plate locations according to tables 5 and 6 without additional reinforcement.

4.3 FASTENING AREA

When using resistances given in section 4.2 the fastening areas of the steel components to be attached on the SBKL fastening plates shall have minimum values according to table 3. If the steel component is welded all around, the welds can be taken as part of the fastening area. If necessary, stiffeners can be used in the connection between the fastening plate and the steel component to achieve the required fastening area.

Table 4. SBKL fastening plate minimum fastening areas

1				2	3			4		
Fastening plate				H	Minimum fastening area					
					SBKL			SBKLR, SBKLH, SBKLRr		
	B	x	L	[mm]	[mm]	x	[mm]	[mm]	x	[mm]
SBKL SBKLR SBKLH SBKLRr	50	x	100	68	5	x	50	15	x	60
	50	x	100	108	20	x	60	30	x	70
	100	x	100	68	45	x	45	55	x	55
	100	x	100	108	70	x	70	75	x	75
	100	x	150	70	30	x	80	40	x	90
	100	x	150	110	50	x	100	65	x	115
	100	x	200	72	20	x	105	30	x	120
	100	x	200	112	30	x	145	50	x	150
	100	x	200	162	52	x	155	65	x	165
	100	x	300	165	42	x	200	60	x	225
	150	x	150	70	50	x	50	65	x	65
	150	x	150	110	100	x	100	110	x	110
	150	x	150	162	100	x	100	115	x	115
	200	x	200	72	40	x	40	55	x	55
	200	x	200	112	120	x	120	135	x	135
	200	x	200	162	120	x	120	135	x	135
	200	x	300	165	100	x	200	125	x	225
	250	x	250	165	150	x	150	170	x	170
	300	x	300	165	190	x	190	215	x	215

If the fastening area of the component to be mounted on the fastening plate is smaller than value given in table 3, the resistances of SBKL fastening plate need to be reduced according to appendix 2.

For shear force and torsional moment, it is not necessary to reduce the resistances due to fastening area.

4.4 MINIMUM EDGE AND CENTER DISTANCES

When using resistance values given in section 4.2, the center and edge distances of SBKL fastening plates need to equal to at least the values given in table 5. The values given in table 4 are such that the concrete edge breakout is not decisive mode of failure. With smaller edge or center distances, the resistances of SBKL fastening plates shall be reduced according to appendix 1 or resistance needs to be calculated according to EN 1992-4.

The edge distances in table 4 are distances between the center of an anchor in SBKL fastening plate to the edge of the concrete structure, according to Figure 3. Similarly, the center distances are distances between the centers of adjacent anchors in SBKL fastening plates.

The center distance k_t has the minimum value of 2 x the edge distance if the full resistances according to table 2 are used. With smaller center distances, the resistance of the fastening plates shall be reduced according to appendix 1 as with single fastening plates

In special cases and for further information please contact Semko technical support.

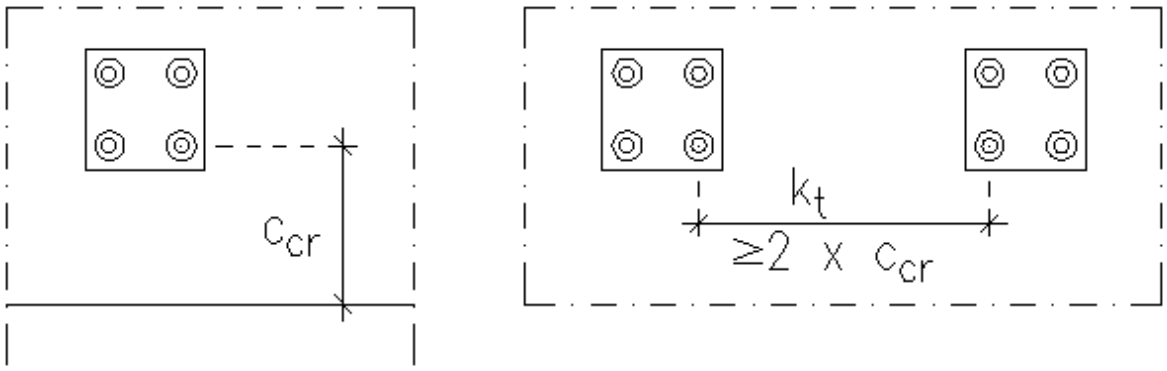

Figure 4. The edge distance c_{cr} of SBKL fastening plate from the center of the anchor to the edge of the concrete structure and the center distance between adjacent fastening plates.

Table 5. Minimum edge distances of SBKL fastening plates for resistances according to section 4.2.

1				2	3	4
Fastening plate				H	Minimum edge distance for resistances N_{Rd}, M_{RdL} ja M_{RdB}	Minimum edge distance for resistances V_{Rd} ja T_{Rd}
	B	x	L	[mm]	$c_{cr.N.1}$ [mm]	$c_{cr.V}$ [mm]
SBKL SBKLR SBKLH SBKLRr	50	x	100	68	98	650
	50	x	100	108	158	720
	100	x	100	68	98	650
	100	x	100	108	158	720
	100	x	150	70	101	670
	100	x	150	110	161	720
	100	x	200	72	104	690
	100	x	200	112	164	840
	100	x	200	162	239	840
	100	x	300	165	242	960
	150	x	150	70	101	670
	150	x	150	110	161	720
	150	x	150	162	239	840
	200	x	200	72	86	570
	200	x	200	112	164	840
	200	x	200	162	237	960
	200	x	300	165	242	960
	250	x	250	165	242	960
	300	x	300	165	242	960

4.5 CONCRETE MINIMUM THICKNESS

When using the resistances given in section 4.2 thickness of the concrete base must have the minimum value given in table 6.

Table 6. Minimum concrete thickness for SBKL fastening plate

1				2	3
Fastening plate				H	Minimum thickness h_{min} of the base (concrete structure)
	B	x	L	[mm]	[mm]
SBKL SBKLR SBKLH SBKLRr	50	x	100	68	88
	50	x	100	108	128
	100	x	100	68	88
	100	x	100	108	128
	100	x	150	70	90
	100	x	150	110	130
	100	x	200	72	92
	100	x	200	112	132
	100	x	200	162	182
	100	x	300	165	185
	150	x	150	70	90
	150	x	150	110	130
	150	x	150	162	182
	200	x	200	72	92
	200	x	200	112	132
	200	x	200	162	182
	200	x	300	165	185
	250	x	250	165	185
	300	x	300	165	185

4.6 SPLITTING REINFORCEMENT

For resistances in section 4.2 splitting reinforcement must be installed on the fastening plate area.

Required splitting reinforcement may be determined by EN 1992-4 section 7.2.1.7 equation

$$A_{s,re} = 0{,}5\frac{N_{Ed}}{f_{yk,re}/\gamma_{Ms,re}}$$

where

N_{Ed} = applied tension load on fastening plate
$f_{yk,re}$ = yield strength of reinforcement (≤ 600 MPa)
$\gamma_{Ms,re}$ = partial safety factor of reinforcement = 1,15

Reinforcement areas for resistances in section 4.2 are given in table 6. Splitting reinforcement needs to be placed on top and side of concrete structure (see figure 4). Other reinforcement in concrete may be used for splitting, provided it is not fully utilized for other requirements.

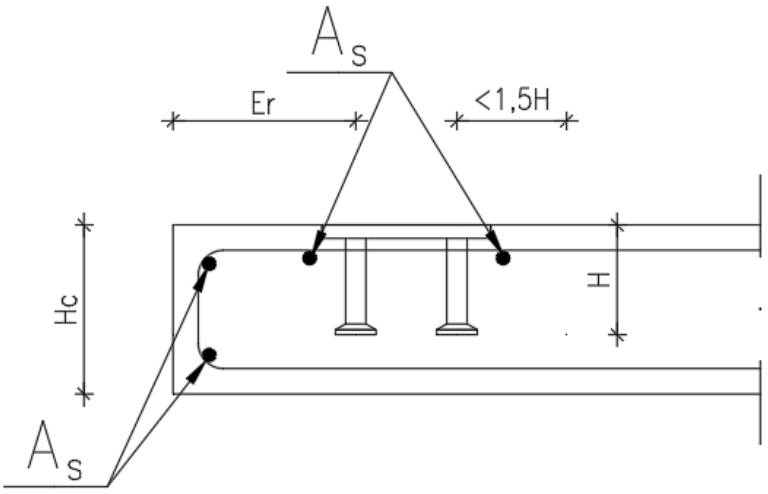

Figure 5. Positioning of splitting reinforcement in structure

Splitting reinforcement area in figure 5 is given in table 7 column 3.

Splitting reinforcement is placed next to fastening plate anchors (max. distance 1,5 H) on top and side of concrete as in figure 5.

Table 7. SBKL fastening plate splitting reinforcement

1				2	3	4	5
Fastening plate				H	Splitting reinforcement A_s	Diameter d_s	Number of rebars n_s
	B	x	L	[mm]	[mm^2]	[mm]	[kpl]
SBKL SBKLR SBKLH SBKLRr	50	x	100	68	16	6	2
	50	x	100	108	31	6	2
	100	x	100	68	22	6	2
	100	x	100	108	47	6	2
	100	x	150	70	24	6	2
	100	x	150	110	51	6	2
	100	x	200	72	28	6	2
	100	x	200	112	56	6	2
	100	x	200	162	89	8	2
	100	x	300	165	99	8	2
	150	x	150	70	27	6	2
	150	x	150	110	55	6	2
	150	x	150	162	89	8	2
	200	x	200	72	27	6	2
	200	x	200	112	65	8	2
	200	x	200	162	98	8	2
	200	x	300	165	110	10	2
	250	x	250	165	118	10	2
	300	x	300	165	121	10	2

4.7 RESISTANCES FOR COMBINATIONS OF LOAD EFFECTS

If multiple load effects act simultaneously on JKL fastening plate the resistance of the fastening plate shall be checked according to the following equations.

$$\beta_N = \frac{N_{Ed}}{N_{Rd}} + \frac{M_{EdL}}{M_{RdL}} + \frac{M_{EdB}}{M_{RdB}} \leq 1{,}0 \qquad (1)$$

$$\beta_V = \frac{V_{EdB}+V_{EdL}}{V_{Rd}} + \frac{T_{Ed}}{T_{Rd}} \leq 1{,}0 \qquad (2)$$

Where subscript Ed means the ultimate limit state value for the dimensioning value of the load effect and Rd the corresponding resistance of the fastening plate and subscript corresponds to the direction of the load or resistance.

In addition to equations (1) and (2) following equations need to be verified:

With no reinforcement in concrete area or additional reinforcement for all loads, equations 3, 4 and 5.

$$(\beta_N)^2 + (\beta_V)^2 \leq 1{,}0 \qquad (3)$$

$$(\beta_N)^{1{,}5} + (\beta_V)^{1{,}5} \leq 1{,}0 \qquad (4)$$

$$\beta_N + \beta_V \leq 1{,}2 \qquad (5)$$

If concrete base is not reinforced for all loads (i.e. reinforcement only for some load and for other load concrete resistance is used) equation 6 needs to be verified.

$$(\beta_N)^{\frac{2}{3}} + (\beta_V)^{\frac{2}{3}} \leq 1{,}0 \qquad (6)$$

See also EN 1992-4.

4.8 EFFECT OF EDGE AND CENTER DISTANCES ON RESISTANCES

If SBKL fastening plate edge or center distances are smaller than given in table 5, resistances in section 4.2 need to be reduced. Resistances may be determined with appendix 1 or calculated according to EN 1992-4.

Minimum values of edge distances which may not be fallen below without additional reinforcement are given in table 8.

Table 8. SBKL fastening plate minimum edge distances without additional reinforcement

1				2	3	4
Fastening plate				H	Minimum edge distance for resistances N_{Rd}, M_{RdL} ja M_{RdB}	Minimum edge distance for resistances V_{Rd} ja T_{Rd}
	B	x	L	[mm]	$c_{cr.N.min}$ [mm]	$c_{cr.V.min}$ [mm]
SBKL SBKLR SBKLH SBKLRr	50	x	100	68	50	150
	50	x	100	108	50	150
	100	x	100	68	50	150
	100	x	100	108	50	150
	100	x	150	70	50	150
	100	x	150	110	50	150
	100	x	200	72	50	150
	100	x	200	112	50	150
	100	x	200	162	50	150
	100	x	300	165	60	150
	150	x	150	70	50	150
	150	x	150	110	50	150
	150	x	150	162	50	150
	200	x	200	72	50	150
	200	x	200	112	50	150
	200	x	200	162	50	150
	200	x	300	165	60	150
	250	x	250	165	50	150
	300	x	300	165	60	150

4.9 EFFECT OF REINFORCEMENT ON EDGE DISTANCES

Concrete cover required by exposure class and fire class must be accounted for with additionally reinforced SBKL fastening plates. Section 4.10 gives the reinforcement effect on resistances and figures 6 and 7 principles on reinforcing.

4.10EFFECT OF REINFORCEMENT ON RESISTANCES

Reinforcement improves SBKL fastening plate resistances when resistances should otherwise need to be reduced due to edge distances. In tables 9 and 10 resistance of one rebar placed as in figures 6 and 7 is presented. Total resistance of SBKL fastening plate with additional reinforcement depends on the number of correctly placed rebars in concrete.

Maximum resistances with additional reinforcement are in paragraph 4.11.

4.10.1REINFORCEMENT FOR TENSION AND BENDING

Additional reinforcement for tension and bending loads is to be placed to concrete as in figure 6. Additional reinforcement is placed as close to SBKL anchors as possible. Maximum distance between SBKL anchor and reinforcement bar is 0,5H from the center of anchor. Additional reinforcement is to be anchored to the concrete structure outside SBKL fastening plate concrete cone for full yield force.

Straight rebar is to be placed inside the bend of the additional reinforcement, diameter at least the same as additional rebar.

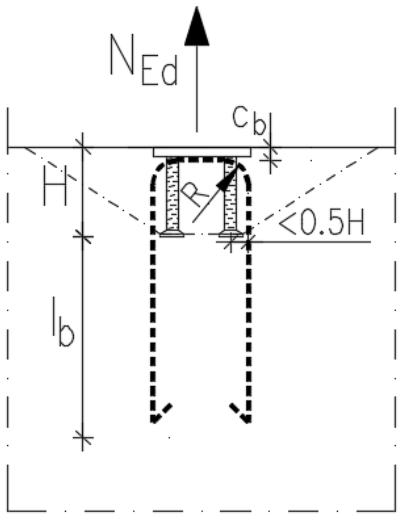

Figure 6. SBKL fastening plate reinforcement for tension and bending

c_b = concrete cover (20mm)
l_b = anchoring length in EN 1992-1-1
R = bending radius of reinforcement according to EN 1992-1-1

Table 9 gives tension resistances (anchoring resistance in concrete cone) for SBKL fastening plates when positioned as in figure 6. Values in table are for ”poor” bond conditions. Total tension resistance for additionally reinforced SBKL fastening plate is obtained by multiplying the number of reinforcing bars with the resistance of one rebar in table 9. Additional reinforcement must be placed as close as possible to JKL fastening plate anchors.

Values in table 9 are calculated for steel grade B500B or similar rebar.

Table 9. Tension resistances for SBKL fastening plate additional reinforcement (one reinforcement loop positioned as in figure 6)

1	2	3	4	5	6
Fastening plate		Tension resistance of reinforcement $N_{Rd.s}$ [kN]			
		Rebar diameter Φs [mm]			
	H [mm]	T6	T8	T10	T12
SBKL SBKLR SBKLH SBKLRr	68	1,4	-	-	-
	70	1,4	-	-	-
	72	1,5	-	-	-
	110	2,9	2,5	3,2	3,8
	112	2,9	2,6	3,2	3,9
	162	4,7	4,2	5,2	6,3
	165	4,8	4,3	5,3	6,4

For shallow fastening plates the concrete cone heigth is only sufficient for anchoring 6 mm rebar.

If required concrete cover for additional rebar is greater than 20 mm, anchoring resistance in concrete cone must be calculated on a case-by-case basis and table 9 values can’t be used.

In ”good” bond conditions values in table 8 may be increased by factor 1,42.

4.10.2 REINFORCEMENT FOR SHEAR AND TORSION

Additional reinforcement for shear and torsion loads is to be placed to concrete as in figure 7. Shear reinforcement is to be placed in the direction of the applied shear load and as close as possible to the SBKL steel plate. Additional reinforcement is bent and positioned to be in tight contact with SBKL fastening plate anchors. Additional reinforcement is to be anchored outside the SBKL concrete cone for full reinforcement tension force as in figure 7 section A-A.

It is vitally important to ensure tight contact between additional reinforcement and SBKL anchors when using resistances in table 10. It is assumed the force from anchors is directly transferred to the reinforcement.

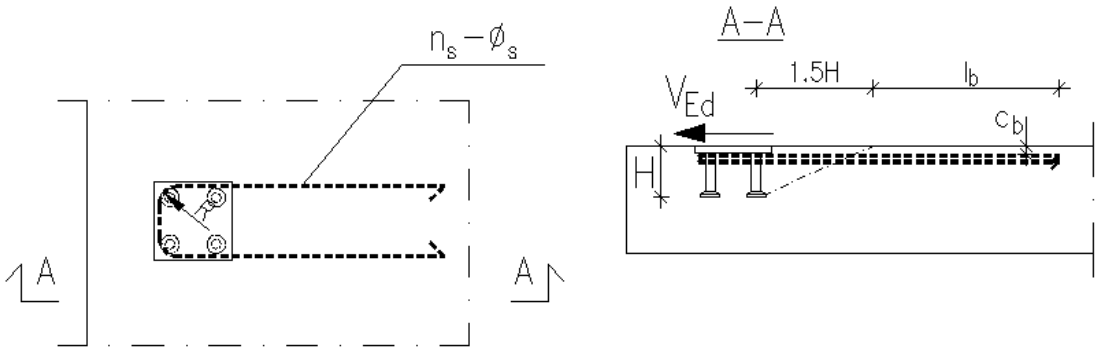

Figure 7. SBKL fastening plate reinforcement for shear and torsion

c_b = concrete cover (20mm)
l_b = anchoring length in EN 1992-1-1
R = bending radius of reinforcement according to EN 1992-1-1

Values in table 10 are calculated for steel grade B500B or similar rebar.

Table 10. Shear resistances for SBKL fastening plate additional reinforcement (one reinforcement loop positioned as in figure 7)

1		2	3	4	5
Fastening plate		Shear resistance of reinforcement $V_{Rd.s}$ [kN]			
		Rebar diameter Φs [mm]			
B x L		T6	T8	T10	T12
SBKL SBKLR SBKLH SBKLRr	ALL SIZES	6,1	10,9	17,1	24,6

From the eccentricity between shear force plane and reinforcement plane an additional tension force originates to the reinforcement. This additional tension force is calculated as follows:

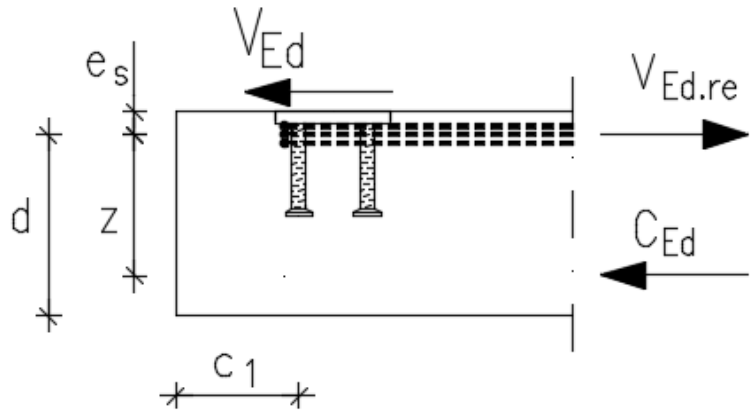

Figure 8. Additional tension force in shear force reinforcement

$$V_{Ed.re} = \left(\frac{e_s}{z} + 1\right) \cdot V_{Ed} \qquad (4)$$

where

e_s = distance between shear force (steel plate top) and middle of reinforcement

z = internal lever arm in concrete ≈ 0,85d ($d \leq \min\begin{Bmatrix} 2H \\ 2c_1 \end{Bmatrix}$)

See also EN 1992-4.

4.11 MAXIMUM RESISTANCES WITH ADDITIONAL REINFORCEMENT

Maximum resistances of SBKL fastenin plates are given in tables 11…13. Applicable resistance depends on reiforcement resistance according to 4.10.1 and 4.10.2. Additional reinforcement is to be placed according to figures 6 and 7.

In practical design maximum values in tables 11…13 are difficult to obtain even with additional reinforcement.

Table 11. Maximum resistances of SBKL fastening plate

1				2	3	4	5	6	7
Fastening plate				H	$N_{Rd.max}$	$V_{Rd.max}$	$M_{RdL.max}$	$M_{RdB.max}$	$T_{Rd.max}$
	B	x	L	mm	[kN]	[kN]	[kNm]	[kNm]	[kNm]
SBKL	50	x	100	68	15,8	38,5	1,6	0,3	2,9
	50	x	100	108	26,8	38,5	2,3	0,5	2,9
	100	x	100	68	34,9	71,2	1,8	1,8	4,1
	100	x	100	108	71,4	71,2	4,6	4,6	4,1
	100	x	150	70	31,9	70,3	3,0	2,0	5,2
	100	x	150	110	63,4	70,3	6,3	4,5	5,2
	100	x	200	72	38,3	74,2	4,7	2,9	6,5
	100	x	200	112	55,6	101,0	8,5	3,8	8,8
	100	x	200	162	106,5	101,0	13,1	6,0	8,8
	100	x	300	165	124,8	141,5	21,0	5,7	16,3
	150	x	150	70	32,5	73,3	2,5	2,5	6,1
	150	x	150	110	98,9	73,3	7,2	7,2	6,1
	150	x	150	162	134,6	99,8	9,9	9,9	8,3
	200	x	200	72	37,7	106,1	2,5	2,5	11,1
	200	x	200	112	144,5	106,1	12,4	12,4	11,1
	200	x	200	162	160,6	138,6	15,3	15,3	14,5
	200	x	300	165	195,9	144,6	25,1	16,8	18,5
	250	x	250	165	187,9	146,9	22,0	22,0	20,6
	300	x	300	165	203,1	148,0	25,8	25,8	21,8

Table 12. Maximum resistances of SBKLR and SBKLH fastening plates

1				2	3	4	5	6	7
Fastening plate				H	$N_{Rd.max}$	$V_{Rd.max}$	$M_{RdL.max}$	$M_{RdB.max}$	$T_{Rd.max}$
	B	x	L	mm	[kN]	[kN]	[kNm]	[kNm]	[kNm]
SBKLR SBKLH	50	x	100	68	21,1	38,5	1,7	0,4	2,9
	50	x	100	108	26,8	38,5	2,0	0,6	2,9
	100	x	100	68	36,6	71,2	2,0	2,0	4,1
	100	x	100	108	42,2	71,2	3,2	3,2	4,1
	100	x	150	70	25,0	70,3	2,4	1,7	5,2
	100	x	150	110	66,0	70,3	6,8	4,3	5,2
	100	x	200	72	29,5	74,2	3,9	2,4	6,5
	100	x	200	112	58,2	101,0	8,7	4,5	8,8
	100	x	200	162	95,0	101,0	13,1	6,2	8,8
	100	x	300	165	148,4	141,5	18,2	7,2	16,3
	150	x	150	70	25,9	73,3	2,1	2,1	6,1
	150	x	150	110	66,0	73,3	7,2	7,2	6,1
	150	x	150	162	95,0	99,8	10,0	10,0	8,3
	200	x	200	72	26,4	106,1	2,6	2,6	11,1
	200	x	200	112	95,0	106,1	12,4	12,4	11,1
	200	x	200	162	95,0	138,6	12,8	12,8	14,5
	200	x	300	165	148,4	144,6	25,4	16,9	18,5
	250	x	250	165	148,4	146,9	22,0	22,0	20,6
	300	x	300	165	148,4	148,0	25,8	25,8	21,8

Table 13. Maximum resistances of SBKLRr fastening plate

1				2	3	4	5	6	7
Fastening plate				H	$N_{Rd.max}$	$V_{Rd.max}$	$M_{RdL.max}$	$M_{RdB.max}$	$T_{Rd.max}$
	B	x	L	mm	[kN]	[kN]	[kNm]	[kNm]	[kNm]
SBKLRr	50	x	100	68	15,8	19,0	1,7	0,5	1,4
	50	x	100	108	15,8	19,0	2,0	0,6	1,4
	100	x	100	68	36,6	35,1	2,0	2,0	2,0
	100	x	100	108	42,2	35,1	2,9	2,9	2,0
	100	x	150	70	25,0	34,7	2,4	1,7	2,6
	100	x	150	110	54,9	34,7	4,3	2,9	2,6
	100	x	200	72	29,5	36,6	3,9	2,4	3,2
	100	x	200	112	58,2	49,8	7,7	3,8	4,3
	100	x	200	162	77,6	49,8	8,1	4,1	4,3
	100	x	300	165	105,6	69,7	14,5	4,8	8,0
	150	x	150	70	25,9	36,1	2,1	2,1	3,0
	150	x	150	110	58,5	36,1	4,4	4,4	3,0
	150	x	150	162	79,6	49,2	6,1	6,1	4,1
	200	x	200	72	26,4	52,3	2,2	2,2	5,5
	200	x	200	112	85,5	52,3	7,9	7,9	5,5
	200	x	200	162	95,0	68,3	9,9	9,9	7,2
	200	x	300	165	115,9	71,3	15,8	10,5	9,1
	250	x	250	165	119,1	72,4	13,7	13,7	10,2
	300	x	300	165	120,1	73,0	15,9	15,9	10,7

5 USE OF FASTENING PLATES

5.1 SERVICE LIFE AND ALLOWED EXPOSURE CLASSES

Service life of SBKL fastening plates depends on the chosen fastening plate material. SBKL fastening plates may be used in all concrete structure exposure classes when the requirements of the exposure classes for the concrete cover of steel parts of the fastening plate are complied with. If necessary, stainless SBKLR, acid proof SBKLH or totally stainless SBKLRr fastening plate types are to be used.

5.2 LIMITATIONS FOR USE

Capacities for SBKL fastening plates are calculated for static loads. For dynamic or fatigue loads larger partial safety factors for loads must be used and the components of the connection must be checked on a case-by-case basis.

Resistances for SBKL fastening plates have been calculated for cracked concrete with strength class C25/30.

A reinforcement to guarantee ductile action of the structure in ultimate limit state must always be installed in location of the SBKL fastening plates.

6 STORAGE, TRANSPORTATION AND MARKING OF THE FASTENING PLATES

SBKL fastening plates are to be stored protected from the rain.

Marking is made into SBKL fastening plates that shows at least the manufacturer, type and identifier and manufacturing date of the fastening plate.