SUJ ANCHOR BOLTS

TECHNICAL MANUAL
EuroCODE DESIGN

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1 ANCHOR BOLT PRINCIPLE

SUJ anchor bolts are steel parts embedded in concrete before casting. They transfer loads from attached structures to base column or footing. Bolts are anchored with rebar anchorage (SUJ/P) or with anchor plates (SUJ/L).

2 ANCHOR BOLTS

2.1 ANCHOR BOLT MATERIALS

Table 1. Anchor bolt materials

Part	Material	Standard
Rebar	B500B	SFS 1300
Anchor plate	S355J2+N	SFS-EN 10025
Washer	S235JR+AR	SFS-EN 10025
Nut	Grade 8 Dimensions	EN ISO 898-2 DIN 934 / ISO 4032

2.2 ANCHOR BOLTS ORDERING CODE

Anchor bolts may be ordered without coating or hot-dip galvanized.

Ordering code SUJ/P: long anchor bolt

Ordering code SUJ/L: short anchor bolt with anchor plate

Ordering code SUJ/P-KZN: long anchor bolt hot-dip galvanized

Ordering code SUJ/L-KZN: short anchor bolt with anchor plate hot-dip galvanized

2.3 SUJ/L ANCHOR BOLT DIMENSIONS

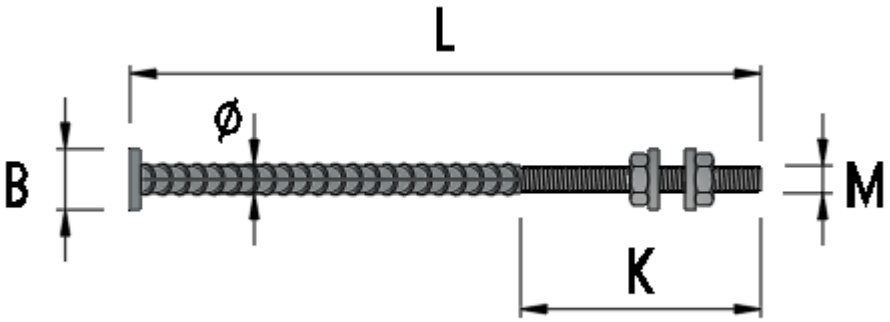

Figure 1. SUJ/L anchor bolt dimensions

Table 2. SUJ/L anchor bolt dimensions

Anchor bolt	M	Ø [mm]	K [mm]	B x B [mm x mm]	t [mm]	h_{ef} [mm]	L [mm]	Washers	Weight [kg]	Color
SUJ 16 L	16	16	140	35 x 35	6	169	280	35 x 35 x 6 tai Ø38 x 6	0,5	Yellow
SUJ 20 L	20	20	140	45 x 45	8	227	350	45 x 45 x 6 tai Ø46 x 6	1,0	Blue
SUJ 24 L	24	25	170	50 x 50	10	290	430	50 x 50 x 6 tai Ø56 x 6	1,8	Grey
SUJ 30 L	30	32	190	60 x 60	12	338	500	60 x 60 x 8 tai Ø65 x 8	3,4	Green
SUJ 39 L	39	40	200	80 x 80	15	505	700	70 x 70 x 10 tai Ø90 x 10	7,6	Orange

Bolt delivery includes nuts and washers (2 pcs/bolt).

NB! When using SUJ anchor bolts with SSK wall shoes, washers for wall shoes must be used.

2.4 SUJ/P ANCHOR BOLT DIMENSIONS

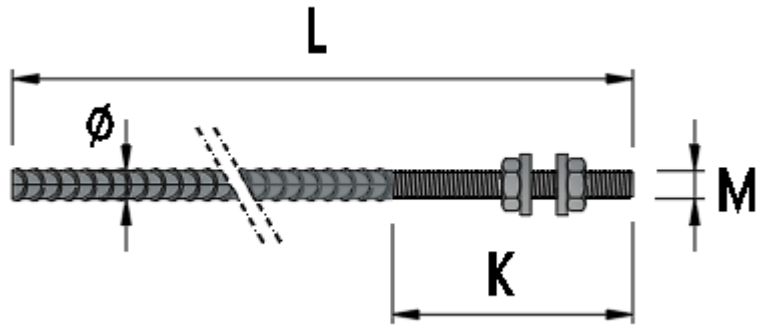

Figure 2. SUJ/P anchor bolt dimensions

Table 3. SUJ/P anchor bolt dimensions

Anchor bolt	M	Ø [mm]	K [mm]	L [mm]	Washers	Weight [kg]	Color
SUJ 16 P	16	16	140	820	35 x 35 x 6 tai Ø38 x 6	1,3	Yellow
SUJ 20 P	20	20	140	1000	45 x 45 x 6 tai Ø46 x 6	2,5	Blue
SUJ 24 P	24	25	170	1150	50 x 50 x 6 tai Ø56 x 6	4,4	Grey
SUJ 30 P	30	32	190	1410	60 x 60 x 8 tai Ø65 x 8	8,9	Green
SUJ 39 P	39	40	200	2000	70 x 70 x 10 tai Ø90 x 10	19,7	Orange

Bolt delivery includes nuts and washers (2 pcs/bolt).

SUJ/P anchor bolt lenght is determined for rebar lap lenght in ”good” bond conditions with concrete class C25/30.

NB! When using SUJ anchor bolts with SSK wall shoes, washers for wall shoes must be used.

2.5 MANUFACTURING

2.5.1 Manufacturing method

Rebars are cut to length mechanically. Rebars are welded to the thread part and anchor plates are welded to rebar ends (SELP/L). MIG welding, manual or robotic. Welding class C according to SFS-EN ISO 5817.

2.5.2 Tolerances

Total length:	± 10 mm
Thread length:	+ 5, -0 mm, thread 6g
Washer sides and hole	± 1 mm

2.5.3 Markings

Delivery includes Kiwa Inspecta Oy marking, steel part code and manufacturers name.

3 RESISTANCES

3.1 DESIGN CONCEPT

Resistances of SUJ anchor bolts are designed according to

EN 1992-1-1: Eurocode 2: Design of concrete structures
EN 1992-4: Eurocode 2: Design of concrete structures
EN 1993-1-1: Eurocode 3: Design of steel structures
EN 1993-1-8: Eurocode 3: Design of steel structures

Resistances are calculated in concrete class C25/30.

Resistances are calculated for static loads in ULS in ”good” bond conditions. Design for dynamic loads must be done separately.

3.2 RESISTANCES FOR AXIAL FORCE

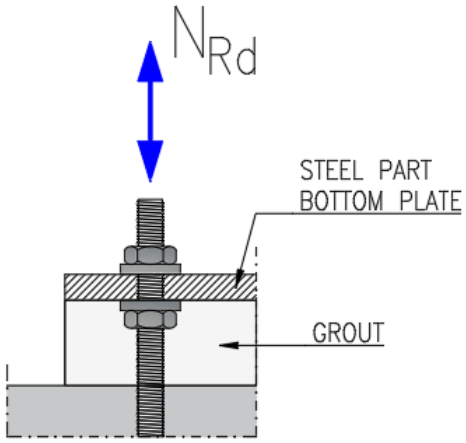

Figure 3. Resistance for axial force

Table 4. Design values of resistance for axial forces (concrete class C25/30)

Anchor bolt	Design value of resistance for axial force N_{Rd} [kN]
SUJ 16	62
SUJ 20	96
SUJ 24	139
SUJ 30	220
SUJ 39	383

Design value of resistance for axial force in assembly stage is the same as in final situation with grout thicknesses in table 5.

3.3 RESISTANCES FOR SHEAR FORCE

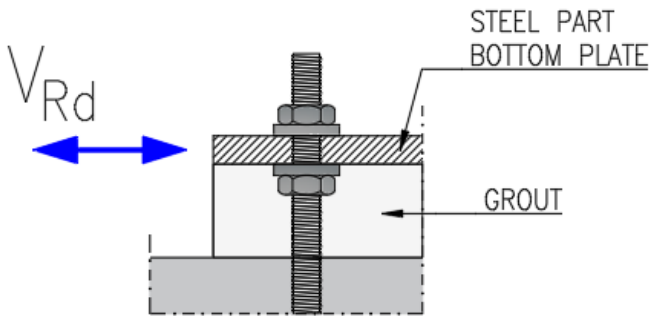

Figure 4. Resistance for shear force

Table 5. Design values of resistance for shear force (concete class C25/30)

Anchor bolt	Design value of resistance for shear force V_{Rd} [kN]		Grout thickness [mm]
	Final situation	Asennustilanne	
SUJ 16	20	5	50
SUJ 20	31	10	50
SUJ 24	45	19	50
SUJ 30	72	40	50
SUJ 39	125	78	60

In final situation after grout concrete has hardened, shear force may also be transferred with friction between column and foundation. Friction coefficient must be selected according to applicable design standards. Use of friction requires concrete structure to be reinforced accordingly.

4 USE OF ANCHOR BOLTS

4.1 LIMITATIONS OF USE

Resistances of SUJ anchor bolts are designed for static loads. Resistances for dynamic and fatigue loads must be designed separately for each use case.

4.2 ANCHOR BOLT EDGE AND CENTER DISTANCES

Edge and center distances of SUJ anchor bolts must always be designed according to exposure class and anchoring of ribbed steel bars.

For SUJ/P anchor bolts edge and center distances are defined by exposure class and center distances between ribbed steel bars (anchoring according to Eurocodes).

For SUJ/L anchor bolts reinforced according to section 5 minimum edge and center distances are given in figure 5 and table 6.

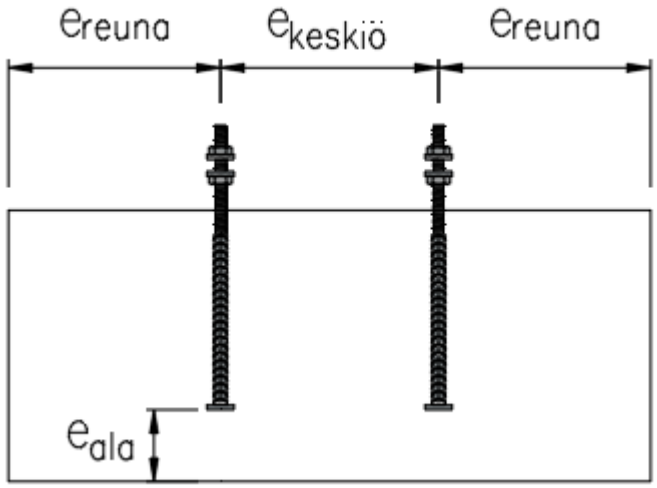

Figure 5. Minimum distances of SUJ/L anchor bolts

Table 6. Minimum distances of SUJ/L anchor bolts

Anchor bolt	edge distance e_{reuna} [mm]	center distance $e_{keskiö}$ [mm]	distance to bottom e_{ala} [mm]
SUJ 16 L	50	100	According to exposure class. For compressed bolts according to section 5.2.
SUJ 20 L	60	120	
SUJ 24 L	70	140	
SUJ 30 L	80	160	
SUJ 39 L	100	200	

5 REINFORCEMENT

5.1 REINFORCEMENT FOR TENSION

5.1.1 LAP REINFORCEMENT OF SELP/P ANCHOR BOLTS

Tension force in long SELP/P anchor bolts is transmitted by lapping of bars. Surface area of lap bars according to surface area for bars in anchor bolt.

For SUJ/P 39 anchor bolt additional rules for thick rebars in EN 1992-1-1 paragraph 8.8 must be observed (anchor bolt rebar diameter 40 mm).

Surface area of lap bars is given in figure 6 and table 7.
A_{sj} = minimum surface area for full tension resistance of anchor bolt.

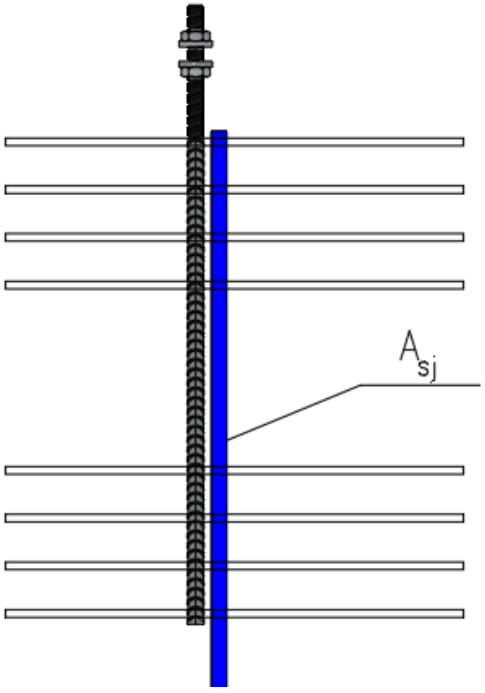

Figure 6. Lap reinforcement of SUJ/P anchor bolts

Table 7. Lap reinforcement of SUJ/P anchor bolts

Anchor bolt	Lap length l_0 [mm]	A_{sj} [mm^2]
SUJ 16 P	690	201
SUJ 20 P	860	314
SUJ 24 P	990	491
SUJ 30 P	1230	804

SUJ 39 P	1865	1257

5.1.2 TRANSVERSE REINFORCEMENT OF SUJ/P ANCHOR BOLTS

For long SUJ/P anchor bolts transverse reinforcement is required in the lap zone to resist transverse tension forces. Reinforcement areas and placement in tension zone according to EN 1992-1-1 paragraph 8.7.4.

Transverse reinforcement in the lap zone for SUJ/P anchor bolts is given in figure 7 and table 8.

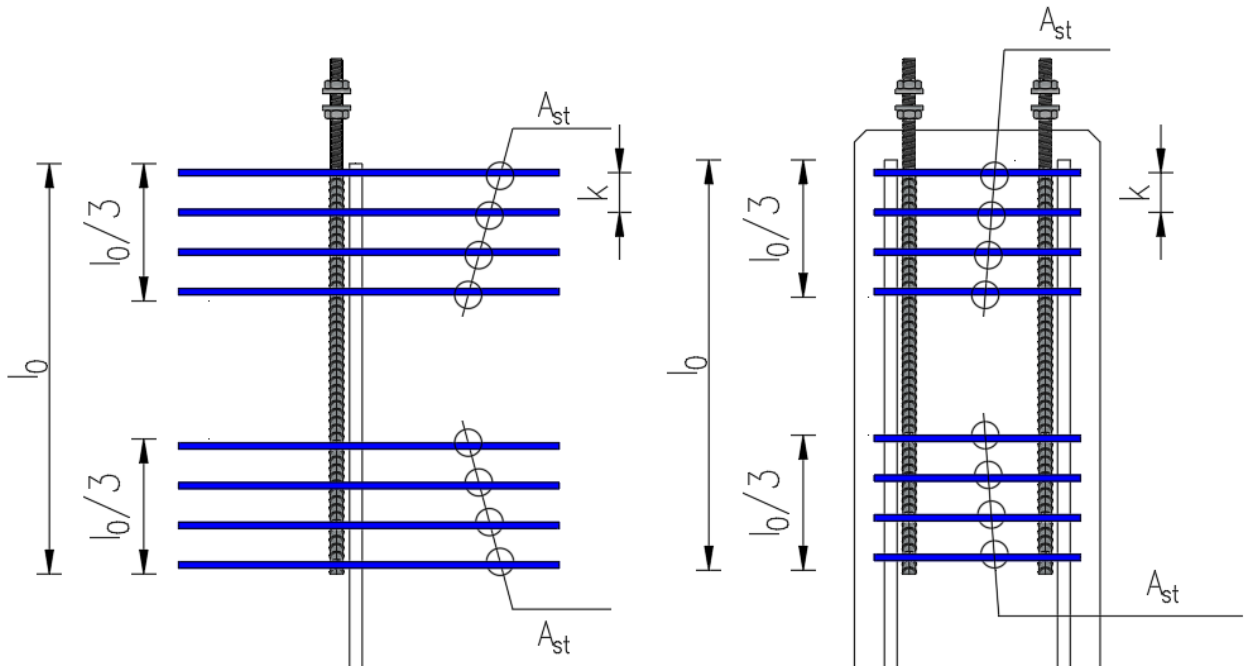

Figure 7. Transverse reinforcement in the lap zone for SUJ/P

Table 8. Transverse reinforcement in the lap zone for SUJ/P

Anchor bolt	Lap length l_0 [mm]	l_0 / 3 [mm]	A_{st} [mm^2]	n_s [kpl]	d_s [mm]
SUJ 16 P	690	230	101	4	6
SUJ 20 P	860	287	157	4	8
SUJ 24 P	990	330	245	4	10
SUJ 30 P	1230	410	402	5	10
SUJ 39 P	1865	622	628	6	12

5.1.3 CONCRETE CONE REINFORCMEENT OF SUJ/L ANCHOR BOLTS

Tension reinforcement of short SUJ/L anchor bolts is given in figure 8 and table 9. Reinforcement is made of loops or stirrups, and it is anchored outside the concrete cone.

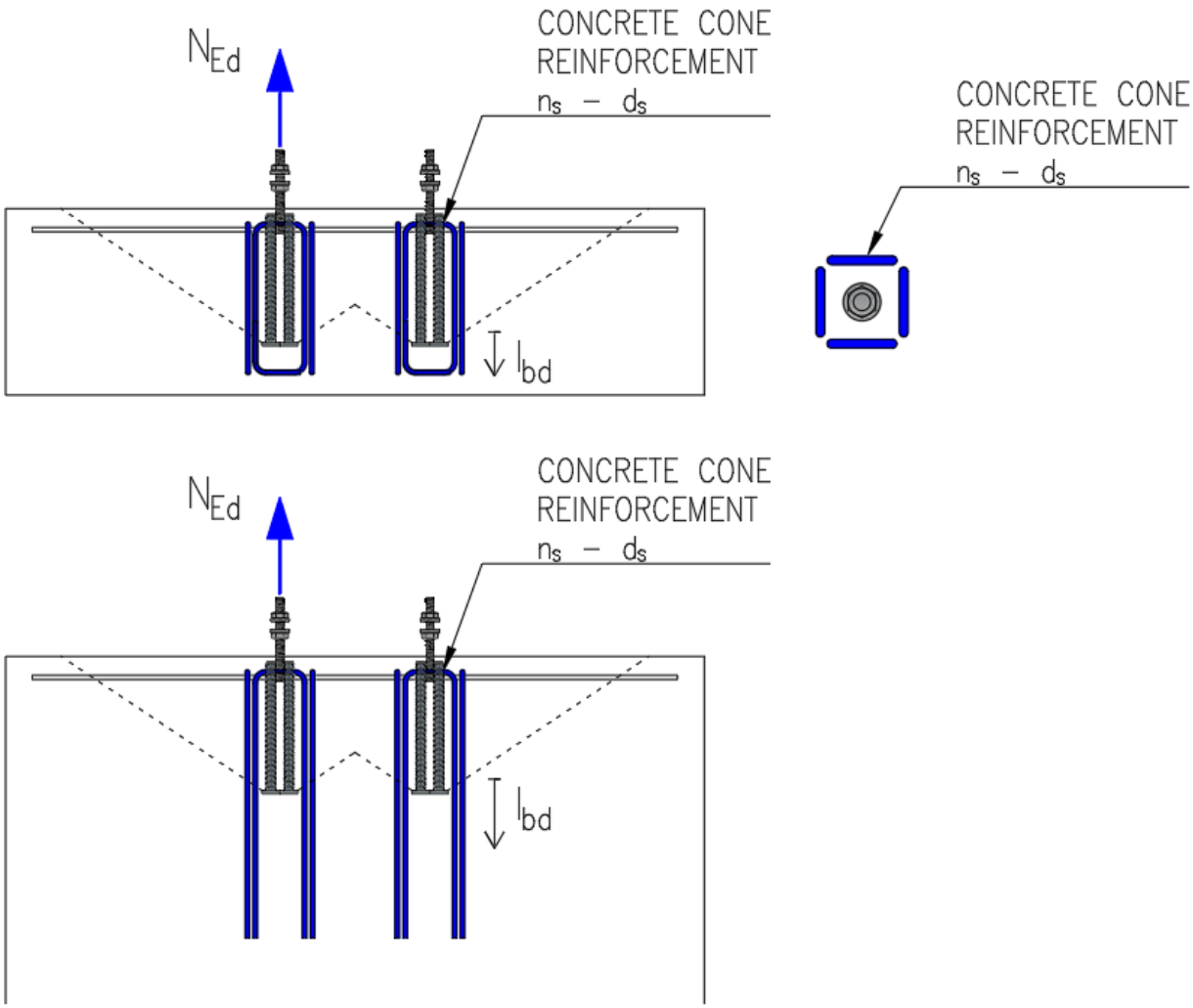

Figure 8. Concrete cone reinforcement of SUJ/L

Table 9. Concrete cone reinforcement of SUJ/L

Anchor bolt	n_s [kpl]	d_s [mm]
SUJ 16 L	4	8
SUJ 20 L	4	8
SUJ 24 L	4	8
SUJ 30 L	4	10
SUJ 39 L	4	12

5.1.4 SPLITTING REINFORCEMENT OF SUJ/L ANCHOR BOLTS

Splitting reinforcement to the top of the concrete structure given in figure 9 and table 10 is required for SUJ/L anchor bolts. Splitting reinforcement is required also for sides of the concrete structure if bolt edge distance is less than $1{,}8h_{ef}$.

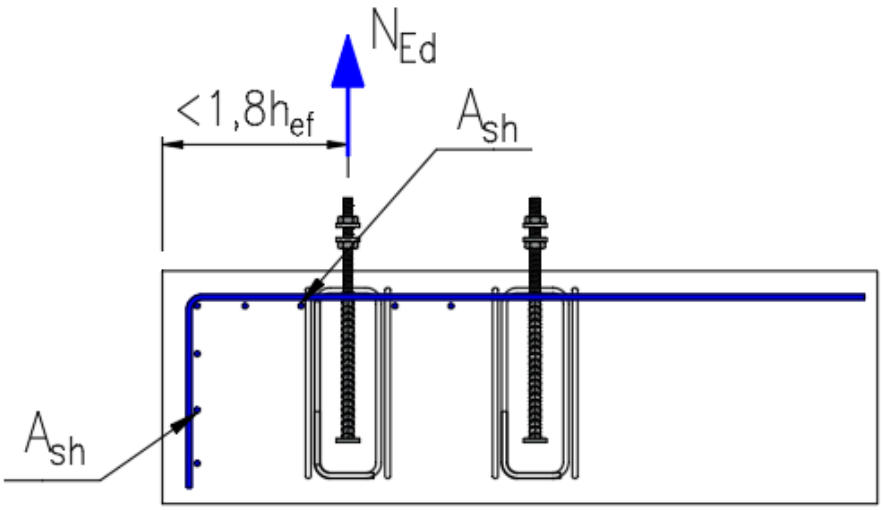

Figure 9. SUJ/L splitting reinforcement

Table 10. SUJ/L splitting reinforcement

Anchor bolt	A_{sh} [mm^2]	n_s [kpl]	d_s [mm]
SUJ 16 L	71	3	6
SUJ 20 L	110	4	6
SUJ 24 L	160	4	8
SUJ 30 L	253	4	10
SUJ 39 L	440	4	12

5.1.5 BLOW-OUT REINFORCEMENT OF SUJ/L ANCHOR BOLTS

If edge distance of SUJ/L anchor bolt is less than $0{,}5h_{ef}$, reinforcement for blow-out failure is required. Minimum edge distance for reinforced SUJ/L anchor bolt is given in figure 10 and table 11.

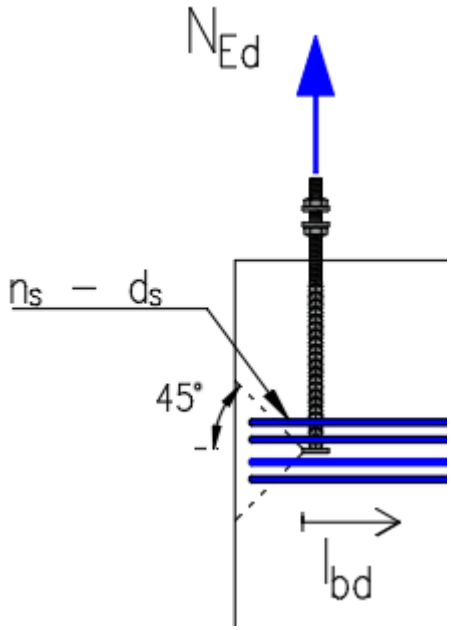

Figure 10. Blow-out reinforcement of SUJ/L

Table 11. Blow-out reinforcement of SUJ/L

Anchor bolt	n_s [kpl]	d_s [mm]
SUJ 16 L	4	6
SUJ 20 L	4	8
SUJ 24 L	4	8
SUJ 30 L	4	10
SUJ 39 L	4	12

5.2 REINFORCEMENT FOR COMPRESSION FORCE

Concrete cone below anchor plate of compressed SUJ/L bolts must be reinforced as instructed in figure 11 and table 12. Minimum distance from the bottom surface of concrete with reinforcement is given in table 12.

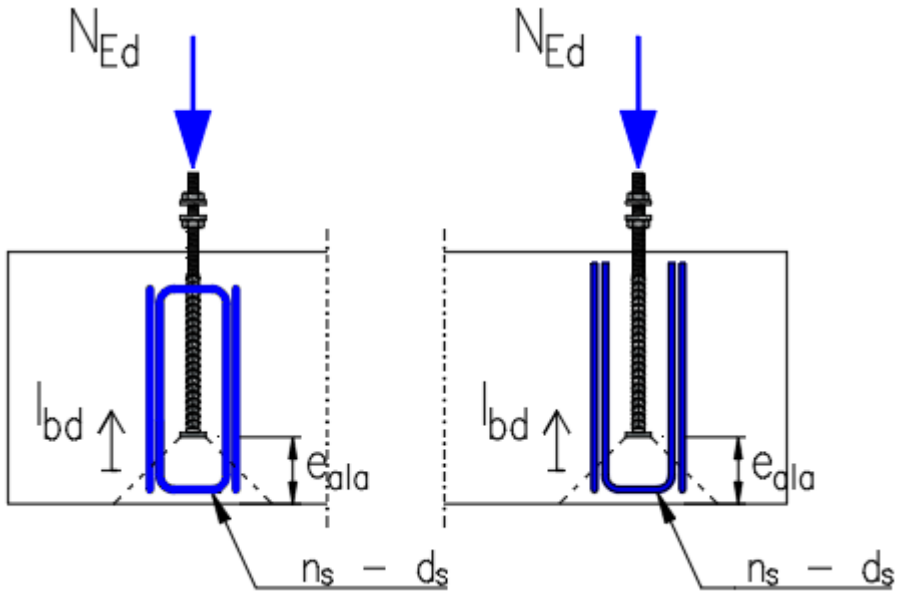

Figure 11. Reinforcement and distance from bottom for compressed SUJ/L bolts

Table 12. Reinforcement and distance from bottom for compressed SUJ/L bolts

Anchor bolt	e_{ala} [mm]	n_s [kpl]	d_s [mm]
SUJ 16 L	65	4	8
SUJ 20 L	110	4	8
SUJ 24 L	115	4	8
SUJ 30 L	138	4	10
SUJ 39 L	196	4	12

5.3 SHEAR REINFORCEMENT

Shear reinforcement of SUJ anchor bolts (both P and L) is done according to figure 12 and table 13. Shear reinforcement is installed to tight contact with the anchor bolt. Reinforcement in table 13 is calculated with concrete cover of 35 mm.

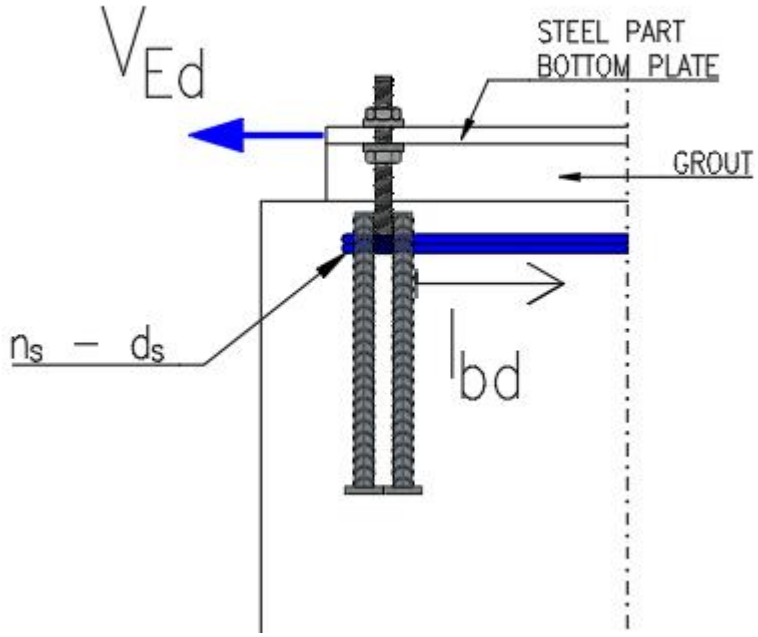

Figure 12. Shear reinforcement of SUJ anchor bolts

Table 13. Shear reinforcement of SUJ anchor bolts

Anchor bolt	n_s [kpl]	d_s [mm]
SUJ 16	1	10
SUJ 20	1	10
SUJ 24	1	12
SUJ 30	2	12
SUJ 39	2	16

6 INSTALLATION

6.1 EQUIPMENT

Assembling of bolts may be done with an assembly frame or bolts may be assembled as a group by the manufacturer. Assembly frame facilitates use of bolts on work site and transport.

Assembly frames are manufactured for standard column dimensions or by order. Assembly frames ensure the right c/c-dimensions and plumbness of bolts. Assembly frame is attached to the concrete cast mould.

6.2 INSTALLATION TOLERANCES

Bolts are installed with following grout thicknesses.

Anchor bolt	Grout thickness [mm]
SUJ 16	50
SUJ 20	50
SUJ 24	50
SUJ 30	50
SUJ 39	60

Height from concrete surface with Semko column and wall shoes are given in technical manuals of column and wall shoes.

With Semko Oy assembly frames c/c-dimension tolerance is ± 3 mm.

6.3 BENDING OF BOLTS

SUJ bolts are manufactured with B500B rebars anchors. Normal rules and principles for rebar bending according to *EN1992-1-1* may be used. Lowest allowed bending temperature is -5 °C. If bending must be done in lower temperatures, rebars must be pre-heated to +50 °C.

6.4 WELDING OF BOLTS

SUJ bolt rebars may be welded with normal fusion welding. Instructions given in applicable parts of Eurocode must be accounted for. In all welding following points must be observed:

- under -5°C or in generally moist environment steel must be pre-heated to at least +50°C
- welding area must be thoroughly cleaned before welding
- welding must be done by qualified professional with adequate welding current and suitable additives.

7 QUALITY CONTROL

Quality control of steel parts manufactured by Semko Oy in Seinäjoki factory is supervised by Inspecta Sertifiointi Oy.

Semko steel products have BY (Concrete Society of Finland) approval.

8 SUPERVISION OF ASSEMBLY

8.1 ASSEMBLY OF COLUMNS

SUJ anchor bolts are primarily intended for attaching columns to foundations. Before column installation lower nuts and washers are adjusted to right height. Columns are lifted over washers and upper washers and nuts are installed. Final tightening is done after verification of column plumbness. If needed additional supports under column may be used.

After column installation gap between column and foundation is grouted.

Columns may not be burdened before grouting is hardened.

8.2 SUPERVISION OF BOLT ASSEMBLY

Before casting of bolt group following points must be observed:

- bolt and frame size are correct

- positioning of bolt group is correct

- bolt thread is not damaged during casting, if necessary, thread must be protected with tape or other protective measures

After casting positioning of bolt group must be checked. Deviations from plans must be informed to the designer.

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