RSTEEL®

RPP Base Bolt

Technical manual

Version: **26.08.2025**

Index

1. DESCRIPTION OF THE SYSTEM

RPP base bolts transfer tension, compression and shear forces to reinforced concrete foundation structures. Tension and compression forces are transferred by anchorage of the ribbed rebars, and by bearing onto anchorage plates.

Shear forces are transferred to the concrete by bearing onto the shank of the bolt.

2. MATERIALS AND DIMENSIONS

Table 1. Materials and standards of RPP base bolts

Part	Material	Standard
Rebars	B500B	EN 10080 (SFS 1300)
Anchorage plates	S355J2	EN 10025
Washers	S355J2	EN 10025
Nuts	Property class 8	EN 20898-2

Base bolts have no surface treatment. Upon request, they can be supplied fully galvanized.

Table 2. RPP base bolt dimensions

Base bolt	Thread			Rebar		Washer	RPP-P		RPP-L	
	Size	l_{thread}	Net tensile area	D	D_u	D_a / t	L	weight	L	weight
		[mm]	[mm^2]	[mm]	[mm]	[mm]	[mm]	[kg]	[mm]	[kg]
M16	16	140	157	16	38	38 / 6	810	1.5	280	0.7
M20	20	140	245	20	46	46 / 6	960	2.8	350	1.3
M24	24	170	352	25	55	55 / 6	1160	5.1	430	2.4
M30	30	190	561	32	70	65 / 8	1460	10.2	500	4.4
M39	39	200	976	40	90	90 / 10	2000	21.7	700	9.4

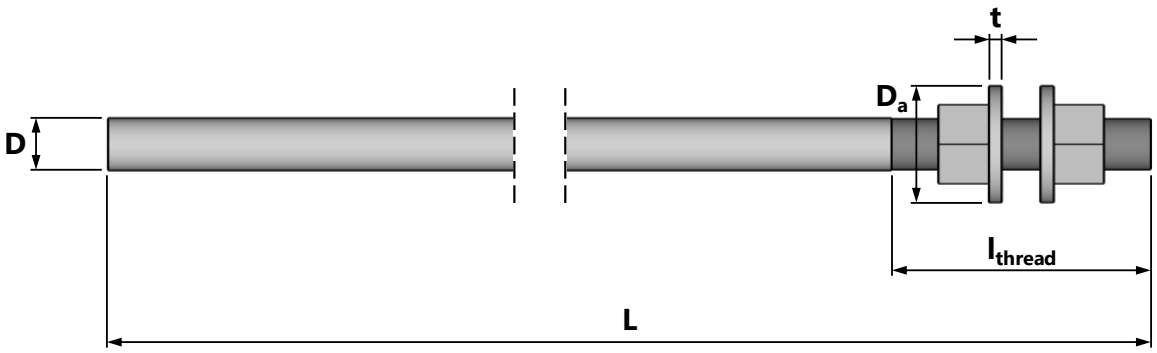


Figure 1. RPP-P type bolt dimensions

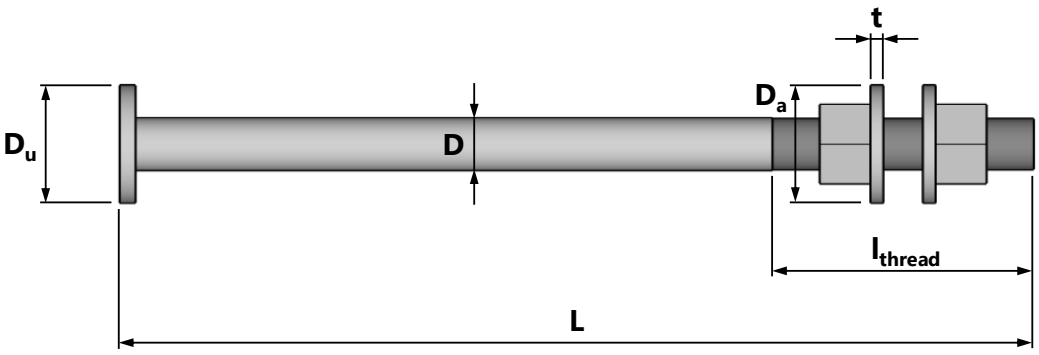


Figure 2. RPP-L type bolt dimensions

3. MANUFACTURING AND TOLERANCES

3.1. Manufacturing method

Plates:	Thermal or mechanical cutting
Rebars:	Mechanical cutting
	Thread Coarse; ISO 68-1; ISO 261; ISO 965-1
	The threads are mechanically machined or rolled
Welding:	MAG welding, manual or robotic
Welding class:	B (EN ISO 5817)
Execution class:	EXC2 (EN 1090-2) [more demanding classes according to a separate guideline]

The product shall be produced clean and dry. Light surface rusting may be present at delivery of the product. The product is to be stored in dry conditions. The product may be installed with light surface rusting, and in accordance with general requirements for reinforcement bars.

3.2. Manufacturing tolerances

Overall length:	±10 mm
Threaded length:	+5, -0 mm

3.3. Quality control

R-Group Baltic OÜ internal manufacturing and quality control in accordance with EN 1090-2. External quality control provided to R-Group Baltic OÜ by Kiwa Inspecta OÜ.

3.4. Markings

RPP base bolts are marked with at least the RSTEEL® logo, type and identifier, manufacturing date, FI and BY (Concrete Association of Finland) logo.

4. RESISTANCES

The tension resistance of the base bolt is calculated in accordance with EN 1992 and EN 1993. The shear resistance of the base bolt is calculated in accordance with EN 1992-4:2018. The thickness of the grout layer, as well as the thickness of the base plate to the column shoe or steel column influences the shear resistance of the base bolt. The anchorage of the short base bolts is verified in accordance with EN 1992-4:2018; required additional reinforcement is presented below.

The tension/compression and shear resistances are governed by the net tensile area of the threaded section of the base bolt. Nominal design resistances are given below for individual base bolts. The nominal shear resistance of the base bolts has been calculated taking into account typical thickness of the grout layer. The total resistance of a bolt group is to be calculated in accordance with clause 6.2.2 of EN 1993-1-8 and EN 1992-4:2018.

Concrete grade C25/30. Anchorage coefficients, η_1 = 1.0 (good), lap factor α_6 = 1.5, α_2 =0.7, others α_1-α_5 =1.0.

Table 3. RPP base bolt resistances

Base bolt	N_{Rd} [kN]	$V_{Rd,u}$ [kN]
M16	62.2	4.5
M20	97.0	8.3
M24	139.4	13.0
M30	222.2	23.0
M39	386.5	44.3

N_{Rd} - nominal design tension resistance, and $V_{Rd,u}$ - nominal design shear resistance during installation, see below.

4.1. RPP base bolt shear resistances before grouting

Table 4. RPP base bolt resistances before grouting

Base bolt	Shear	Net tensile area	Lever arm
	$V_{Rd,u}$ [kN]	A [mm²]	l [mm]
M16	4.5	157	65
M20	8.3	245	69
M24	13.0	352	76
M30	23.0	561	86
M39	44.3	976	103

EN 1993-1-8:

$N_{R,d} = 0.9 \cdot f_{uk} \cdot A / \gamma_{Ms}$

$\gamma_{Ms} = 1.25$ and $f_{uk} = 550$ MPa

EN 1992-4:2018:

$V_{Rd,u} = V_{Rk,s} / \gamma_{M,s}$

$V_{Rk,s} = \alpha_M \cdot M_{Rk,s} / l_i$

$M_{Rk,s} = M^o_{Rk,s} \cdot (1 - N_{sd} / N_{Rd,s})$

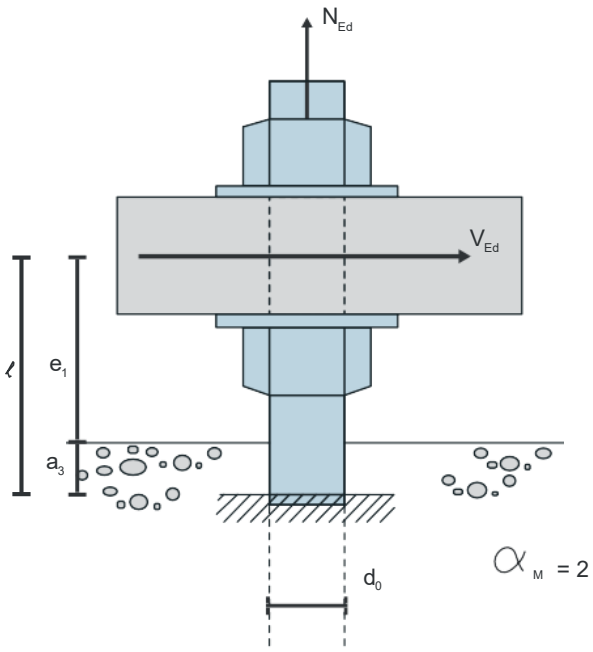
($N_{sd} = 0$; shear only)

$M^o_{Rk,s} = 1.2 \cdot W_{el} \cdot f_{uk}$

$W_{el} = \pi d^3 / 32$

$\alpha_M = 2.0$

$\gamma_{Ms} = 1.25$



e_1 = base grout thickness + 0.5 × base plate thickness

$a_3 = 0.5 \cdot d_0$

4.2. RPP base bolt shear resistances after grouting

Table 5. RPP base bolt resistance after grouting

Base bolt	Shear	Net tensile area
	$V_{Rd,g}$ [kN]	A_{bolt} [mm^2]
M16	20.0	157
M20	31.3	245
M24	44.9	352
M30	71.6	561
M39	124.5	976

EN 1993-1-8; 6.2.2(7):

$V_{Rd,g} = \min \{F_{1,vb,Rd} ; F_{2,vb,Rd}\}$

$F_{1,vb,Rd} = (\alpha_v \cdot f_{bolt,u} \cdot A_{bolt}) / \gamma_{M2}$

$F_{2,vb,Rd} = (\alpha_b \cdot f_{bolt,u} \cdot A_{bolt}) / \gamma_{M2}$ - critical

$\alpha_b = 0.44 – 0.0003 \cdot f_{bolt,y}$

$f_{bolt,u}$ is the ultimate tensile strength of the bolt

$f_{bolt,y}$ is the yield strength of the bolt ≤640 N/mm^2

A_{bolt} is the net tensile area of the bolt

$Y_{M2} = 1.25$

$\alpha_v = 0.5$

4.3. Design criteria

$$V_{Ed} \leq V_{Rd}$$

$$N_{Ed} \leq N_{Rd}$$

$$N^1_{Ed} / 1.4N_{Rd} + V^1_{Ed} / V_{Rd} \leq 1$$

Where N^1_{Ed} and V^1_{Ed} are applied coincident axial force and shear force.

In accordance with EN 1992-4:2018 section 7.2.3, the following requirements must also be taken into account for the coincident applied normal and shear forces:

- Base bolts without provision of additional reinforcement according to EN 1992-4:2018 section 7.2.3.1, table 7.3
- Base bolts that are installed with additional reinforcement for normal and shear forces (see Section 5.2) according to EN 1992-4:2018 section 7.2.3.2

The tension and compression resistances of the cast-in-place base bolt are identical. The base bolt and bolt group capacities are to be calculated in accordance with EN 1992-4:2018, taking into account the dimensions of the foundations and the positions the bolts and bolt group.

The forces to be transferred through the base bolts influences the local reinforcement required to be provided to the concrete structures; the base bolt axial and shear forces are transferred to the concrete structures with the help of the local reinforcement. Reinforcement, base bolt edge and spacing distances, as well as their influence on the overall base bolt design resistance, are to be calculated in accordance with EN 1992-1-1 and EN 1992-4:2018.

4.4. Adjustment of the nominal design resistance for lower concrete grades

Base bolt nominal design resistances are to be adjusted according to the required concrete grade as follows:

The tension/compression design resistance is reduced according to the required concrete grade. The adjustment is only applied for lower concrete grades. The nominal tension/compression design resistance is reduced by factor:

$$n_1 = \frac{f_{cd}}{f_{cd}(C25/30)}$$

As an example, if the RPP-P M20 base bolt was used in C20/25 concrete grade, the reduction factor n_1 would be calculated as follows:

$$n_1 = \frac{20}{25} = 0.8$$

RPP-P M20 base bolt tension design resistance = 0.8 × 97.0 = 77.6 kN

The nominal design shear resistance is not adjusted for other grades of concrete.

5. USER INSTRUCTIONS

Base bolts are used for transferring vertical and shear forces, as well as bending moments, between the base of a column and its foundation. RPP M16…M30 and M39 base bolts can also be used for transferring vertical and shear forces, as well as bending moments, across a joint in a column. The standard lengths of the bolt's rebars are anchoring lengths. Extension lengths of rebars can be ordered separately.

5.1. Limits of Use

The resistances of the base bolts have been calculated for static loads. Increased load factors are to be adopted for case specific dynamic and fatigue effects. For seismic actions, see also EN 1992-4:2018 section 9. For design in accordance with the Eurocodes, the lowest operating temperature is calculated from EN 1991-1-5.

5.2. Design Guidance

Base bolt minimum edge distance for tension/compression forces:

The required minimum edge distance of the base bolt is determined from the cover and durability requirements that are based on the environmental conditions and design working life in which the base bolt is situated, EN 1992-4:2018 clause 4.

Base bolt minimum spacing for tension/compression forces:

The minimum spacing of the long base bolts is determined taking into account the embedded length of the bolt, "l", that is available for the lap joint.

Table 6. Minimum embedded length of RPP-P type base bolts

Base bolt	l [mm]
M16	675
M20	815
M24	1000
M30	1280
M39	1790

Note! RPP-P M39 additional requirements for the use of Ø40 bars:

1. A 2×Ø32 bundle of rebars or a 3×Ø25 bundle of rebars must be used to form the lap to the Ø40 base bolt (RPP-P M39); that is the lap must not be formed to another Ø40 rebar directly. The base bolt forces must be transferred into the structure via smaller rebars, taking note of the reinforcement requirements for the lesser stressed level.
2. Shear link hooks are always used as expansion control reinforcement.
3. Splitting forces and crack control must be considered, and surface reinforcement must be designed taking into account additional rules given in EN1992-1-1 section 8.8 for large diameter bars.

5.3. RPP-L type base bolt minimum edge distance

The required minimum edge distance of the base bolt is determined from the cover and durability requirements that are based on the environmental conditions and design working life in which the base bolt is situated, EN 1992-1-1 clause 4. Also, national annexes must be checked according to the project location. Other limitations are as follows.

The long base bolt minimum edge distances and spacing are based on column shoe or wall shoe positioning conditions in the precast element.

When using short base bolts, they should be anchored by bearing onto an anchorage plate. The minimum edge distances given in Table 7 and Figure 3 calculated are according to short bolt geometries and local concrete crushing of the concrete. Short bolts have circular plates on the bottom of the rebar legs. Short bolts can't be positioned closer that the values in Table 7.

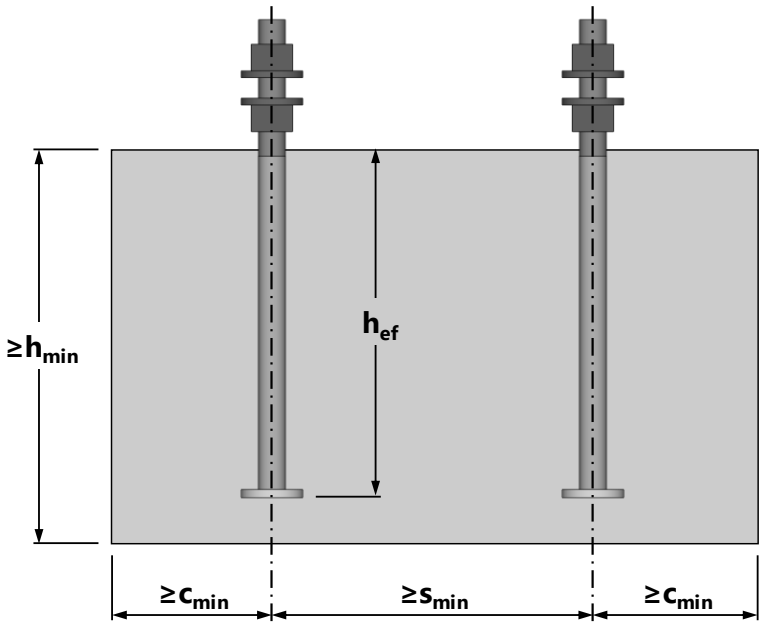


Figure 3. Positioning of RPP-L type base bolts

Table 7. Positioning of RPP-L type base bolts

Base bolt	c_{min} [mm]	s_{min} [mm]	h_{min} [mm]	h_{ef} [mm]
M16	60	80	270	169
M20	80	110	330	229
M24	90	120	395	294
M30	130	180	445	342
M39	160	280	610	510

The following checks given in Table 8 and Table 9 are to be carried out for short base bolts (RPP-L). Base bolt groups can also be checked according to EN 1992-4 tables 7.1 and 7.2.

Table 8. Required checks for design axial resistance for RPP-L type base bolts

Required checks for N_{Rd} (by failure mode)	Single base bolt	Group/most heavily loaded base bolt	Group	Explanation
1. Base bolt steel fracture	x	x	-	-
2. Base bolt pull-out	x	x	-	-
3. Concrete blow-out failure	x	-	x	Not needed if: $c_1 \geq 0.5h_{ef}$
4. Concrete cone failure	x	-	x	-
5. Concrete splitting	x	-	x	Not needed if: $c_1 \geq 1.5h_{ef}$ (single base bolt) $c_1 \geq 1.8h_{ef}$ (group)

Table 9. Required checks for design shear resistance for RPP-L type base bolts

Required checks for V_{Rd} (by failure mode)	Single base bolt	Group/most heavily loaded base bolt	Group	Explanation
1. Base bolt steel fracture	x	x	-	Without moment lever arm
2. Base bolt steel fracture	x	x	-	With moment lever arm
3. Concrete edge failure	x	-	x	-
4. Concrete pry-out failure	x	-	x	-

5.4. Additional reinforcement

Additional reinforcement is needed only for short bolts (RPP-L). In Column to Column and wall-to-wall connections, reinforcement usage for lapping can be found in EN 1992-1-1.

In this section, reinforcement instructions for foundation bolts are explained.

5.4.1. Concrete cone failure

For RPP-L type bolts Table 10, values must be used if concrete cone resistance is not adequate. Concrete cone resistance depends on the distance between foundation anchors and edge distances; thus it needs to be calculated for each case.

To prevent concrete cone failure, ① and ② supplementary reinforcement must be used. Supplementary reinforcement positions are shown in Figure 4.

Table 10. Concrete cone reinforcement for RPP-L type base bolts

Base bolt	Required cross-section of the reinforcement per bolt [mm²] ①	Selected reinforcement per bolt (stirrups) ①	Surface rebars ②
M16	143	2×Ø8	1×Ø8
M20	224	3×Ø8	1×Ø8
M24	321	4×Ø8	1×Ø8
M30	511	4×Ø10	1×Ø10
M39	889	4×Ø12	1×Ø12

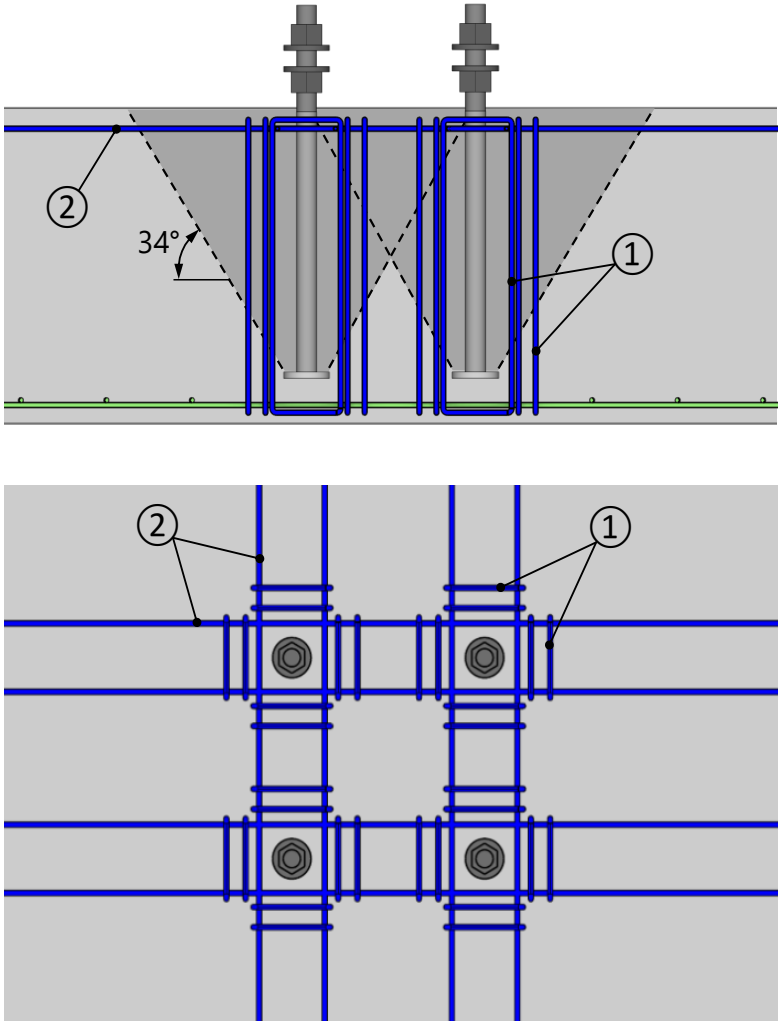


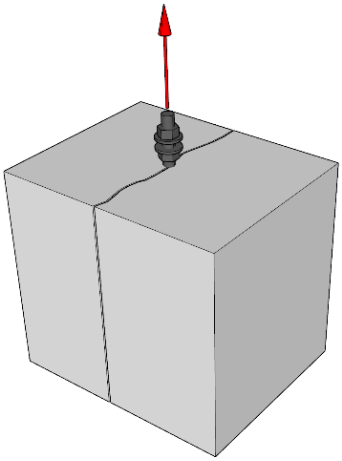
Figure 4. Concrete cone reinforcement for RPP-L type base bolts

5.4.2. Concrete splitting failure

If the edge distance $c_{cr} < 1.8h_{ef}$ additional reinforcement in Table 11 and Figure 5 for RPP-L type bolts near the concrete side and top face surface shall be used to resist the splitting forces and to limit cracks. 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. Please note that perpendicular edges should be considered independently (i.e. A_s per direction).

Table 11. Concrete splitting reinforcement for RPP-L type base bolts

Base bolt	Required cross-section of the reinforcement per bolt A_s [mm²]	Selected reinforcement ① and ② per bolt
M16	72	3×Ø6
M20	112	4×Ø6
M24	161	4×Ø8
M30	256	4×Ø10
M39	445	4×Ø12



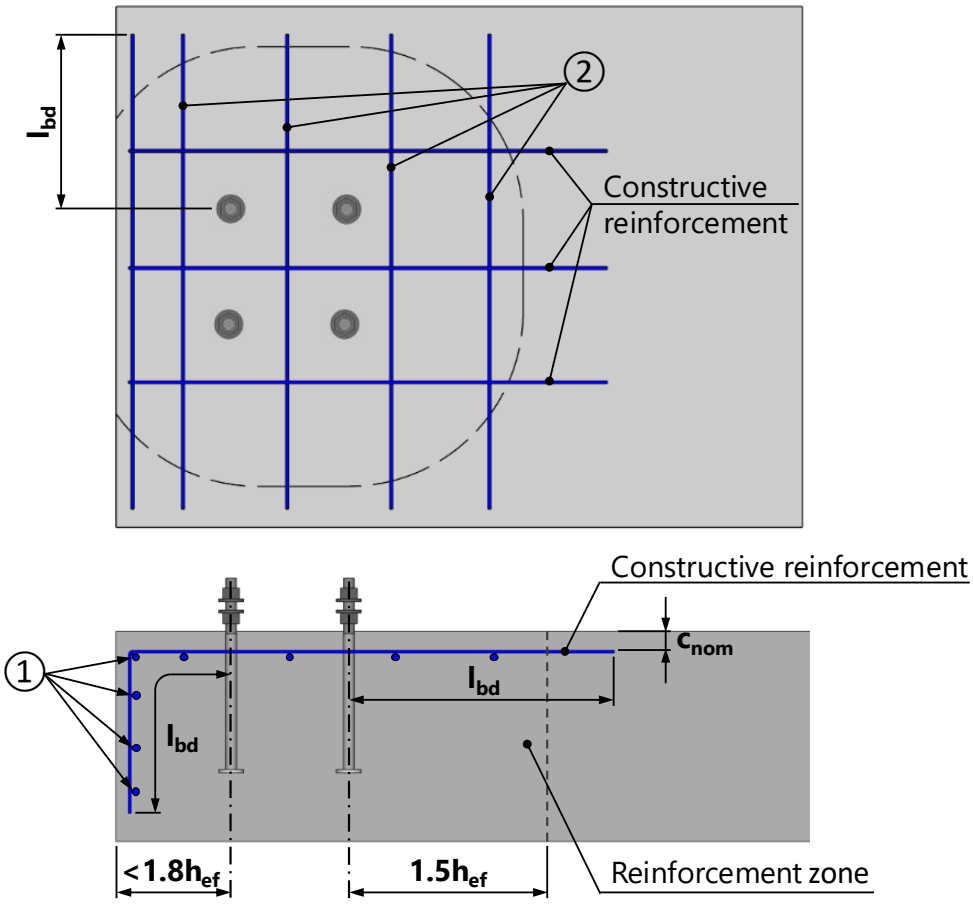


Figure 5. Concrete splitting reinforcement for RPP-L type base bolts

5.4.3. Concrete edge reinforcement

If the edge distances (c_{min}) of RPP-L bolts are smaller than the values given in Table 7, additional reinforcement according to Figure 6 and Table 12 must be used to prevent concrete edge failure.

Table 12. Concrete edge reinforcement for RPP-L type base bolts

Base bolt	Selected reinforcement ① per bolt
M16	1×Ø12
M20	2×Ø12
M24	1×Ø16
M30	2×Ø16
M39	3×Ø16

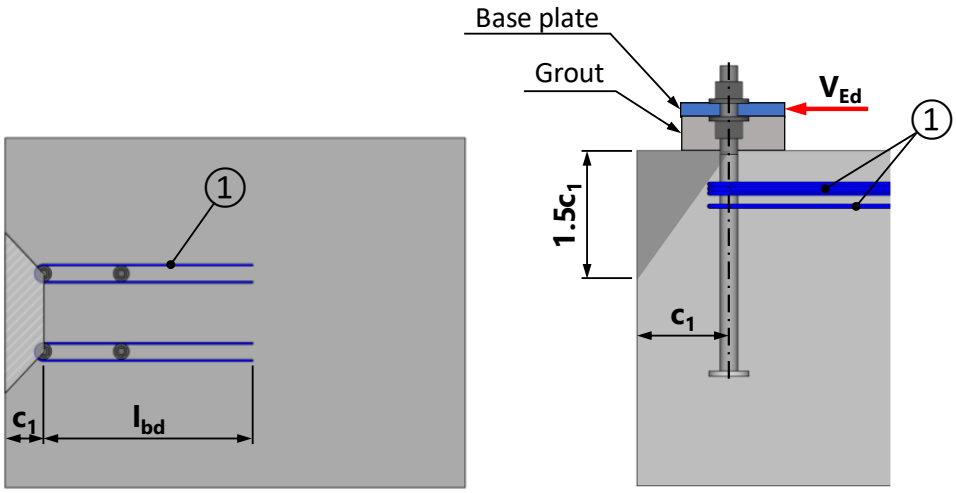


Figure 6. Concrete edge reinforcement for RPP-L type base bolts ($c_1 \leq c_{min}$)

For RPP-P minimum edge distances with edge reinforcement defined according to code regulations for normal reinforcement. The limitation of the minimum edge distances for RPP-L is concrete cover. Our recommended value is 40 mm.

6. INSTALLATION

Template plates are to be used when forming bolt groups from the base bolts. The template plates help to obtain the correct spacing of base bolts and general alignment and positioning of the bolt groups relative to the building or structure. Furthermore, the template plates help to obtain the correct installation level of the bolts as well as help with protecting the threads of the base bolts during concrete casting.

6.1. Base bolt installation tolerances

The positional tolerance of the bolt group for installation of the precast concrete elements = ±10 mm. Tolerance for the level of the top of the base bolt = ±20 mm.

Table 13. RPP base bolt height positions and positional tolerances

Base bolt	Grout thickness [mm]	Height of top of bolt above the top of the concrete surface [mm]	Base bolt spacing tolerance within the bolt group [mm]
M16	50	105	±3
M20	50	115	±3
M24	50	130	±3
M30	50	150	±3
M39	60	180	±3

6.2. Bending and welding of the base bolts

Where space for installation is limited, the straight anchorage section of the ribbed bar to the base bolt may be bent on site. Bending of the bars must be performed taking into account requirements and instructions in design standards, in relation to bending radius and working temperatures. Furthermore, the modified anchorage length of the bar must be taken into account in relation to the required anchorage.

The base bolts can be welded using all common fusion welding methods. All welding of the reinforcement to reinforced concrete structures must be performed taking into account the requirements and instructions presented in EN 17660-1.

It is not allowed to weld connection plates or fasteners to the base bolts without prior approval from the structural designer.

6.3. Installation of the column

The column is installed to the correct level by adjusting at the nuts of the base bolts and by using packer plates placed under the columns. The verticality of the columns is checked, and the nuts are tightened, for example using an impact wrench. Recommended tightening torques for the column shoe to base bolt connection are given in the table below. The space below the base plate and (where required) the void presented by the column shoes, must be grouted prior to further installation of structural elements on top of the column. The column joint must not be loaded before the grout has reached the required strength for the design.

Table 14. Indicative nut tightening torque values

Base bolt	T_{min} [Nm]	T_{max} [Nm]
M16	120	200
M20	150	250
M24	200	380
M30	200	450
M39	350	1000

T_{min} - minimum tightening torque, and T_{max} - maximum tightening torque

6.4. Inspection instructions for installation of the base bolts

Before casting:

- Check that the correct base bolts and the correct template plates are being used (centerline to centerline dimensions, thread size), and that the base bolts have not been damaged during delivery.
- Check that the positions of the base bolts and bolt groups within the mould are within the required tolerances.
- Check that the levels of the top of the base bolts are within the required tolerances.
- Check that the reinforcement required for the base bolts is installed.
- Check that the installation frame is horizontal and within required tolerances.
- Protect the threads of the base bolts until the column is installed.

After casting:

- Check the position of the base bolt group. Dimensions that are greater than the tolerance requirements are to be reported to the structural designer.
- Protect the thread of the base bolt until the column is installed (using for example tape, plastic tube, etc.)

6.5. Inspection instructions for installation of the column

The column is to be installed in accordance with the project's erection plans. The installation inspector must check the following items:

- Installation sequence of the elements as presented in the erection plan.
- Temporary support requirements for the column during erection.
- Tightness of the nuts to the base bolts.
- Timing of joint grouting as well as the type of grout to be used.

NOTES

TECHNICAL MANUAL REVISIONS

06.01.2020 (SAU)

- Web page version

12.11.2024 (FA)

- Graphic update, reorganizing index

15.01.2025 (AV)

- New format
- New figures

26.08.2025 (AV)

- Minor text changes

SUPPORT MATERIAL

DESIGN TOOLS

RSTEEL® Design Tool was created to facilitate the work of designers and offer the best and most transparent design process on the market. The free and fully cloud-based software guarantees seamless workflow within the design organization, as well as continuous support and updates.

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DESIGN COMPONENTS

We have created design components for Tekla as well as Revit and AutoCAD. More products will be created, and existing products will receive steady updates and fixes when needed.

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