RSTEEL®

RSK-E wall shoe

Design according to Eurocodes

TECHNICAL MANUAL

Technical changes and errors reserved

Version: **19.04.2023***

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1. DESCRIPTION OF THE SYSTEM

RSK wall shoes are fastening components that are used with RPP- and RPP-E-base bolts to create tension resisting connections across joints between two precast wall elements or between precast wall elements and a cast-in-situ structure. Compression stresses are transferred directly across the grout filled joint. Shear stresses along the joint are transferred by friction or by additional installed shear studs for this purpose.

Tension stresses developed at the joint are transferred within the wall, via reinforcement, to the next wall joint above and below. The RSK-E wall shoes are designed with matching design tension resistance of the associated RPP-E base bolts.

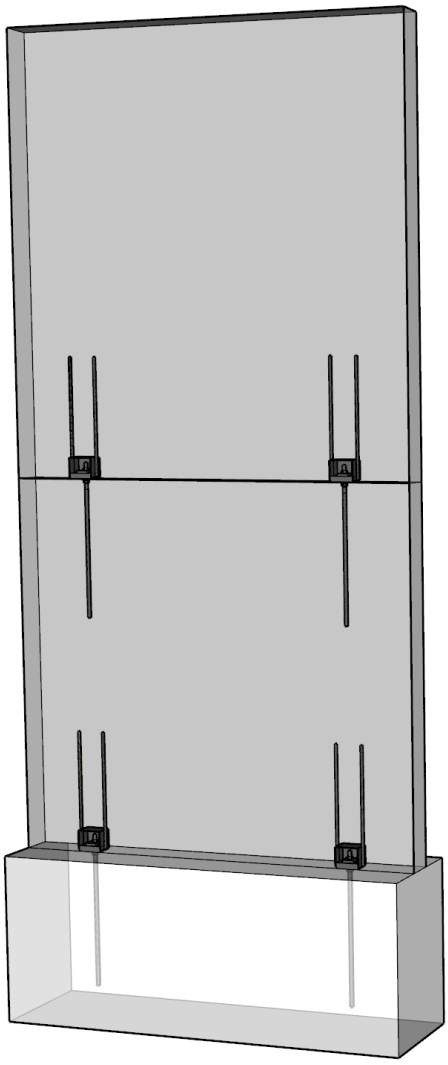


Figure 1. Example of using wall shoes

2. DIMENSIONS AND MATERIALS

Table 1. Materials and standards of RSK-E wall shoe

Part	Material	Standard
Plates	S355J2	EN 10025
	S355J2+N	EN 10025
Rebars	B500B	EN 10080 (SFS 1268)

Table 2. Dimensions of RSK-E wall shoe

Type	Size	B [mm]	C [mm]	n [mm]	H [mm]	h [mm]	t [mm]	a_x [mm]	a_y [mm]	c_c [mm]	Weight [kg]
RSK-E	**M30**	130	145	2Ø25	1460	120	45	90	55	52.5	20.3
	M36	150	164	2Ø32	1765	140	55	96	61	59	37.1
	M39	150	165	4Ø25	1650	147	60	99	64	22.5	38.3
	M45	175	180	4Ø32	2015	162	70	105	75	28.5	69.6
	M52	230	210	4Ø32	2215	185	80	112	82	33	89.6

Note: n – the number of side bar, Ø is diameter of side bar

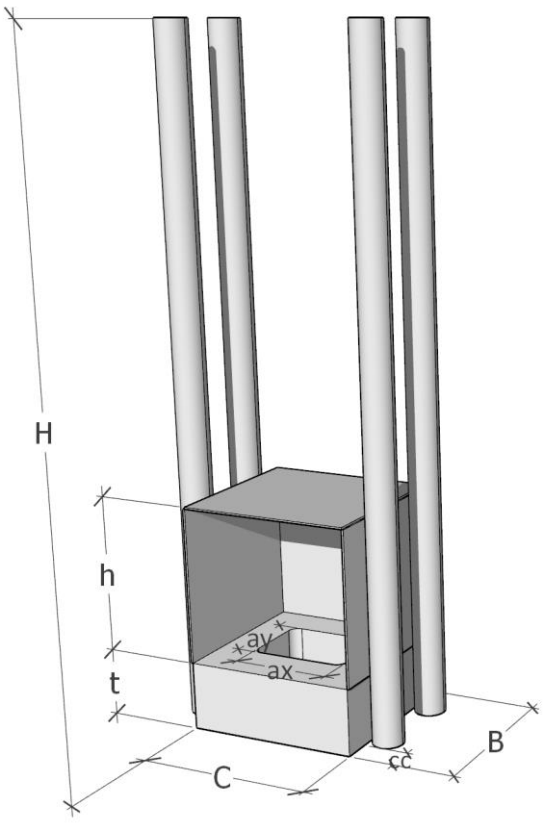


Figure 2. RSK-E wall shoe dimensions

Table 3. Wall shoe non-centric washer dimensions

Type	Size	e [mm]	c [mm]	D [mm]	t [mm]
RAL	**N30**	37.5	95	31	20
	N36	45.0	110	37	30
	N39	47.5	115	40	30
	N45	55.0	130	46	35
	N52	67.5	155	52	40

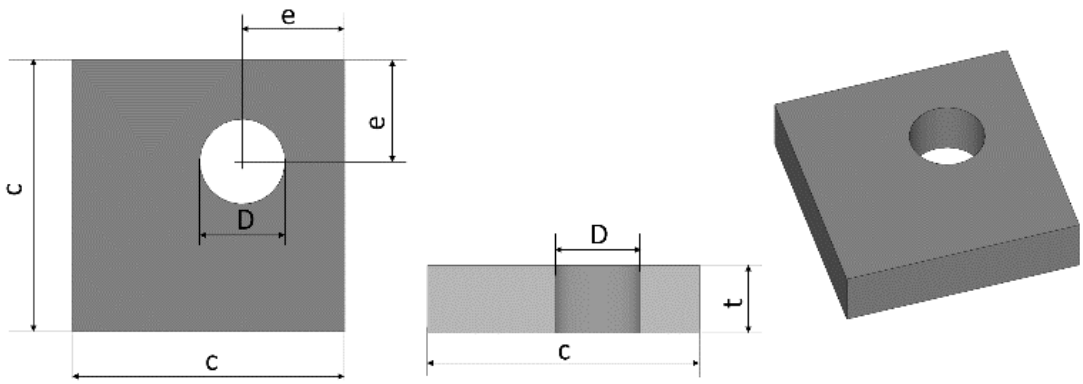


Figure 3. RAL wall shoe non-centric washer dimensions

3. MANUFACTURING

3.1. Manufacturing method

Execution standard:	EN 1090-2
Plates:	Flame cut, laser/plasma and mechanically cut
Rebars:	Mechanically cut
Welding:	MAG hand/robot
Welding class:	C (EN ISO 5817) in accordance with EXC 2
Surface treatment:	Untreated as standard

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. Quality control

Manufacturing and quality control in accordance with SFS-EN 1090-2. R-Group Baltic OÜ internal quality control in accordance with ISO 9001 and ISO 14001. External quality control provided by Kiwa Inspecta Estonia OÜ.

3.3. Markings

- R-Group Baltic OÜ identifier marking
- Manufacturing date

4. RESISTANCES

The tension capacities of the wall shoes, calculated in accordance with EC (EN 1992, 1993), are governed by the tension capacity of the connected RPP-E base bolt. More information is provided in the RSTEEL® RPP-E base bolt technical manuals.

Minimum concrete grade of the wall is C25/30.

The anchorage length is determined according to the diameter of the anchor bar.

Anchorage coefficients, lap factor $\alpha_6 = 1.5$, $\alpha_2 = 0.7$, others $\alpha_1 \ldots \alpha_5 = 1.0$

Table 4. Nominal RSK-E wall shoe design tension resistances

RSK-E	RAL	RPP-E base bolt	N_{Rd} [kN]
M30	N30	M30	299.2
M36	N36	M36	435.7
M39	N39	M39	520.5
M45	N45	M45	696.5
M52	N52	M52	937.6

RAL non-centric washers are supplied with RPP-E base bolts on request. Please see Table 3.

The shear capacity of the shoe is governed by the connected RPP-E base bolt. The shear strength of the connection can be calculated in accordance with EN 1993-1-8 clause 6.2.2. The additional contribution of friction to shear strength can be taken into account; a friction coefficient of 0.2 can be adopted for a sand-cement grout, without additional tests.

The design shear resistance $F_{v,Rd}$ between a column base plate and a grout layer are calculated as follows:

$$F_{v,Rd} = F_{f,Rd} + n \cdot F_{vb,Rd}$$

where:

n – the number of anchor bolts in the base plate

$F_{f,Rd}$ – design friction resistance and calculated as follows:

$$F_{f,Rd} = C_{f,d} \cdot N_{c,Ed}$$

where:

$C_{f,d} = 0.2$

$N_{c,Ed}$ – the design value of the normal compressive force in the wall

The design shear resistance $F_{vb,Rd}$ of an anchor bolt and should be taken as follows:

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

$F_{1,vb,Rd} = \frac{k_1 \cdot a_b \cdot f_{uk} \cdot d_b \cdot t}{\gamma_{M2}}$	f_{uk} = ultimate strength of the bolt RPP-E bolts→ f_{uk} = 800 MPa, d_b = diameter of nominal stress area in thread of anchor bolt t = thickness of base plate of the wall shoe γ_{M2} = material factor RPP-E bolts→ γ_{M2} = 1.5
$k_1 = \min\{2.8\frac{e_2}{D} - 1.7;\ 2.5\}$	e_2 = edge distance of the bolt center D = hole diameter of non-centric washer (with tolerances)
$a_b = 0.44 - 0.0003 \cdot f_{yd}$	f_{yd} = the yield strength of the anchor bolt, where 235 MPa ≤ f_{yd} ≤ 640 MPa RPP-E bolts→ f_{yd} = 640 MPa
$F_{2,vb,Rd} = \frac{a_b \cdot f_{uk} \cdot A_s}{\gamma_{M2}}$	A_s = net tensile area of the bolt

Shear force transmission

$F_{vb,Rd}$ values can be used only if cavity between wall shoe and washer filled with expanding grout, minimum strength corresponding to wall.

If the cavity hasn't filled with expanding grout, shear force can only be transmitted through the anchor bolt if the washer is welded with load bearing weld to the bottom plate of the shoe. In this case $F_{3,vb,Rd}$ values can be used and $F_{f,Rd}$ value will be zero ($F_{f,Rd} = 0$).

Shear and tensile capacity of the wall shoes are given Table 5.

Table 5. Tensile and shear capacity of wall shoes

Type	Size	Tensile capacity N_{Rd} [kN]	Shear capacity $F_{3,vb,Rd}$ [kN]	Shear capacity $F_{vb,Rd}$ [kN]
RSK-E	M30	299.2	32.6	61.2
	M36	435.7	47.7	89.2
	M39	520.5	58.7	106.5
	M45	696.5	80.0	142.5
	M52	937.6	111.2	191.8

R-Steel's R-Design Suite software for wall shoe connections on https://rsteel.fi/ Registration is required.

Wall shoe installation and additional reinforcement must be in accordance with instructions in this user guide.

5. USER INSTRUCTIONS

5.1. Limits of use

The capacities of the wall shoes have been calculated for static loads. Increased load factors are to be adopted for case specific dynamic and fatigue effects. For design in accordance with the Eurocodes, the lowest operating temperature is calculated from EN 1991-1-5.

5.2. Design guidance

Grout is to be applied to the joint as soon as possible after the wall element has been lifted into position. Other structures can be installed on top of the wall element after the grout has hardened. Out-of-plane (transverse) support of the wall element must always be considered carefully.

The RSK-E wall shoe is to be installed in the middle of the precast wall element, and the anchor bars are to be tied to the reinforcement of the wall. Minimum wall thickness and associated minimum concrete cover to the anchor bars of the wall shoe, are given in the table below. Minimum wall thickness is determined considering minimum requirements presented in EN 1992-1-1 for concrete cover to the anchor bars of the wall shoe.

The wall shoe is designed for environmental condition exposure class XC1. Design standard requirements must be carefully considered for other exposure classes, for example minimum wall thickness and concrete cover for fire and exposure classes.

Table 6. Minimum wall thickness and concrete cover

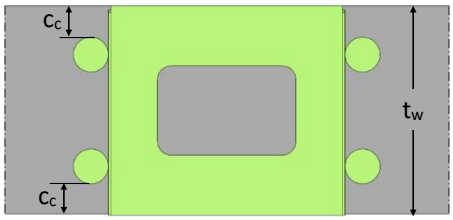
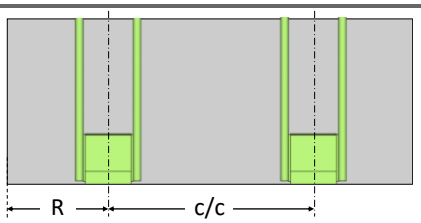
Type	Size	Wall thickness t_w [mm]	Concrete cover c_c [mm]	Figure
RSK-E	M30	130	53	
	M36	150	59	
	M39	190	43	
	M45	210	46	
	M52	250	43	

Table 7. Minimum edge distance and spacing

Type	Size	Edge distance R [mm]	Spacing c/c [mm]	Figure
RSK-E	M30	180	280	
	M36	200	320	
	M39	170	300	
	M45	200	320	
	M52	220	350	

5.3. Reinforcement instructions

The reinforcement of the wall according to EN 1992-1-1 and following details:

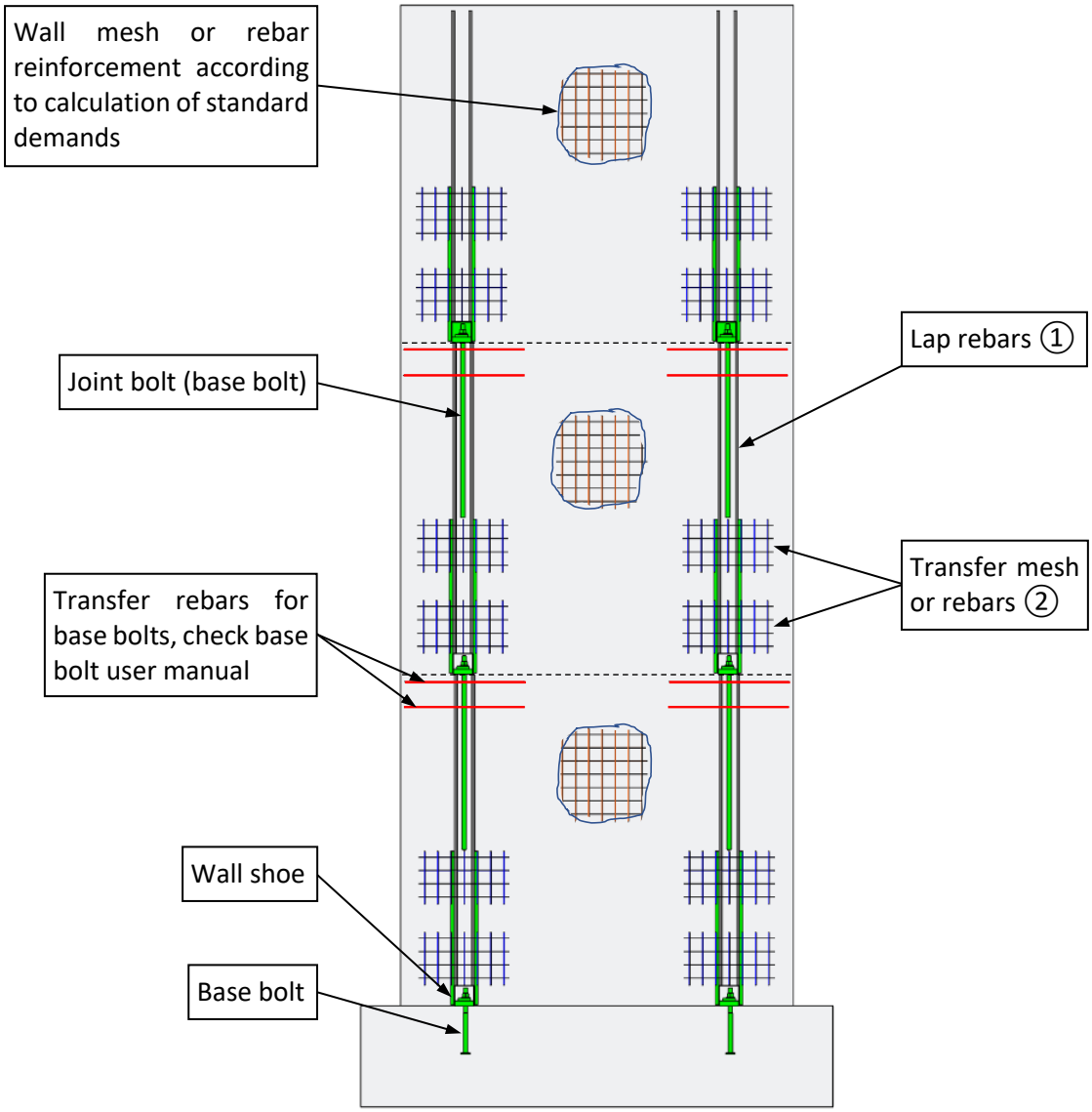


Figure 4. Overview of the reinforced structure

Supplementary transfer reinforcement for the wall shoes must be added according to shoe size. Related values are given in Table 8 to Table 13 based on the shoe type and size. This reinforcement is transverse reinforcement for lapped bars in tension and is applied in the lapping zone between wall shoe sidebars and lapping rebars. Transverse reinforcement is required in the lap zone to resist transverse tension forces and it must be used independently of the main wall reinforcement. Only if the diameter of the lapped bars is less than 20 mm, then any transverse reinforcement or links necessary for other reasons may be assumed sufficient for the transverse tensile forces without further justification according to EN 1992-1-1: 8.7.4.1.

Reinforcement mesh or rebar according to calculation or standard demands.

Minimum mesh requirement on the wall is defined in EN 1992-1-1 section 9.6. Vertical reinforcement should be not less than 0.002Ac. Horizontal reinforcement is 25% of vertical reinforcement or 0.001Ac. Greater value should be used (National Annexes should be checked).

Table 8. Supplementary transfers reinforcement on one side mesh

RSK-E	Lapping rebars ①	Horizontal rebars ②		a [mm]	L_{B1} [mm]	L_{A1} [mm]	L_{S1} [mm]
		$Øm_1$	n				
M30	2Ø25	Ø8	4	150	600	820	304.5
M36	2Ø32	Ø10	4	150	600	845	298.5

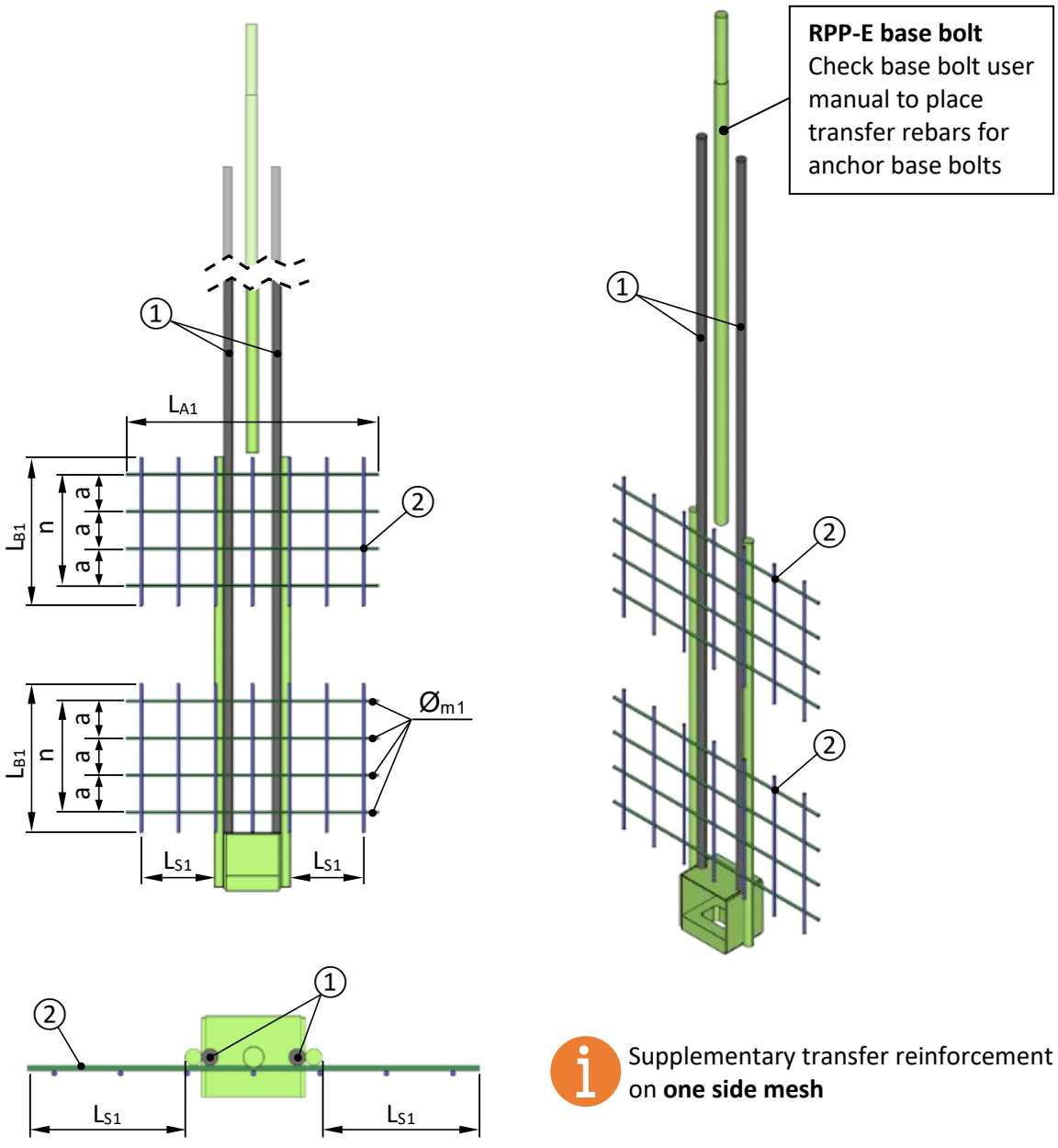


Figure 5. Supplementary transfer reinforcement with one side mesh for RSK-E wall shoe

Table 9. Supplementary transfer reinforcement on one side rebar

RSK-E	Lapping rebars ①	Horizontal rebars ②		a [mm]	L_{A1} [mm]
		$Øm_1$	n		
M30	2Ø25	Ø8	4	150	1070
M36	2Ø32	Ø10	4	150	1095

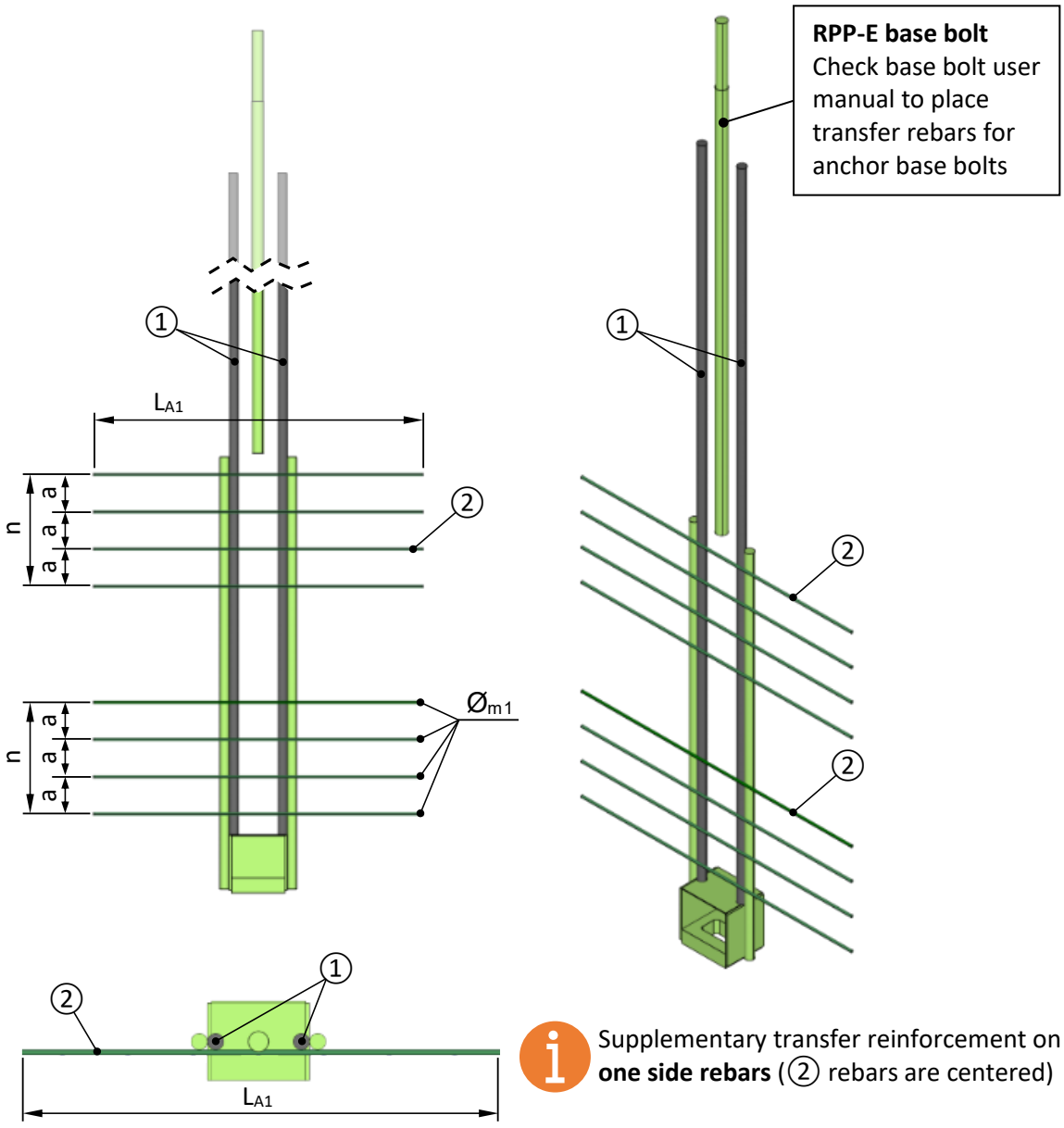


Figure 6. Supplementary transfer reinforcement with one side rebar for RSK-E wall shoe

Table 10. Supplementary transfers reinforcement two sides mesh

RSK-E	Lapping rebars ①	Horizontal rebars ②		a [mm]	L_{A2} [mm]	L_{S1} [mm]
		$Øm_2$	n			
M30	2Ø25	Ø8	2	150	820	304.5
M36	2Ø32	Ø10	2	150	845	298.5

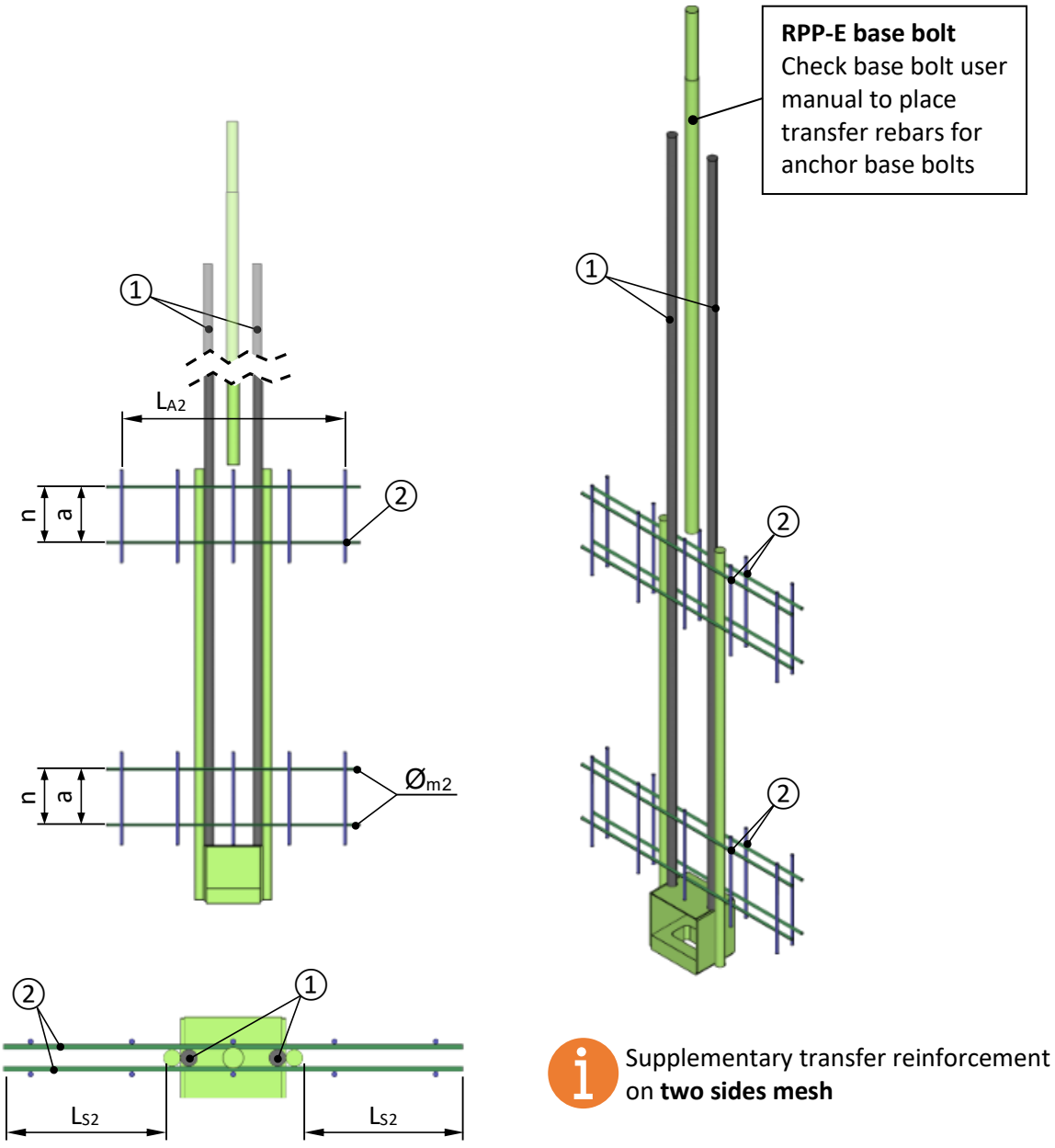


Figure 7. Supplementary transfer reinforcement with two sides mesh for RSK-E wall shoe

Table 11. Supplementary transfers reinforcement two sides rebar

RSK-E	Lapping rebars ①	Horizontal rebars ②		a [mm]	L_{A2} [mm]
		$Øm_2$	n		
M30	2Ø25	Ø8	2	150	1070
M36	2Ø32	Ø10	2	150	1095

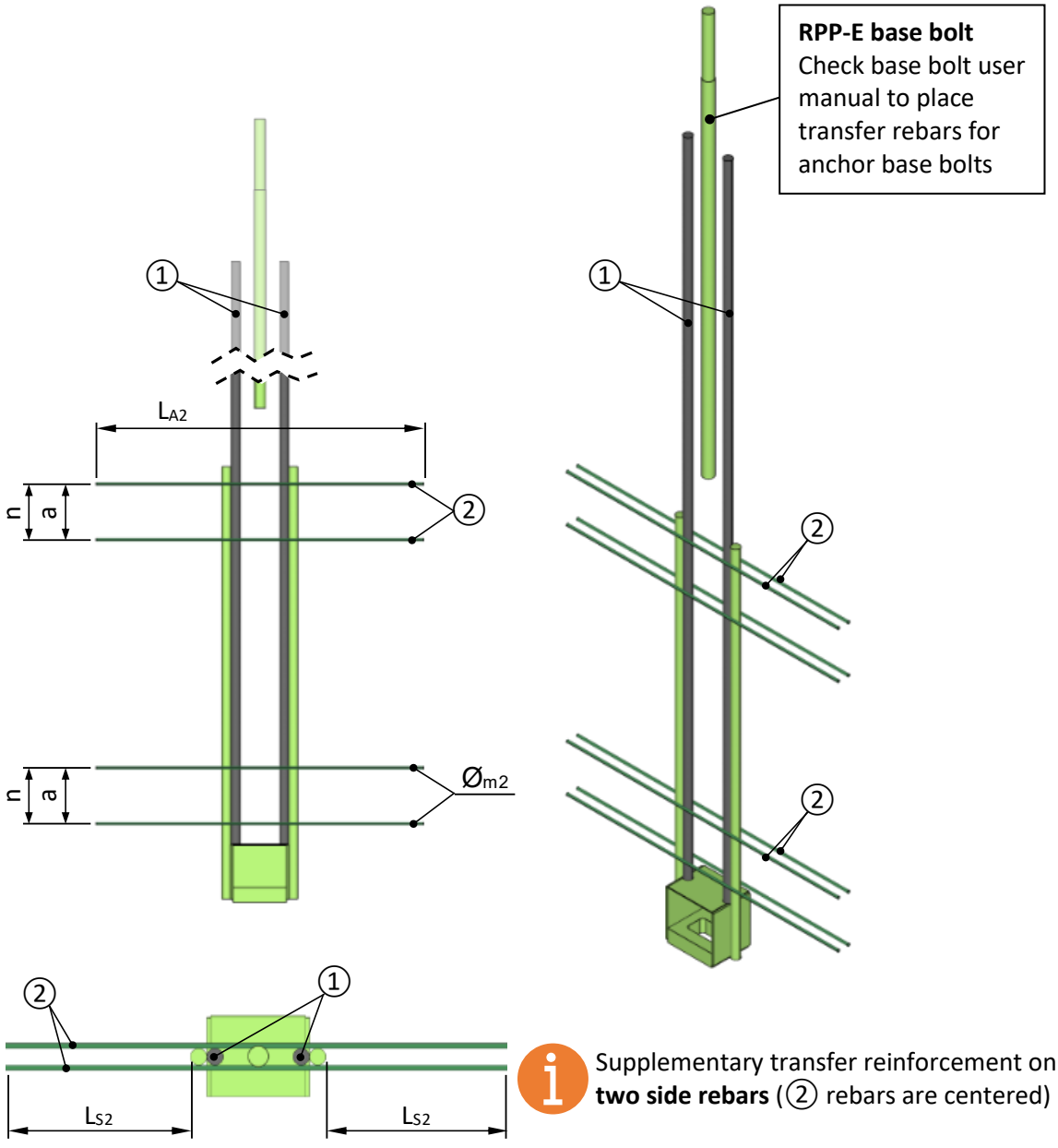


Figure 8. Supplementary transfer reinforcement with two sides rebars for RSK-E wall shoe

Table 12. Supplementary reinforcement with stirrups

RSK-E	Lapping rebars ①	Horizontal stirrups ②		a [mm]
		$Øm_s$	n	
M30	4Ø20	Ø8	5	100
M36	4Ø20	Ø10	5	100

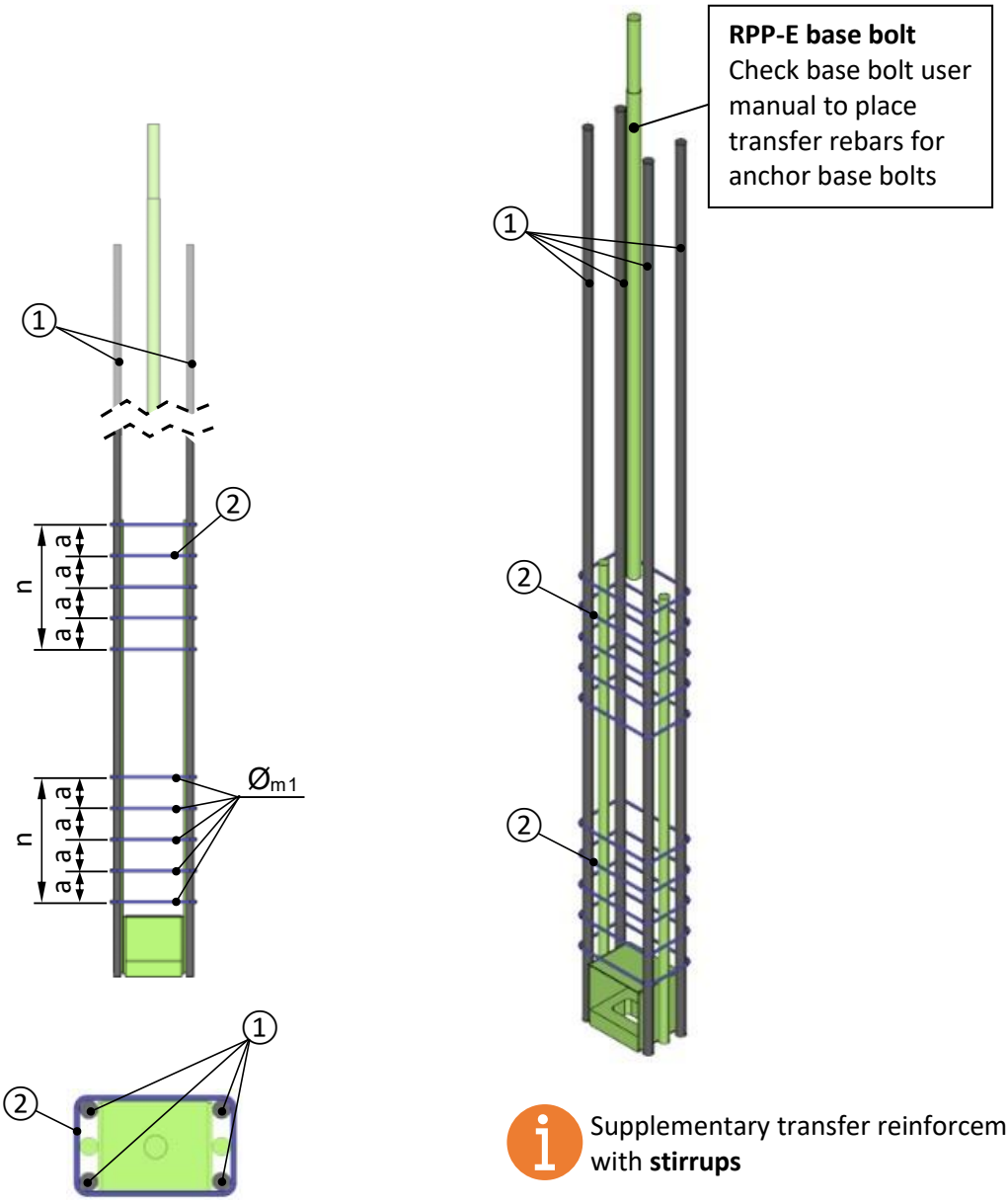


Figure 9. Supplementary transfer reinforcement with stirrups for RSK-E wall shoe

Table 13. Supplementary reinforcement with stirrups

RSK-E	Lapping rebars ①	Horizontal stirrups ②		a [mm]
		$Øm_s$	n	
M39	4Ø25	Ø8	5	100
M45	4Ø32	Ø10	5	120
M52	4Ø32	Ø10	5	130

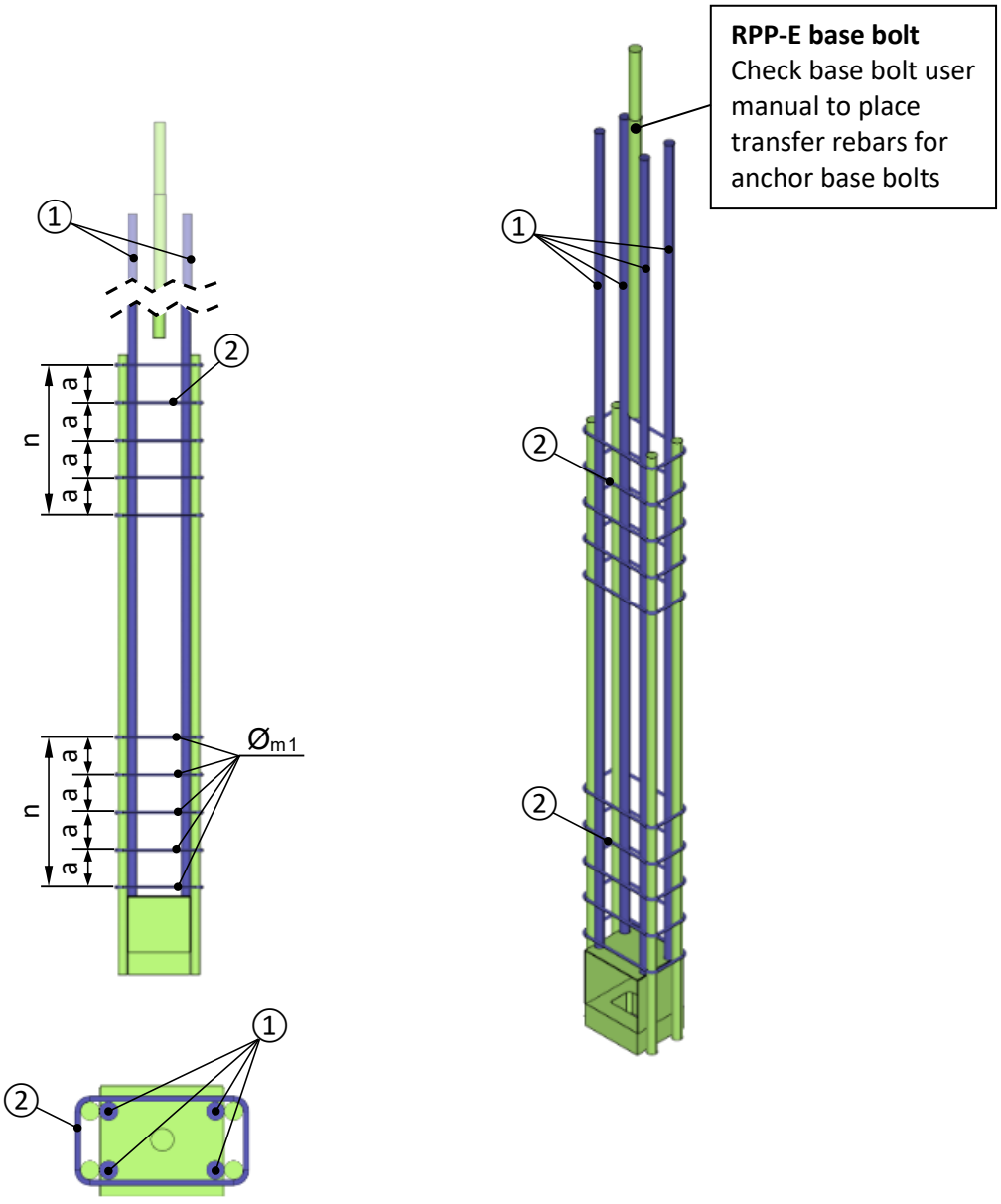


Figure 10. Supplementary transfer reinforcement with stirrups for RSK-E wall shoe

6. INSTALLATION

The wall shoe is secured to the reinforcement of the wall, and its base plate is connected, for example, by clamping to the mould. Additional reinforcement is to be installed according to requirements set out in section 5.3. Length of anchor bolt above element joint bottom surface, gap = 20mm.

Table 14. Installation tolerances for RSK-E wall shoe

RSK-E	Transversal direction $T_{w,t}$ [mm]	Longitudinal direction $T_{w,l}$ [mm]
M30	± 3	± 5
M36	± 3	± 5
M39	± 3	± 5
M45	± 4	± 5
M52	± 4	± 5

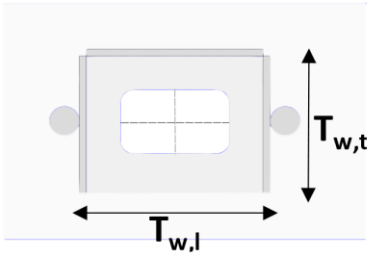


Figure 11. Installation tolerances for RSK-E wall shoe

Table 15. Installation dimensions and tolerances for RPP-E base bolts

RPP-E base bolt	Bolt length h [mm]	Installation tolerance T [mm]
M30	145	± 3
M36	165	± 4
M39	185	± 4
M45	195	± 4
M52	220	± 5

RPP-E base bolt tolerances are in accordance with their respective technical user manuals.

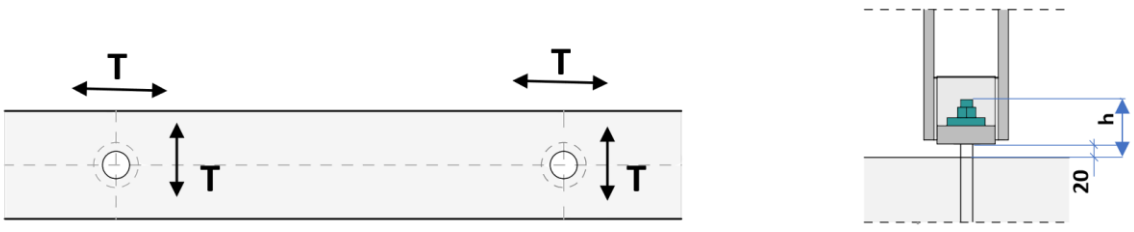


Figure 12. Installation dimensions and tolerances for RPP-E base bolts

6.1. At the factory

Checklist before casting:

- The correct shoe type and size is installed
- The positioning of the shoe is correct and according to installation tolerances
- The shoe is properly secured in the reinforcement and mould
- The correct supplementary reinforcement is installed according to manufacturing drawings

Checklist after casting:

- Position of the shoe is correct and according to tolerances
- Shoes are cleaned and any casting boxes are removed

6.2. Installation of the precast wall element

The precast wall element is installed at the correct level by using packer plates. The wall element is to be temporarily supported during erection, and its level and inclination checked. Before the nuts are tightened, the position of the RAL washer plates inside the wall shoe must be checked. Nuts are to be firmly tightened, for example using an impact wrench. Following tightening of the nuts, lifting connections can be disconnected. Erection must follow the erection scheme that is approved by the responsible engineer. Space required for tightening the nut with an impact wrench is verified in accordance with DIN 7444. Once the wall element is set at the correct level and inclination, and the nuts are tightened, the base is to be grouted in accordance with the manufacturer's guidance. The grout must be of a non-shrinking type and with strength greater than the weakest of the concrete structures connected with the bolt and shoe assembly.

NOTES

TECHNICAL MANUAL REVISIONS

08.08.2022 (JK)

- RSK-N and RSK-E separated into own manuals.

31.10.2022 (FA)

- New graphical layout

19.04.2023 (FA, AV)

- Supplementary reinforcement graphics and tables visually updated
- Stirrup version is added.