



HPM AND PPM BOLTS



ISO 9001
ISO 14001

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HPM AND PPM BOLTS



Benefits of HPM and PPM bolts

- Bolt connection – no welding at the site
 - HPM L -bolts have ETA-approval
 - Right to use CE-marking
- Free use of the product without commercial limitations and obstacles
- Standardized products
 - Precalculated design parameters available
 - Fast delivery time



Peikko benefits

- reliable: passed demanding test program
- competitive price and delivery time
- economical and easy to use in designing, manufacturing and installation of the elements

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HPM AND PPM BOLTS

1. DESCRIPTION OF THE SYSTEM

Tension, compression and shear forces are transferred to the reinforced concrete base structure by Peikko® PPM and HPM bolts.

There are two types of PPM and HPM anchor bolts:

- long bolts (HPM P and PPM P) for splices
- short bolts (HPM L and PPM L) for anchoring

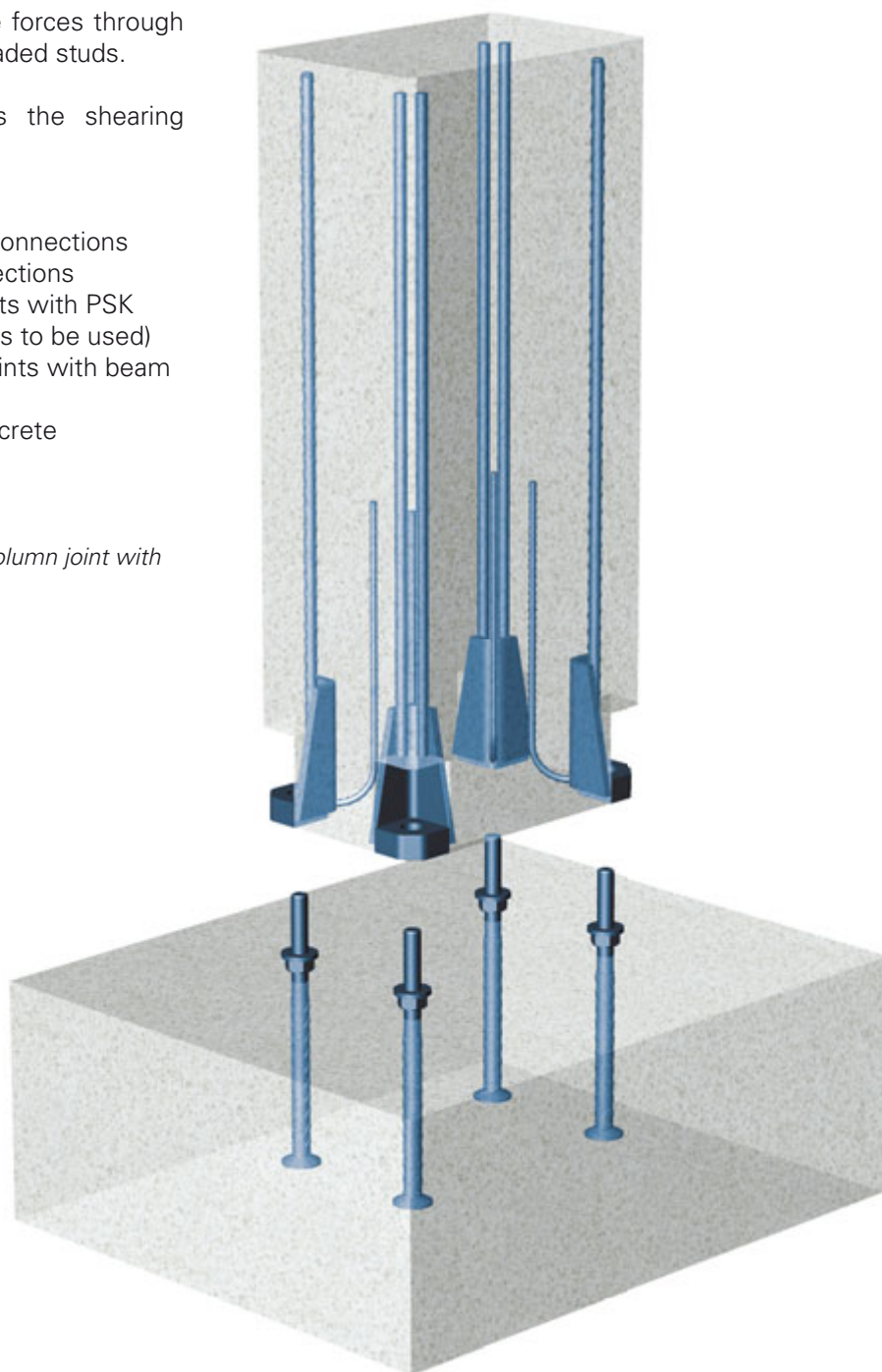
The long anchor bolts transfer the compression and tension forces through the bond of the ribbed bars. The short anchor bolts transfer the forces through the bond of the ribbed bars and headed studs.

Concrete pry out failure defines the shearing capacity of the bolt.

Use range:

- in precast concrete column connections
- in steel column joints / connections
- in concrete element wall joints with PSK wall shoes (Note! AL washers to be used)
- in concrete element beam joints with beam shoes
- in fixing machines to the concrete

Figure 1. Bolts in reinforced concrete column joint with precast concrete connection



2. DIMENSIONS AND MATERIALS

Materials and standards:

Ribbed bars	A500HW B500B	SFS 1215 SFS-EN 10080-1:2005
Thread bars (PPM)	High strength steel	$f_{yk} \geq 770 \text{ MPa}$ ($d \leq 35 \text{ mm}$) $f_{yk} \geq 700 \text{ MPa}$ ($d > 35 \text{ mm}$)
Washers	S355J2 + N	SFS-EN 10025 / DIN 7349
Nuts	property class 8	SFS-EN ISO 4032

HPM and PPM bolts are also available as hot dip galvanized. (Ordering code: For example HPM 24 L **HDG**)

Table 1. Dimensions [mm], weights [kg], stress areas of the threads [mm²] and colors of the HPM bolts

	thread M	A	stress area of the thread	ribbed bar \varnothing	washer \varnothing	HPM P		HPM L		color
						L	weight	L	weight	
HPM 16	16	140	157	16	$\varnothing 38-6$	810	1.7	280	0.9	yellow
HPM 20	20	140	245	20	$\varnothing 46-6$	1000	2.9	350	1.4	blue
HPM 24	24	170	352	25	$\varnothing 56-6$	1160	4.9	430	2.2	grey
HPM 30	30	190	561	32	$\varnothing 65-8$	1420	9.8	500	4.1	green
HPM 39	39	200	976	40	$\varnothing 90-10$	2000	21.8	700	9.2	orange

HPM P

HPM L

Table 2. Dimensions [mm], weights [kg], stress areas of the threads [mm²] and colors of the PPM bolts

	thread M	A	stress area of the thread	ribbed bar \varnothing	washer \varnothing	PPM P		PPM L		color
						L	weight	L	weight	
PPM 22	22	160	303	2 $\varnothing 20$	$\varnothing 56-6$	1190	6.2	510	2.9	light. blue
PPM 27	27	170	459	2 $\varnothing 25$	$\varnothing 65-8$	1415	11.5	650	5.7	black
PPM 30	30	190	561	2 $\varnothing 25$	$\varnothing 65-8$	1705	14.1	670	6.2	-
PPM 36	36	190	817	4 $\varnothing 20$	$\varnothing 80-8$	1450	16.0	740	9.4	red
PPM 39	39	190	976	3 $\varnothing 25$	$\varnothing 90-10$	1815	23.5	880	12.7	brown
PPM 45	45	220	1306	4 $\varnothing 25$	$\varnothing 100-10$	1825	31.4	980	18.6	purple
PPM 52	52	250	1758	4 $\varnothing 32$	$\varnothing 100-12$	1930	52.1	1140	32.6	white
PPM 60	60	310	2362	4 $\varnothing 32$	$\varnothing 115-15$	2490	71.0	1330	42.0	-

PPM P

PPM L

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3. MANUFACTURING

3.1 Manufacturing method

Ribbed bars	Mechanical cutting
Threads	Mechanical machining
Welding	MAG by hand or robot
Forging	Hot forging or similar end anchor

Welding class C (SFS-EN 25817)

3.2 Manufacturing tolerances

Length	±10 mm
Thread length	+5, -0 mm

3.3 Manufacturing markings

Products are marked with the mark of Inspecta, the emblem of Peikko Group, the type of the product and a year and a week of manufacturing. The bolt is marked with same color as corresponding column shoe. Headed bolts have either "PG" or Peikko® emblem on the headed studs. HPM L bolts have CE-marking.

3.4 Quality control

The quality control involved in producing the steel parts conforms to the requirements set by the Regulations of Finnish Code of Building. Peikko Finland Oy is under the Inspecta Certification for quality control.

HPM and PPM bolts have certified product declarations in Finland, Sweden, Poland and Russia. PPM L bolts have certified product declaration in Germany. HPM L bolts are ETA approved.

4. CAPACITIES

Table 3. Design values for tensile- (N_{Rd}) and shear capacities (V_{Rd}) [kN]; concrete K30-2*

bolt	RakMK (concrete K30-2)		ETA
	N_{Rd}	V_{Rd}	N_{Rd}
HPM 16	65.4	14.7	61.7
HPM 20	102.1	22.9	96.3
HPM 24	147.1	33.0	138.7
HPM 30	233.8	52.4	220.4
HPM 39*	406.7	91.1	383.4
PPM 22	194.4	35.1	161.6
PPM 27	294.5	53.2	244.8
PPM 30	360.0	65.0	299.2
PPM 36	476.6	90.2	435.7
PPM 39	569.3	107.8	520.5
PPM 45	761.8	144.3	696.5
PPM 52	1025.5	194.2	937.6
PPM 60	1340.4	260.9	1259.7

*Bolts are dimensioned for concrete grade K30-2 (concrete grade according to Finnish national building code RakMK) except HPM 39, which is dimensioned for reinforced concrete C30/37 according to EN 1992-1/Eurocode 2 chapter 8.4.2 in the case of good bond.

When tensile and shear forces strain the bolt simultaneously, the interaction should be checked with the following formula (according to Finnish national building code RakMK):

$$\left(\frac{N_d}{N_{Rd}}\right)^{\frac{4}{3}} + \left(\frac{V_d}{V_{Rd}}\right)^{\frac{4}{3}} \leq 1$$

N_d	is the design value of tensile force
N_{Rd}	is the design value of tensile resistance
V_d	is the design value of shear force
V_{Rd}	is the design value of shear resistance

The capacity of the normal force of a bolt cast in concrete is the same in tension and compression. The bending and buckling of the bolt should be noted in situations occurring during erection and installation. Such a situation can be dimensioned with the Peik-Col dimensioning program that can be freely downloaded from Peikko's web-site, www.peikko.com.

5. APPLICATION

5.1 Limitations for application

The capacities of the bolts have been calculated for static loads. In the case of dynamic and fatigue loads, greater safety factors have to be used individually for each case.

5.2 Design principles

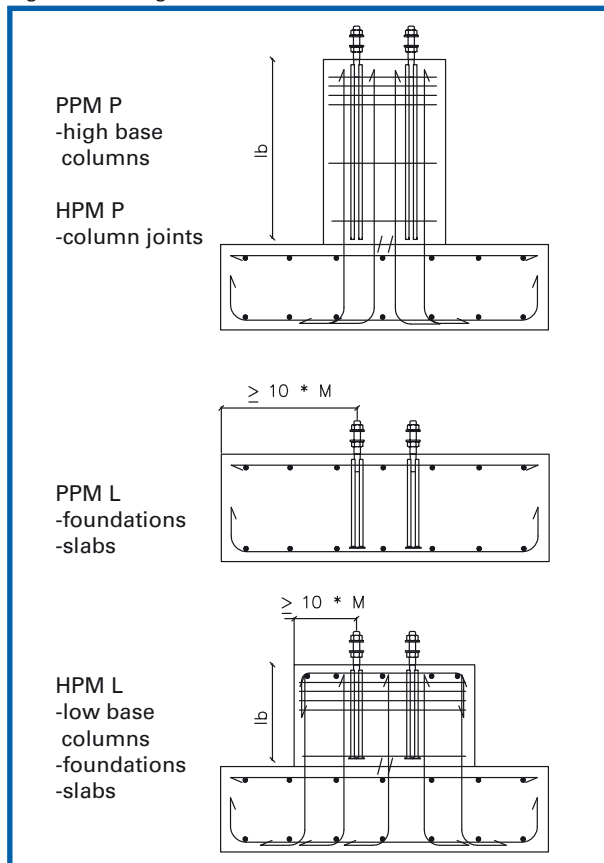
5.2.1 Principle of application

HPM P ribbed bar bolts are used as overlapping bolts in pre-cast columns and as foundation bolts.

HPM L bolts are also used as anchor bolts in foundations, and they are suitable for bolt joints at the top of concrete beams or on sides of columns.

PPM P bolts are used as overlapping bolts in columns. The main reinforcement of the basic bolt is attached to reinforcement of the column with an overlap.

Figure 2. Using the bolts



PPM L bolts are used as anchor bolts in foundations.

5.2.2 Calculation principles

With short bolts tension and compression forces create a concrete cone into the base structure in the situation of ultimate limit state. To ensure the capacities minimum distances of the edge and centres, minimum concrete cover and minimum reinforcement has to be undertaken according to sections 5.2.4 and 5.2.5.

The normal forces on the long bolts (PPM P and HPM P) are transferred through the overlapped ribbed bars to the main reinforcement of the structure.

Table 4. Splice factors for the long bolts

bolt type	RakMK B4 kj	Eurocode 2 α6
HPM P	1.5	1.5
PPM P	2.0	1.5

PPM and HPM bolts have been designed for reinforced concrete K30-2 in bond condition I.

Shear capacities of bolts have been defined according to publication FIB Bulletin No. 43. There is a requirement for minimum edge distance for short and long bolts.

The maximum level of the bolts should be according to section 6.2.

The effect of the stability forces has been taken into consideration with factor 0.8 in the capacities.

5.2.3 Requirements for concrete bedding

PPM and HPM bolts have been designed for reinforced concrete C25/30. The correction factors for lower grades and also for structure class 1 can be found in section 5.2.6.

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5.2.4 Minimum edge distances, centres and attachment bedding reinforcement for long bolts

The fire-resistance period and environment class, in which the anchor bolt is situated, defines the concrete cover thickness according to local regulations.

Also centre distances of long bolts (P-types) are defined according to local regulations.

Attachment bedding reinforcement

A basic column is reinforced with the amount of reinforcement corresponding to the bolts' bond.

Table 5. Reinforcement of column with PPM P bolts

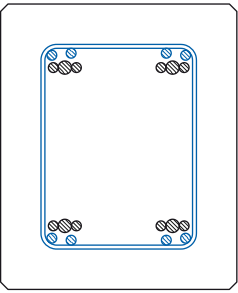
PPM P	rebars of the bolt	
	PPM 22P	2ø20
	PPM 27P	2ø25
	PPM 30P	2ø25
	PPM 36P	4ø20
	PPM 39P	3ø25
	PPM 45P	4ø25
	PPM 52P	4ø32
	PPM 60P	4ø32

Table 6. The defining criteria for bolt lengths (acc. to Fin RakMK)

	HPM P	HPM P	PPM P
concrete	K30-2	K40-1	K30-2
bond coefficient	I	II	I
splice factor	1.5	1.5	2

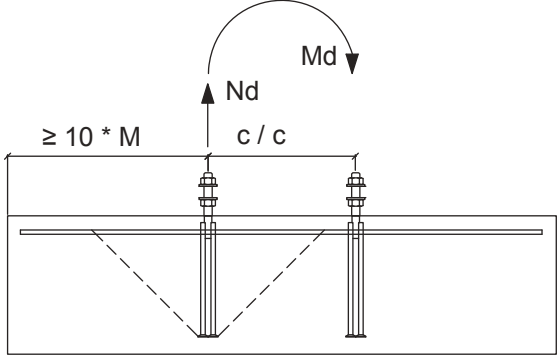
Shear forces

When shear forces are transferred, the edge distance has to be at least $10 \times M$. In the case of smaller edge distance, the edge has to be reinforced against the shearing forces or the capacity has to be decreased according to section 5.2.6

5.2.5 Minimum edge distances, centres and attachment bedding reinforcement for short bolts

The minimum edge distance from the edge of the foundation is $10 \times M$ for short HPM L and PPM L bolts.

Table 7. The edge distance of short bolts in foundation plate and the minimum centre distances, when the joint consists of four bolts [mm]

	
	c/c
HPM 16L	80
HPM 20L	110
HPM 24L	120
HPM 30L	180
HPM 39L	280
PPM 22L	100
PPM 27L	100
PPM 30L	200
PPM 36L	280
PPM 39L	280
PPM 45L	280
PPM 52L	280
PPM 60L	280

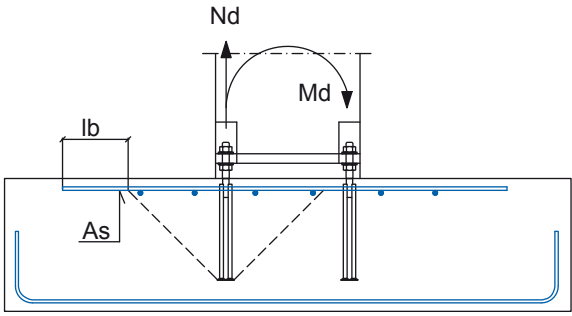
If tensile force is affecting more than two bolts, the centre distances has to be checked as special case.

Tensile forces

A single bolt can be anchored without the need for punching reinforcement.

A pair of bolts requires the use of mesh reinforcement according to the concrete standards. The reinforcement is distributed evenly in the area of the concrete cone.

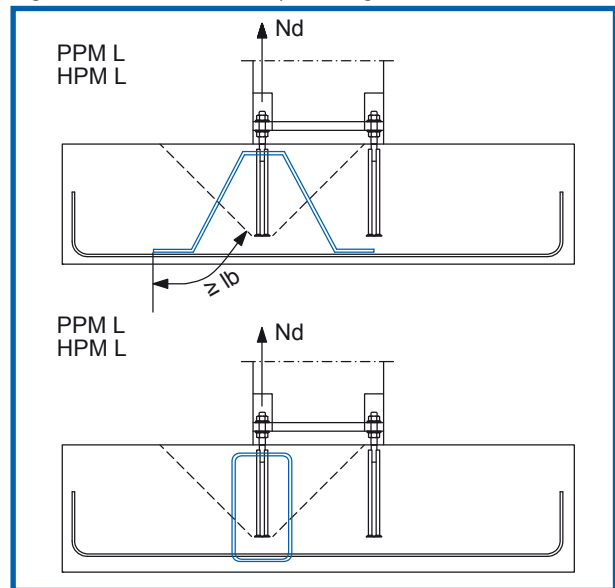
Table 8. Foundation reinforcement



	A_s [mm ² /m]	mesh
HPM 16L	167	Ø8 #200
HPM 20L	225	Ø8 #200
HPM 24L	288	Ø8 #150
HPM 30L	336	Ø8 #150
HPM 39L	500	Ø10 #150
PPM 22L	355	Ø8 #150
PPM 27L	470	Ø10 #150
PPM 30L	490	Ø10 #150
PPM 36L	539	Ø10 #150
PPM 39L	663	Ø12 #150
PPM 45L	745	Ø12 #150
PPM 52L	869	Ø12 #100
PPM 60L	1019	Ø12 #100

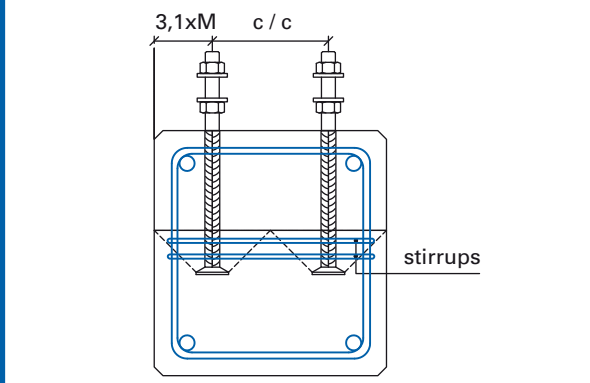
If necessary, values lower than the edge distances stated in table 7 can be used if the concrete cone is anchored against bolt force by using the following principles.

Figure 3. Alternatives for punching reinforcement



If necessary, the HPM L anchor bolt can be located closer to the edge of the structure if the corner of the structure is reinforced according to the bolt forces. In that case, with the HPM L anchor bolt, the minimum edge distance is $3,1 \times M$. Using this small edge distance (min. $3,1 \times M$) may be necessary in beams, columns and in the edges of other strongly reinforced structures.

Table 9. The minimum edge distance of the HPM L anchor bolt. The reinforcement of the structure will prevent concrete failure.



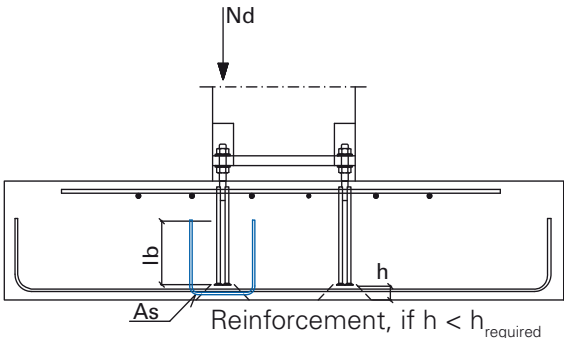
	A_{sh} [mm ²]	stirrups
HPM 16L	52	1ø8
HPM 20L	82	2ø8
HPM 24L	118	3ø8
HPM 30L	187	4ø8
HPM 39L	325	5ø10

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Compression forces

The compression anchoring of short bolts requires a sufficient concrete layer (h) under the bolt's head, so that the anchor piece does not cause a conical fracture under the plate. If h in the structure is lower than the required $h_{required}$, the structure has to be reinforced.

Table 10. Reinforcing the conical fracture under the bolt

		
	$h_{required}$ [mm]	A_s [mm ²]
HPM 16L	80	96
HPM 20L	100	141
HPM 24L	115	186
HPM 30L	145	311
HPM 39L	190	508
PPM 22L	90	149
PPM 27L	105	152
PPM 30L	120	298
PPM 36L	170	588
PPM 39L	195	720
PPM 45L	205	961
PPM 52L	220	1024
PPM 60L	280	1510

Shear forces

When shearing forces are transferred, the edge distance has to be $10 \times M$ at the most. Otherwise, the edge has to be reinforced against the shearing forces or the capacity has to be decreased according to section 5.2.6.

5.2.6 The correction factors of capacity values

Correction factors according to:

a) Finnish National Building code RakMK:

construction class	1	2
tension capacity	1.09	1.00
shear capacity	1.04	1.00
strength of concrete	K25-2	K30-2
correction factor	0.83	1.00

b) Eurocode 2 (P-bolts)

	tension capacities		
strength of concrete	C20/25	C25/30	C30/37
rebars $d_s \leq 32$	0.86	1.00	-
rebars $d_s > 32$	0.76	0.89	1.00

Values are calculated for design value of bonding strengths

Edge distances for shear force

The shear force capacity requires an minimum edge distance of $10 \times M$. If this requirement is not in place, reinforcement must be used to make sure the edge of the concrete structure will not break. Alternatively, the capacities must be reduced in relation to the edge distances.

$$\text{correction factor} = \left(\frac{C}{10 \times M} \right)^2$$

C = distance from structure edge to the centre of the bolt

M = thread size



5.2.7 Joining to foundations and column to column connections

Figure 4. Column joint of two different size columns

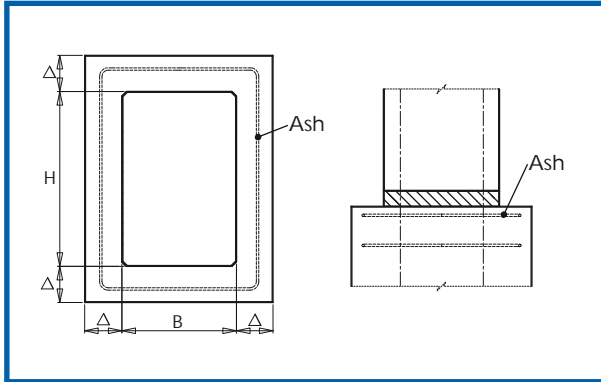


Table 11.
The expansion of the (Δ_{min}) and splitting stirrups

concrete grade (column)	K40-1	K50-1	K60-1	K60-1	K80-1
concrete grade (foundation)	K30-2	K30-2	K30-2	K40-2	K40-2
the bolts of the tension side yield Δ [mm]	$0.13 \times H$	$0.26 \times H$	$0.38 \times H$	$0.20 \times H$	$0.38 \times H$
cross section compressed Δ [mm]	$0.24 \times H$	$0.43 \times H$	$0.61 \times H$	$0.33 \times H$	$0.61 \times H$
diametric reinforcement (BSt500S) Ash > A [mm ²]	$A = B \times H / 430$	$A = B \times H / 240$	$A = B \times H / 170$	$A = B \times H / 278$	$A = B \times H / 153$

The concrete strength of the lower column, in the column to column connection should be at least the same as the concrete strength of the upper column.

6. INSTALLATION

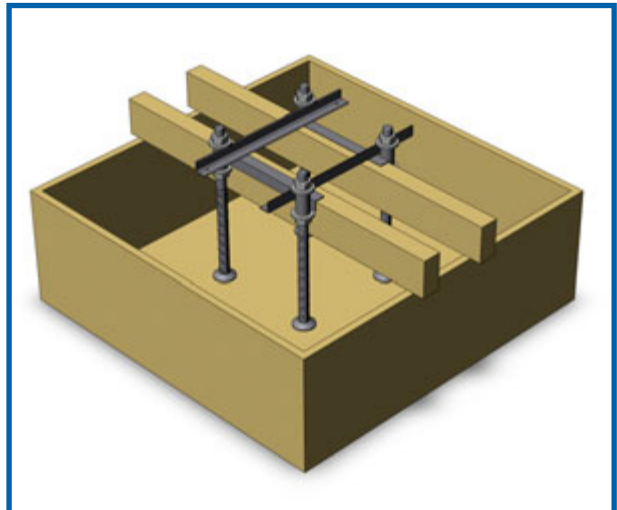
6.1 Appliance and equipment

Compiling the bolts to bolt groups is done with the PPK installation frame.

By using the installation frame, the right centre distance c/c as well as the verticality of the bolts is secured. Centre lines marked to the installation frame make it easier to measure the bolt groups to their exact location according to module line. With the help of the installation frame, the bolts can be grouped easily for direct use in reinforcement. Use of the welded bolt groups, or grillages, is unnecessary.

The frame is installed by tightening it between the nuts. During casting, the frame protects the threads. By greasing the threads before casting helps in the removal of the frame. The installation frame is attached by nailing it to the mould with a support timber and by binding the bolt group into the reinforcement. An open frame makes casting and compacting the concrete easier. After casting, the frame is detached and can be reused.

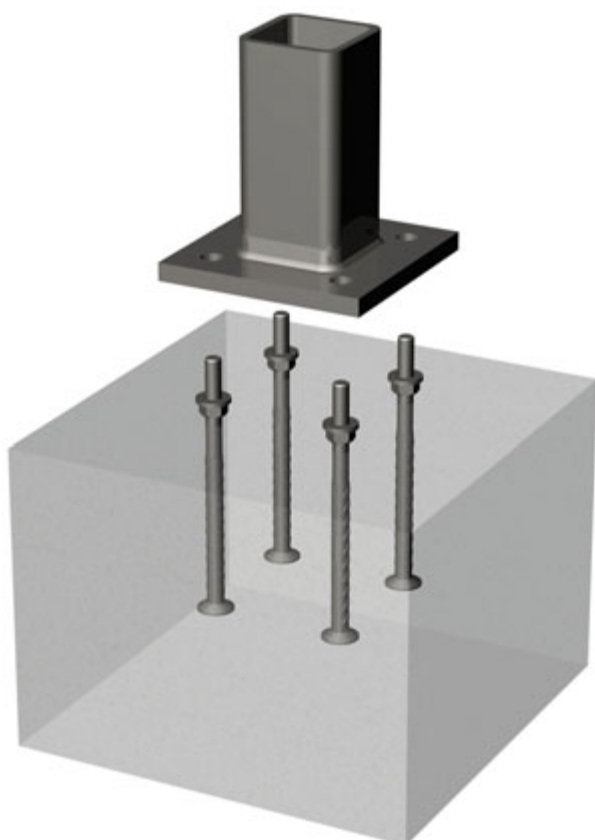
Figure 5. Using the PPK installation frame



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Table 12. Sizes of the nuts [mm]

Thread	Key
M16	24
M20	30
M22	34
M24	36
M27	41
M30	46
M36	55
M39	60
M45	70
M52	80
M60	90



6.2 Bolt installation and installation tolerances

The bolts are installed to the level according to the figures in table 13. The level is measured from the surface of the rough casting, and the level tolerance is ± 20 mm.

Table 13. Installation tolerances and the anchoring bolt's height level [mm] from the surface of concrete when HPKM, PPKM and PEC column shoes are used.

		installation tolerance T	location tolerance of bolt group ± 10 mm	
	Column shoe	Grouting	Bolt height from cast level	Installation tolerance for the bolt (T)
HPM 16	HPKM 16	50	105	± 3
HPM 20	HPKM 20	50	115	± 3
HPM 24	HPKM 24	50	130	± 3
HPM 30	HPKM 30	50	150	± 3
HPM 39	HPKM 39	60	180	± 3
PPM 22	PEC 24	50	130	± 3
PPM 27	PEC 30	50	160	± 3
PPM 30		50	150	± 3
PPM 36	PPKM 36	55	170	± 4
PPM 39	PPKM 39	60	180	± 4
PPM 45	PPKM 45	65	195	± 4
PPM 52	PPKM 52	70	225	± 5
PPM 60		80	260	± 5

When the bolt group for the PPK installation frame is formed, a reciprocal location tolerance of ± 3 mm is achieved for the bolts. The location tolerance of the bolt group's hub has to be ± 10 mm in concrete element installation.

6.3 Bending the bolts

The HPM bolts and the anchor bars of the PPM bolts are made of BSt500S (A500HW) ribbed steel. Bending must be done in accordance with either EN or the Finnish Code of Building Regulations.

6.4 Welding of the bolts

Welding of the bolts should be avoided, although all materials used in HPM and PPM bolts are weldable (except the nuts).

Requirements and instructions of standard EN 17660-1: *Welding of reinforcing steel, Part 1: load bearing welding joints* shall be taken into account when welding rebars.

6.5 Installing the columns

Column installation is done on top of washers adjusted to the right level with the nuts and by using installation pieces (shims or packers) under columns. The verticality of the column is checked and the nuts are screwed on tight, eg. with impact tool or spanner. Joint castings are done prior to installing the upper structures.



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7. INSTALLATION CONTROL

7.1 Instructions for controlling bolt installation

Before casting

- ensure that the right frame is being used (c/c centre distance, thread size). HPKM, PPKM and PEC column shoes have a column side measurement of 100 mm (M16 - M36) or 120 mm (M39 – M52 and PEC 36) greater than the bolts' c/c standards.
- ensure the location of the bolt group in relation to the module lines
- ensure that the reinforcement required by the bolts has been installed
- ensure that the bolts are on correct level
- ensure that installation frame and bolt group is not rotated

After casting

- ensure the location of the bolt group (the tolerance for concrete element column joints are portrayed in section 6.2). Greater variations must be reported to the structural designer.
- protect the thread until the installation of the column (tape, plastic tube etc.)

7.2 Instructions for controlling column installation

The joints have to be made according to the installation plan composed by the designer (construction engineer). If needed, Peikko's technical support will give advice.

In particular, check the following:

- installation order
- supports and bracing during installation
- instructions for tightening the nuts
- instructions for joint casting







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