peikko®

HPM AND PPM ANCHOR BOLTS

Version 08/2016
Revision 002

HPM AND PPM ANCHOR BOLTS

Benefits of HPM and PPM Anchor Bolts

- Wide variety of capacities available
- Forged heads allow for shallow foundations
- Bolt Connection – No Welding at the Site
- HPM/L Anchor Bolts Have ETA-Approval
- Right to Use CE-Marking
- Free Use of the Product Without Commercial Limitations
- Standardized Products
- Precalculated Design Parameters Available
- Fast Delivery Time
- Available in Stainless Steel and Hot Dip Gavanized

For technical support, please contact us at 1-888-PEIKKO-1

peikko®

CONCRETE CONNECTIONS

Peikko's benefits:

Reliable: passed demanding test program

Competitive price and delivery time

Economical and easy to use in designing, manufacturing and installation of the elements

Printed in Canada

SAFETY CONSIDERATIONS

Improper Use of the Peikko Products Can Cause Severe Injuries or Death

Read, understand and follow the information in this publication before using any of the Peikko product displayed herein. When in doubt about the proper use or installation of any Peikko® lifting product, immediately contact the Peikko Engineering Services for clarification.

Peikko® guarantees the products it manufactures only when used by qualified, experienced and properly supervised workmen adhering to the safety factor standards detailed below. Misuse, misapplication or lack of proper supervision and/or inspection can result in serious accidents. If you have unusual applications or are uncertain about a product application, contact Peikko's Engineering Services for clarification and carefully field test the application prior to general use.

The user of a Peikko® product must evaluate the product application to determine the safe working load and control all field conditions to prevent application of loads in excess of a product's safe working load. The Safety Factors Table shown in this publication are approximate minimum values. The data used to develop safe working loads for products displayed in this publication is a combination of actual testing and/or other industry sources.

Recommended safe working loads given for the products in the publication must never be exceeded. Safety factors are determined by the degree of risk involved in the use of the product and are established by the American Concrete Institute (ACI), Occupational Safety and Health Administration (OSHA) and American National Standards Institute (ANSI).

All products displayed in this publication have the applicable safety factor used to derive their safe working loads. This does not relieve the user of the responsibility to carefully calculate and determine the actual loads that will be applied in a specific product application.

WORN WORKING PART

For safety, concrete accessories must be properly used and maintained. Concrete accessories shown in this publication may be subject to wear, overloading, deformation, intentional alteration and other factors that may affect the device's performance. All reusable accessories must be inspected regularly by the user to determine if they may be used at the rated safe working load or removed from service. The frequency of inspections depends upon factors such as (but not limited to) the amount of use, period of service and environment. It is the responsibility of the user to schedule hardware inspections for wear and to remove from service when wear is noted.

WELDING CONSIDERATIONS

Peikko cannot control field conditions or field workmanship; therefore it cannot guarantee any Peikko® product that has been altered in any ways after it has left the manufacturing facility. This includes welding, bending, filing, etc. Never weld to a casting unless authorized by a lisenced metallurgical engineer. Welding to a casting can cause localized embrittlement that greatly reduces the load-carrying capacity of the casting. Tack welding to wire products can have the same effect.

PRODUCT DESIGN AND SAFE WORKING LOAD CHANGES

As a manufacturer of quality concrete accessories, Peikko reserves the right to change product designs and/or product safe working load ratings at any time without prior notice to prospective users. Any such changes will only be made to improve the product or to increase product safety.

CORROSION OF THE PRODUCTS

Corrosion may occur on exposed metal products when architectural precast members are etched or acid washed. The amount of corrosion will depend on the acidity of the wash and/or the type of chemicals used.

EMBRITTLEMENT

Carbon steels, cold-worked steels and heat treated steels are susceptible to embrittlement in both electroplating and hot dip galvanizing operations. Any severely cold-worked steel must be stress-relieved from strain aging by baking prior to electro-plating or hot dip galvanizing. Any steel with significant high strength or high carbon content is susceptible to hydrogen embrittlement during electro-plating or hot dip galvanizing.It must be baked after the coating is applied to drive out excessive hydrogen. WARNING : Products manufactured from high carbon steel that are electro-plated or hot dip galvanized must be properly heat treated to minimize embrittlement. Failure to properly heat treat these products may cause a compromise of their safe working loads and result in a premature failure of the product.

CAPACITIES

Please note that the information contained in graphs, tables and figures is provided only as a guideline. Local authorities having jurisdiction should be consulted prior to plan submission.

CONTENTS

1. DESCRIPTION OF THE SYSTEM

The Peikko® PPM and HPM Anchor Bolts transfer the tension, compression and shear forces to the reinforced concrete base structure.

There are two types of PPM and HPM Anchor Bolts:

- Long Anchor Bolts (HPM/P and PPM/P) for splices
- Short Anchor 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 blow out failure generally defines the tensile capacity of the Bolt.

Use range:

- in concrete element column joints with Column Shoes
- in steel column joints
- 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

Note: The capacities and reinforcements specified in this brochure's tables are provided as guidelines. Local authorities having jurisdiction should be consulted prior to plan submission.

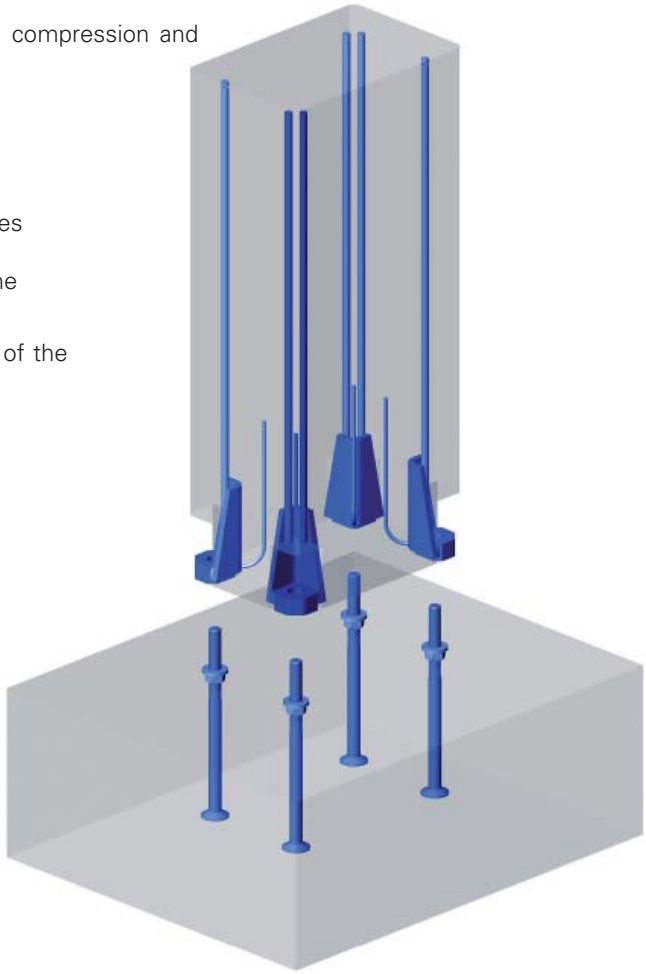


Figure 1. Bolts in reinforced concrete column joint

2. DIMENSIONS AND MATERIALS

Materials and standards:

Ribbed Bars	A500HW	SFS 1215 / B500B
		SFS-EN 10080-1:2005
Threaded Bars (PPM)	High strength steel	fyk ≥ 92.8 ksi (640 MPa)
		fuk ≥ 116.0 ksi (800 MPa)
Washers	S355J2 + N	SFS-EN 10025 / DIN 7349
Nuts (HPM / PPM)	property class 8 / property class 10	SFS-EN ISO 4032 / SFS-EN 24032 / DIN 934

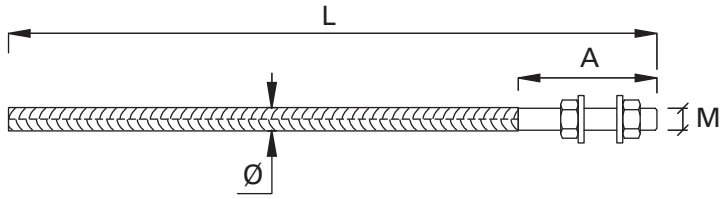
HPM AND PPM ANCHOR BOLTS

Table 1. Dimensions, Weights, Stress areas of the threads and Colors of the HPM Anchor Bolts

	M Thread Type		A		Stress area of the thread		Ribbed Bar Ø		Washer Ø		HPM/P L		HPM/P Weight		HPM/L L		HPM/L Weight		Color
	[US*]	[SI]	[in]	[mm]	[in²]	[mm²]	[SI]	[US*]	[in]	[mm]	[in]	[mm]	[lb]	[kg]	[in]	[mm]	[lb]	[kg]	
HPM 16	5/8	M16	5-1/2	140	0.243	157	M16	#5	ø 1-1/2-1/4	ø38-6	31-7/8	810	3.75	1.7	11	280	1.98	0.9	yellow
HPM 20	3/4	M20	5-1	140	0.379	245	M20	#6	ø 1-13/16-1/4	ø46-6	39-3/8	1000	6.39	2.9	13-3/4	350	3.09	1.4	blue
HPM 24	7/8	M24	6-11/16	170	0.545	352	M25	#8	ø 2-13/16-1/4	ø56-6	45-5/8	1160	10.80	409	16-15/16	430	4.85	2.2	grey
HPM 30	1-1/8	M30	7-1/2	190	0.869	561	M32	#10	ø 2-1/2-5/16	ø65-8	55-7/8	1420	21.61	9.8	19-11/16	500	9.04	4.1	green
HPM 39	1-1/2	M39	7-7/8	200	1.512	976	M40	#11	ø 3-1/2-3/8	ø90-10	78-3/4	2000	48.06	21.8	27-9/16	700	20.28	9.2	orange

* Imperial values converted from metric standards

HPM P



HPM L

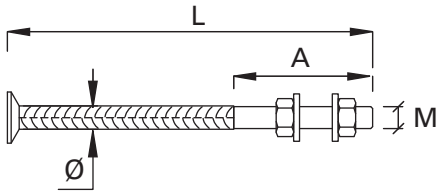
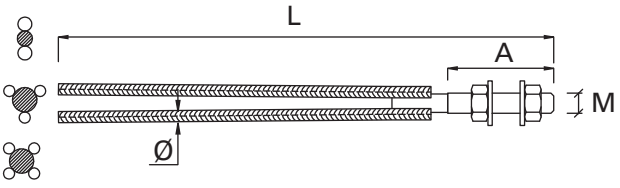


Table 2. Dimensions, Weights, Stress areas of the threads and Colors of the PPM Anchor Bolts

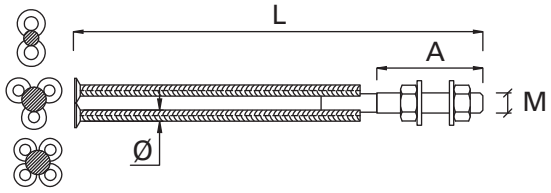
	M Thread Type		A		Stress area of the thread		Ribbed Bar Ø		Washer Ø		PPM/P L		PPM/P Weight		PPM/L L		PPM/L Weight		Color
	[US*]	[SI]	[in]	[mm]	[in²]	[mm²]	[in]	[mm]	[in]	[mm]	[in]	[mm]	[lb]	[kg]	[in]	[mm]	[lb]	[kg]	
PPM 22	7/8	M22	6-1/4	160	0.469	303	2ø#6	2ø20	ø 2-1/4-1/4	ø56-6	46-7/8	1190	13.67	6.2	20	510	6.39	2.9	light. blue
PPM 27	1	M27	6-11/16	170	0.711	459	2ø#8	2ø25	ø 2-9/16-5/16	ø65-8	55-3/4	1415	25.35	11.5	25-9/16	650	12.57	5.7	black
PPM 30	1-1/8	M30	7-1/2	190	0.869	561	2ø#8	2ø25	ø 2-9/16-5/16	ø65-8	67-1/8	1705	31.09	14.1	26-3/8	670	13.67	6.2	-
PPM 36	1-1/4	M36	7-1/2	190	1.266	817	4ø#6	4ø20	ø 80-5/16	ø80-8	57	1450	35.27	16.0	29-1/8	740	20.72	9.4	red
PPM 39	1-1/2	M39	7-1/2	190	1.512	976	3ø#8	3ø25	ø 3-1/2-13/32	ø90-10	71-1/2	1815	51.81	23.5	34-5/8	880	28.00	12.7	brown
PPM 45	1-3/4	M45	8-11/16	220	2.023	1306	4ø#8	4ø25	ø 3-15/16-13/32	ø100-10	71-7/8	1825	69.23	31.4	38-9/16	980	41.00	18.6	purple
PPM 52	2	M52	9-7/8	250	2.723	1758	4ø#10	4ø32	ø 3-15/16-1/2	ø100-12	76	1930	114.86	52.1	44-7/8	1140	71.87	32.6	white
PPM 60	2-1/4	M60	12-1/4	310	3.659	2362	4ø#10	4ø32	ø 4-1/2-19/32	ø115-15	98	2490	156.53	71.0	52-3/8	1330	92.59	42.0	-

* Imperial values converted from metric standards

PPM P



PPM L



3. MANUFACTURING

3.1 Manufacturing method

Ribbed Bars	Mechanical cutting
Threads	Mechanical machining
Welding	MAG by hand or robot
Forging	Hot forging or similar anchoring
Welding class	C (SFS-EN 25817)

3.2 Manufacturing tolerances

Length	± 3/8" (±10 mm)
Thread length	+3/16", -0" (+5 mm, -0 mm)

3.3 Manufacturing markings

Products are marked with the mark of Inspecta, the emblem of Peikko Group, the type of the product, the year and the week of manufacturing. The Bolt is marked with the same color as the corresponding Column Shoes. Studded Bolts have either "PG" or Peikko® emblem on the headed studs. HPM L Anchor Bolts have CE-marking.

3.4 Quality control

Peikko is under the Inspecta Certification for quality control. HPM and PPM Anchor Bolts have certified product declarations. PPM/L Anchor Bolts have certified product declaration. HPM/L Anchor Bolts are ETA approved.

4. CAPACITIES

4.1 Capacity values

All values in table 3 are obtained from steel capacity of the bolt as being the governing failure mode. In order to make sure that the steel failure will be the governing failure mode, the minimum compressive strength of the concrete used in the bolt ($f'_c \geq 4500$ psi (30 MPa)), the minimum edge distance (1,5 X h_{ef}) and the thickness of the slab of at least 2,25 X h_{ef} must be respected.

If a bolt is located at less than 1,5 times the embedment length; for an edge or if the minimum concrete compressive strenght is lower than specified, all possible failures modes must be checked.

Shear capacities presented in Table3. are factored according to bolt material limits only. Buckling and bending of the bolt should be noted in situation occuring during erection time and installation. An exemple of calculation is given above in section 5.3.

Designer must provide to erectors instructions for tightening the nuts. If needed, Peikko's technical support will give advice.

In the event that high shear loads must be transfered to the Anchor bolts, the shear should be transfered by another mecanism such as a shear dowel.

4.2 Interaction of tensile and shear forces

Anchors or Anchor Groups that are subjected to bolt shear and axial loads shall be designed to satisfy the requirements of clauses 4.2.1 through 4.2.3.

The value of N_r (factored resistance in tension) shall be the smallest of the steel resistance of the Anchor in tension, concrete breakout resistance of the Anchor in tension, pull-out resistance of the Anchor in tension and side-face blow-out resistance.

The value of V_r (factored shear resistance) shall be the smallest of the steel resistance of the Anchor in shear, the concrete breakout resistance of the Anchor in shear and the pryout resistance.

N_f = factored axial load normal to the cross-section occurring simultaneously with v_f, including effects of tension due to creep and shrinkage (taken as positive for tension and negative for compression).

V_f = factored shear force according to bolt material capacities

Table 3. Design values for tensile(N_S) and shear capacities(V_S)

Bolt	ACI 318-19		CSA A23.3-04	
	Ns [kips]	Vs [kips]	Nsr [kN]	Vsr [kN]
HPM 16	12.4	5.5	51	29
HPM 20	19.3	8.6	80	45
HPM 24	28.0	12.4	116	64
HPM 30	44.5	19.7	184	102
HPM 39	77.6	34.4	319	178
PPM 22	35.1	15.5	144	80
PPM 27	53.1	23.5	218	122
PPM 30	64.8	28.7	267	149
PPM 36	94.4	41.8	389	217
PPM 39	112.9	50.0	465	259
PPM 45	151.1	66.9	622	346
PPM 52	203.4	90.1	837	466
PPM 60	273.5	121.2	1124	626

4.2.1 Formula for tension

If $V_f \leq 0.2V_r$,full resistance in tension shall be permitted, as follows (see figure 2)

$$N_R \geq N_F$$

4.2.2 Formula for shear

If $N_f \leq 0.2N_r$,full resistance in shear shall be permitted, as follows (see figure 2)

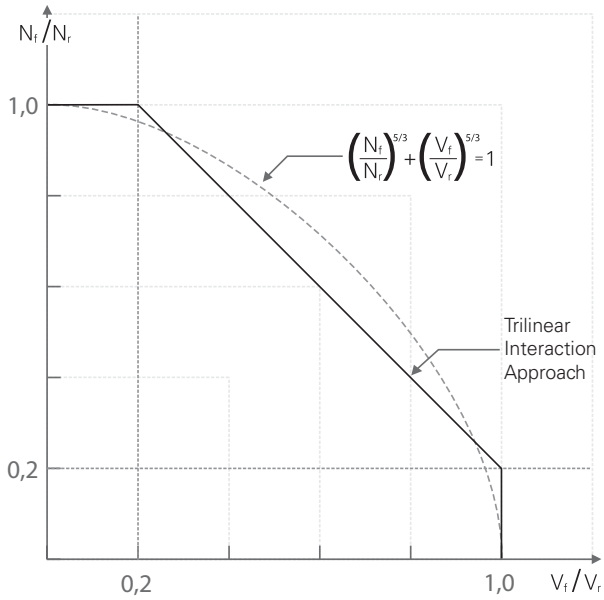
$$V_R \geq V_F$$

4.2.3 Formula for tension and shear

If $V_f > 0.2V_r$ and $N_f > 0.2N_r$, the following shall apply (see figure 2)

$$\frac{N_f}{N_r} + \frac{V_f}{V_r} \leq 1.2$$

Figure 2. Shear and tensile load interaction equation



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 assembly. Such a situation can be dimensioned with

the PeikCol dimensioning program that can freely be downloaded from Peikko's website www.peikko.com.

5. APPLICATION

5.1 Limitations for application

The capacities of the Anchor 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

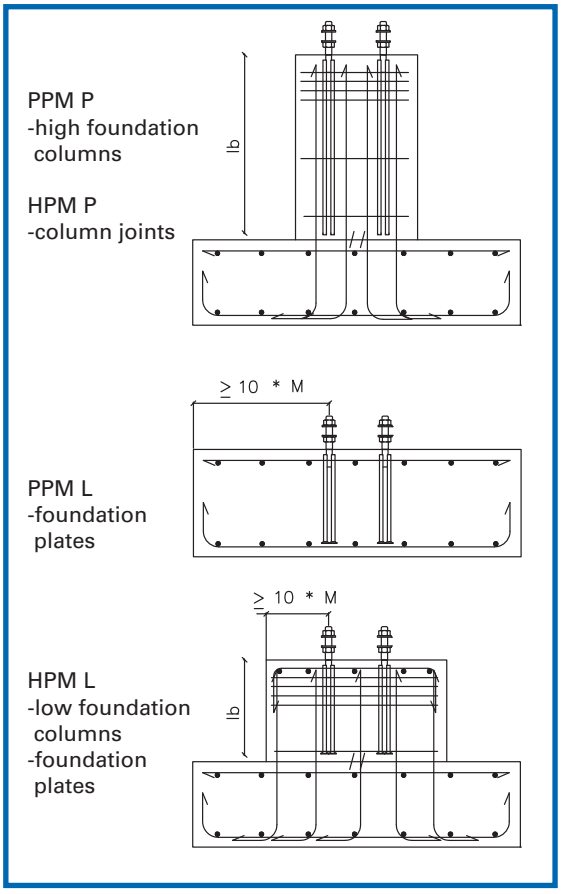
HPM/P Ribbed Bar Anchor Bolts are used as overlapping Bolts in precast columns and as foundation Bolts.

HPM/L Ribbed Bar Anchor Bolts are also used as Anchor Bolts in foundations, and they are suitable for Bolt joints at the top of concrete beams or on the sides of columns.

PPM/P Ribbed Bar Anchor Bolts are used as overlapping Bolts in columns. The main reinforcement of the basic Bolt is attached to the reinforcement of the column with an overlap.

PPM/L Ribbed Bar Anchor Bolts are used as Anchor Bolts in foundations.

Figure 3. Using the Bolts



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 section 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	Factor
HPM/P	1.5
PPM/P	2.0

The factors in this table are provided as guidelines, local authorities having jurisdiction should be consulted prior to plan submission.

PPM and HPM Anchor Bolts have been designed for reinforced concrete 4500 PSI (30 MPa) in bond condition I.

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

The effect of the stability forces has been taken into consideration with a reduction factor of 0.8.

5.2.3 Requirements for concrete bedding

PPM and HPM Bolts have been designed for reinforced concrete 4500 PSI (30 MPa). The correction factors for lower grades and also for structure class 1 exist in section 5.2.6.

5.2.4 Minimum edge distances, centers and attachment bedding reinforcement for long Bolts

The fire-resistance period and environment class, in which the Column Shoes 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.

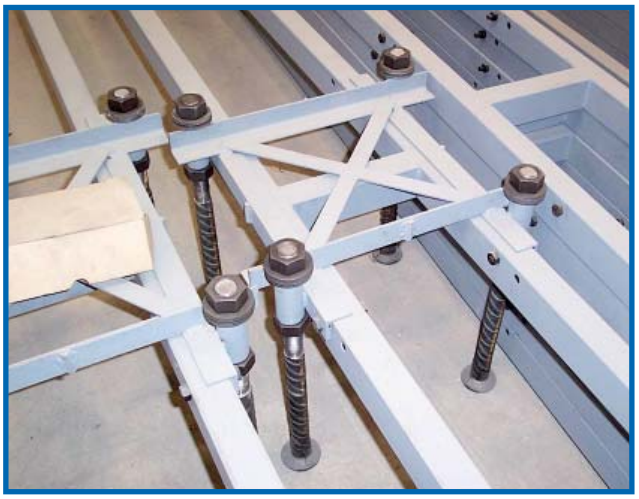


Table 5. Reinforcement of column with PPM/P Bolts

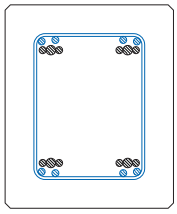
PPM P		Rebars of the Bolt	
		[imperial]	[metric]
	PPM 22P	2#6	2 M20
	PPM 27P	2#8	2 M25
	PPM 30P	2#8	2 M25
	PPM 36P	4#6	4 M20
	PPM 39P	3#8	3 M25
	PPM 45P	4#8	4 M25
	PPM 52P	4#10	4 M35
	PPM 60P	4#10	4 M35

Table 6. The defining criteria for Bolt lengths

		HPM/P	HPM/P	PPM/P
Concrete	[psi]	4000	5000	4000
	[MPa]	30	35	30
Bond coefficient		I	II	I
Splice factor		1.5	1.5	2

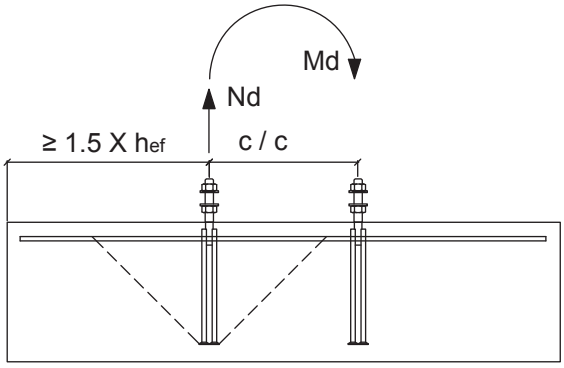
Shearing forces

When shearing forces are transferred, the edge distance has to be at least 1.5 h_{ef} and the thickness of the slab must be at least 2.25 h_{ef}. Otherwise, the edge has to be reinforced against the shearing forces or the capacity has to be decreased according to section 5.2.6

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

The minimum edge distance from the edge of the foundation is 1.5 h_{ef} and the thickness of the slab must be at least 2.25 h_{ef} for short HPM/L and PPM/L Anchor Bolts.

Table 7. The edge distance of short Bolts in footing and the minimum centre distances, when the joint consists of four Anchor Bolts



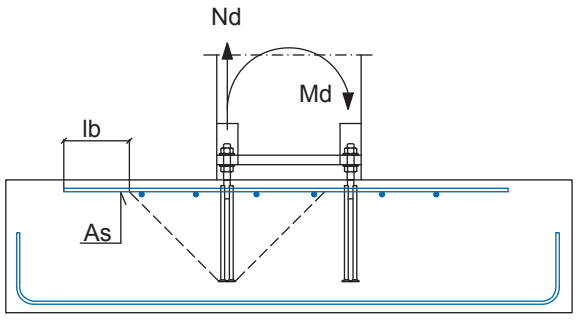
	c/c	
	[in]	[mm]
HPM 16L	3-1/2	80
HPM 20L	4-1/2	110
HPM 24L	5	120
HPM 30L	8	180
HPM 39L	12	280
PPM 22L	4	100
PPM 27L	4	100
PPM 30L	8	200
PPM 36L	12	280
PPM 39L	12	280
PPM 45L	12	280
PPM 52L	12	280
PPM 60L	12	280

If tensile force is affecting more than two Anchor Bolts, the centre distances have to be treated as a 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.

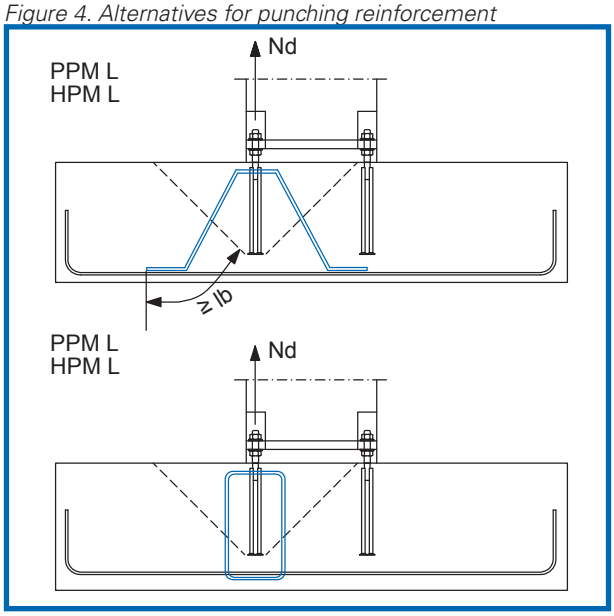
Table 8. Foundation reinforcement



	As		Min. mesh reinforcement	
	[in²/ft]	[mm²/m]	[imperial]	[metric]
HPM 16L	0.079	167	# 3 @ 8	M10 @ 200
HPM 20L	0.106	225	# 3 @ 8	M10 @ 200
HPM 24L	0.136	288	# 3 @ 6	M10 @ 150
HPM 30L	0.159	336	# 3 @ 6	M10 @ 150
HPM 39L	0.236	500	# 3 @ 6	M10 @ 150
PPM 22L	0.168	355	# 3 @ 6	M10 @ 150
PPM 27L	0.222	470	# 3 @ 6	M10 @ 150
PPM 30L	0.231	490	# 3 @ 6	M10 @ 150
PPM 36L	0.255	539	# 3 @ 6	M10 @ 150
PPM 39L	0.313	663	# 4 @ 6	M15 @ 150
PPM 45L	0.352	745	# 4 @ 6	M15 @ 150
PPM 52L	0.410	869	# 4 @ 4	M15 @ 150
PPM 60L	0.481	1019	# 4 @ 4	M15 @ 150

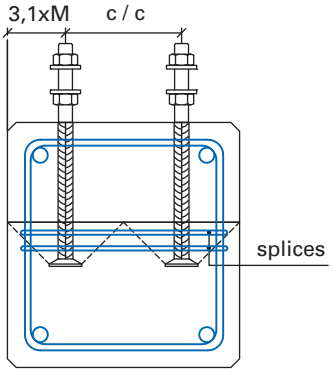
If necessary, values lower than the edge distances stated in table 7 can be used if the concrete cone is anchored against Bolt force by using the following principles.

Figure 4. Alternatives for punching reinforcement



If necessary, the HPM/L Anchor Bolts 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 Bolts, you can use the minimum edge distance of 3,1 x M, calculated on the basis of the local compression fraction of the concrete. Using this small edge distance (min. 3,1 x M) becomes necessary in beams, columns and in the edges of other strongly reinforced structures.

Table 9. The minimum edge distance of the HPM/L Anchor Bolts according to local compression factor. The reinforcement of the structure will prevent conical fracture.



	Ash		Splices	
	[in²]	[mm²]	[imperial]	[metric]
HPM 16L	0.025	52	1 # 3	1 M10
HPM 20L	0.039	82	2 # 3	2 M10
HPM 24L	0.056	118	3 # 3	3 M10
HPM 30L	0.088	187	4 # 3	3 M10
HPM 39L	0.153	325	5 # 3	5 M10

Compression forces

The compression anchoring of short Bolts requires a sufficient concrete layer (h) underneath the Bolt's forged head,

so that the anchor piece does not cause a blowout failure under the Anchor Bolt. If (h) in the structure is lower than the required (hrequired,) the structure has to be reinforced.

Shearing forces

When shearing forces are transferred, the edge distance has to be 1.5 h_{ef} and the thickness of the slab must be at least 2.25 h_{ef} at the most. Oterwise, 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

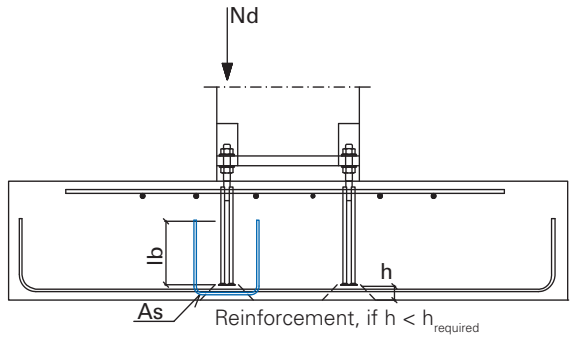
Concrete grade

Correction factor for concrete 3000 psi (25 MPa) = 0.83

Edge distances for shearing force

The shearing force capacity requires an edge distance of 1.5 h_{ef} and the thickness of the slab must be at least 2.25 h_{ef}. 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.

Table 10. Reinforcing the blowout failure under the Bolt



	$h_{required}$		As	
	[in]	[mm]	[in²]	[mm²]
HPM 16L	3-1/8	80	0.045	96
HPM 20L	3-15/16	100	0.067	141
HPM 24L	4-1/2	115	0.088	186
HPM 30L	5-11/16	145	0.147	311
HPM 39L	7-1/2	190	0.240	508
PPM 22L	3-1/2	90	0.070	149
PPM 27L	4-1/8	105	0.072	152
PPM 30L	4-3/4	120	0.141	298
PPM 36L	6-11/16	170	0.278	588
PPM 39L	7-11/16	195	0.340	720
PPM 45L	8-1/16	205	0.454	961
PPM 52L	8-11/16	220	0.484	1024
PPM 60L	11	280	0.713	1510

Correction Factor= $\left(\frac{C}{10 \times M}\right)^2$

C = Distance from structure section to the centre of the Bolt (mm)
M = Thread Size (metric)

5.2.7 Joining to foundations and column to column connections

Figure 5. Column joint of two different size columns

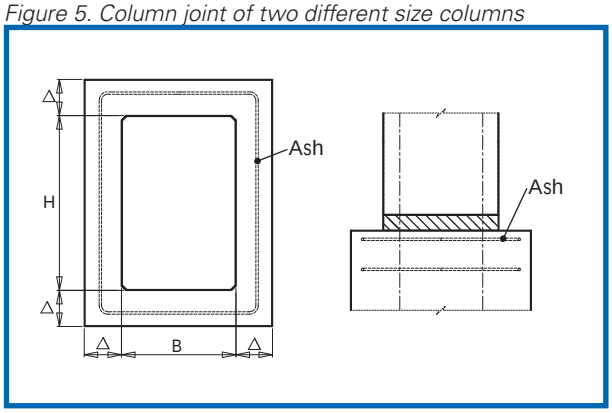


Table 11. The expansion of the (Δmin) and splitting stirrups

Concrete grade (column)	[psi]	6000	7500	8000	8000	12000
	[MPa]	40	50	60	60	80
Concrete grade (foundation)	[psi]	4500	4500	4500	6000	6000
	[MPa]	30	30	30	40	40
The Bolts of the tension side yield Δ	[in]	0.13 x H	0.26 x H	0.38 x H	0.20 x H	0.38 x H
	[mm]	0.13 x H	0.26 x H	0.38 x H	0.20 x H	0.38 x H
Cross section compressed Δ	[in]	0.24 x H	0.43 x H	0.61 x H	0.33 x H	0.61 x H
	[mm]	0.24 x H	0.43 x H	0.61 x H	0.33 x H	0.61 x H
Diametric reinforcement (BSt500S) Ash > A	[in²]	A = B x H / 430	A = B x H / 240	A = B x H / 170	A = B x H / 278	A = B x H / 153
	[mm²]	A = B x H / 430	A = B x H / 240	A = B x H / 170	A = B x H / 278	A = B x 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.

5.3 ERECTION NOTICE

Erection time

For program must calculate:

- G_d = Weight of column
- M_d = Bending moment (caused by wind)
- Warning: Joint is not grouted - bolts analisis is similar to cantilever columns.

Table 12. Bolt design during erection

Imperial	Metric
Diameter of thread	
$d_{sp} = \sqrt{\frac{4 X A_{sp}}{\pi}} = \sqrt{\frac{4 X 1{,}513}{\pi}} = 1{,}388 \text{ in}$	$d_{sp} = \sqrt{\frac{4 X A_{sp}}{\pi}} = \sqrt{\frac{4 X 976}{\pi}} = 35{,}3 \text{ mm}$
Lever arm of shear force ($j_{max} \leq 3{,}75$ in or 100 mm)	
$a_b = \left(\frac{t}{2} + j + 0{,}5 \times d_{sp}\right) = \left(\frac{2}{2} + 2{,}5 + 0{,}5 \times 1{,}388\right) = 4{,}2 \text{ in}$	$a_b = \left(\frac{t}{2} + j + 0{,}5 \times d_{sp}\right) = \left(\frac{50}{2} + 60 + 0{,}5 \times 35{,}3\right) = 102{,}6 \text{ mm}$
Forces per bolt; centre distance of bolt:	
$c = b - 2 \times E = 24 - 2 \times 2{,}5 = 19 \text{ in}$	$c = b - 2 \times E = 600 - 2 \times 60 = 480 \text{ mm}$
Normal force of single bolt	
$N_{b,d} = \frac{G_d}{n} \pm \frac{M_d}{n/2 \times c} = -\frac{61{,}0}{4} \pm \frac{104{,}73}{2 \times 1{,}583} = \frac{-48{,}6 \text{ kips}}{+17{,}9 \text{ kips}}$	$N_{b,d} = \frac{G_d}{n} \pm \frac{M_d}{n/2 \times c} = -\frac{273{,}00}{4} \pm \frac{142{,}00}{2 \times 0{,}48} = \frac{-216{,}2 \text{ kN}}{+79{,}7 \text{ kN}}$
Shear force of single bolt	
$V_{b,d} = \frac{V_d}{n} = \frac{3{,}0}{4} = 0{,}75 \text{ kips}$	$V_{b,d} = \frac{V_d}{n} = \frac{14{,}30}{4} = 3{,}58 \text{ kN}$
Bending moment of single bolt	
$M_{b,d} = \frac{V_{b,d} \times a_b}{\alpha_M} = \frac{0{,}75 \times 0{,}35}{2{,}0} = 0{,}13 \text{ kipsXft}$	$M_{b,d} = \frac{V_{b,d} \times a_b}{\alpha_M} = \frac{3{,}58 \times 0{,}103}{2{,}0} = 0{,}184 \text{ kNm}$
Elastic section modulus S	
$S_b = \frac{\pi \times d_{sp}^3}{32} = \frac{\pi \times 1{,}513^3}{32} = 0{,}340 \text{ in}^3$	$S_b = \frac{\pi \times d_{sp}^3}{32} = \frac{\pi \times 35{,}3^3}{32} = 4318 \text{ mm}^3$
Stress due to normal force	
$\sigma_{Nb,d} = \frac{N_b}{A_{sp}} = \frac{48{,}6}{1{,}51} = 32190 \text{ psi}$	$\sigma_{Nb,d} = \frac{N_b}{A_{sp}} = \frac{216{,}2 \times 10^3}{976} = 221{,}5 \frac{N}{mm^2}$
Stress due to bending moment	
$\sigma_{Mb,d} = \frac{M_b}{S_b} = \frac{1{,}56}{0{,}340} = 4588 \text{ psi}$	$\sigma_{Mb,d} = \frac{M_b}{S_b} = \frac{0{,}184 \times 10^6}{4318} = 42{,}6 \frac{N}{mm^2}$
Combined stresses of one single bolt	
$\Sigma\sigma_{b,d} = \sigma_{Nb,d} + \sigma_{Mb,d} = 32190 + 4588 = 36778 \text{ psi}$	$\Sigma\sigma_{b,d} = \sigma_{Nb,d} + \sigma_{Mb,d} = 221{,}5 + 42{,}6 = 264{,}1 \frac{N}{mm^2}$
Design value factored according:	
ACI 318-05	CSA A23.3-04
$f_{yd} = f_{uk} \text{ X } 0{,}65 = 51851 \text{ psi}$	$f_{yd} = f_{uk} \text{ X } 0{,}70 \text{ X } 0{,}85 = 327 \frac{N}{mm^2}$
Requirement	
$\Sigma\sigma_{b,d} \leq f_{ud} \Rightarrow 36778 \text{ psi} \leq 51851 \text{ psi}$	$\Sigma\sigma_{b,d} \leq f_{ud} \Rightarrow 264{,}1 \frac{N}{mm^2} \leq 327 \frac{N}{mm^2}$

Figure 6. Static Model of the Anchor Bolt during erection

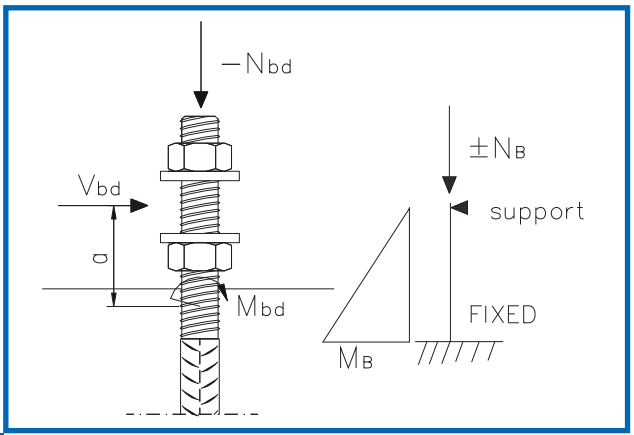
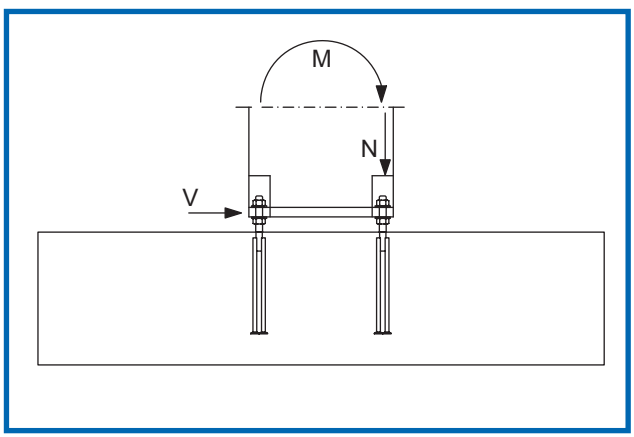


Figure 7. Forces on bolts during erection



Static model of bolt:

Bolt will transfer the loads like a small cantilever or mast column.

Column connection:

- Column cross section bXh = 24X35 in^2 or 600X900 mm^2
- With 4 HPKM 39 Column Shoes
- With 4 HPM 39 Anchor Bolts ⟶ n = 4
  - Thread cross section A_{sp} = 1,513 in^2 or 976 mm^2

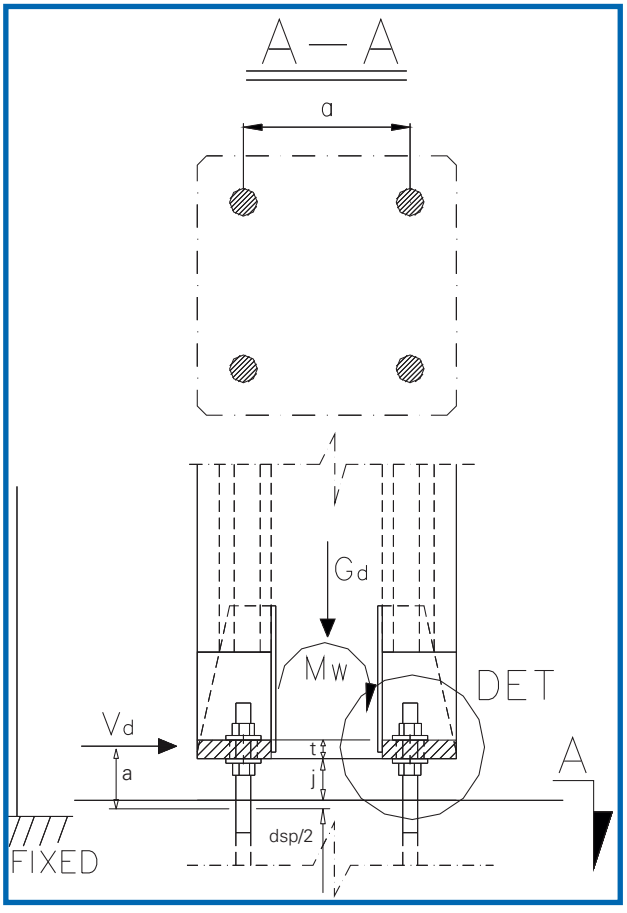
Design Values of actions / forces:

G_d= 61,0 kips or 273 kN
V_d= 3,0 kips or 14,3 kN
M_d= 104,73 kips•ft or 142 kNm
These values are according to information of civil engineer/ client .

Information for design:

- Bottom plate thickness t = 2 in or 50 mm
- Joint thickness j=2,5in or 60mm ($j_{max} \leq$ 3,75in or 100mm)
- Edge distance of bolt E = 2,5 in or 60 mm

Figure 8. Forces on bolts at the bottom of a column during erection



Design Values of actions / forces for one bolt:

$N_{b,d}$ = -48,6 kips or -216,5 kN
$V_{b,d}$ = 0,75 kips or 3,58 kN
$M_{b,d}$ = 1,56 kips•ft or 0,184 kNm

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 c/c distance as well as the verticality of the Anchor Bolts is secured. Centre lines marked on the installation frame make it easier to measure the Anchor Bolt groups to their location according to module line. With the help of the installation frame, the Anchor Bolts can be grouped easily for direct use in reinforcement. Use of the welded Anchor 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 it 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 Anchor Bolt group into the reinforcement. An open frame makes casting and compacting the concrete with mechanical vibrators easier. After casting, the frame is detached and can be reused.

Figure 9. Using the PPK installation frame

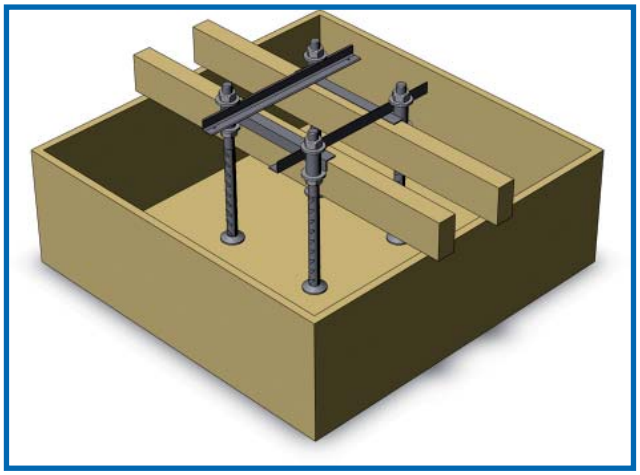


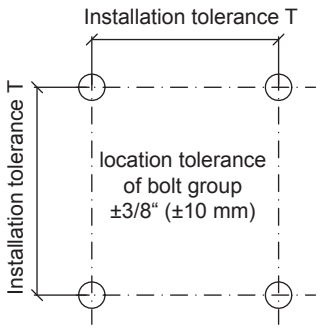
Table 13. Wrench to be used for Peikko Bolts

Thread	Wrench (mm)	Compatible Wrench (in)
M16	24	1
M20	30	1-3/16
M22	34	1-3/8
M24	36	1-7/16
M27	41	1-5/8
M30	46	1-13/16
M36	55	2-3/16
M39	60	2-3/8
M45	70	2-13/16
M52	80	3-1/4
M60	90	3-5/8

6.2 Bolt installation and installation tolerances

The Anchor Bolts are installed at 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 ±3/4" (±20 mm).

Table 14. Installation tolerances and the Anchoring Bolt's height level from the surface of concrete when HPKM, PPKM and PEC Column Shoes are used.



Anchor Bolts	Column Shoes	Grouting		Bolt height from cast level		Installation tolerance for the Bolt (T)	
		[in]	[mm]	[in]	[mm]	[in]	[mm]
HPM 16	HPKM 16	2	50	4-1/8	105	±1/8	±3
HPM 20	HPKM 20	2	50	4-1/2	115	±1/8	±3
HPM 24	HPKM 24	2	50	5-1/8	130	±1/8	±3
HPM 30	HPKM 30	2	50	6	150	±1/8	±3
HPM 39	HPKM 39	2-3/8	60	7	180	±1/8	±3
PPM 22	PEC 24	2	50	5-1/8	130	±1/8	±3
PPM 27	PEC 30	2	50	6-1/4	160	±1/8	±3
PPM 30	_____	2	50	5-7/8	150	±1/8	±3
PPM 36	PPKM 36	2-5/32	55	6-5/8	170	±5/32	±4
PPM 39	PPKM 39	2-3/8	60	7-1/16	180	±5/32	±4
PPM 45	PPKM 45	2-9/16	65	7-5/8	195	±5/32	±4
PPM 52	PPKM 52	2-3/4	70	8-7/8	225	±3/16	±5
PPM 60	_____	3-1/8	80	10-1/4	260	±3/16	±5

When the Anchor Bolt group for the PPK installation frame is formed, a reciprocal location tolerance of ±1/8" (±3 mm) is achieved for the Anchor Bolts. The location tolerance of the Bolt group's frame has to be ± 3/8" (±10 mm) in concrete element installation. The location of the center of each Anchor Bolt must be positioned at a maximum of 3/8" (±10 mm) from the position specified in the plan drawing.

6.3 Bending the Anchor Bolts

The HPM Anchor Bolts and the rebars or Anchor Bars of the PPM Anchor Bolts are made of BSt500S (A500HW) ribbed steel.

6.4 Welding of the Anchor Bolts

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

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 the columns. The verticality of the column is checked and the nuts are screwed on tight. Joint grouting must be done prior to installing the upper structures. Using shims is not mandatory. However, you can also install precast columns with shims.

7. INSTALLATION CONTROL

7.1 Instructions for controlling Bolt installation

Before casting

- ensure that the right frame is being used (c/c standards, thread size). HPKM and PPKM Column Shoes have a column side measurement of 4" (100 mm) (M16 - M36) or 4-3/4" (120 mm) (M39 – M52) greater than the Anchor Bolts' c/c standards.
- ensure the location of the Anchor Bolt group in relation to the module lines

- ensure that the reinforcement required by the Anchor Bolts has been installed
- ensure that the Anchor Bolts are in planned, correct and right level
- ensure that the installation frame did not rotated

After casting

- ensure the location of the Anchor 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 drawn by the designer (construction engineer). If needed, Peikko's technical support will give advice.

In particular, check the following:

- installation order
- support during installation
- instructions for tightening the nuts
- instructions for joint casting

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