Deutsches Institut für Bautechnik DIBt

Public-law institution jointly founded by the federal states and the Federation

European Technical Assessment Body for construction products

European Technical Assessment

ETA-02/0006 of 13 August 2024

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	PEIKKO HPM L Anchor Bolts
Product family to which the construction product belongs	Cast-in anchor bolts under fatigue or seismic action
Manufacturer	PEIKKO GROUP CORPORATION Voimakatu 3 15101 Lahti FINNLAND
Manufacturing plant	PEIKKO manufacturing plants
This European Technical Assessment contains	20 pages including 3 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 330924-01-0601-v01, Edition 10/2023
This version replaces	ETA-02/0006 issued on 26 March 2024

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Specific Part

1 Technical description of the product

The PEIKKO HPM L Anchor Bolts consist of ribbed reinforcing steel B500B of the diameters 16, 20, 25, 32 and 40 mm, two hexagon nuts and two washers. One of the ends of the bolt is provided with an anchor head and the other end with a thread of the sizes M16, M20, M24, M30 and M39.

The anchor bolt is embedded in concrete up to the marking of embedment depth.

The product description is given in Annex A.

2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the anchor bolt is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor bolt of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance under static and quasi-static tension load	See Annex B2 and C1
Characteristic resistance under static and quasi-static shear load	See Annex C2
Characteristic resistance under static and quasi static tension and shear load	See Annex C2
Displacement under static and quasi-static tension or shear load	See Annex C2
Characteristic resistance under fatigue cyclic loading	See Annex C3 to C5
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C1 and C2

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	No performance assessed

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with EAD No. 330924-01-0601-v01, the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Beatrix Wittstock
Head of Section

beglaubigt:
Müller

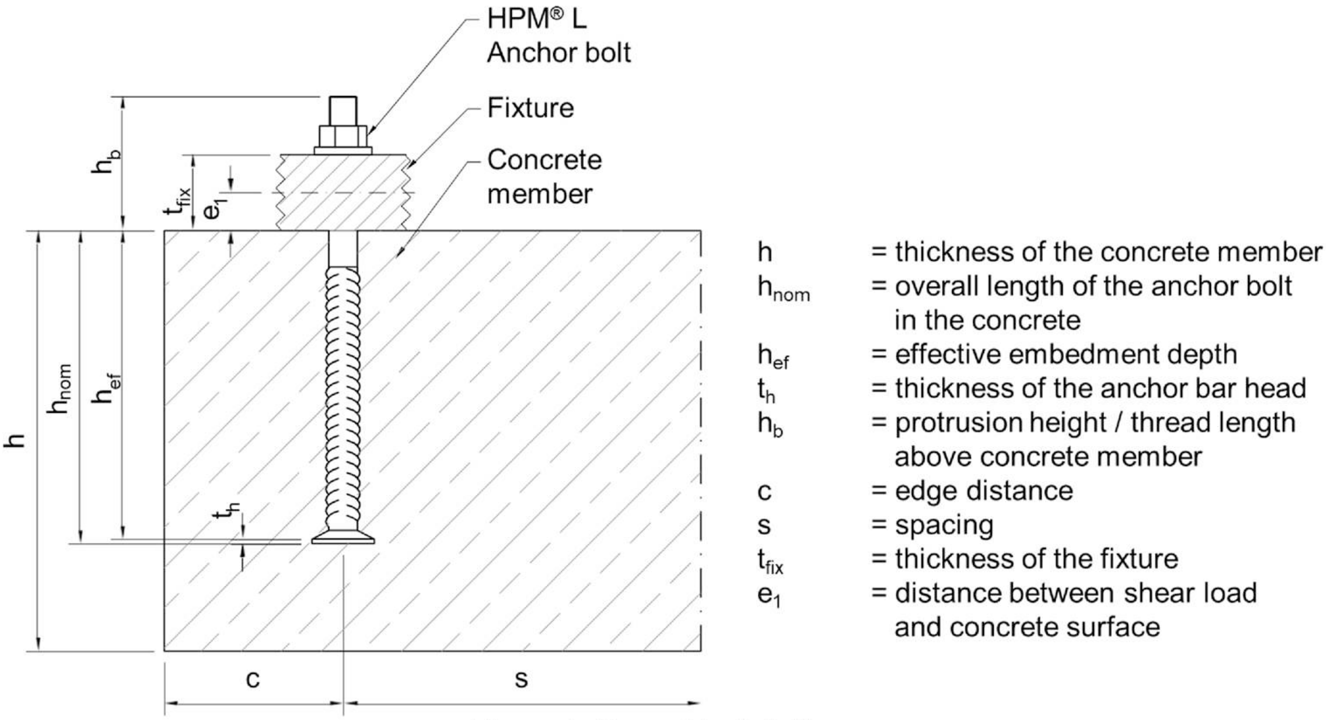


Figure 1: General installation

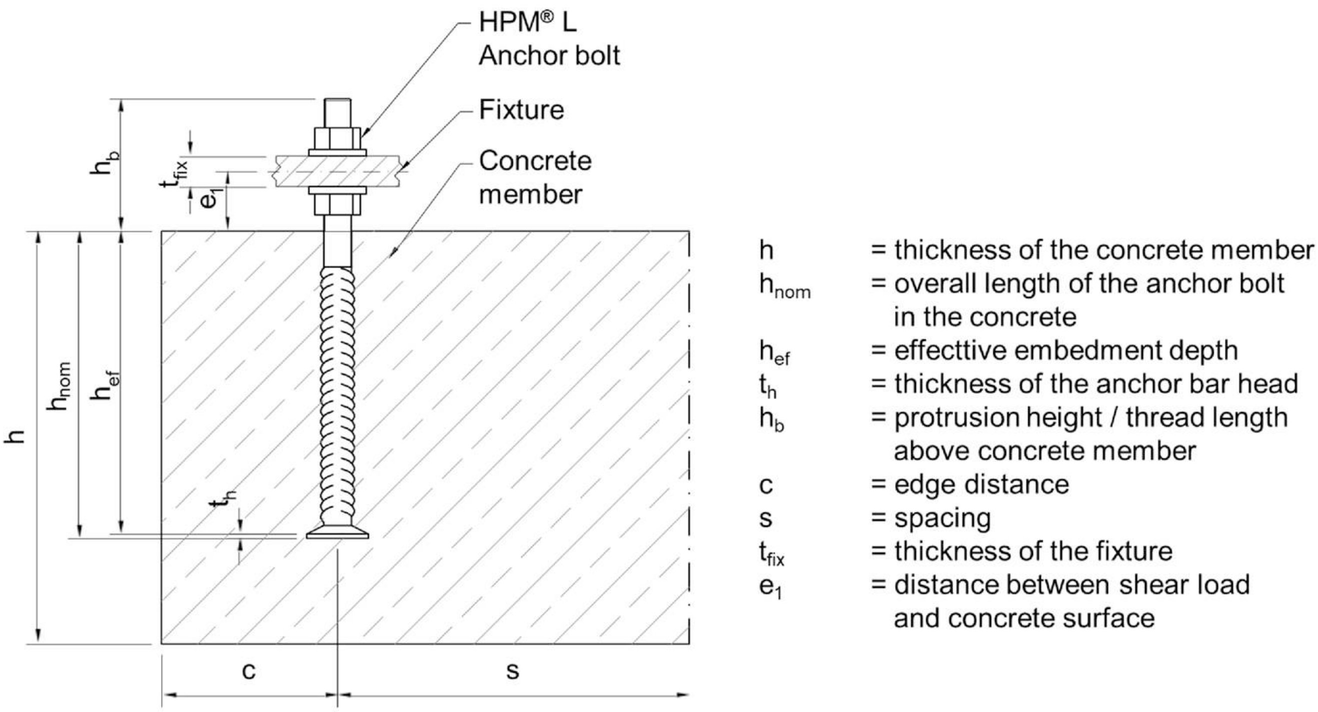
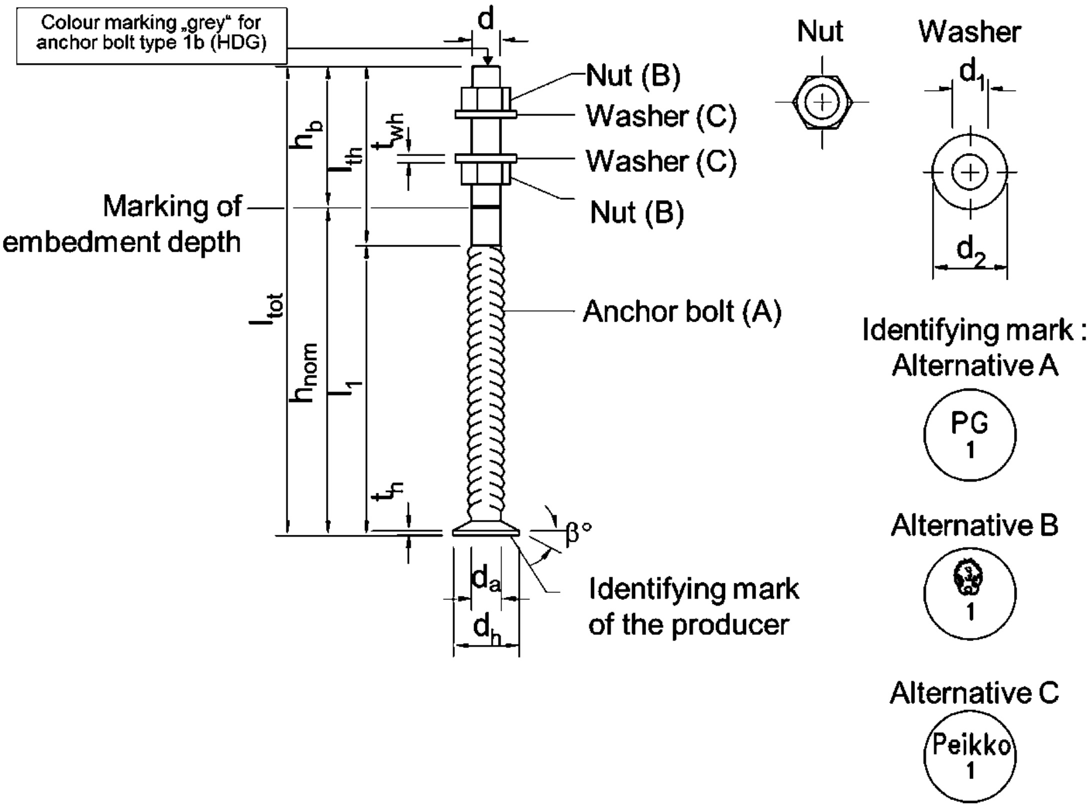


Figure 2: Steel to steel contact (Stand-off installation)

Peikko HPM® L Anchor Bolts	**Annex A1**
Product description **Installed conditions**	



l_{tot}	= lenght of the anchor bolt		d	= thread diameter
h_{nom}	= overall length of the anchor bolt in the concrete		d_h	= diameter of the anchor bar head
			d_a	= diameter of the anchor bar
h_b	= protrusion height / thread length above concrete member		t_{wh}	= thickness of the washer
			d_1	= hole diameter of the washer
l_1	= length without thread		d_2	= outside diameter of the washer
l_{th}	= lenght of the thread		β	= inclination angle of the anchor bar head
t_h	= thickness of the anchor bar head			

Components A, B and C according to Annex A4, Table 4

Figure 3: Dimensions of HPM® L Anchor bolts

Table 1: Dimensions of HPM® L Anchor bolts

Anchor bolt	Anchor bar										Nut [1)]
	d_a	d_h	d	l_{tot}	h_{nom}	h_b	l_1	l_{th}	t_h	A_h	
	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm²]	[-]
HPM® 16 L	16	38	16	280	175	105	140	140	10	933	M16
HPM® 20 L	20	46	20	350	235	115	210	140	12	1348	M20
HPM® 24 L	25	55	24	430	300	130	260	170	13	1885	M24
HPM® 30 L	32	70	30	500	350	150	310	190	15	3044	M30
HPM® 39 L	40	90	39	700	520	180	500	200	18	5105	M39

1) Dimensions according EN ISO 4032:2012

Peikko HPM® L Anchor Bolts	**Annex A2**
Product description **Dimensions, components and product marking**	

Table 2: Washer (B) dimensions of HPM® L Anchor bolt

Anchor bolt	Washer			
	Ød_1	Ød_2	t_{wh}	Øb
	[mm]	[mm]	[mm]	[mm]
HPM® 16 L	17	40	6	4
HPM® 20 L	21	44	6	4
HPM® 24 L	26	56	6	4
HPM® 30 L	32	65	8	4
HPM® 39 L	41	90	10	4

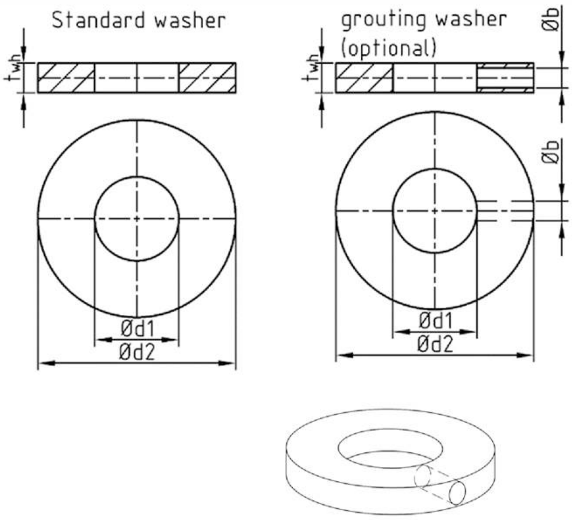
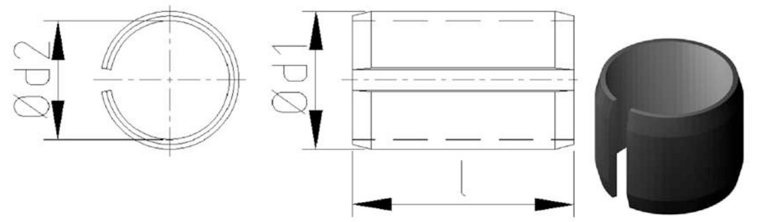
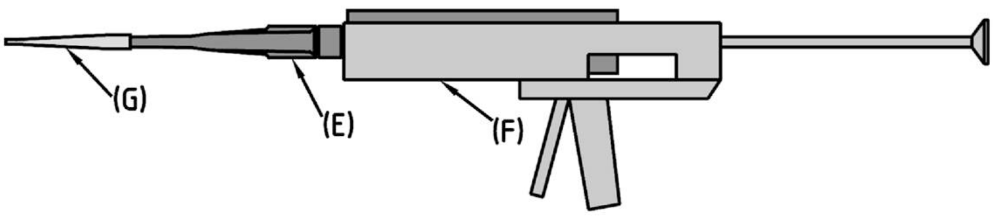


Table 3: Spring pins (D) of HPM® L Anchor bolts

Anchor bolt	Spring pin	
	Ød_2	Type d1 …
	[mm]	[mm]
HPM® 16 L	16,5	20 x l
HPM® 20 L	21,5	25 x l
HPM® 24 L	25,5	30 x l
HPM® 30 L	32,5	40 x l
HPM® 39 L	40,5	50 x l



Dimensions follow EN ISO 13337:2009
Dimension "l" depends on the individual application and must be selected accordingly ($l = t_{fix}$ – 1 mm).

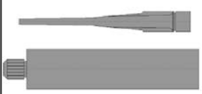
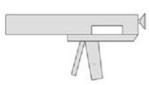


(E) Static mixer and Injection mortar (supplied by mortar manufacturer)
(F) Application gun (supplied by mortar manufacturer)
(G) Peikko Injection fuse (supplied by Peikko)

Figure 4: Injection system of HPM® L Anchor bolts

Peikko HPM® L Anchor Bolts	Annex A3
Product description **Dimensions of components and Injection system**	

Table 4: Materials and dimensions of HPM® L Anchor bolts

Component		Type		Material	Mechanical properties	Dimensions
A	Anchor bolt	1a	HPM® ** L	Reinforcing steel B500B, B500C or B450B according to EN 1992-1-1:2004 + AC:2010 + A1:2014, Annex C	f_{uk} ≥ 550 N/mm² f_{yk} ≥ 470 N/mm² according to EN 1992-1-1:2004 + AC:2010 + A1:2014, Annex C	acc. Annex A2, Table 1
		1b	HPM® ** L-HDG	Reinforcing steel B500B, B500C or B450B according to EN 1992-1-1:2004 + AC:2010 + A1:2014, Annex C, hot dip galvanized according to EN ISO 1461:2022 or EN ISO 10684:2004 + AC:2009	f_{uk} ≥ 550 N/mm² f_{yk} ≥ 470 N/mm² according to EN 1992-1-1:2004 + AC:2010 + A1:2014, Annex C	
B	Hexagonal nut (first nut and/or counter nut	1a	HPM® ** L	According to EN ISO 4032:2012	Strength class 8 according to EN ISO 898-2:2022	
		1b	HPM® ** L-HDG	According to EN ISO 4032:2012, hot dip galvanized according to EN ISO 1461:2022 or EN ISO 10684:2004 + AC:2009	Strength class 8 according to EN ISO 898-2:2022	
C	Washer/ Grouting washer	1a	HPM® ** L	Steel S355J2 according to EN 10025-2:2019	According to EN 10025-2:2019	acc. Annex A3, Table 2
		1b	HPM® ** L-HDG	Steel S355J2 according to EN 10025-2:2019, hot dip galvanized according to EN ISO 1461: 2022 or EN ISO 10684:2004 + AC:2009	According to EN 10025-2:2019	
D	Spring pin			Steel according to EN ISO 13337:2009	according to EN ISO 13337:2009	acc. Annex A3, Table 3
E	Injection mortar			Injection mortar according to • WIT VM-250 ETA -12/0164 (12.11.2015) • HIT HY 200 ETA-19/0601 (02.06.2023) • FIS V Plus ETA-20/0603 (13.11.2020)	Compressive strength ≥ 40 N/mm²	acc. Annex A3, Figure 4
F	Application gun			Application gun as according to • ETA -12/0164 (12.11.2015) • ETA-19/0601 (02.06.2023) • ETA-20/0603 (13.11.2020)		
G	Injection adapter			Polypropylene	EN ISO 19069-1: 2015	
H	Locking nut			• Spring steel galvanized ≥ 5µm acc. EN10029:2010 or EN10048:1996 or EN10140:2006	according to DIN 7967:1970-11	acc. Annex B3, Figure 5
I	Hexagonal nut half height (counter nut)			Steel according to EN ISO 4035:2023	Strength class 8 according to EN ISO 898-2:2022	

Peikko HPM® L Anchor Bolts

Product description
Materials and Components

Annex A4

Specifications of intended use
Anchor bolts subject to:

- Static and quasi-static tension, shear or combination of tension and shear.
- Fatigue tension and shear (no stand-off installation).
- Seismic tension and shear (no stand-off installation).
- No combination of fatigue and seismic actions.

Base materials:

- Reinforced compacted normal weight concrete without fibres according to EN 206:2013 + A2:2021.
- Strength classes C20/25 to C90/105 according to EN 206:2013 + A2:2021.
- Cracked or uncracked concrete.

Intended use and environmental conditions:

- Anchor bars made of ribbed reinforcing steel, washer and hexagonal nut are made of steel:
  Anchor bolts for use in structures subject to dry internal conditions.

- Anchor bars made of ribbed reinforcing steel, washer and hexagonal nut are made of hot dip galvanized steel (for static and quasi-static and seismic loads) according to EN ISO 1461:2022 or EN ISO 10684:2004 + AC:2009 with at least 50 µm zinc layer thickness. Anchor bolts for use in structures subject to internal conditions with usual humidity (exceptional permanently damp conditions and applications under water).

- Anchor bars made of ribbed reinforcing steel, washer and hexagonal nut are made of steel with concrete cover according to EN 1992-1-1:2004 + AC:2010 + A1:2014: Anchor bolts for use in structures subject to appropriate exposition relating to the concrete cover.

Design:

- Anchor bolts are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor bolts is indicated on the design drawings (e.g. position of the anchor bolts relative to reinforcement or to supports).
- For static, quasi-static and seismic loading the anchor bolts are designed in accordance with EN 1992-4:2018.
- For fatigue loading, the anchor bolts are designed in accordance with EN 1992-4:2018 or EOTA TR 061:2024-02.
- The occurring splitting forces are resisted by the reinforcement. The required cross section of the minimum reinforcement is determined according EN 1992-4:2018, section 7.2.1.7.

Peikko HPM® L Anchor Bolts	**Annex B1**
Intended use **Specifications**	

Installation:

Placing anchor bolts into concrete

- The installation of anchor bolts is carried out by appropriately qualified personnel under the supervision of the person responsible for the technical matters on site.
- Use of the product only as supplied by the manufacturer.
- Installation in accordance with the manufacturers product installation instructions given in Annex B3.
- The anchor bolts are fixed to the formwork, reinforcement, or auxiliary construction such that no movement of the product will occur during the time of laying the reinforcement and of placing and compacting the concrete.
- The anchor bolts are embedded in concrete up to the marking of installation depth.
- The concrete under the anchor bar head is properly compacted.
- The annular gap between anchor thread and hole in the fixture is properly filled with injection mortar according to Annex A4, Table 4 or a spring pin according to Annex A3, Table 3 (for seismic and fatigue with shear loads)
- The max. installation torque according to Table 5 may not be exceeded.
- The counter nut or the locking nut is applied on top of the first nut according to Annex B3, Figure 5 (for seismic and fatigue actions)

Table 5: Installation parameters of HPM® L Anchor bolts

HPM® ...			**16 L**	**20 L**	**24 L**	**30 L**	**39 L**
Effective embedment depth	h_{ef}	[mm]	165	223	287	335	502
Minimum spacing	s_{min}	[mm]	80	100	100	130	150
Minimum edge distance	c_{min}	[mm]	50	70	70	100	130
Protrusion height / thread length above concrete member	h_b	[mm]	105	115	130	150	180
Min. thickness of concrete member	h_{min}	[mm]	$h_{ef} + t_h + c_{nom}$ 1)				
Max. installation torque General installation, case (a)	T_{inst}	[Nm]	20	45	75	125	290
Max. installation torque Steel to steel contact, case (b)	T_{inst}	[Nm]	80	150	270	540	1200

1) Required concrete cover "c_{nom}" according to EN 1992-1-1:2004 + AC:2010 + A1:2014

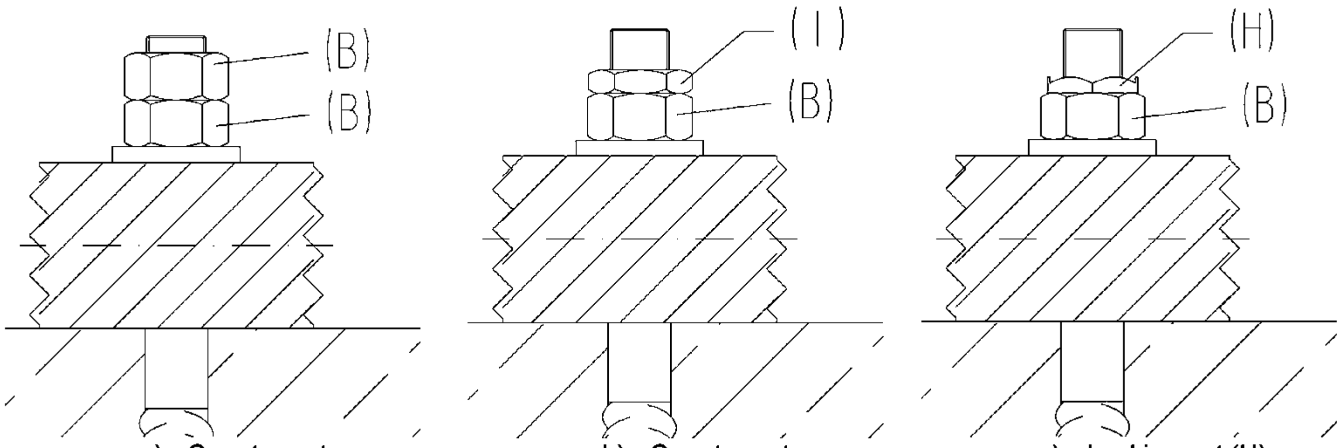


Figure 5: Measures to prevent loosening of the nuts under fatigue and seismic loading

Table 6: Specifications of intended use

	Static and quasi-static		Fatigue		Seismic	
	Tension	Shear	Tension	Shear	Tension	Shear
Anchor bolt acc. Annex A4, Table 4 Line 1a	✓	✓	✓	✓	✓	✓
HDG anchor bolt acc. Annex A4, Table 4 Line 1b	✓	✓	×	×	✓	✓
Injection mortar + washer or spring pin	×	×	×	✓	×	✓
Secured against turning off (locking nut, counter nut)	×	×	✓	✓	✓	✓
Stand-off installation acc. Annex A1 Figure 2	✓	✓	×	×	×	×

✓ permissible, required

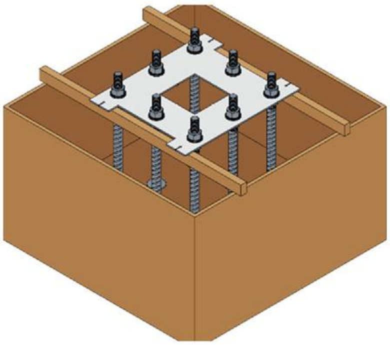
× not allowed, not required

Peikko HPM® L Anchor Bolts

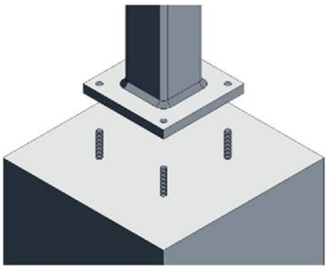
Specification of intended use

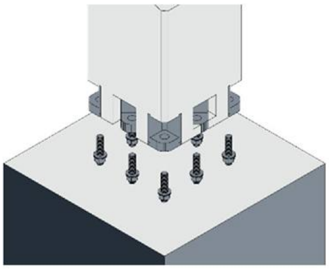
Annex B3

Installation instruction for tension loads (static, quasi static, fatigue, seismic) and shear loads (static, quasi static):

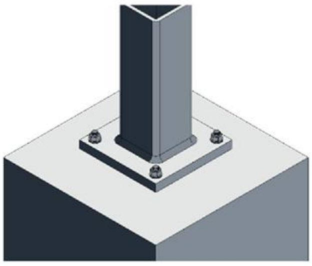


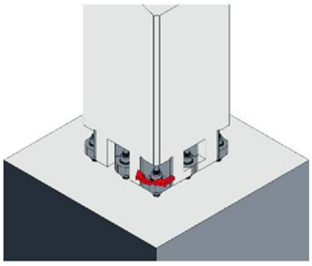
- Install the anchor bolts to the formwork by using a Peikko® installation template according design drawings to ensure the correct position, size, and protrusion height (h_b) of the anchor bolts.
- Pay attention to a strong fixing of the anchor bolts to avoid moving during pouring.
- Compact concrete properly around and under the anchor bar head.
- After hardening of the concrete, the installation template can be removed.



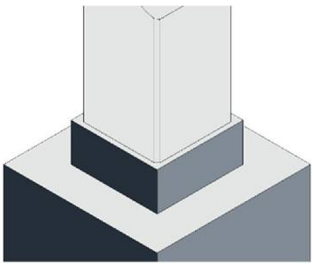


- For the installation of a steel column according to Figure 1 (general installation) all nuts are removed.
- For the installation of a precast concrete column or steel column according to Figure 2 (steel to steel contact) the lower levelling nuts are adjusted to the correct level.





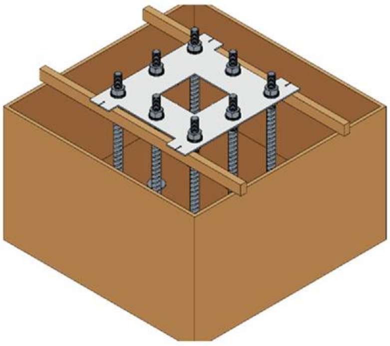
- The connection is fixed by tightening the upper nuts.
  The installation torque T_{inst} acc. to Annex B2 may not be exceeded.
  For fatigue cycling and seismic loading anchor bolts have to be secured against turning off the nuts by suitable means (e.g. counter nuts or locking nuts) according Annex B3, Figure 5.



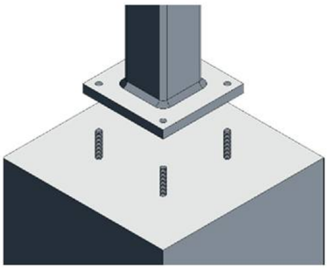
- The joint between the base structure and the column must be filled properly with non-shrinking mortar.

Peikko HPM® L Anchor Bolts	**Annex B4**
Intended use **Manufacturers product installation instructions (MPII)**	

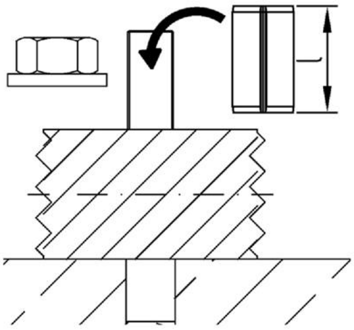
Installation instruction for shear (fatigue and seismic loads) with spring pins:



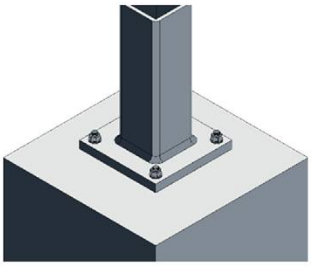
- Install the anchor bolts to the formwork by using a Peikko® installation template according design drawings to ensure the correct position, size, and protrusion height (h_b) of the anchor bolts.
- Pay attention to a strong fixing of the anchor bolts to avoid moving during pouring.
- Compact concrete properly around and under the anchor bar head.
- After hardening of the concrete, the installation template can be removed.



- For the installation of a steel column according to Figure 1 (general installation) all nuts are removed.
- For the installation of a precast concrete column or steel column according to Figure 2 (steel to steel contact) the lower levelling nuts are adjusted to the correct level.



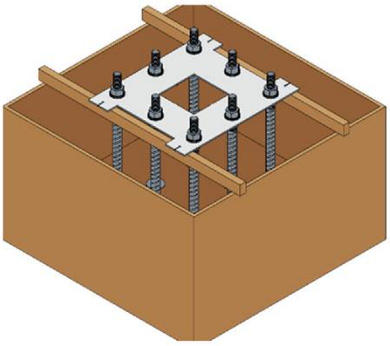
The joint between the anchor bolt and the steel plate must be filled with a spring pin according to Annex A3, Table 3



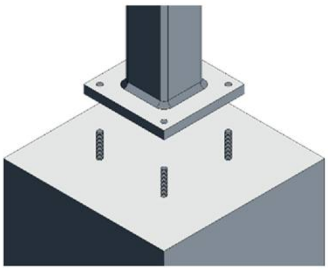
- The connection is fixed by tightening the upper nuts.
  The installation torque T_{inst} acc. to Annex B2 may not be exceeded.
  For fatigue cycling and seismic loading anchor bolts have to be secured against turning off the nuts by suitable means (e.g. counter nuts or locking nuts) according to Annex B3, Figure 5.

Peikko HPM® L Anchor Bolts	Annex B5
Manufacturers product installation instructions (MPII)	

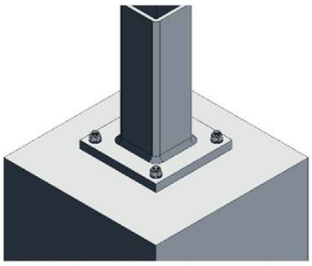
Installation instruction for shear (fatigue and seismic loads) with mortar injection system:



- Install the anchor bolts to the formwork by using a Peikko® installation template according design drawings to ensure the correct position, size, and protrusion height (h_b) of the anchor bolts.
- Pay attention to a strong fixing of the anchor bolts to avoid moving during pouring.
- Compact concrete properly around and under the anchor bar head.
- After hardening of the concrete, the installation template can be removed.



- For the installation of a steel column according to Figure 1 (general installation) all nuts are removed.
- For the installation of a precast concrete column or steel column according to Figure 2 (steel to steel contact) the lower levelling nuts are adjusted to the correct level.



- The connection is fixed by tightening the upper nuts. The installation torque T_{inst} acc. to Annex B2 may not be exceeded.
- For fatigue cycling and seismic loading anchor bolts have to be secured against turning off the nuts by suitable means (e.g. counter nuts or locking nuts) according Annex B3, Figure 5.

- The annular gap between the anchor bolt and the steel plate must be filled with injection mortar according to Table 4

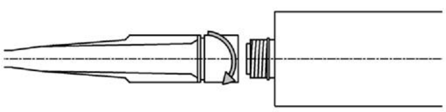
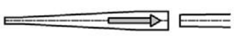
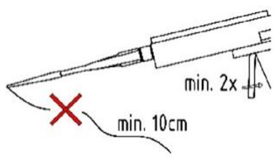
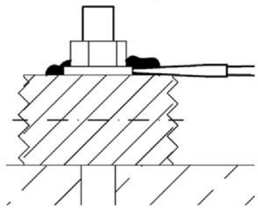
Mortar injection	All sizes with injection system
	Remove cap from cartridge and screw the static mixer on it. Always use new static mixer with helix inside on new cartridges. Check expiry date of cartridge prior to use.
	Place the reducing adapter on top of the static mixer.
	Insert cartridge in dispenser. Before injecting discard mortar (at least 2 full strokes or a line of min 10 cm) until the mortar shows a consistent grey colour. Never use this mortar.
	Insert the reducing adapter into the washer hole and fill up the annular gap between anchor bolt and fixture until the mortar is getting squeezed out.

Table 7.1: Maximum working time and minimum curing time acc. to ETA-12/0164 (12.11.2015)

Temperature	Maximum working time	Minimum curing time
-10°C to -6°C	90 min[1)]	24 h
-5°C to -1°C	90 min	14 h
0°C to +4°C	45 min	7 h
+5°C to +9°C	25 min	2 h
+10°C to +19°C	15 min	80 min
+20°C to +29°C	6 min	45 min
+30°C to +34°C	4 min	25 min
+35°C to +39°C	2 min	20 min
> +40°C	1,5 min	15 min
cartridge temperature	+5°C to +40°C	
1) cartridge temperature must be ≥ 15°C		

Table 7.2: Maximum working time and minimum curing time acc. to ETA-19/0601 (02.06.2023)

Temperature	Maximum working time	Minimum curing time
-10°C to -5°C	90 min	7 h
> -5°C to 0°C	50 min	4 h
> 0°C to +5°C	25 min	2 h
> 5°C to +10°C	15 min	75 min
> 10°C to +20°C	7 min	45 min
> 20°C to +30°C	4 min	30 min
> 30°C to +40°C	3 min	30 min
cartridge temperature must be ≥ 0°C		

Table 7.3: Maximum working time and minimum curing time acc. to ETA-20/0603 (13.11.2020)

Temperature	Maximum working time	Minimum curing time
> 0°C to +5°C	13 min	3 h
> 5°C to +10°C	9 min	90 min
> 10°C to +20°C	5 min	60 min
> 20°C to +30°C	4 min	45 min
> 30°C to +40°C	2 min	35 min
cartridge temperature must be ≥ +5°C		

Peikko HPM® L Anchor Bolts

Maximum working time and minimum curing time of different injection mortars

Annex B7

Table 8: Characteristic resistances of HPM® L Anchor bolts under tension load for static and quasi-static or seismic action

HPM® ...			16 L	20 L	24 L	30 L	39 L
Steel failure							
Characteristic resistance	$N_{Rk,s}$	[kN]	86,2	134,6	193,9	308,3	536,7
Characteristic resistance under seismic action	$N_{Rk,s,C1} = N_{Rk,s,C2}$	[kN]	83,6	83,6	83,6	83,6	83,6
Partial factor	γ_{Ms}	[-]	1,4				
Concrete pull-out failure							
Characteristic resistance In uncracked concrete C20/25	$N_{Rk,p}$	[kN]	195,9	283,0	395,8	639,3	1072,1
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p}$	[kN]	140,0	202,2	282,7	456,6	765,8
Characteristic resistance in cracked concrete C20/25 under seismic action	$N_{Rk,p,C1} = N_{Rk,p,C2}$	[kN]	62,5	62,5	62,5	62,5	62,5
Increase factor for higher concrete grades for $N_{Rk,p}$ $N_{Rk,p} = N_{Rk,p\,(C20/25)} \cdot \psi_c$	ψ_c	C25/30	1,25				
		C30/37	1,50				
		C35/45	1,75				
		C40/50	2,00				
		C45/55	2,25				
		C50/60	2,50				
Partial factor	γ_{Mp} 1)	[-]	1,5				
Concrete cone failure							
Effective embedment depth	h_{ef}	[mm]	165	223	287	335	502
Factor for the influence of the load transfer mechanism	$k_{ucr,N}$	[-]	12,7				
	$k_{cr,N}$	[-]	8,9				
Characteristic spacing	$s_{cr,N} = s_{cr,sp}$	[mm]	3 h_{ef}				
Characteristic edge distance	$c_{cr,N} = c_{cr,sp}$	[mm]	1,5 h_{ef}				
Partial factor	γ_{Mc} 1)	[-]	1,5				
Concrete splitting							
A reinforcement must be present to resist the splitting forces and limits the crack width to $w_k \leq 0{,}3$ mm. See EN 1992-4:2018, section 7.2.1.7							

1) In absence of other national regulations

Table 9: Characteristic resistances of HPM® L Anchor bolts under shear load for static and quasi-static or seismic action

HPM® ...			16 L	20 L	24 L	30 L	39 L
Steel failure without lever arm							
Characteristic resistance	$V^0_{Rk,s}$	[kN]	43,1	67,3	96,9	154,2	268,3
Characteristic resistance under seismic action	$V^0_{Rk,s,C1} = V^0_{Rk,s,C2}$	[kN]	26,8	26,8	26,8	26,8	26,8
Factor acc. EN 1992-4:2018, section 7.2.2.3.1	k_7	[-]	1,0				
Partial factor	γ_{Ms}	[-]	1,5				
Steel failure with lever arm							
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	183	356	616	1236	2837
Partial factor	γ_{Ms}	[-]	1,5				
Concrete pry-out failure							
Factor acc. EN 1992-4:2018, section 7.2.2.4	k_8 1)	[-]	2,0				
Partial factor	γ_{Mcp} 2)	[-]	1,5				
Concrete edge failure							
Effective embedment depth under shear load	l_f	[mm]	128	160	192	240	312
Effective outer diameter	$d_{nom} = d$	[mm]	16	20	24	30	39
Partial factor	γ_{Mc} 2)	[-]	1,5				
Factor for anchorages with filled annular gap	α_{gap}	[-]	1,0				

1) If supplementary reinforcement is present, the factor k_8 has to be multiplied by 0,75
2) In absence of national regulations

Combined tension and shear load			
Exponent acc. EN 1992-4:2018, section 7.2.3	k_{11}	[-]	2/3

Table 10: Displacements of HPM® L Anchor bolts under tension load

HPM® ...			16 L	20 L	24 L	30 L	39 L
Tension load	N	[kN]	41	64	92	147	256
Short-term displacement	δ_{N0}	[mm]	0,3	0,3	0,4	0,4	0,6
Long-term displacement	$\delta_{N\infty}$	[mm]	0,6	0,6	0,8	0,8	1,2
Displacements under seismic actions							
Displacement	$\delta_{N,C2\ (DLS)}$	[mm]	1,1	1,1	1,1	1,1	1,1
	$\delta_{N,C2\ (ULS)}$	[mm]	2,5	2,5	2,5	2,5	2,5

Table 11: Displacements of HPM® L Anchor bolts under shear load

HPM® ...			16 L	20 L	24 L	30 L	39 L
Shear load	V	[kN]	18	25	41	66	115
Short-term displacement	δ_{V0}	[mm]	1,5	1,5	1,5	1,5	1,5
Long-term displacement	$\delta_{V\infty}$	[mm]	2,3	2,3	2,3	2,3	2,3
Displacements under seismic actions							
Displacement	$\delta_{V,C2\ (DLS)}$	[mm]	4,4	4,4	4,4	4,4	4,4
	$\delta_{V,C2\ (ULS)}$	[mm]	10,9	10,9	10,9	10,9	10,9

Table 12: Characteristic values of the fatigue resistance under tension load after n load cycles without static actions (F_{Elod} = 0), design method I according to EOTA TR 061:2024-02

HPM® ..			**16 L**	**20 L**	**24 L**	**30 L**	**39 L**
Steel failure							
Characteristic resistance without static actions	$\Delta N_{Rk,s,0,n}$	[kN]	$\Delta N_{Rk,s,0,n}$				
Number of load cycles n		$< 10^4$	$0{,}556 \cdot N_{Rk,s}$(HPM 16)				
		$10^4 \leq n \leq 5 \cdot 10^6$	$N_{Rk,s}$(HPM 16) $\cdot 10^{(0{,}1 - 0{,}0888 \cdot \log(n))}$				
		$5 \cdot 10^6 < n \leq 10^8$	$N_{Rk,s}$(HPM 16) $\cdot 10^{(-0{,}21 - 0{,}0425 \cdot \log(n))}$				
		$n > 10^8$	$0{,}282 \cdot N_{Rk,s}$(HPM 16)				
Partial factor	$\gamma_{Ms,fat,n}$	[-]	according to EOTA TR 061: 2024-02, Equ. (3)				
Pull-out failure							
Characteristic resistance without static actions	$\Delta N_{Rk,p,0,n}$	[kN]	$\Delta N_{Rk,p,0,n}$				
Number of load cycles n		$< 10^4$	$0{,}684 \cdot N_{Rk,p}$(HPM 16)				
		$10^4 \leq n \leq 5 \cdot 10^6$	$N_{Rk,p}$(HPM 16) $\cdot 10^{(0{,}055 - 0{,}055 \cdot \log(n))}$				
		$5 \cdot 10^6 < n \leq 10^8$	$N_{Rk,p}$(HPM 16) $\cdot 10^{(0{,}35 - 0{,}099 \cdot \log(n))}$				
		$n > 10^8$	$0{,}361 \cdot N_{Rk,p}$(HPM 16)				
Partial factor	$\gamma_{Mp,fat}$	[-]	1,5				
Concrete failure							
Characteristic resistance without static actions	$\Delta N_{Rk,c,0,n}$	[kN]	$\Delta N_{Rk,c,0,n}$				
Number of load cycles n		$< 10^4$	$0{,}684 \cdot N_{Rk,c}$(HPM 16)				
		$10^4 \leq n \leq 5 \cdot 10^6$	$N_{Rk,c}$(HPM 16) $\cdot 10^{(0{,}055 - 0{,}055 \cdot \log(n))}$				
		$5 \cdot 10^6 < n \leq 10^8$	$N_{Rk,c}$(HPM 16) $\cdot 10^{(0{,}35 - 0{,}099 \cdot \log(n))}$				
		$n > 10^8$	$0{,}361 \cdot N_{Rk,c}$(HPM 16)				
Effective anchorage depth	h_{ef}	[mm]	165	223	287	335	502
Partial factor	$\gamma_{Mc,fat}$	[-]	1,5				
Splitting failure							
Characteristic resistance without static actions	$\Delta N_{Rk,sp,0,n}$	[kN]	$\Delta N_{Rk,sp,0,n}$				
Number of load cycles n		$< 10^4$	$0{,}684 \cdot N_{Rk,sp}$(HPM 16)				
		$10^4 \leq n \leq 5 \cdot 10^6$	$N_{Rk,sp}$(HPM 16) $\cdot 10^{(0{,}055 - 0{,}055 \cdot \log(n))}$				
		$5 \cdot 10^6 < n \leq 10^8$	$N_{Rk,sp}$(HPM 16) $\cdot 10^{(0{,}35 - 0{,}099 \cdot \log(n))}$				
		$n > 10^8$	$0{,}361 \cdot N_{Rk,sp}$(HPM 16)				
Partial factor	$\gamma_{Msp,fat}$	[-]	1,5				
Blow-out failure							
Characteristic resistance without static actions	$\Delta N_{Rk,cb,0,n}$	[kN]	$\Delta N_{Rk,cb,0,n}$				
Number of load cycles n		$< 10^4$	$0{,}684 \cdot N_{Rk,cb}$(HPM 16)				
		$10^4 \leq n \leq 5 \cdot 10^6$	$N_{Rk,cb}$(HPM 16) $\cdot 10^{(0{,}055 - 0{,}055 \cdot \log(n))}$				
		$5 \cdot 10^6 < n \leq 10^8$	$N_{Rk,cb}$(HPM 16) $\cdot 10^{(0{,}35 - 0{,}099 \cdot \log(n))}$				
		$n > 10^8$	$0{,}361 \cdot N_{Rk,cb}$(HPM 16)				
Partial factor	$\gamma_{Mcb,fat}$	[-]	1,5				

Table 13: Characteristic values of the fatigue resistance under shear load after n load cycles without static actions (F_{Elod} = 0), design method I according to EOTA TR 061: 2024-02

HPM® ..			16 L	20 L	24 L	30 L	39 L
Steel failure							
Characteristic resistance without static actions	$\Delta V_{Rk,s,0,n}$	[kN]	$\Delta V_{Rk,s,0,n}$				
Number of load cycles n		< 10^4	$0{,}303 \cdot V_{Rk,s}$(HPM 16)				
		$10^4 \leq n \leq 5 \cdot 10^6$	$V_{Rk,s}$(HPM 16) $\cdot 10^{(-0{,}016 - 0{,}126 \cdot \log(n))}$				
		$5 \cdot 10^6 < n \leq 10^8$	$V_{Rk,s}$(HPM 16) $\cdot 10^{(-0{,}0462 - 0{,}059 \cdot \log(n))}$				
		$n > 10^8$	$0{,}116 \cdot V_{Rk,s}$(HPM 16)				
Partial factor	$\gamma_{Ms,fat,n}$	[-]	according to EOTA TR 061:2024-02, Equ. (3)				
Concrete edge failure							
Characteristic resistance without static actions	$\Delta V_{Rk,c,0,n}$	[kN]	$\Delta V_{Rk,c,0,n}$				
Number of load cycles n		< 10^4	$0{,}575 \cdot V_{Rk,c}$(HPM 16)				
		$10^4 \leq n \leq 5 \cdot 10^6$	$V_{Rk,c}$(HPM 16) $\cdot 10^{(0{,}08 - 0{,}08 \cdot \log(n))}$				
		$5 \cdot 10^6 < n \leq 10^8$	$V_{Rk,c}$(HPM 16) $\cdot 10^{(-0{,}198 - 0{,}038 \cdot \log(n))}$				
		$n > 10^8$	$0{,}312 \cdot V_{Rk,c}$(HPM 16)				
	$\gamma_{Mc,fat}$	[-]	1,5				
Concrete pryout failure							
Characteristic resistance without static actions	$\Delta V_{Rk,cp,0,n}$	[kN]	$\Delta V_{Rk,cp,0,n}$				
Number of load cycles n		< 10^4	$0{,}575 \cdot V_{Rk,cp}$(HPM 16)				
		$10^4 \leq n \leq 5 \cdot 10^6$	$V_{Rk,cp}$(HPM 16) $\cdot 10^{(0{,}08 - 0{,}08 \cdot \log(n))}$				
		$5 \cdot 10^6 < n \leq 10^8$	$V_{Rk,cp}$(HPM 16) $\cdot 10^{(-0{,}198 - 0{,}038 \cdot \log(n))}$				
		$n > 10^8$	$0{,}312 \cdot V_{Rk,cp}$(HPM 16)				
Partial factor	$\gamma_{Mc,fat}$	[-]	1,5				
Exponent for combined loading	$\alpha_{sn} = \alpha_s$	[-]	0,7				
	α_c	[-]	1,5				
Load-transfer factor for fastener groups	$\psi_{FN} = \psi_{FV}$	[-]	0,5				

Peikko HPM® L Anchor Bolts

Performance
Characteristic fatigue resistances under shear load for design method I according to EOTA TR 061: 2024-02

Annex C4

Table 14: Characteristic fatigue limit resistances of HPM® L Anchor bolts for design according to EN 1992-4:2018 and design method II according to EOTA TR 061: 2024-02

HPM® ..			16 L	20 L	24 L	30 L	39 L
Tension load							
Steel failure							
Characteristic fatigue resistance	$\Delta N_{Rk,s,0,\infty}$	[kN]	24,3				
Partial factor	$\gamma_{Ms,fat}$	[-]	1,35				
Pull-out failure							
Characteristic fatigue resistance	$\Delta N_{Rk,p,0,\infty}$	[kN]	$0{,}361 \cdot N_{Rk,p}$(HPM 16)				
	$\gamma_{Mp,fat}$	[-]	1,5				
Concrete failure							
Characteristic fatigue resistance	$\Delta N_{Rk,c,0,\infty}$	[kN]	$0{,}361 \cdot N_{Rk,c}$(HPM 16)				
Effective anchorage depth	h_{ef}	[mm]	165	223	287	335	502
Partial factor	$\gamma_{Mc,fat}$	[-]	1,5				
Splitting failure							
Characteristic fatigue resistance	$\Delta N_{Rk,sp,0,\infty}$	[kN]	$0{,}361 \cdot N_{Rk,sp}$(HPM 16)				
Partial factor	$\gamma_{Msp,fat}$	[-]	1,5				
Blow-out failure							
Characteristic fatigue resistance	$\Delta N_{Rk,cb,0,\infty}$	[kN]	$0{,}361 \cdot N_{Rk,cb}$(HPM 16)				
Partial factor	$\gamma_{Mcb,fat}$	[-]	1,5				
Shear load							
Steel failure							
Characteristic fatigue resistance	$\Delta V_{Rk,s,0,\infty}$	[kN]	5,01				
Partial factor	$\gamma_{Ms,fat}$	[-]	1,35				
Concrete edge failure							
Characteristic fatigue resistance	$\Delta V_{Rk,c,0,\infty}$	[kN]	$0{,}312 \cdot V_{Rk,c}$(HPM 16)				
Partial factor	$\gamma_{Mc,fat}$	[-]	1,5				
Concrete pryout failure							
Characteristic fatigue resistance	$\Delta V_{Rk,cp,0,\infty}$	[kN]	$0{,}312 \cdot V_{Rk,cp}$(HPM 16)				
Partial factor	$\gamma_{Mc,fat}$	[-]	1,5				
Exponent for combined loading	$\alpha_{sn} = \alpha_s$	[-]	0,7				
	α_c	[-]	1,5				
Load-transfer factor for fastener groups	$\psi_{FN} = \psi_{FV}$	[-]	0,5				