fischer High Performance anchor FH II

Anchor design according to fischer specification

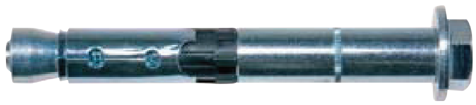
1. Types

European Technical Approval – Option 1 for cracked concrete *)

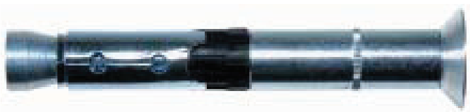
Fire resistance classification R 120
Anchor types see test report

ICC ES ESR-2691 — See ICC-ES Evaluation Report at www.ic-es.org — Inspection agency: AA-707 *)

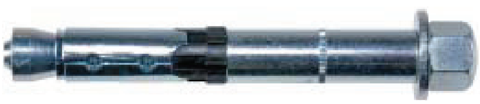
CALCULATION WITH CC COMPUFIX CALCULATION SOFTWARE



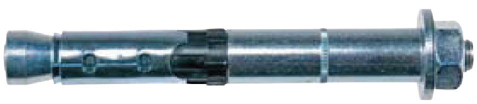
FH II-S 10 M6 - 32 M24 (gvz) – with hexagon head
FH II-S 10 M6 - 24 M16 (A4) – with hexagon head



FH II-SK 10 M6 - 18 M12 (gvz) – with countersunk head
FH II-SK 10 M6 - 18 M12 (A4) – with countersunk head



FH II-H 10 M6 - 24 M16 (gvz) – with cap nut



FH II-B 10 M6 - 32 M24 (gvz) – with hexagon nut

Features and Advantages

- European Technical Approval option 1*) for cracked and non-cracked concrete.
- ICC-ES Evaluation Report*) for cracked and non-cracked concrete. Seismic categories A-F.
- Highest tensile and shear loads.
- Independent controlled and confirmed product characteristics due to the European Technical Approval.
- Fire resistance classifications according to test report independently proved, gives safety in case of fire.
- The high strength class of the steel (8.8) combined with the optimised interaction of screw (bolt) and sleeve gives very high admissible shear loads.
- With the permitted small spacing and edge distances small, cost-efficient anchor plates and fixings near to the edge can be used.
- The design of the anchor allows a surface flush removal of the fixing.
- The different available head designs gives the opportunity to realise visually high-quality connections.
- Convenient push-through installation.

*) The conditions of use (e.g. design resistances, characteristic distances, ...) in the European Technical Approval or in the ICC-ES Evaluation Report may vary from those of the Technical Handbook.
The ICC-ES ER is currently only valid for several FH II anchors in carbon steel (gvz).

Materials

Threaded rod and components:	- Carbon steel grade 8.8. zinc plated (5 µm) and passivated (gvz)
	- Stainless steel of corrosion resistance class III, e.g. A4 (1.4401 optional 1.4571, 1.4362) and according to ASTM/AISI steel grade 316

fischer High Performance anchor FH II

Anchor design according to fischer specification

2. Ultimate resistance of single anchors with large spacing and large edge distance

Mean values

Anchor type	FH II 10 M6			FH II 12 M8			FH II 15 M10			FH II 18 M12		
	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4
non-cracked concrete												
tension C20/25 N_u [kN]	16.9		14.8	28.5		26.9	35.8			48.5		
C50/60 N_u [kN]	16.9		14.8	30.8		26.9	48.7		42.6	70.8		62.0
shear ≧ C20/25 V_u [kN]	17.7			34.3	42.4	34.2	52.7	71.7	52.5	79.1	96.3	80.6
cracked concrete												
tension C20/25 N_u [kN]	13.8			20.8			28.9			36.2		
C50/60 N_u [kN]	16.9		14.8	30.8		26.9	45.7		42.6	57.3		
shear ≧ C20/25 V_u [kN]	13.8			34.3	41.5	34.2	52.7	57.8	52.5	72.5		

Anchor type	FH II 24 M16			FH II 28 M20		FH II 32 M24	
	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	B/H gvz	S/SK gvz
non-cracked concrete							
tension C20/25 N_u [kN]	71.7			106.2		145.9	
C50/60 N_u [kN]	113.4			167.9		230.7	
shear ≧ C20/25 V_u [kN]	143.4			212.4		210.6	266.4
cracked concrete							
tension C20/25 N_u [kN]	61.0			88.8		131.7	
C50/60 N_u [kN]	96.4			140.4		208.3	
shear ≧ C20/25 V_u [kN]	121.9			177.6		210.6	263.4

3. Characteristic, design and recommended resistance of single anchors with large spacing and large edge distance

3.1 Characteristic resistance

Anchor type	FH II 10 M6			FH II 12 M8			FH II 15 M10			FH II 18 M12		
	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4
non-cracked concrete												
tension C20/25 N_{Rk} [kN]	14.1			25.8		25.6	32.5			39.7		
C50/60 N_{Rk} [kN]	16.1		14.1	29.3		25.6	46.4		40.6	61.6		59.0
shear ≧ C20/25 V_{Rk} [kN]	14.1			27.0	33.0	28.0	41.0	59.0	43.0	62.0	76.0	66.0
cracked concrete												
tension C20/25 N_{Rk} [kN]	7.5			14.7			21.1			25.6		
C50/60 N_{Rk} [kN]	11.6			22.8			32.7			39.7		
shear ≧ C20/25 V_{Rk} [kN]	9.1			27.0	33.0	28.0	41.0	42.2	42.2	51.5		

Anchor type	FH II 24 M16			FH II 28 M20		FH II 32 M24	
	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	B/H gvz	S/SK gvz
non-cracked concrete							
tension C20/25 N_{Rk} [kN]	55.6			77.6		102.1	
C50/60 N_{Rk} [kN]	86.1			120.3		158.2	
shear ≧ C20/25 V_{Rk} [kN]	111.1			146.0	155.3	169.0	204.1
cracked concrete							
tension C20/25 N_{Rk} [kN]	36.0			50.3		66.1	
C50/60 N_{Rk} [kN]	55.8			78.0		102.5	
shear ≧ C20/25 V_{Rk} [kN]	72.0			100.6		132.3	

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Anchor design according to fischer specification

3.2 Design resistance

Anchor type	FH II 10 M6			FH II 12 M8			FH II 15 M10			FH II 18 M12		
	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4
non-cracked concrete												
tension C20/25 N_{Rd} [kN]	9.4			17.2		13.3	21.7			26.5		
C50/60 N_{Rd} [kN]	10.7		9.4	19.5		17.1	30.9		27.1	41.1		39.3
shear ≧ C20/25 V_{Rd} [kN]	9.4			21.6	26.4	22.4	32.8	43.4	34.4	49.6	53.0	52.8
cracked concrete												
tension C20/25 N_{Rd} [kN]	5.0			9.8			14.1			17.1		
C50/60 N_{Rd} [kN]	7.8			15.2			21.8			26.5		
shear ≧ C20/25 V_{Rd} [kN]	6.1			21.6	22.3		28.1			34.3		

Anchor type	FH II 24 M16			FH II 28 M20		FH II 32 M24	
	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	B/H gvz	S/SK gvz
non-cracked concrete							
tension C20/25 N_{Rd} [kN]	37.0			51.8		68.0	
C50/60 N_{Rd} [kN]	57.4			80.2		105.5	
shear ≧ C20/25 V_{Rd} [kN]	74.1			103.5		135.2	136.1
cracked concrete							
tension C20/25 N_{Rd} [kN]	24.0			33.5		44.1	
C50/60 N_{Rd} [kN]	37.2			52.0		68.3	
shear ≧ C20/25 V_{Rd} [kN]	48.0			67.1		88.2	

3.3 Recommended resistance [1)]

Anchor type	FH II 10 M6			FH II 12 M8			FH II 15 M10			FH II 18 M12		
	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	S/SK A4	B/H gvz	S/SK gvz	A4
non-cracked concrete												
tension C20/25 N_R [kN]	6.7			12.3		9.5	15.5			18.9		
C50/60 N_R [kN]	7.7		6.7	14.0		12.2	22.1		19.3	29.3		28.1
shear ≧ C20/25 V_R [kN]	6.7			15.4	18.9	16.0	23.4	31.0	24.6	35.4	37.9	37.7
cracked concrete												
tension C20/25 N_R [kN]	3.6			7.0			10.0			12.2		
C50/60 N_R [kN]	5.5			10.9			15.6			18.9		
shear ≧ C20/25 V_R [kN]	4.3			15.4	15.9		20.1			24.5		

Anchor type	FH II 24 M16			FH II 28 M20		FH II 32 M24	
	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	B/H gvz	S/SK gvz
non-cracked concrete							
tension C20/25 N_R [kN]	26.5			37.0		48.6	
C50/60 N_R [kN]	41.0			57.3		75.3	
shear ≧ C20/25 V_R [kN]	52.9			73.9		96.6	97.2
cracked concrete							
tension C20/25 N_R [kN]	17.1			24.0		31.5	
C50/60 N_R [kN]	26.6			37.1		48.8	
shear ≧ C20/25 V_R [kN]	34.3			47.9		63.0	

1) Material safety factors γ_M and safety factor for action γ_L = 1.4 are included. Material safety factor γ_M depends on failure mode of the anchor.

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Anchor design according to fischer specification

4. Calculation of tension resistance

The decisive design resistance in tension is the lowest value of following failure modes:

Steel failure: $N_{Rd,s}$

Pull-out / pull-through failure: $N_{Rd,p} = N^0_{Rd,p} \cdot f_{b,N}$

Concrete cone failure: $N_{Rd,c} = N^0_{Rd,c} \cdot f_{b,N} \cdot f_{s1} \cdot f_{s2} \cdot f_{s3} \cdot f_{c1,A} \cdot f_{c1,B} \cdot f_{c2}$

Concrete splitting failure: $N_{Rd,sp} = N^0_{Rd,c} \cdot f_{b,N} \cdot f_{s1,sp} \cdot f_{s2,sp} \cdot f_{s3,sp} \cdot f_{c1,sp,A} \cdot f_{c1,sp,B} \cdot f_{c2,sp} \cdot f_h$

4.1 Steel failure of the highest loaded anchor

Design resistance of single anchor

Anchor type			FH II 10 M6		FH II 12 M8		FH II 15 M10		FH II 18 M12		FH II 24 M16		FH II 28 M20	FH II 32 M24
			gvz	A4	gvz	A4	gvz	A4	gvz	A4	gvz	A4	gvz	gvz
Design resistance	$N_{Rd,s}$	[kN]	10.7	9.4	19.5	17.1	30.9	27.1	44.9	39.3	83.5	73.1	130.5	188.0

4.2 Pull-out/pull-through failure of the highest loaded anchor

$$N_{Rd,p} = N^0_{Rd,p} \cdot f_{b,N}$$

Design resistance of single anchor

Anchor type			FH II 10 M6		FH II 12 M8		FH II 15 M10		FH II 18 M12		FH II 24 M16		FH II 28 M20	FH II 32 M24
			gvz	A4	gvz	A4	gvz	A4	gvz	A4	gvz	A4	gvz	gvz
non-cracked concrete														
Design resistance	$N^0_{Rd,p}$	[kN]	9.4		17.2	13.3	21.7		26.5		37.0		51.8	68.0
cracked concrete														
Design resistance	$N^0_{Rd,p}$	[kN]	5.0		9.8		14.1		17.1		24.0		33.5	44.1

4.3 Concrete cone failure and splitting of the most unfavourable anchor

Concrete cone failure: $N_{Rd,c} = N^0_{Rd,c} \cdot f_{b,N} \cdot f_{s1} \cdot f_{s2} \cdot f_{s3} \cdot f_{c1,A} \cdot f_{c1,B} \cdot f_{c2}$

Concrete splitting failure: $N_{Rd,sp} = N^0_{Rd,c} \cdot f_{b,N} \cdot f_{s1,sp} \cdot f_{s2,sp} \cdot f_{s3,sp} \cdot f_{c1,sp,A} \cdot f_{c1,sp,B} \cdot f_{c2,sp} \cdot f_h$

Proof of splitting failure is only necessary if all of the following conditions are met:

- non-cracked concrete
- $c_{cr,sp} > c_{cr,N}$
- $c < 1.2\, c_{cr,sp}$

Design resistance of single anchor

Anchor type			FH II 10 M6		FH II 12 M8		FH II 15 M10		FH II 18 M12		FH II 24 M16		FH II 28 M20	FH II 32 M24
			gvz	A4	gvz	A4	gvz	A4	gvz	A4	gvz	A4	gvz	gvz
non-cracked concrete														
Design resistance	$N^0_{Rd,c}$	[kN]	9.4		17.2		21.7		26.5		37.0		51.8	68.0
cracked concrete														
Design resistance	$N^0_{Rd,c}$	[kN]	6.1		11.2		14.1		17.2		24.0		33.5	44.1

4.3.1 Influence of concrete strength for tension

$$f_{b,N} = \sqrt{\frac{f_{ck,\,cube}}{25}} = \sqrt{\frac{f_{ck,\,cyl}}{20}}$$

Concrete strength class			C 12/15	C 16/20	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55	C 50/60
cylinder compressive strength	$f_{ck,cyl}$	[N/mm²]	12	16	20	25	30	35	40	45	50
cube compressive strength	$f_{ck,cube}$	[N/mm²]	15	20	25	30	37	45	50	55	60
influence factor	$f_{b,N}$	[-]	0.77	0.89	1.00	1.10	1.22	1.34	1.41	1.48	1.55

4.3.2 Concrete cone failure

Characteristic edge distance and spacing for design

Anchor type		FH II 10 M6	FH II 12 M8	FH II 15 M10	FH II 18 M12	FH II 24 M16	FH II 28 M20	FH II 32 M24
h_{ef}	[mm]	40	60	70	80	100	125	150
$s_{cr.N}$	[mm]	120	180	210	240	300	375	450
$c_{cr.N}$	[mm]	60	90	105	120	150	187.5	225

4.3.2.1 Influence of spacing / concrete cone failure

$$f_{s1} = f_{s2} = f_{s3} = \left(1.0 + \frac{s}{s_{cr,N}}\right) \cdot 0.5 \leqq 1.0$$

$s/s_{cr.N}$	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	≧1.0
$f_{s.1}$	0.55	0.58	0.6	0.63	0.65	0.68	0.7	0.73	0.75	0.78	0.8	0.83	0.85	0.88	0.9	0.93	0.95	0.98	1.0

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4.3.2.2 Influence of edge distance / concrete cone failure

$$f_{c1,A} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leqq 1.0$$

$$f_{c1,B} = f_{c2} = \left(1.0 + \frac{c}{c_{cr,N}}\right) \cdot 0.5 \leqq 1.0$$

$c/c_{cr.N}$	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	≧1.0
$f_{c1.A}$	0.73	0.75	0.76	0.78	0.79	0.81	0.82	0.84	0.85	0.87	0.88	0.9	0.91	0.93	0.94	0.96	0.97	0.99	1.0
$f_{c1.B}$ f_{c2}	0.55	0.58	0.6	0.63	0.65	0.68	0.7	0.73	0.75	0.78	0.8	0.83	0.85	0.88	0.9	0.93	0.95	0.98	1.0

4.3.3 Concrete splitting failure

Characteristic edge distance and spacing for design

Anchor type		FH II 10 M6	FH II 12 M8	FH II 15 M10	FH II 18 M12	FH II 24 M16	FH II 28 M20	FH II 32 M24
h_{ef}	[mm]	40	60	70	80	100	125	150
$s_{cr.sp}$	[mm]	190	300	320	340	380	480	570
$c_{cr.sp}$	[mm]	95	150	160	170	190	240	285
h_{min}	[mm]	80	120	140	160	200	250	300

4.3.3.1 Influence of spacing / Concrete splitting failure

$$f_{s1,sp} = f_{s2,sp} = f_{s3,sp} = \left(1.0 + \frac{s}{s_{cr,sp}}\right) \cdot 0.5 \leqq 1.0$$

$s/s_{cr.sp}$	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	≧1.0
$f_{s.sp}$	0.55	0.58	0.6	0.63	0.65	0.68	0.7	0.73	0.75	0.78	0.8	0.83	0.85	0.88	0.9	0.93	0.95	0.98	1.0

4.3.3.2 Influence of edge distance / Concrete splitting failure

$$f_{c1,sp,A} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} \leqq 1.0$$

$$f_{c1,sp,B} = f_{c2,sp} = \left(1.0 + \frac{c}{c_{cr,sp}}\right) \cdot 0.5 \leqq 1.0$$

$c/c_{cr.sp}$	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	≧1.0
$f_{c1.sp.A}$	0.73	0.75	0.76	0.78	0.79	0.81	0.82	0.84	0.85	0.87	0.88	0.9	0.91	0.93	0.94	0.96	0.97	0.99	1.0
$f_{c1.sp.B}$ $f_{c2.sp}$	0.55	0.58	0.6	0.63	0.65	0.68	0.7	0.73	0.75	0.78	0.8	0.83	0.85	0.88	0.9	0.93	0.95	0.98	1.0

4.3.3.3 Influence of concrete thickness / Concrete splitting failure

$$f_h = \left(\frac{h}{h_{min}}\right)^{2/3} \leqq 1.5$$

h/h_{min}	1.0	1.05	1.1	1.15	1.2	1.25	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65	1.7	1.75	1.8	≧1.84
f_h	1.0	1.03	1.07	1.1	1.13	1.16	1.19	1.22	1.25	1.28	1.31	1.34	1.37	1.4	1.42	1.45	1.48	1.5

5. Calculation of shear resistance

The decisive design resistance in shear is the lowest value of the following failure modes:

Steel failure: $V_{Rd,s}$

Pryout failure: $V_{Rd,cp} = N_{Rd,c} \cdot k$

Concrete edge failure: $V_{Rd,c} = V^0_{Rd,c} \cdot f_{b,V} \cdot f_{\alpha,V} \cdot f_{s1,V} \cdot f_{s2,V} \cdot f_{c2,V} \cdot f_{h,V} \cdot f_m$

5.1 Steel failure of the highest loaded anchor

Design resistance of single anchor

Anchor type			FH II 10 M6			FH II 12 M8			FH II 15 M10			FH II 18 M12		
			B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	A4
Design resistance	$V_{Rd,s}$	[kN]	12.4	14.4	14.4	21.6	26.4	22.4	32.8	47.2	34.4	49.6	60.8	52.8

Anchor type			FH II 24 M16			FH II 28 M20		FH II 32 M24	
			B/H gvz	S/SK gvz	A4	B/H gvz	S/SK gvz	B/H gvz	S/SK gvz
Design resistance	$V_{Rd,s}$	[kN]	95.2	116.8	95.2	116.8	139.2	135.2	173.6

5.2 Pryout failure of the most unfavourable anchor

$$V_{Rd,cp} = N_{Rd,c} \cdot k$$

k-factor

Anchor type	FH II 10 M6	FH II 12 M8 - FH II 32 M24
K	1.0	2.0

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5.3 Concrete edge failure of the most unfavourable anchor

$$V_{Rd,c} = V^{0}_{Rd,c} \cdot f_{b,V} \cdot f_{\alpha,V} \cdot f_{s1,V} \cdot f_{s2,V} \cdot f_{c2,V} \cdot f_{h,V} \cdot f_{m}$$

Proof of concrete edge failure is only necessary. if the following condition is met:

- $c < \max(10\ h_{ef}\ ;\ 60\ d)$ with d = nominal anchor diameter

Design resistance of single anchor in concrete C 20/25 dependent on edge distance c_1

edge distance	$V^{0}_{Rd,c}$ [kN]							
	FH II 10 M6		FH II 12 M8		FH II 15 M10		FH II 18 M12	
[mm]	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete
40	3.4	2.4						
45	3.9	2.8						
50	4.5	3.2		3.6				
55	5.2	3.7		4.1				
60	5.8	4.1	6.4	4.5		4.9		
65	6.5	4.6	7.1	5.0		5.4		
70	7.2	5.1	7.9	5.6	8.4	5.9		6.3
75	7.9	5.6	8.6	6.1	9.2	6.5		6.9
80	8.6	6.1	9.4	6.7	10.0	7.1	10.6	7.5
85	9.3	6.6	10.2	7.2	10.8	7.7	11.4	8.1
90	10.1	7.2	11.0	7.8	11.7	8.3	12.3	8.7
95	10.9	7.7	11.8	8.4	12.5	8.9	13.2	9.4
100	11.7	8.3	12.7	9.0	13.4	9.5	14.1	10.0
120	15.0	10.6	16.2	11.5	17.1	12.1	18.0	12.7
130	16.8	11.9	18.1	12.8	19.1	13.5	20.0	14.2
135	17.7	12.5	19.1	13.5	20.1	14.2	21.0	14.9
140	18.6	13.2	20.0	14.2	21.1	14.9	22.1	15.6
160	22.5	15.9	24.1	17.0	25.2	17.9	26.4	18.7
180	26.5	18.8	28.3	20.0	29.6	21.0	30.9	21.9
200	30.7	21.8	32.7	23.2	34.2	24.2	35.6	25.2
250	42.1	29.8	44.6	31.6	46.5	32.9	48.2	34.2
300	54.5	38.6	57.6	40.8	59.8	42.4	61.9	43.9
350	67.9	48.1	71.5	50.7	74.1	52.5	76.6	54.3
400	82.1	58.2	86.3	61.2	89.3	63.3	92.2	65.3
450	97.2	68.8	102.0	72.2	105.4	74.6	108.6	76.9
500	113.0	80.0	118.4	83.8	122.2	86.6	125.8	89.1
550	129.6	91.8	135.5	96.0	139.8	99.0	143.7	101.8
600	146.8	104.0	153.4	108.6	158.0	111.9	162.4	115.0
650			171.9	121.8	177.0	125.3	181.7	128.7
700			191.1	135.3	196.6	139.2	201.7	142.9
750					216.8	153.5	222.3	157.5
800					237.6	168.3	243.5	172.5
850					259.0	183.4	265.3	187.9
900					280.9	199.0	287.7	203.8
950							310.6	220.0
1000							334.0	236.6
1100							382.5	270.9

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fischer High Performance anchor FH II

Anchor design according to fischer specification

edge distance [mm]	$V^0_{Rd.c}$ [kN] FH II 24 M16		FH II 28 M20		FH II 32 M24	
[mm]	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete
80		8.3				
85		9.0				
90		9.6				
95		10.3				
100	15.5	11.0		12.0		
120	19.6	13.9	21.2	15.0		16.1
130	21.8	15.4	23.5	16.6		17.8
135	22.9	16.2	24.6	17.4		18.6
140	24.0	17.0	25.8	18.2		19.5
160	28.5	20.2	30.6	21.6		23.1
180	33.3	23.6	35.6	25.2	37.8	26.8
200	38.3	27.1	40.8	28.9	43.2	30.6
250	51.6	36.5	54.7	38.7	57.7	40.8
300	65.9	46.7	69.6	49.3	73.2	51.8
350	81.3	57.6	85.5	60.6	89.7	63.5
400	97.5	69.1	102.4	72.5	107.1	75.8
450	114.6	81.2	120.1	85.1	125.3	88.8
500	132.5	93.9	138.6	98.2	144.4	102.3
550	151.1	107.1	157.8	111.8	164.2	116.3
600	170.5	120.8	177.8	126.0	184.8	130.9
650	190.5	135.0	198.5	140.6	206.0	145.9
700	211.2	149.6	219.8	155.7	227.9	161.5
750	232.6	164.7	241.8	171.3	250.5	177.4
800	254.5	180.3	264.3	187.2	273.7	193.8
850	277.0	196.2	287.5	203.7	297.4	210.7
900	300.2	212.6	311.3	220.5	321.8	227.9
950	323.8	229.4	335.6	237.7	346.7	245.6
1000	348.0	246.5	360.4	255.3	372.1	263.6
1100	398.0	281.9	411.7	291.6	424.6	300.8
1200	450.0	318.7	465.0	329.4	479.2	339.4
1300	503.8	356.9	520.2	368.5	535.6	379.4
1400	559.6	396.4	577.3	408.9	594.0	420.7
1500			636.2	450.6	654.1	463.3
1600			696.8	493.5	715.9	507.1
1700					779.4	552.1
1800					844.6	598.3
1900					911.3	645.5

5.3.1 Influence of concrete strength for shear

$$f_{b,V} = \sqrt{\frac{f_{ck,\,cube}}{25}} = \sqrt{\frac{f_{ck,\,cyl}}{20}}$$

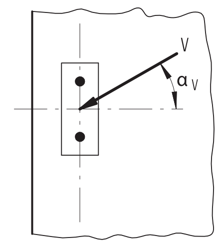
Concrete strength class			C 12/15	C 16/20	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55	C 50/60
Cylinder compressive strength	$f_{ck.cyl}$	[N/mm²]	12	16	20	25	30	35	40	45	50
Cube compressive strength	$f_{ck.cube}$	[N/mm²]	15	20	25	30	37	45	50	55	60
Influence factor	$f_{b.N}$	[-]	0.77	0.89	1.00	1.10	1.22	1.34	1.41	1.48	1.55

5.3.2 Influence of load direction

$$f_{\alpha,V} = \sqrt{\frac{1}{(\cos \alpha_V)^2 + \left(\frac{\sin \alpha_V}{2.5}\right)^2}} \leqq 2.5$$

	0	10	20	30	40	50	60	70	80	90
$f_{\alpha.V}$	1.00	1.01	1.05	1.13	1.24	1.40	1.64	1.97	2.32	2.50

For angle $\alpha \geqq 90°$ the component of the shear load acting away from the edge may be neglected and the proof may be done with the component of the load acting parallel to the edge.



5.3.3 Influence of spacing

$$f_{s1,V} = f_{s2,V} = \frac{1}{6} \cdot \frac{s}{c_1} + \frac{1}{2} \leqq 1.0$$

s/c_1	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	≧3.0
$f_{s1.V}$	0.58	0.6	0.62	0.63	0.65	0.67	0.7	0.73	0.77	0.8	0.83	0.87	0.9	0.93	0.97	1.0

5.3.4 Influence of edge distance

Distance to second edge; $c_1 < c_2$

$$f_{c2,V} = \left(\frac{1}{2} + \frac{1}{3} \cdot \frac{c_2}{c_1}\right) \cdot \left(0.7 + 0.3 \cdot \frac{c_2}{1.5 \cdot c_1}\right) \leqq 1.0$$

c_2/c_1	1.0	1.1	1.2	1.3	1.4	≧1.5
$f_{c2.V}$	0.75	0.8	0.85	0.9	0.95	1.0

5.3.5 Influence of member thickness

$$f_{h,V} = \left(\frac{h}{1.5 \cdot c_1}\right)^{0.5} \leqq 1.0$$

h/c_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.3	1.4	≧1.5
$f_{h.V}$	0.26	0.37	0.45	0.52	0.58	0.63	0.68	0.73	0.77	0.82	0.89	0.93	0.97	1.0

5.3.6 Influence of group with ≧ 4 anchors in a row at the edge

f_m

s/c_1	0.25	0.5	1.0	≧2.0
f_m	0.3	0.5	0.75	1.0

6. Summary of required proof:

6.1 Tension: $N_{Sd} \leqq N_{Rd}$ = *lowest value of* $N_{Rd.s}$; $N_{Rd.p}$; $N_{Rd.c}$; $N_{Rd.sp}$

6.2 Shear: $V_{Sd} \leqq V_{Rd}$ = *lowest value of* $V_{Rd.s}$; $V_{Rd.cp}$; $V_{Rd.c}$

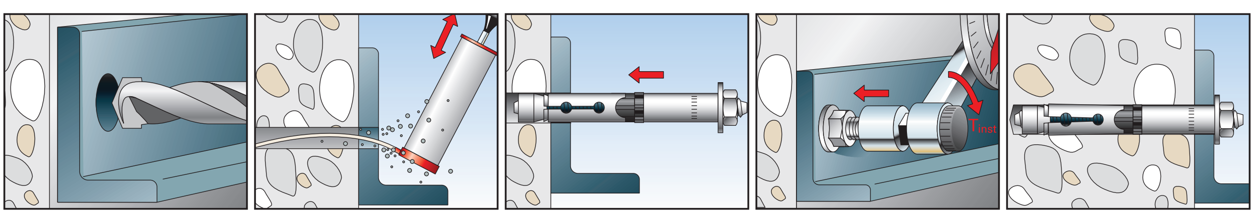
6.3 Combined tension and shear load:

$$\frac{N_{Sd}}{N_{Rd}} + \frac{V_{Sd}}{V_{Rd}} \leqq 1.2$$

N_{Sd}; V_{Sd} = **tension/shear component of the design load acting on the most unfavourable single anchor**

N_{Rd}; V_{Rd} = **tension/shear design resistance including safety factors of the most unfavourable single anchor**

7. Installation details



fischer High Performance anchor FH II

Anchor design according to fischer specification

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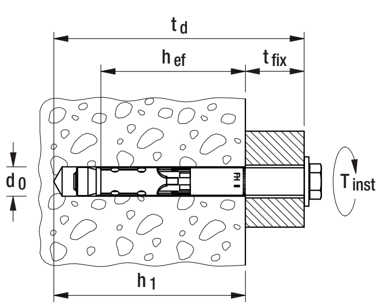
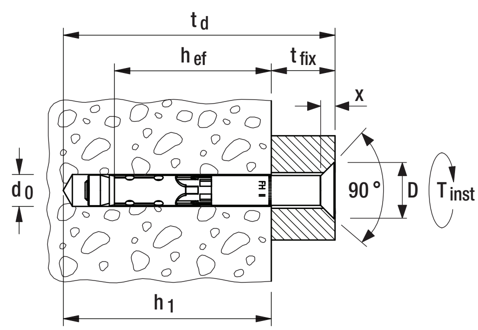
8. Anchor characteristics

Anchor type			FH II 10 M6		FH II 12 M8		FH II 15 M10		FH II 18 M12		FH II 24 M16		FH II 28 M20	FH II 32 M24
			gvz	A4	gvz	A4	gvz	A4	gvz	A4	gvz	A4	gvz	gvz
diameter of thread			M6		M8		M10		M12		M16		M20	M24
nominal drill hole diameter	d_0	[mm]	10		12		15		18		24		28	32
drill depth	h_1	[mm]	55		80		90		105		125		155	180
effective anchorage depth	h_{ef}	[mm]	40		60		70		80		100		125	150
clearance-hole in fixture to be attached	d_f	[mm]	12		14		17		20		26		31	35
drill hole depth for through fixing	t_d	[mm]	$t_d = h_1 + t_{fix}$											
wrench size – type H	SW	[mm]	13	10	17	13	17		19		24		-	-
wrench size – type SK [1]	SW	[mm]	4		5		6		8		-		-	-
wrench size – type S/B	SW	[mm]	10		13		17		19		24		30	36
required installation torque – type B	T_{inst}	[Nm]	10	15	17.5	25	38	40	80	100	120	160	180	200
required installation torque – type H	T_{inst}	[Nm]	10	15	22.5	25	40	40	80	100	90	160	-	-
required installation torque – type S	T_{inst}	[Nm]	10	15	22.5	25	40	40	80	100	160	160	180	200
required installation torque – type SK	T_{inst}	[Nm]	10	10	22.5	25	40	40	80	100	-	-	-	-
min. thickness of concrete member	h_{min}	[mm]	80		120		140		160		200		250	300
non-cracked concrete [2]														
minimum spacing	s_{min}	[mm]	40		60		70		80		100		120	160
for required edge distances	for c	[mm]	70		100		100		160		200		220	360
minimum edge distances	c_{min}	[mm]	40		60		70		80		100		120	180
for required spacing	for s	[mm]	70		100		140		200		220		240	380
cracked concrete [2]														
minimum spacing	s_{min}	[mm]	40		50		60		70		80		100	120
for required edge distances	for c	[mm]	40		80		120		140		180		200	260
minimum edge distances	c_{min}	[mm]	40		50		60		70		80		100	120
for required spacing	for s	[mm]	40		80		120		160		200		220	280

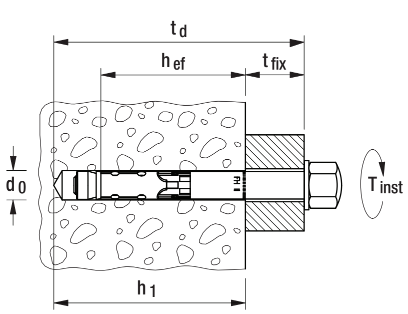
[1] Internal hexagon

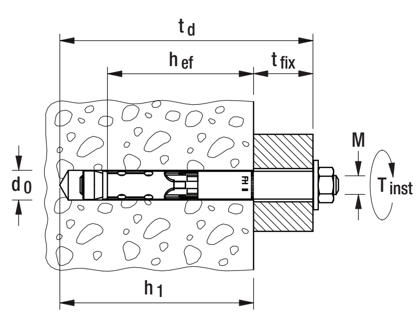
[2] Intermediate values by linear interpolation.





	X [mm]	∅ D [mm]	counter bore [°]
FH II 10 M6 SK	5	18	90°
FH II 12 M8 SK FH II 12 M8 SK A4	5.8	22	90°
FH II 15 M10 SK FH II 15 M10 SK A4	5.8	25	90°
FH II 18 M12 SK FH II 18 M12 SK A4	8	32	90°





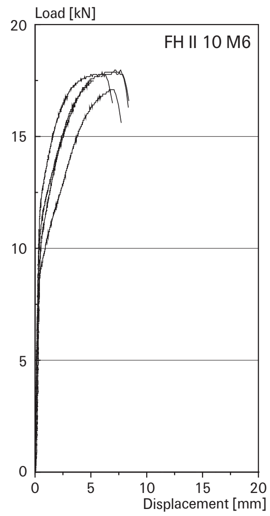
fischer High Performance anchor FH II

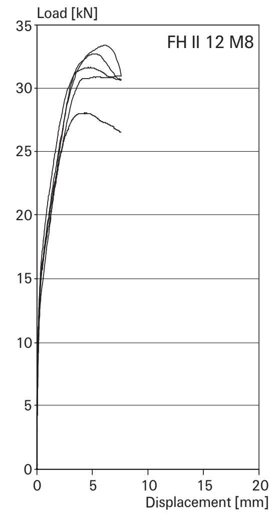
Anchor design according to fischer specification

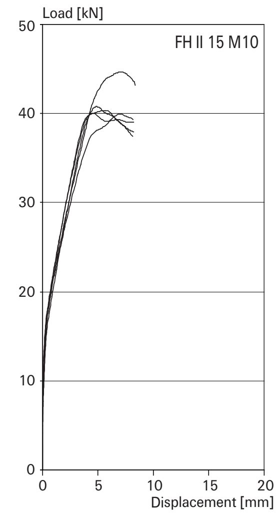
9. Mechanical characteristics

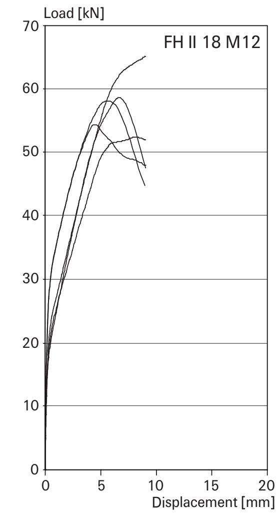
Anchor type			FH II 10 M6		FH II 12 M8		FH II 15 M10		FH II 18 M12		FH II 24 M16		FH II 28 M20	FH II 32 M24
			gvz	A4	gvz	A4	gvz	A4	gvz	A4	gvz	A4	gvz	gvz
stressed cross sectional area threaded rod	A_s	[mm²]	20.1		36.6		58.0		84.3		157.0		245.0	353.0
resisting moment threaded rod	W	[mm³]	12.7		31.2		62.3		109.2		277.5		541.0	935.0
design value of bending moment	$M^0_{Rd,s}$	[N/m]	9,6	8,4	24,0	20,8	48,0	42,0	84,0	73,6	212,8	186,4	414,4	716,8
yield strength threaded rod	f_{yk}	[N/mm²]	640	560	640	560	640	560	640	560	640	560	640	640
tensile strength threaded rod	f_{uk}	[N/mm²]	800	700	800	700	800	700	800	700	800	700	800	800

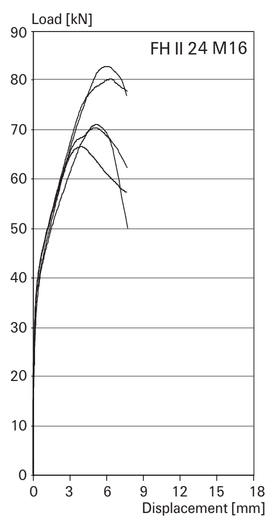
10. Load displacement curves for tension in non-cracked concrete ($f_{ck.cube\ (200)}$ = 30 N/mm²)

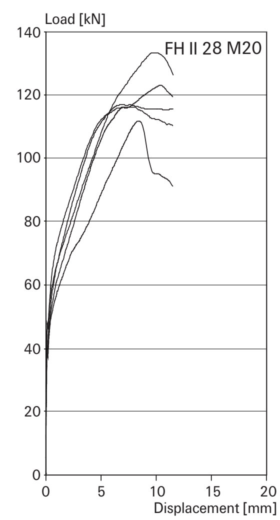


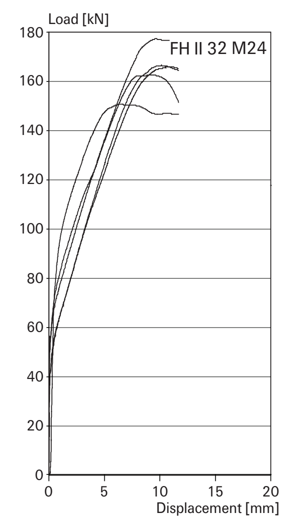












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