fischer Zykon anchor FZA

Anchor design according to fischer specification

1. Types

FZA – Bolt anchor (gvz)

FZA – Bolt anchor (A4)

FZA – Bolt anchor (C)

Fire resistance classification **F 120**
Anchor types see test report

*) European Technical Approval – Option 1 for cracked concrete

FM APPROVED from thread M 10

CALCULATION WITH CC COMPUFIX CALCULATION SOFTWARE

Features and Advantages

- European Technical Approval option 1*) for cracked an non-cracked concrete.
- Independent controlled and confirmed product characteristics (Approval) gives the required safety guarantees.
- Expansion free fixing allows small spacing and edge distances.
- Depth marking (green ring) enable visual control and ensures correct function.
- Fire resistance classifications (F 120) according to test report independently proved gives the safety case of fire.
- Formlocking fit in the undercut enables high loads at shallow anchorage depth.

*) The conditions of use in the European Technical Approval may vary from those of the Technical Handbook.

Materials

Anchor:
- Carbon steel, 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
- Highly corrosion-resistant steel of the corrosion resistance class IV, e. g. 1.4529.

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

Mean values

Anchor type			FZA 10x40 M 6			FZA 12x40 M 8			FZA 14x40 M 10			FZA 12x50 M 8			FZA 14x60 M 10			FZA 18x80 M 12			FZA 22x100 M 16			FZA 22x125 M 16		
			gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C
non-cracked concrete																										
tension	C 20/25	N_u [kN]	16.1	14.1		17.1			17.1			23.9			31.4			48.3			67.5			94.3		
	C 50/60	N_u [kN]	16.1	14.1		26.4			26.4			29.3	25.6		46.4	40.6		67.4	59.0		104.6			125.6	110.0	
shear	≧ C 20/25	V_u [kN]	9.6	8.4		17.6	15.4		27.8	24.4		17.6	15.4		27.8	24.4		40.5	35.4		75.4	65.9		75.4	65.9	
cracked concrete																										
tension	C 20/25	N_u [kN]	12.0			12.0			12.0			16.7			22.0			33.8			47.2			66.0		
	C 50/60	N_u [kN]	16.1	14.1		18.5			18.5			25.9	25.6		34.1			52.3			73.1			102.2		
shear	C 20/25	V_u [kN]	9.6	8.4		15.5	15.4		15.5			17.6	15.4		27.8	24.4		40.5	35.4		75.4	65.9		75.4	65.9	

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

3.1 Characteristic resistance

Anchor type			FZA 10x40 M 6			FZA 12x40 M 8			FZA 14x40 M 10			FZA 12x50 M 8			FZA 14x60 M 10			FZA 18x80 M 12			FZA 22x100 M 16			FZA 22x125 M 16		
			gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C
non-cracked concrete																										
tension	C 20/25	N_{Rk} [kN]		14.0			14.0			14.0			19.6			25.8			39.7			55.4			77.5	
	C 50/60	N_{Rk} [kN]	16.1	14.1			21.7			21.7		29.3	25.6			39.9		61.5	59.0			85.9		120.0	110.0	
shear	C 20/25	V_{Rk} [kN]	8.0	7.0		14.7	12.8			18.2		14.7	12.8		23.2	20.3		33.8	29.5		62.8	55.0		62.8	55.0	
	≧ C 40/50	V_{Rk} [kN]	8.0	7.0		14.7	12.8		23.2	20.3		14.7	12.8		23.2	20.3		33.8	29.5		62.8	55.0		62.8	55.0	
cracked concrete																										
tension	C 20/25	N_{Rk} [kN]		9.1			9.1			9.1			12.7			16.7			25.8			36.0			50.3	
	C 50/60	N_{Rk} [kN]		14.1			14.1			14.1			19.7			25.9			39.9			55.8			77.9	
shear	C 20/25	V_{Rk} [kN]	8.0	7.0			11.8			11.8		14.7	12.8		23.2	20.3		33.8	29.5		62.8	55.0		62.8	55.0	
	C 50/60	V_{Rk} [kN]	8.0	7.0		14.7	12.8			18.3		14.7	12.8		23.2	20.3		33.8	29.5		62.8	55.0		62.8	55.0	

3.2 Design resistance

Anchor type			FZA 10x40 M 6			FZA 12x40 M 8			FZA 14x40 M 10			FZA 12x50 M 8			FZA 14x60 M 10			FZA 18x80 M 12			FZA 22x100 M 16			FZA 22x125 M 16		
			gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C
non-cracked concrete																										
tension	C 20/25	N_{Rd} [kN]	9.4	7.5	9.4		9.4			9.4			13.1			17.2			26.4			37.0			51.7	
	C 50/60	N_{Rd} [kN]	10.7	7.5	9.4	14.5	13.7	14.5		14.5		19.5	13.7	17.1	26.6	21.7	26.6	41.0	31.6	39.3		57.3		80.0	58.8	73.3
shear	C 20/25	V_{Rd} [kN]	6.4	4.5	5.6	11.8	8.2	10.2		12.2		11.8	8.2	10.2	18.6	13.0	16.2	27.0	18.9	23.6	50.2	35.3	44.0	50.2	35.3	44.0
	C 40/50	V_{Rd} [kN]	6.4	4.5	5.6	11.8	8.2	10.2	18.6	13.0	16.2	11.8	8.2	10.2	18.6	13.0	16.2	27.0	18.9	23.6	50.2	35.3	44.0	50.2	35.3	44.0
cracked concrete																										
tension	C 20/25	N_{Rd} [kN]		6.1			6.1			6.1			8.5			11.2			17.2			24.0			33.5	
	C 50/60	N_{Rd} [kN]	9.4	7.5	9.4		9.4			9.4			13.1			17.3			26.6			37.2			52.0	
shear	C 20/25	V_{Rd} [kN]	6.4	4.5	5.6		7.9			7.9		11.0	8.2	10.2	18.6	13.0	16.2	27.0	18.9	23.6	48.0	35.3	44.0	50.2	35.3	44.0
	C 50/60	V_{Rd} [kN]	6.4	4.5	5.6	11.8	8.2	10.2		12.2		11.8	8.2	10.2	18.6	13.0	16.2	27.0	18.9	23.6	50.2	35.3	44.0	50.2	35.3	44.0

3.3 Recommended resistance [1)]

Anchor type			FZA 10x40 M 6			FZA 12x40 M 8			FZA 14x40 M 10			FZA 12x50 M 8			FZA 14x60 M 10			FZA 18x80 M 12			FZA 22x100 M 16			FZA 22x125 M 16		
			gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C
non-cracked concrete																										
tension	C 20/25	N_R [kN]	6.7	5.4	6.7		6.7			6.7			9.3			12.3			18.9			26.4			36.9	
	C 50/60	N_R [kN]	7.7	5.4	6.7	10.3	9.8	10.3		10.3		14.0	9.8	12.2	19.0	15.5	19.0	19.3	22.5	28.1		40.9		57.2	42.0	52.4
shear	C 20/25	V_R [kN]	4.6	3.2	4.0	7.2	5.9	7.2		7.2		8.4	5.9	7.3	13.3	9.3	11.6	19.3	13.5	16.9	35.9	25.2	31.4	35.9	25.2	31.4
	C 40/50	V_R [kN]	4.6	3.2	4.0	8.4	5.9	7.3	11.2	9.3	11.2	8.4	5.9	7.3	13.3	9.3	11.6	19.3	13.5	16.9	35.9	25.2	31.4	35.9	25.2	31.4
cracked concrete																										
tension	C 20/25	N_R [kN]		4.3			4.3			4.3			6.1			8.0			12.3			17.1			24.0	
	C 50/60	N_R [kN]	6.7	5.4	6.7		6.7			6.7			9.4			12.3			19.0			26.6			37.1	
shear	C 20/25	V_R [kN]	4.6	3.2	4.0		5.6			5.6		7.9	5.9	7.3	13.3	9.3	11.6	19.3	13.5	16.9	34.3	25.2	31.4	35.9	25.2	31.4
	≧ C 45/55	V_R [kN]	4.6	3.2	4.0	8.4	5.9	7.3		8.7		8.4	5.9	7.3	13.3	9.3	11.6	19.3	13.5	16.9	35.9	25.2	31.4	35.9	25.2	31.4

[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.

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: *Failure mode is not decisive*

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

Concrete splitting failure: *Failure mode is not decisive*

4.1 Steel failure of the highest loaded anchor

Design resistance of single anchor

Anchor type		FZA 10x40 M 6			FZA 12x40 M 8			FZA 14x40 M 10			FZA 12x50 M 8			FZA 14x60 M 10			FZA 18x80 M 12			FZA 22x100 M 16			FZA 22x125 M 16		
		gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C
design resistance	$N_{Rd,s}$ [kN]	10.7	7.5	9.4	19.5	13.7	17.1	30.9	21.7	27.1	19.5	13.7	17.1	30.9	21.7	27.1	44.9	31.6	39.3	84.0	58.8	73.3	84.0	58.8	73.3

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

Failure mode is not decisive and therefore may be neglected

4.3 Concrete cone failure and splitting of the most unfavourable anchor

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

Concrete splitting failure: *Failure mode is not decisive*

Design resistance of single anchor

Anchor type		FZA 10x40 M 6	FZA 12x40 M 8	FZA 14x40 M 10	FZA 12x50 M 8	FZA 14x60 M 10	FZA 18x80 M 12	FZA 22x100 M 16	FZA 22x125 M 16
eff. anchorage depth	h_{ef} [mm]	40	40	40	50	60	80	100	125
non-cracked concrete									
design resistance	$N^{0}_{Rd,c}$ [kN]	9.4	9.4	9.4	13.1	17.2	26.4	37.0	51.7
cracked concrete									
design resistance	$N^{0}_{Rd,c}$ [kN]	6.1	6.1	6.1	8,5	11.2	17.2	24.0	33.5

4.3.1 Influence of concrete strength for tension

$$f_{b,N} = \sqrt[4]{\frac{f_{ck,\,cube}}{25}} = \sqrt[4]{\frac{f_{ck,\,cyl}}{20}}$$

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		FZA 10x40 M 6	FZA 12x40 M 8	FZA 14x40 M 10	FZA 12x50 M 8	FZA 14x60 M 10	FZA 18x80 M 12	FZA 22x100 M 16	FZA 22x125 M 16
h_{ef}		40	40	40	50	60	80	100	125
$s_{cr,N}$	[mm]	120	120	120	150	180	240	300	375
$c_{cr,N}$	[mm]	60	60	60	75	90	120	150	188

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_{s1}	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

4.3.2.2 Influence of edge distance / concrete cone failure

$$f_{c1,A} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leqq 1.0 \qquad f_{c1,B} = f_{c2} = \left(1.0 + \frac{c}{c_{cr,N}}\right) \cdot 0.5 \leqq 1.0$$

$c/c_{cr,N}$	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

Failure mode is not decisive and therefore may be neglected

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

5.1 Steel failure for the highest loaded anchor

Design resistance of single anchor

Anchor type		FZA 10x40 M 6			FZA 12x40 M 8			FZA 14x40 M 10			FZA 12x50 M 8			FZA 14x60 M 10			FZA 18x80 M 12			FZA 22x100 M 16			FZA 22x125 M 16		
		gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C
design resistance	$V_{Rd,s}$ [kN]	6.4	4.5	5.6	11.8	8.2	10.2	18.6	13.0	16.2	11.8	8.2	10.2	18.6	13.0	16.2	27.0	18.9	23.6	50.2	35.3	44.0	50.2	35.3	44.0

5.2 Pryout failure for the most unfavourable anchor

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

k-factor

Anchor type	FZA 10x40 M 6	FZA 12x40 M 8	FZA 14x40 M 10	FZA 12x50 M 8	FZA 14x60 M 10	FZA 18x80 M 12	FZA 22x100 M 16	FZA 22x125 M 16
k	1.3	1.3	1.3	1.3	2.0	2.0	2.0	2.0

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5.3 Concrete edge failure of the most unfavourable anchor

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

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 [mm]	$V^{o}_{Rd,c}$ [kN]							
	FZA 10x40 M6		FZA 12x40 M8		FZA 14x40 M10		FZA 12x50 M8	
	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete
35	2.8	2.0						
40	3.4	2.4	3.5	2.5				
45	3.9	2.8	4.1	2.9			4.2	3.0
50	4.5	3.2	4.7	3.3			4.9	3.4
55	5.2	3.7	5.3	3.8			5.5	3.9
60	5.8	4.1	6.0	4.2			6.2	4.4
65	6.5	4.6	6.6	4.7			6.9	4.9
70	7.2	5.1	7.3	5.2	7.5	5.3	7.6	5.4
75	7.9	5.6	8.0	5.7	8.2	5.8	8.3	5.9
80	8.6	6.1	8.8	6.2	8.9	6.3	9.1	6.4
85	9.3	6.6	9.5	6.8	9.7	6.9	9.9	7.0
90	10.1	7.2	10.3	7.3	10.5	7.4	10.7	7.6
95	10.9	7.7	11.1	7.9	11.3	8.0	11.5	8.1
100	11.7	8.3	11.9	8.4	12.1	8.6	12.3	8.7
120	15.0	10.6	15.3	10.9	15.6	11.0	15.8	11.2
125	15.9	11.3	16.2	11.5	16.5	11.7	16.7	11.8
130	16.8	11.9	17.1	12.1	17.4	12.3	17.6	12.5
135	17.7	12.5	18.0	12.8	18.3	13.0	18.6	13.2
140	18.6	13.2	19.0	13.4	19.3	13.6	19.5	13.8
160	22.5	15.9	22.8	16.2	23.2	16.4	23.5	16.6
180	26.5	18.8	26.9	19.1	27.3	19.3	27.7	19.6
200	30.7	21.8	31.2	22.1	31.6	22.4	32.0	22.7
250	42.1	29.8	42.7	30.2	43.2	30.6	43.7	31.0
300	54.5	38.6	55.3	39.1	55.9	39.6	56.5	40.0
350	67.9	48.1	68.8	48.7	69.5	49.2	70.2	49.7
400	82.1	58.2	83.1	58.9	84.0	59.5	84.8	60.1
450	97.2	68.8	98.3	69.7	99.3	70.4	100.3	71.0
500	113.0	80.0	114.3	81.0	115.4	81.8	116.5	82.5
550	129.6	91.8	131.0	92.8	132.3	93.7	133.4	94.5
600	146.8	104.0	148.4	105.1	149.8	106.1	151.1	107.0
650			166.5	117.9	168.0	119.0	169.4	120.0
700			185.2	131.2	186.8	132.3	188.3	133.4
750			204.5	144.8	206.3	146.1	207.9	147.3
800					226.3	160.3		
850					246.9	174.9		
900								
950								
1000								
1100								
1200								
1300								
1400								

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Anchor design according to fischer specification

edge distance [mm]	FZA 14x60 M10		FZA 18x80 M12		FZA 22x100 M16		FZA 22x125 M16	
	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete
35								
40								
45								
50								
55	5.9	4.2						
60	6.6	4.7						
65	7.3	5.2						
70	8.0	5.7	8.9	6.3				
75	8.8	6.2	9.7	6.9				
80	9.6	6.8	10.6	7.5				
85	10.4	7.4	11.4	8.1				
90	11.2	8.0	12.3	8.7				
95	12.1	8.6	13.2	9.4				
100	12.9	9.2	14.1	10.0	15.3	10.8		
120	16.5	11.7	18.0	12.7	19.4	13.7		
125	17.5	12.4	19.0	13.4	20.4	14.5	21.4	15.2
130	18.4	13.1	20.0	14.2	21.5	15.2	22.5	16.0
135	19.4	13.7	21.0	14.9	22.6	16.0	23.6	16.7
140	20.4	14.4	22.1	15.6	23.7	16.8	24.8	17.5
160	24.5	17.3	26.4	18.7	28.2	20.0	29.4	20.9
180	28.8	20.4	30.9	21.9	32.9	23.3	34.3	24.3
200	33.3	23.6	35.6	25.2	37.9	26.8	39.4	27.9
250	45.3	32.1	48.2	34.2	51.0	36.2	53.0	37.5
300	58.4	41.4	61.9	43.9	65.3	46.3	67.6	47.9
350	72.5	51.3	76.6	54.3	80.5	57.0	83.2	58.9
400	87.4	61.9	92.2	65.3	96.7	68.5	99.7	70.6
450	103.2	73.1	108.6	76.9	113.6	80.5	117.0	82.9
500	119.7	84.8	125.8	89.1	131.4	93.1	135.2	95.8
550	137.0	97.1	143.7	101.8	149.9	106.2	154.1	109.1
600	155.0	109.8	162.4	115.0	169.2	119.8	173.7	123.0
650	173.7	123.0	181.7	128.7	189.1	134.0	194.0	137.4
700	193.0	136.7	201.7	142.9	209.7	148.5	215.0	152.3
750	213.0	150.8	222.3	157.5	230.9	163.6	236.6	167.6
800	233.5	165.4	243.5	172.5	252.7	179.0	258.8	183.3
850	254.6	180.4	265.3	187.9	275.1	194.9	281.6	199.5
900			287.7	203.8	298.1	211.2	305.0	216.0
950			310.6	220.0	321.7	227.9	328.9	233.0
1000			334.0	236.6	345.8	244.9	353.4	250.3
1100			382.5	270.9	395.5	280.1	403.9	286.1
1200					447.2	316.8	456.5	323.3
1300					500.8	354.8	510.9	361.9
1400					556.3	394.1	567.2	401.8

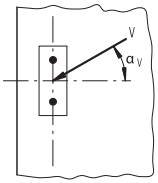
5.3.1 Influence of concrete strength for shear

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

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	$f_{b,V}$	[-]	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

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



	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

fischer Zykon anchor FZA

Anchor design according to fischer specification

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 $V_{Rd.s}$; $V_{Rd.cp}$; $V_{Rd.c}$

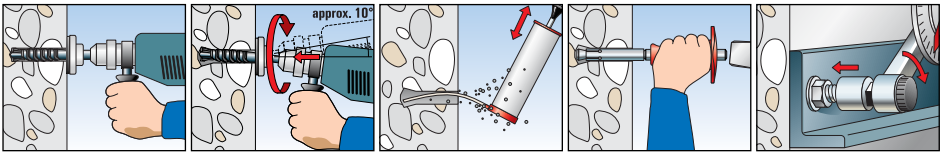
6.3 Combined tension and shear load:

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

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

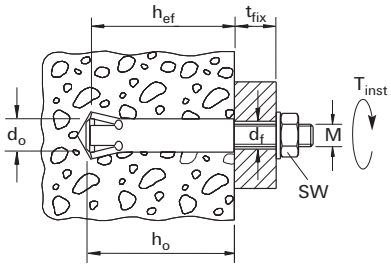
N_{Rd}; V_{Rd} = tension/shear design resistance including safety factors of the most unfavourable single anchor

7. Installation details



8. Anchor installation data

Anchor type			FZA 10x40 M 6	FZA 12x40 M 8	FZA 14x40 M 10	FZA 12x50 M 8	FZA 14x60 M 10	FZA 18x80 M 12	FZA 22x100 M 16	FZA 22x125 M 16
diameter of thread			M 6	M 8	M 10	M 8	M 10	M 12	M 16	M 16
nominal drill hole diameter	d_0	[mm]	10	12	14	12	14	18	22	22
drill depth	h_0	[mm]	43	43	43	54	63	83	103	127
effective anchorage depth	h_{ef}	[mm]	40	40	40	50	60	80	100	125
clearance-hole in fixture to be attached	d_f	[mm]	≦ 7	≦ 9	≦ 12	≦ 9	≦ 12	≦ 14	≦ 18	≦ 18
wrench size	SW	[mm]	10	13	17	13	17	19	24	24
required torque	T_{inst}	[Nm]	8.5	20	40	20	40	60	100	100
minimum thickness of concrete member	h_{min}	[mm]	100	100	100	110	130	160	200	250
minimum spacing	s_{min}	[mm]	40	40	70	50	60	80	100	125
minimum edge distances	c_{min}	[mm]	35	40	70	45	55	70	100	125



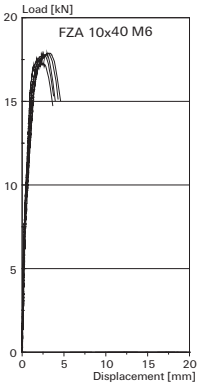
fischer Zykon anchor FZA

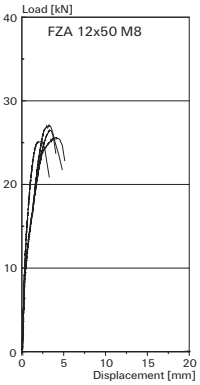
Anchor design according to fischer specification

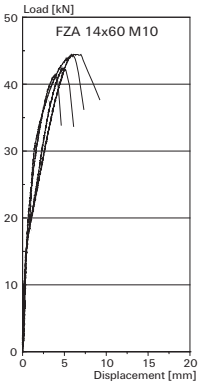
9. Mechanical anchor material characteristics

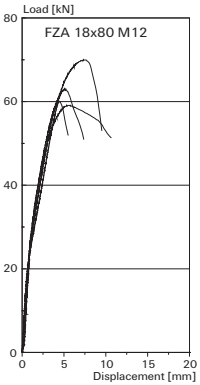
Anchor type			FZA 10x40 M 6			FZA 12x40 M 8			FZA 14x40 M 10			FZA 12x50 M 8			FZA 14x60 M 10			FZA 18x80 M 12			FZA 22x100 M 16			FZA 22x125 M 16		
			gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C
stressed cross sectional area cone bolt	A_s	[mm²]	20.1			36.6			58.0			36.6			58.0			84.3			157			157		
resisting moment cone bolt	W	[mm³]	12.7			31.2			62.3			31.2			62.3			109			278			278		
design value of bending moment	$M^0_{Rd,s}$	[Nm]	9.8	6.9	8.6	24.0	16.8	21.0	47.8	33.5	41.8	24.0	16.8	21.0	47.8	33.5	41.8	84.0	58.7	73.3	212.8	148.7	185.6	212.8	148.7	185.6
yield strength cone bolt	f_{yk}	[N/mm²]	640	450	560	640	450	560	640	450	560	640	450	560	640	450	560	640	450	560	640	450	560	640	450	560
tensile strength cone bolt	f_{uk}	[N/mm²]	800	700		800	700		800	700		800	700		800	700		800	700		800	700		800	700	

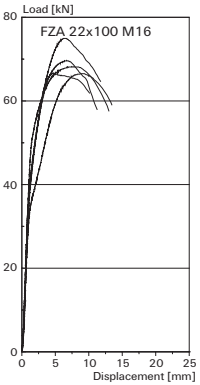
10. Load displacement curves for tension in non-cracked concrete ($f_{ck,cube\,(200)}$ = 30 N/mm²)

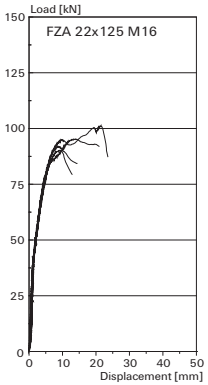












Notes