fischer Zykon through anchor FZA-D

Anchor design according to fischer specification

1. Types

FZA-D – Through anchor (gvz)

FZA-D – Through anchor (A4)

FZA-D – Through 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 12x50 M 8 D			FZA 12x60 M 8 D			FZA 12x80 M 8 D			FZA 14x80 M 10 D			FZA 14x100 M 10 D		FZA 18x100 M 12 D			FZA 18x130 M 12 D			FZA 22x125 M 16 D	
			gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	gvz	A4	C	gvz	A4	C	gvz	A4
non-cracked concrete																								
tension	C 20/25	N_u [kN]	17.1			23.9			23.9			31.4			31.4		48.3			48.3			67.5	
	C 50/60	N_u [kN]	26.4			29.3	25.6		29.3	25.6		46.4	40.6		46.4	40.6	67.4	59.0		67.4	59.0		104.6	
shear	≧ C 20/25	V_u [kN]	23.8	25.4		23.8	25.4		23.8	25.4		33.6	34.5		33.6	34.5	53.1	56.2		53.1	56.2		85.3	85.5
cracked concrete																								
tension	C 20/25	N_u [kN]	12.0			16.7			16.7			22.0			22.0		33.8			33.8			47.2	
	C 50/60	N_u [kN]	18.5			25.9	25.6		25.9	25.6		34.1			34.1		52.3			52.3			73.1	
shear	C 20/25	V_u [kN]	15.5			21.7			21.7			33.6	34.5		33.6	34.5	53.1	56.2		53.1	56.2		85.3	85.5

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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 12x50 M 8 D			FZA 12x60 M 8 D			FZA 12x80 M 8 D			FZA 14x80 M 10 D			FZA 14x100 M 10 D		FZA 18x100 M 12 D			FZA 18x130 M 12 D			FZA 22x125 M 16 D	
			gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	gvz	A4	C	gvz	A4	C	gvz	A4
non-cracked concrete																								
tension	C 20/25	N_{Rk} [kN]	14.0			19.6			19.6			25.8			25.8		39.7			39.7			55.4	
	C 50/60	N_{Rk} [kN]	21.7			29.3	25.6		29.3	25.6		39.9			39.9		61.5	59.0		61.5	59.0		85.9	
shear	C 20/25	V_{Rk} [kN]	18.2	17.8		21.3	17.8		21.3	17.8		29.8	25.4		29.8	25.4	46.3	38.7		46.3	38.7		75.3	64.1
	≧ C 30/37	V_{Rk} [kN]	21.3	17.8		21.3	17.8		21.3	17.8		29.8	25.4		29.8	25.4	33.8	38.7		33.8	38.7		75.3	64.1
cracked concrete																								
tension	C 20/25	N_{Rk} [kN]	9.1			12.7			12.7			16.7			16.7		25.8			25.8			36.0	
	C 50/60	N_{Rk} [kN]	14.1			19.7			19.7			25.9			25.9		39.9			39.9			55.8	
shear	C 20/25	V_{Rk} [kN]	11.8			16.5			16.5			29.8	25.4		29.8	25.4	46.3	38.7		46.3	38.7		72.0	64.1
	C 50/60	V_{Rk} [kN]	18.3	17.8		21.3	17.8		21.3	17.8		29.8	25.4		29.8	25.4	46.3	38.7		46.3	38.7		72.0	64.1

3.2 Design resistance

Anchor type			FZA 12x50 M 8 D			FZA 12x60 M 8 D			FZA 12x80 M 8 D			FZA 14x80 M 10 D			FZA 14x100 M 10 D		FZA 18x100 M 12 D			FZA 18x130 M 12 D			FZA 22x125 M 16 D	
			gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	gvz	A4	C	gvz	A4	C	gvz	A4
non-cracked concrete																								
tension	C 20/25	N_{Rd} [kN]	9.4			13.1			13.1			17.2			17.2		26.4			26.4			37.0	
	C 50/60	N_{Rd} [kN]	14.5	13.7	14.5	19.5	13.7	17.1	19.5	13.7	17.1	26.6	21.7	26.6	26.6	21.7	41.0	31.6	39.3	41.0	31.6	39.3	57.3	
shear	C 20/25	V_{Rd} [kN]	12.2	11.4	12.2	17.0	11.4	14.2	17.0	11.4	14.2	23.8	16.3	20.3	23.8	16.3	37.0	24.8	31.0	37.0	24.8	31.0	60.2	41.1
	C 30/37	V_{Rd} [kN]	17.0	11.4	14.2	17.0	11.4	14.2	17.0	11.4	14.2	23.8	16.3	20.3	23.8	16.3	37.0	24.8	31.0	37.0	24.8	31.0	60.2	41.1
cracked concrete																								
tension	C 20/25	N_{Rd} [kN]	6.1			8.5			8.5			11.2			11.2		17.2			17.2			24.0	
	C 50/60	N_{Rd} [kN]	9.4			13.1			13.1			17.3			17.3		26.6			26.6			37.2	
shear	C 20/25	V_{Rd} [kN]	7.9			11.0			11.0			22.3	16.3	20.3	22.3	16.3	34.3	24.8	31.0	34.3	24.8	31.0	60.2	41.1
	C 50/60	V_{Rd} [kN]	10.2			14.2	11.4	14.2	14.2	11.4	14.2	23.8	16.3	20.3	23.8	16.3	37.0	24.8	31.0	37.0	24.8	31.0	60.2	41.1

3.3 Recommended resistance [1)]

Anchor type			FZA 12x50 M 8 D			FZA 12x60 M 8 D			FZA 12x80 M 8 D			FZA 14x80 M 10 D			FZA 14x100 M 10 D		FZA 18x100 M 12 D			FZA 18x130 M 12 D			FZA 22x125 M 16 D	
			gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	gvz	A4	C	gvz	A4	C	gvz	A4
non-cracked concrete																								
tension	C 20/25	N_R [kN]	6.7			9.3			9.3			12.3			12.3		18.9			18.9			26.4	
	C 50/60	N_R [kN]	10.3	9.8	10.3	14.0	9.8	12.2	14.0	9.8	12.2	19.0	15.5	19.0	19.0	15.5	29.3	22.5	28.1	29.3	22.5	28.1	40.9	
shear	C 20/25	V_R [kN]	8.7	8.2	8.7	12.1	8.2	10.2	12.1	8.2	10.2	17.0	11.6	14.5	17.0	11.6	26.5	17.7	22.1	26.5	17.7	22.1	43.0	29.3
	C 30/37	V_R [kN]	12.2	8.2	10.2	12.2	8.2	10.2	12.2	8.2	10.2	17.0	11.6	14.5	17.0	11.6	26.5	17.7	22.1	26.5	17.7	22.1	43.0	29.3
cracked concrete																								
tension	C 20/25	N_R [kN]	4.3			6.1			6.1			8.0			8.0		12.3			12.3			17.1	
	C 50/60	N_R [kN]	6.7			9.4			9.4			12.3			12.3		19.0			19.0			26.6	
shear	C 20/25	V_R [kN]	5.6			7.9			7.9			15.9	11.6	14.5	15.9	11.6	24.5	17.7	22.1	24.5	17.7	22.1	34.3	29.3
	≧ C 50/60	V_R [kN]	10.2	8.2	10.2	10.2	8.2	10.2	10.2	8.2	10.2	17.0	11.6	14.5	17.0	11.6	26.5	17.7	22.1	26.5	17.7	22.1	43.0	29.3

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

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

Concrete splitting failure: *Failure mode is not decisive*

4.1 Steel failure of the highest loaded anchor

Design resistance of single anchor

Anchor type		FZA 12x50 M 8 D			FZA 12x60 M 8 D			FZA 12x80 M 8 D			FZA 14x80 M 10 D			FZA 14x100 M 10 D		FZA 18x100 M 12 D			FZA 18x130 M 12 D			FZA 22x125 M 16 D	
		gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	gvz	A4	C	gvz	A4	C	gvz	A4
design resistance	$N_{Rd,s}$ [kN]	19.5	13.7	17.1	19.5	13.7	17.1	19.5	13.7	17.1	30.9	21.7	27.1	30.9	21.7	44.9	31.6	39.3	44.9	31.6	39.3	84.0	58.8

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

Concrete splitting failure: *Failure mode is not decisive*

Design resistance of single anchor

Anchor type		FZA 12x50 M 8 D	FZA 12x60 M 8 D	FZA 12x80 M 8 D	FZA 14x80 M 10 D	FZA 14x100 M 10 D	FZA 18x100 M 12 D	FZA 18x130 M 12 D	FZA 22x125 M 16 D
eff. anchorage depth	h_{ef} [mm]	40	50	50	60	60	80	80	100
non-cracked concrete									
design resistance	$N^0_{Rd,c}$ [kN]	9.4	13.1	13.1	17.2	17.2	26.4	26.4	37.0
cracked concrete									
design resistance	$N^0_{Rd,c}$ [kN]	6.1	8.5	8.5	11.2	11.2	17.2	17.2	24.0

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		FZA 12x50 M 8 D	FZA 12x60 M 8 D	FZA 12x80 M 8 D	FZA 14x80 M 10 D	FZA 14x100 M 10 D	FZA 18x100 M 12 D	FZA 18x130 M 12 D	FZA 22x125 M 16 D
h_{ef}		40	50	50	60	60	80	80	100
$s_{cr,N}$	[mm]	120	150	150	180	180	240	240	300
$c_{cr,N}$	[mm]	60	75	75	90	90	120	120	150

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 12x50 M 8 D			FZA 12x60 M 8 D			FZA 12x80 M 8 D			FZA 14x80 M 10 D			FZA 14x100 M 10 D		FZA 18x100 M 12 D			FZA 18x130 M 12 D			FZA 22x125 M 16 D	
		gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	gvz	A4	C	gvz	A4	C	gvz	A4
design resistance	$V_{Rd,s}$ [kN]	17.0	11.4	14.2	17.0	11.4	14.2	17.0	11.4	14.2	23.8	16.3	20.3	23.8	16.3	37.0	24.8	31.0	37.0	24.8	31.0	60.2	41.1

5.2 Pryout failure for the most unfavourable anchor

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

k-factor

Anchor type	FZA 12x50 M 8 D	FZA 12x60 M 8 D	FZA 12x80 M 8 D	FZA 14x80 M 10 D	FZA 14x100 M 10 D	FZA 18x100 M 12 D	FZA 18x130 M 12 D	FZA 22x125 M 16 D
k	1.3	1.3	1.3	2.0	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 12x50 M 8 D		FZA 12x60 M 8 D		FZA 12x80 M 8 D		FZA 14x80 M 10 D		FZA 14x100 M 10 D		FZA 18x100 M 12 D		FZA 18x130 M 12 D		FZA 22x125 M 16 D	
	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete	non-cracked concrete	cracked concrete
40	3.6	2.6														
45	4.2	3.0	4.4	3.1	4.7	3.3										
50	4.9	3.4	5.1	3.6	5.4	3.8										
55	5.5	3.9	5.7	4.1	6.1	4.3	6.3	4.4	6.6	4.7						
60	6.2	4.4	6.4	4.5	6.8	4.8	7.0	5.0	7.4	5.2						
65	6.9	4.9	7.1	5.0	7.5	5.3	7.8	5.5	8.2	5.8						
70	7.6	5.4	7.9	5.6	8.3	5.9	8.5	6.0	9.0	6.4	9.4	6.7	10.1	7.1		
75	8.3	5.9	8.6	6.1	9.1	6.4	9.3	6.6	9.8	6.9	10.3	7.3	11.0	7.8		
80	9.1	6.4	9.4	6.7	9.9	7.0	10.2	7.2	10.6	7.5	11.1	7.9	11.9	8.4		
85	9.9	7.0	10.2	7.2	10.7	7.6	11.0	7.8	11.5	8.2	12.0	8.5	12.8	9.1		
90	10.7	7.6	11.0	7.8	11.6	8.2	11.8	8.4	12.4	8.8	12.9	9.2	13.8	9.7		
95	11.5	8.1	11.8	8.4	12.4	8.8	12.7	9.0	13.3	9.4	13.9	9.8	14.7	10.4		
100	12.3	8.7	12.7	9.0	13.3	9.4	13.6	9.6	14.2	10.1	14.8	10.5	15.7	11.1	16.1	11.4
120	15.8	11.2	16.2	11.5	17.0	12.0	17.3	12.3	18.1	12.8	18.8	13.3	19.8	14.0	20.3	14.4
125	16.7	11.8	17.2	12.2	17.9	12.7	18.3	13.0	19.1	13.5	19.8	14.0	20.9	14.8	21.4	15.2
130	17.6	12.5	18.1	12.8	18.9	13.4	19.3	13.7	20.1	14.2	20.8	14.8	22.0	15.6	22.5	16.0
135	18.6	13.2	19.1	13.5	19.9	14.1	20.3	14.4	21.1	14.9	21.9	15.5	23.1	16.3	23.6	16.7
140	19.5	13.8	20.0	14.2	20.9	14.8	21.3	15.1	22.1	15.7	23.0	16.3	24.2	17.1	24.8	17.5
160	23.5	16.6	24.1	17.0	25.1	17.7	25.5	18.1	26.5	18.7	27.4	19.4	28.8	20.4	29.4	20.9
180	27.7	19.6	28.3	20.0	29.4	20.8	30.0	21.2	31.0	22.0	32.0	22.7	33.6	23.8	34.3	24.3
200	32.0	22.7	32.7	23.2	34.0	24.1	34.6	24.5	35.7	25.3	36.9	26.1	38.6	27.3	39.4	27.9
250	43.7	31.0	44.6	31.6	46.2	32.7	47.0	33.3	48.4	34.3	49.8	35.3	51.9	36.8	53.0	37.5
300	56.5	40.0	57.6	40.8	59.5	42.1	60.4	42.8	62.1	44.0	63.9	45.2	66.3	47.0	67.6	47.9
350	70.2	49.7	71.5	50.7	73.7	52.2	74.8	53.0	76.8	54.4	78.8	55.8	81.7	57.9	83.2	58.9
400	84.8	60.1	86.3	61.2	88.9	63.0	90.1	63.8	92.4	65.5	94.7	67.1	98.0	69.5	99.7	70.6
450	100.3	71.0	102.0	72.2	104.9	74.3	106.2	75.3	108.9	77.1	111.5	79.0	115.2	81.6	117.0	82.9
500	116.5	82.5	118.4	83.8	121.6	86.1	123.2	87.2	126.1	89.3	129.0	91.4	133.1	94.3	135.2	95.8
550	133.4	94.5	135.5	96.0	139.1	98.5	140.8	99.8	144.0	102.0	147.3	104.3	151.8	107.5	154.1	109.1
600	151.1	107.0	153.4	108.6	157.3	111.4	159.2	112.8	162.7	115.3	166.2	117.8	171.2	121.3	173.7	123.0
650	169.4	120.0	171.9	121.8	176.2	124.8	178.2	126.3	182.1	129.0	185.9	131.7	191.3	135.5	194.0	137.4
700	188.3	133.4	191.1	135.3	195.7	138.6	197.9	140.2	202.1	143.1	206.2	146.1	212.1	150.2	215.0	152.3
750	207.9	147.3	210.8	149.4	215.9	152.9	218.2	154.6	222.7	157.8	227.2	160.9	233.5	165.4	236.6	167.6
800							239.2	169.4	243.9	172.8	248.7	176.2	255.4	180.9	258.8	183.3
850							260.7	184.6	265.8	188.3	270.9	191.9	278.0	196.9	281.6	199.5
900											293.6	208.0	301.2	213.3	305.0	216.0
950											316.9	224.4	324.9	230.1	328.9	233.0
1000											340.7	241.3	349.1	247.3	353.4	250.3
1100											389.8	276.1	399.2	282.8	403.9	286.1
1200															456.5	323.3
1300															510.9	361.9
1400															567.2	401.8

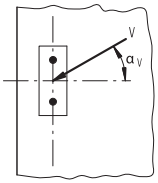
5.3.1 Influence of concrete strength for shear

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

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 through anchor FZA-D

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* $V_{Rd,s}$; $V_{Rd,cp}$; $V_{Rd,c}$

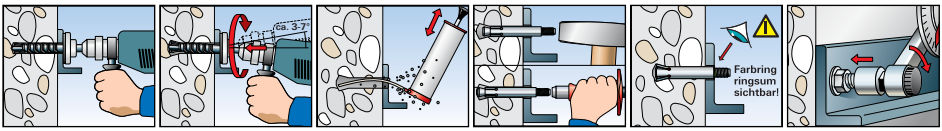
6.3 **Combined tension and shear load:**

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

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

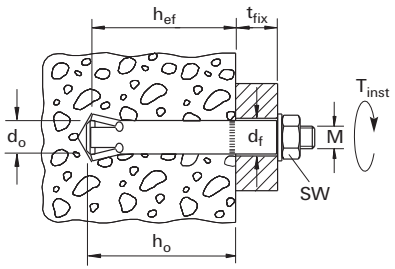
N_{Rd} ; V_{Rd} = tension/shear design resistance including safety factors of the most unfavourable single anchor

7. Installation details



8. Anchor installation data

Anchor type			FZA 12x50 M 8 D	FZA 12x60 M 8 D	FZA 12x80 M 8 D	FZA 14x80 M 10 D	FZA 14x100 M 10 D	FZA 18x100 M 12 D	FZA 18x130 M 12 D	FZA 22x125 M 16 D
diameter of thread			M 8	M 8	M 8	M 10	M 10	M 12	M 12	M 16
nominal drill hole diameter	d_0	[mm]	12	12	12	14	14	18	18	22
drill depth	h_0	[mm]	43	53	53	63	63	83	83	105
effective anchorage depth	h_{ef}	[mm]	40	50	50	60	60	80	80	100
clearance-hole in fixture to be attached	d_f	[mm]	≦ 14	≦ 14	≦ 14	≦ 16	≦ 16	≦ 20	≦ 20	≦ 24
wrench size	SW	[mm]	13	13	13	17	17	19	19	24
required torque	T_{inst}	[Nm]	20	20	20	40	40	60	60	100
minimum thickness of concrete member	h_{min}	[mm]	100	110	110	130	130	160	160	200
minimum spacing	s_{min}	[mm]	40	50	50	60	60	80	80	100
minimum edge distances	c_{min}	[mm]	35	45	45	55	55	70	70	100



fischer Zykon through anchor FZA-D

Anchor design according to fischer specification

9. Mechanical characteristics

Anchor type			FZA 12x50 M 8 D			FZA 12x60 M 8 D			FZA 12x80 M 8 D			FZA 14x80 M 10 D		
			gvz	A4	C	gvz	A4	C	gvz	A4	C	gvz	A4	C
stressed cross sectional area cone bolt	A_s	[mm²]	36.6			36.6			36.6			58.0		
resisting moment cone bolt	W	[mm³]	31.2			31.2			31.2			62.3		
design value of bending moment	$M^0_{Rd,s}$		24.0	16.8	21.0	24.0	16.8	21.0	24.0	16.8	21.0	47.8	33.5	41.8
yield strength cone bolt	f_{yk}	[N/mm²]	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	

Anchor type			FZA 14x100 M 10 D			FZA 18x100 M 12 D			FZA 18x130 M 12 D			FZA 22x125 M 16 D		
			gvz	A4		gvz	A4	C	gvz	A4	C	gvz	A4	
stressed cross sectional area cone bolt	A_s	[mm²]	58.0			84.3			84.3			157		
resisting moment cone bolt	W	[mm³]	62.3			109			109			278		
design value of bending moment	$M^0_{Rd,s}$		47.8	33.5	41.8	84.0	58.7	73.3	84.0	58.7	73.3	212.8	148.7	185.6
yield strength cone bolt	f_{yk}	[N/mm²]	640	450		640	450	560	640	450	560	640	450	
tensile strength cone bolt	f_{uk}	[N/mm²]	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)