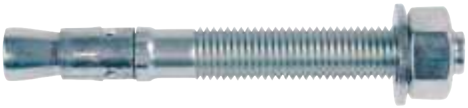
fischer Bolt FBN II

Anchor design according to fischer specification

1. Types



FBN II (gvz)

FBN II (fvz)

FBN II (A4)

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FBN II GS (gvz) with large washer

(outside diameter approx. 3.5 x d)

ETA
CE
ETA-07/0211
ETAG 001-2
Option 7 for non-cracked concrete
*)

Fire resistance classification
R 120
Anchor types see test report

CALCULATION WITH CC COMPUFIX CALCULATION SOFTWARE

Features and Advantages

- European Technical Approval option 7*) for non-cracked concrete.
- Fire resistance classification according test report independently proved gives safety in case of fire.
- Independent controlled and confirmed product characteristics due to the European Technical Approval.
- Head imprint to identify the anchor type and length.
- Long thread for stand-off installations. In combination with the variable anchorage depth the FBN II permits a maximum of flexibility.
- The reduced embedment depths minimise the risk of rebar hits.
- The version with large washer is specially adapted for wood constructions and for slotted holes in the anchor plate.
- Drill diameter and thread diameter are the same for economic push-through installation.
- With the permitted small spacing and edge distances small, cost-efficient anchor plates and fixings near to an edge can be realised.

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

Materials

Anchor bolt:
- Zinc plated steel
- Hot-dip galvanised
- 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 Bolt FBN II

Anchor design according to fischer specification

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

Mean values

Anchor type		FBN II M6		FBN II M8			FBN II M8			FBN II M10			FBN II M10			FBN II M12		
		gvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
h_{ef}		30	30	30	30	30	40	40	40	40	40	40	50	50	50	50	50	50
non-cracked concrete																		
Tension	C 20/25 N_u [kN]	8.7	9.0	10.0	10.0	10.0	15.0	15.0	15.0	16.0	16.0	16.0	21.0	21.0	21.0	22.0	22.0	22.0
	C 50/60 N_u [kN]	8.7	11.1	15.5	15.5	15.5	17.3	17.3	17.3	24.8	24.8	24.8	28.6	28.6	28.6	34.1	34.1	34.1
Shear	≧ C 20/25 V_u [kN]	6.3	5.6	14.0	14.0	13.4	14.0	14.0	13.4	22.1	22.1	21.3	22.1	22.1	21.3	32.9	32.9	28.8

Anchor type		FBN II M12			FBN II M16			FBN II M16			FBN II M20			FBN II M20		
		gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
h_{ef}		65	65	65	65	65	65	80	80	80	80	80	80	105	105	105
non-cracked concrete																
Tension	C 20/25 N_u [kN]	31.0	31.0	31.0	35.4	35.4	35.4	46.0	46.0	46.0	48.3	48.3	48.3	72.6	72.6	72.6
	C 50/60 N_u [kN]	43.7	43.7	43.7	54.8	54.8	54.8	71.3	71.3	71.3	74.8	74.8	74.8	112.4	112.4	112.5
Shear	≧ C 20/25 V_u [kN]	32.9	32.9	28.8	57.9	57.9	53.6	57.9	57.9	53.6	70.4	70.4	90.3	70.4	70.4	90.3

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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		FBN II M6		FBN II M8			FBN II M8			FBN II M10			FBN II M10			FBN II M12		
		gvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
h_{ef}		30	30	30	30	30	40	40	40	40	40	40	50	50	50	50	50	50
non-cracked concrete																		
Tension	C 20/25 N_{Rk} [kN]	6.0	6.0	6.0	6.0	6.0	12.8	12.0	12.8	12.8	12.8	12.8	17.9	16.0	17.9	17.9	17.9	17.9
	C 50/60 N_{Rk} [kN]	8.3	9.3	9.3	9.3	9.3	16.5	16.5	16.5	19.8	19.8	19.8	27.2	24.8	27.2	27.7	27.7	27.7
Shear	≧ C 20/25 V_{Rk} [kN]	6.0	5.3	13.3	13.3	12.8	13.3	13.3	12.8	21.0	21.0	20.3	21.0	21.0	20.3	31.3	31.3	27.4

Anchor type		FBN II M12			FBN II M16			FBN II M16			FBN II M20			FBN II M20		
		gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
h_{ef}		65	65	65	65	65	65	80	80	80	80	80	80	105	105	105
non-cracked concrete																
Tension	C 20/25 N_{Rk} [kN]	26.5	25.0	26.5	26.5	26.5	26.5	36.1	36.1	36.1	36.1	36.1	36.1	54.3	54.3	54.3
	C 50/60 N_{Rk} [kN]	41.0	38.8	41.0	41.0	41.0	41.0	56.0	56.0	56.0	56.0	56.0	56.0	84.2	84.2	84.2
Shear	≧ C 20/25 V_{Rk} [kN]	31.3	31.3	27.4	55.1	55.1	51.0	55.1	55.1	51.0	67.0	67.0	83.1	67.0	67.0	86.0

3.2 Design resistance

Anchor type		FBN II M6		FBN II M8			FBN II M8			FBN II M10			FBN II M10			FBN II M12		
		gvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
h_{ef}		30	30	30	30	30	40	40	40	40	40	40	50	50	50	50	50	50
non-cracked concrete																		
Tension	C 20/25 N_{Rd} [kN]	4.0	4.0	4.0	4.0	4.0	8.5	8.0	8.5	8.5	8.5	8.5	11.9	10.7	11.9	11.9	11.9	11.9
	C 50/60 N_{Rd} [kN]	5.5	6.2	6.2	6.2	6.2	11.8	11.8	11.8	13.2	13.2	13.2	18.4	16.5	18.4	18.4	18.4	18.4
Shear	≧ C 20/25 V_{Rd} [kN]	4.8	4.2	10.0	10.0	10.0	10.6	10.6	10.2	16.8	16.8	16.2	16.8	16.8	16.2	25.0	25.0	21.9

Anchor type		FBN II M12			FBN II M16			FBN II M16			FBN II M20			FBN II M20		
		gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
h_{ef}		65	65	65	65	65	65	80	80	80	80	80	80	105	105	105
non-cracked concrete																
Tension	C 20/25 N_{Rd} [kN]	17.6	16.7	17.6	17.6	17.6	17.6	24.1	24.1	24.1	24.1	24.1	24.1	36.2	36.2	36.2
	C 50/60 N_{Rd} [kN]	27.3	25.8	27.3	27.3	27.3	27.3	37.3	37.3	37.3	37.3	37.3	37.3	56.1	56.1	56.1
Shear	≧ C 20/25 V_{Rd} [kN]	25.0	25.0	21.9	40.6	40.6	40.6	44.1	44.1	40.8	53.6	53.6	55.4	53.6	53.6	68.8

fischer Bolt FBN II

Anchor design according to fischer specification

3.3 Recommended resistance [1)]

Anchor type		FBN II M6		FBN II M8			FBN II M8			FBN II M10			FBN II M10			FBN II M12		
		gvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
h_{ef}		30	30	30	30	30	40	40	40	40	40	40	50	50	50	50	50	50
non-cracked concrete																		
Tension	C 20/25 N_R [kN]	2.9	2.9	2.9	2.9	2.9	6.1	5.7	6.1	6.1	6.1	6.1	8.5	7.6	8.5	8.5	8.5	8.5
	C 50/60 N_R [kN]	4.0	4.4	4.4	4.4	4.4	8.4	8.4	8.4	9.4	9.4	9.4	13.2	11.8	13.2	13.2	13.2	13.2
Shear	≧ C 20/25 V_R [kN]	3.4	3.0	7.1	7.1	7.1	7.6	7.6	7.3	12.0	12.0	11.6	12.0	12.0	11.6	17.9	17.9	15.7

Anchor type		FBN II M12			FBN II M16			FBN II M16			FBN II M20			FBN II M20		
		gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
h_{ef}		65	65	65	65	65	65	80	80	80	80	80	80	105	105	105
non-cracked concrete																
Tension	C 20/25 N_R [kN]	12.6	11.9	12.6	12.6	12.6	12.6	17.2	17.2	17.2	17.2	17.2	17.2	25.9	25.9	25.9
	C 50/60 N_R [kN]	19.5	18.5	19.5	19.5	19.5	19.5	26.7	26.7	26.7	26.7	26.7	26.7	40.1	40.1	40.1
Shear	≧ C 20/25 V_R [kN]	17.9	17.9	15.7	29.0	29.0	29.0	31.5	31.5	29.1	38.3	38.3	39.6	38.3	38.3	49.1

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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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	FBN II M6		FBN II M8			FBN II M10			FBN II M12			FBN II M16			FBN II M20		
	gvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
Design resistance $N_{Rd,s}$ [kN]	5.5	7.1	11.8	11.8	11.8	19.4	19.4	19.4	29.7	29.7	29.7	51.9	51.9	55.7	71.3	71.3	74.0

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	FBN II M6		FBN II M8			FBN II M8			FBN II M10			FBN II M10			FBN II M12		
	gvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
h_{ef}	30		30			40			40			50			50		
non-cracked concrete																	
Design resistance $N^0_{Rd,p}$ [kN]	4.0		4.0			8.5	8.0	8.5	8.5			11.9	10.7	11.9	11.9		

Anchor type	FBN II M12			FBN II M16			FBN II M16			FBN II M20			FBN II M20		
	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
h_{ef}	65			65			80			80			105		
non-cracked concrete															
Design resistance $N^0_{Rd,p}$ [kN]	17.6	16.7	17.6	17.6			24.1			24.1			36.2		

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	FBN II M6	FBN II M8	FBN II M8	FBN II M10	FBN II M10	FBN II M12
h_{ef}	30	30	40	40	50	50
non-cracked concrete						
Design resistance $N^0_{Rd,c}$ [kN]	5.5	5.5	8.5	8.5	11.9	11.9

Anchor type	FBN II M12	FBN II M16	FBN II M16	FBN II M20	FBN II M20
h_{ef}	65	65	80	80	105
non-cracked concrete					
Design resistance $N^0_{Rd,c}$ [kN]	17.6	17.6	24.1	24.1	36.2

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	FBN II M6	FBN II M8	FBN II M8	FBN II M10	FBN II M10	FBN II M12
h_{ef}	30	30	40	40	50	50
$s_{cr,N}$ [mm]	90	90	120	120	150	150
$c_{cr,N}$ [mm]	45	45	60	60	75	75

Anchor type	FBN II M12	FBN II M16	FBN II M16	FBN II M20	FBN II M20
h_{ef}	65	65	80	80	105
$s_{cr,N}$ [mm]	195	195	240	240	315
$c_{cr,N}$ [mm]	98	98	120	120	158

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

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4.3.3 Concrete splitting failure

Characteristic edge distance and spacing for design

Anchor type		**FBN II M6**	**FBN II M8**	**FBN II M8**	**FBN II M10**	**FBN II M10**	**FBN II M12**
h_{ef}		**30**	**30**	**40**	**40**	**50**	**50**
$s_{cr,sp}$	[mm]	130	190	190	200	200	290
$c_{cr,sp}$	[mm]	65	95	95	100	100	145
h_{min}	[mm]	100	100	100	100	100	100

Anchor type		**FBN II M12**	**FBN II M16**	**FBN II M16**	**FBN II M20**	**FBN II M20**
h_{ef}		**65**	**65**	**80**	**80**	**105**
$s_{cr,sp}$	[mm]	290	350	350	370	370
$c_{cr,sp}$	[mm]	145	175	175	185	185
h_{min}	[mm]	120	120	160	160	200

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

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

$c/c_{cr,sp}$	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			FBN II M6		FBN II M8			FBN II M10			FBN II M12			FBN II M16			FBN II M20		
			gvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4	gvz	fvz	A4
h_{ef}																			
Design resistance	$V_{Rd,s}$	[kN]	4.8	4.2	10.6	10.6	10.2	16.8	16.8	16.2	25.0	25.0	21.9	44.1	44.1	40.8	53.6	53.6	68.8

5.2 Pryout failure of the most unfavourable anchor

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

k-factor

Anchor type	FBN II M6	FBN II M8	FBN II M10	FBN II M12	FBN II M16	FBN II M20
k	1.4	1.8	2.1	2.3	2.3	2.3

fischer Bolt FBN II

Anchor design according to fischer specification

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	$V^{0}_{Rd,c}$ [kN]														
	FBN II M6	FBN II M8				FBN II M10			FBN II M12		FBN II M16			FBN II M20	
	gvz fvz A4	gvz fvz	A4	gvz fvz	A4	gvz fvz A4	gvz fvz	A4	gvz fvz A4	gvz fvz A4	gvz fvz A4	gvz fvz	A4	gvz fvz A4	gvz fvz A4
h_{ef}	30	30	30	40	40	40	50	50	50	65	65	80	80	80	105
edge distance [mm]	non-cracked concrete														
40	3.0	3.1		3.3											
45	3.5	3.6	3.6	3.8	3.8										
50	4.1	4.2	4.2	4.4	4.4		4.7								
55	4.6	4.8	4.8	5.0	5.0		5.4	5.4							
60	5.2	5.4	5.4	5.6	5.6		6.0	6.0							
65	5.8	6.0	6.0	6.3	6.3		6.7	6.7							
70	6.5	6.7	6.7	7.0	7.0		7.4	7.4		8.0					
75	7.1	7.4	7.4	7.7	7.7		8.1	8.1		8.7					
80	7.8	8.1	8.1	8.4	8.4	8.6	8.9	8.9		9.5			10.4		
85	8.5	8.8	8.8	9.1	9.1	9.3	9.7	9.7		10.3			11.2		
90	9.2	9.5	9.5	9.8	9.8	10.1	10.4	10.4		11.2		12.1	12.1		
95	10.0	10.2	10.2	10.6	10.6	10.9	11.2	11.2		12.0		13.0	13.0		
100	10.7	11.0	11.0	11.4	11.4	11.7	12.1	12.1	12.3	12.8		13.9	13.9		
110	12.3	12.6	12.6	13.0	13.0	13.3	13.7	13.7	14.0	14.6		15.8	15.8		
120	13.9	14.2	14.2	14.7	14.7	15.0	15.5	15.5	15.8	16.4	17.0	17.7	17.7	18.2	19.3
130	15.5	15.9	15.9	16.4	16.4	16.8	17.3	17.3	17.6	18.3	19.0	19.7	19.7	20.3	21.4
140	17.3	17.7	17.7	18.2	18.2	18.6	19.2	19.2	19.5	20.3	21.0	21.7	21.7	22.4	23.5
150	19.0	19.5	19.5	20.1	20.1	20.5	21.1	21.1	21.5	22.3	23.0	23.8	23.8	24.5	25.8
160	20.9	21.4	21.4	22.0	22.0	22.5	23.1	23.1	23.5	24.3	25.1	26.0	26.0	26.7	28.1
180	24.7	25.2	25.2	26.0	26.0	26.5	27.2	27.2	27.7	28.6	29.5	30.4	30.4	31.3	32.8
200	28.7	29.3	29.3	30.1	30.1	30.7	31.5	31.5	32.0	33.1	34.1	35.1	35.1	36.1	37.7
250	39.5	40.3	40.3	41.4	41.4	42.1	43.0	43.0	43.7	45.1	46.3	47.6	47.6	48.8	50.8
300	51.4	52.3	52.3	53.6	53.6	54.5	55.7	55.7	56.5	58.1	59.7	61.2	61.2	62.6	65.1
350	64.2	65.3	65.3	66.8	66.8	67.9	69.3	69.3	70.2	72.1	73.9	75.8	75.8	77.4	80.3
400	77.9	79.2	79.2	80.9	80.9	82.1	83.7	83.7	84.8	87.0	89.1	91.2	91.2	93.1	96.4
450		93.8	93.8	95.8	95.8	97.2	99.0	99.0	100.3	102.7	105.1	107.5	107.5	109.6	113.3
500		109.2	109.2	111.5	111.5	113.0	115.0	115.0	116.5	119.2	121.9	124.5	124.5	126.9	131.0
550						129.6	131.8	131.8	133.4	136.5	139.4	142.4	142.4	145.0	149.5
600						146.8	149.3	149.3	151.1	154.4	157.7	160.9	160.9	163.8	168.7
650						164.7	167.5	167.5	169.4	173.1	176.6	180.1	180.1	183.2	188.6
700									188.3	192.3	196.1	199.9	199.9	203.3	209.1
750									207.9	212.2	216.3	220.4	220.4	224.1	230.3
800											237.1	241.5	241.5	245.4	252.1
850											258.5	263.1	263.1	267.3	274.4
900											280.4	285.3	285.3	289.8	297.4
950											302.9	308.1	308.1	312.9	320.9
1000											325.9	331.4	331.4	336.4	344.9
1100														385.2	394.5
1200														435.9	446.1

Anchor design according to fischer specification

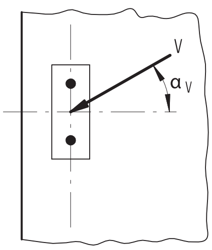
5.3.1 Influence of concrete strength for shear

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

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

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



	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