fischer Injection mortar FIS EM with rebars

Anchor design according to fischer specification

1. Types

Reinforcement bars Ø 8 - Ø 40 mm

Injection mortar FIS EM 390 S, FIS EM 585 S FIS EM 1100 S

ETA CE *)
European Technical Approval – Option 1 for cracked concrete

ICC ES *)
See ICC-ES Evaluation Report at www.ic-es.org
ESR-1990
Inspection agency: AA-707

CALCULATION WITH CC COMPUFIX CALCULATION SOFTWARE

Features and Advantages

- European Technical Approval option 1 *) for cracked and non-cracked concrete.
- ICC-ES Evaluation Report *) for non-cracked concrete, seismic categories A+B.
- Expansion stress free anchoring guarantees for a save use with small spacing and edge distances.
- Less cleaning procedures of the drill hole due to the high-quality epoxy resin.
- The resin seals the drill hole and avoids penetration of dampness and therefore gives corrosion protection for the embedded steel.
- Variable embedment depth enables the application in all kinds of building structure.
- Suitable for underwater installations. (See reduction factor; Section 4.2).
- Suitable for diamond drilled holes guarantees highest flexibility on site. (See reduction factor; Section 4.2).
- Longer curing time for simple installation.
- Low shrinkage of the mortar.
- Approved for temperatures from –40 °C to +72 °C.

*) The conditions of use in the European Technical Approval or the ICC-ES Evaluation Report may vary from those of the Technical Handbook.

Materials

Reinforcing steel : Approved with f_{yk} = 400 - 600 N/mm².
Static values in the Technical Handbook based on f_{yk} = 500 N/mm²

Injection mortar: Epoxy resin, cement and hardener

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2. Ultimate resistances of single anchors with large spacing and large edge distance [1)]

Mean values

Anchor type			FIS EM ⌀ 8	FIS EM ⌀ 10	FIS EM ⌀ 12	FIS EM ⌀ 14	FIS EM ⌀ 16	FIS EM ⌀ 18	FIS EM ⌀ 20	FIS EM ⌀ 22	FIS EM ⌀ 24
h_{ef}		[mm]	80	90	110	120	125	140	170	190	210
non-cracked concrete											
temperature range (+60°C / +35°C) [2)]											
tension	C 20/25	N_u [kN]	29.4	46.2	66.2	88.7	94.3	111.8	149.6	176.8	205.4
shear	≧ C 20/25	V_u [kN]	17.3	27.4	39.2	53.4	69.6	88.0	108.8	131.7	156.6
cracked concrete											
temperature range (+60°C / +35°C) [2)]											
tension	C 20/25	N_u [kN]	18.5	26.0	38.2	48.6	57.9	72.9	98.4	120.2	139.7
shear	≧ C 20/25	V_u [kN]	17.3	27.4	39.2	53.4	69.6	88.0	108.8	131.7	156.6

Anchor type			FIS EM ⌀ 25	FIS EM ⌀ 26	FIS EM ⌀ 28	FIS EM ⌀ 30	FIS EM ⌀ 32	FIS EM ⌀ 34	FIS EM ⌀ 36	FIS EM ⌀ 40
h_{ef}		[mm]	250	250	250	280	300	300	350	400
non-cracked concrete										
temperature range (+60°C / +35°C) [2)]										
tension	C 20/25	N_u [kN]	266.8	266.8	266.8	316.3	350.7	350.7	442.0	540.0
shear	≧ C 20/25	V_u [kN]	170.1	184.0	213.4	245.0	278.6	314.6	352.7	435.6
cracked concrete										
temperature range (+60°C / +35°C) [2)]										
tension	C 20/25	N_u [kN]	180.8	181.4	181.4	215.1	198.4	210.8	260.4	330.7
shear	≧ C 20/25	V_u [kN]	170.1	184.0	213.4	245.0	278.6	314.6	352.7	435.6

[1)] The loads apply to reinforcing steel with f_{yk} = 500 N/mm² and careful drill hole cleaning, carried out with a brush and blow-out tool and temperatures in the substrate in the area of the mortar with short term temperature T ≦ + 60 °C and long term temperature T ≦ 35 °C (see also "Installation details, section 7").

[2)] (short term temperature / long term temperature)

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

3.1 Characteristic resistance[1)]

Anchor type			FIS EM ⌀ 8	FIS EM ⌀ 10	FIS EM ⌀ 12	FIS EM ⌀ 14	FIS EM ⌀ 16	FIS EM ⌀ 18	FIS EM ⌀ 20	FIS EM ⌀ 22	FIS EM ⌀ 24
h_{ef}		[mm]	80	90	110	120	125	140	170	190	210
non-cracked concrete											
temperature range (+60°C / +35°C) [2)]											
tension	C 20/25	N_{Rk} [kN]	28.0	42.4	58.3	66.4	70.6	83.7	111.9	132.3	153.7
shear	≧ C 20/25	V_{Rk} [kN]	13.8	21.6	31.1	42.4	55.3	70.0	87.0	105.0	125.0
cracked concrete											
temperature range (+60°C / +35°C) [2)]											
tension	C 20/25	N_{Rk} [kN]	14.1	19.8	29.0	36.9	44.0	55.4	74.8	91.9	110.8
shear	≧ C 20/25	V_{Rk} [kN]	13.8	21.6	31.1	42.4	55.3	70.0	87.0	105.0	125.0

Anchor type			FIS EM ⌀ 25	FIS EM ⌀ 26	FIS EM ⌀ 28	FIS EM ⌀ 30	FIS EM ⌀ 32	FIS EM ⌀ 34	FIS EM ⌀ 36	FIS EM ⌀ 40
h_{ef}		[mm]	250	250	250	280	300	300	350	400
non-cracked concrete										
temperature range (+60°C / +35°C) [2)]										
tension	C 20/25	N_{Rk} [kN]	199.6	199.6	199.6	236.6	262.4	262.4	330.7	404.0
shear	≧ C 20/25	V_{Rk} [kN]	135.0	146.0	170.0	195.0	221.0	250.0	280.0	346.0
cracked concrete										
temperature range (+60°C / +35°C) [2)]										
tension	C 20/25	N_{Rk} [kN]	137.4	142.9	153.9	184.7	150.8	160.2	197.9	251.3
shear	≧ C 20/25	V_{Rk} [kN]	135.0	146.0	170.0	195.0	221.0	250.0	280.0	346.0

[1)] The loads apply to reinforcing steel with f_{yk} = 500 N/mm² and careful drill hole cleaning, carried out with a brush and blow-out tool and temperatures in the substrate in the area of the mortar with short term temperature T ≦ + 60 °C and long term temperature T ≦ 35 °C (see also "Installation details, section 7").

[2)] (short term temperature / long term temperature)

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3.2 Design resistance[1)]

Anchor type			FIS EM ⌀ 8	FIS EM ⌀ 10	FIS EM ⌀ 12	FIS EM ⌀ 14	FIS EM ⌀ 16	FIS EM ⌀ 18	FIS EM ⌀ 20	FIS EM ⌀ 22	FIS EM ⌀ 24
h_{ef}		[mm]	80	90	110	120	125	140	170	190	210
non-cracked concrete											
temperature range (+60°C / +35°C) [2)]											
tension	C 20/25	N_{Rd} [kN]	20.0	28.3	38.8	44.3	47.1	55.8	74.6	88.2	102.5
shear	≧ C 20/25	V_{Rd} [kN]	9.2	14.4	20.7	28.3	36.9	46.7	58.0	70.0	83.3
cracked concrete											
temperature range (+60°C / +35°C) [2)]											
tension	C 20/25	N_{Rd} [kN]	9.4	13.2	19.4	24.6	24.4	30.8	41.5	51.1	61.6
shear	≧ C 20/25	V_{Rd} [kN]	9.2	14.4	20.7	28.3	36.9	46.7	58.0	70.0	83.3

Anchor type			FIS EM ⌀ 25	FIS EM ⌀ 26	FIS EM ⌀ 28	FIS EM ⌀ 30	FIS EM ⌀ 32	FIS EM ⌀ 34	FIS EM ⌀ 36	FIS EM ⌀ 40
h_{ef}		[mm]	250	250	250	280	300	300	350	400
non-cracked concrete										
temperature range (+60°C / +35°C) [2)]										
tension	C 20/25	N_{Rd} [kN]	133.1	133.1	133.1	157.7	174.9	174.9	220.4	269.3
shear	≧ C 20/25	V_{Rd} [kN]	90.0	97.3	113.3	130.0	147.3	166.7	186.7	230.7
cracked concrete										
temperature range (+60°C / +35°C) [2)]										
tension	C 20/25	N_{Rd} [kN]	76.4	79.4	85.5	102.6	83.8	89.0	110.0	139.6
shear	≧ C 20/25	V_{Rd} [kN]	90.0	97.3	113.3	130.0	147.3	166.7	186.7	230.7

[1)] The loads apply to reinforcing steel with f_{yk} = 500 N/mm² and careful drill hole cleaning, carried out with a brush and blow-out tool and temperatures in the substrate in the area of the mortar with short term temperature T ≦ + 60 °C and long term temperature T ≦ 35 °C (see also "Installation details, section 7").

[2)] (short term temperature / long term temperature)

3.3 Recommended resistance[1) 2)]

Anchor type			FIS EM ⌀ 8	FIS EM ⌀ 10	FIS EM ⌀ 12	FIS EM ⌀ 14	FIS EM ⌀ 16	FIS EM ⌀ 18	FIS EM ⌀ 20	FIS EM ⌀ 22	FIS EM ⌀ 24
h_{ef}		[mm]	80	90	110	120	125	140	170	190	210
non-cracked concrete											
temperature range (+60°C / +35°C) [3)]											
tension	C 20/25	N_R [kN]	14.3	20.2	27.7	31.6	33.6	39.8	53.3	63.0	73.2
shear	≧ C 20/25	V_R [kN]	6.6	10.3	14.8	20.2	26.3	33.3	41.4	50.0	59.5
cracked concrete											
temperature range (+60°C / +35°C) [3)]											
tension	C 20/25	N_R [kN]	6.7	9.4	13.8	17.6	17.5	22.0	29.7	36.5	44.0
shear	≧ C 20/25	V_R [kN]	6.6	10.3	14.8	20.2	26.3	33.3	41.4	50.0	59.5

Anchor type			FIS EM ⌀ 25	FIS EM ⌀ 26	FIS EM ⌀ 28	FIS EM ⌀ 30	FIS EM ⌀ 32	FIS EM ⌀ 34	FIS EM ⌀ 36	FIS EM ⌀ 40
h_{ef}		[mm]	250	250	250	280	300	300	350	400
non-cracked concrete										
temperature range (+60°C / +35°C) [3)]										
tension	C 20/25	N_R [kN]	95.1	95.1	95.1	112.7	125.0	125.0	157.5	192.4
shear	≧ C 20/25	V_R [kN]	64.3	69.5	81.0	92.9	105.2	119.0	133.3	164.8
cracked concrete										
temperature range (+60°C / +35°C) [3)]										
tension	C 20/25	N_R [kN]	54.5	56.7	61.1	73.3	59.8	63.6	78.5	99.7
shear	≧ C 20/25	V_R [kN]	64.3	69.5	81.0	92.9	105.2	119.0	133.3	164.8

[1)] The loads apply to reinforcing steel with f_{yk} = 500 N/mm² and careful drill hole cleaning, carried out with a brush and blow-out tool and temperatures in the substrate in the area of the mortar with short term temperature T ≦ + 60 °C and long term temperature T ≦ 35 °C (see also "Installation details, section 7").

[2)] Material safety factor 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.

[3)] (short term temperature / long term temperature)

4. Calculation of tension resistance

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

Steel failure: $N_{Rd,s}$

Combined pull-out and concrete cone failure:

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

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

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

4.1 Steel failure of the highest loaded anchor

Design resistance of single anchor

Anchor type			**FIS EM ⌀ 8**	**FIS EM ⌀ 10**	**FIS EM ⌀ 12**	**FIS EM ⌀ 14**	**FIS EM ⌀ 16**	**FIS EM ⌀ 18**	**FIS EM ⌀ 20**	**FIS EM ⌀ 22**	**FIS EM ⌀ 24**
design resistance	$N_{Rd,s}$	[kN]	20.0	31.4	45.0	60.7	79.3	100.0	123.6	149.3	177.9

Anchor type			**FIS EM ⌀ 25**	**FIS EM ⌀ 26**	**FIS EM ⌀ 28**	**FIS EM ⌀ 30**	**FIS EM ⌀ 32**	**FIS EM ⌀ 34**	**FIS EM ⌀ 36**	**FIS EM ⌀ 40**
design resistance	$N_{Rd,s}$	[kN]	192.9	208.6	242.1	277.9	316.4	356.4	400.0	493.6

4.2 Combined pull-out and concrete cone failure

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

Design resistance of single anchor [2) 3)]

Anchor type			FIS EM ⌀ 8			FIS EM ⌀ 10			FIS EM ⌀ 12			FIS EM ⌀ 14			FIS EM ⌀ 16			FIS EM ⌀ 18		
eff. anchorage depth	h_{ef}	[mm]	60	80	160	60	90	200	70	110	240	75	120	280	80	125	320	85	140	360
non-cracked concrete																				
temperature range (+60 °C / + 35 °C) [1)]																				
	$N^{0}_{Rd,p}$	[kN]	16.1	21.4	42.9	18.8	28.3	62.8	26.4	41.5	90.5	30.8	49.3	114.9	31.3	48.9	125.1	37.4	61.6	158.3
temperature range (+72 °C / + 50 °C) [1)]																				
	$N^{0}_{Rd,p}$	[kN]	13.1	17.4	34.9	15.1	22.6	50.3	21.1	33.2	72.4	26.4	42.2	98.5	24.6	38.4	98.3	29.4	48.4	124.4
cracked concrete																				
temperature range (+60 °C / + 35 °C) [1)]																				
	$N^{0}_{Rd,p}$	[kN]	7.0	9.4	18.8	8.8	13.2	29.3	12.3	19.4	42.2	15.4	24.6	57.5	15.6	24.4	62.6	18.7	30.8	79.2
temperature range (+72 °C / + 50 °C) [1)]																				
	$N^{0}_{Rd,p}$	[kN]	6.0	8.0	16.1	7.5	11.3	25.1	10.6	16.6	36.2	13.2	21.1	49.3	13.4	20.9	53.6	16.0	26.4	67.9

Anchor type			FIS EM ⌀ 20			FIS EM ⌀ 22			FIS EM ⌀ 24			FIS EM ⌀ 25			FIS EM ⌀ 26			FIS EM ⌀ 28		
eff. anchorage depth	h_{ef}	[mm]	90	170	400	94	190	440	98	210	480	100	250	500	104	250	520	112	250	560
non-cracked concrete																				
temperature range (+60 °C / + 35 °C) [1)]																				
	$N^{0}_{Rd,p}$	[kN]	40.8	77.1	181.5	46.9	94.8	219.6	53.4	114.4	261.4	56.7	141.8	283.6	61.4	147.5	306.8	71.2	158.8	355.8
temperature range (+72 °C / + 50 °C) [1)]																				
	$N^{0}_{Rd,p}$	[kN]	34.6	65.3	153.6	39.7	80.3	185.8	45.2	96.8	221.2	43.6	109.1	218.2	47.2	113.4	236.0	54.7	122.2	273.7
cracked concrete																				
temperature range (+60 °C / + 35 °C) [1)]																				
	$N^{0}_{Rd,p}$	[kN]	22.0	41.5	97.7	25.3	51.1	118.3	28.7	61.6	140.7	30.5	76.4	152.7	33.0	79.4	165.2	38.3	85.5	191.6
temperature range (+72 °C / + 50 °C) [1)]																				
	$N^{0}_{Rd,p}$	[kN]	18.8	35.6	83.8	21.7	43.8	101.4	24.6	52.8	120.6	26.2	65.4	130.9	28.3	68.1	141.6	32.8	73.3	164.2

Anchor type			FIS EM ⌀ 30			FIS EM ⌀ 32			FIS EM ⌀ 34			FIS EM ⌀ 36			FIS EM ⌀ 40		
eff. anchorage depth	h_{ef}	[mm]	120	280	600	128	300	640	136	300	680	144	350	720	160	400	800
non-cracked concrete																	
temperature range (+60 °C / + 35 °C) [1)]																	
	$N^{0}_{Rd,p}$	[kN]	75.4	175.9	377.0	85.8	201.1	428.9	96.8	213.6	484.2	108.6	263.9	542.9	134.0	335.1	670.2
temperature range (+72 °C / + 50 °C) [1)]																	
	$N^{0}_{Rd,p}$	[kN]	62.8	146.6	314.2	71.5	167.6	357.4	80.7	178.0	403.5	86.0	208.9	429.8	106.1	265.3	530.6
cracked concrete																	
temperature range (+60 °C / + 35 °C) [1)]																	
	$N^{0}_{Rd,p}$	[kN]	44.0	102.6	219.9	35.7	83.8	178.7	40.4	89.0	201.8	45.2	110.0	226.2	55.9	139.6	279.3
temperature range (+72 °C / + 50 °C) [1)]																	
	$N^{0}_{Rd,p}$	[kN]	37.7	88.0	188.5	28.6	67.0	143.0	32.3	71.2	161.4	36.2	88.0	181.0	44.7	111.7	223.4

[1)] (short term temperature / long term temperature)

[2)] For underwater installation the resistence values have to be multiplied by a factor of 0.7.

[3)] For applications with diamond drilled holes the resistence values have to be multiplied with a factor of 0.75.

4.2.1 Influence of concrete strength / combined pull-out and concrete cone failure

$f_{b,N,p}$

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	$f_{b,N,p}$	[-]	0.89	0.99	1.00	1.02	1.04	1.06	1.07	1.08	1.09

4.2.2 Characteristic edge distance and spacing for design of combined pull-out and concrete cone failure

Anchor type			FIS EM ⌀ 8			FIS EM ⌀ 10			FIS EM ⌀ 12			FIS EM ⌀ 14			FIS EM ⌀ 16			FIS EM ⌀ 18		
eff. anchorage depth	h_{ef}	[mm]	60	80	160	60	90	200	70	110	240	75	120	280	80	125	320	85	140	360
temperature range (+60 °C / + 35 °C) [1]																				
	$s_{cr,Np}$	[mm]	180	234	234	180	270	283	210	330	339	225	360	383	240	375	437	255	420	492
	$c_{cr,Np}$	[mm]	90	117	117	90	135	141	105	165	170	113	180	191	120	188	219	128	210	246
temperature range (+72 °C / + 50 °C) [1]																				
	$s_{cr,Np}$	[mm]	180	211	211	180	253	253	210	304	304	225	354	354	240	375	388	255	420	436
	$c_{cr,Np}$	[mm]	90	105	105	90	126	126	105	152	152	113	177	177	120	188	194	128	210	218

Anchor type			FIS EM ⌀ 20			FIS EM ⌀ 22			FIS EM ⌀ 24			FIS EM ⌀ 25			FIS EM ⌀ 26			FIS EM ⌀ 28		
eff. anchorage depth	h_{ef}	[mm]	90	170	400	94	190	440	98	210	480	100	250	500	104	250	520	112	250	560
temperature range (+60 °C / + 35 °C) [1]																				
	$s_{cr,Np}$	[mm]	270	510	527	282	570	579	294	630	632	300	658	658	312	685	685	336	737	737
	$c_{cr,Np}$	[mm]	135	255	263	141	285	290	147	315	316	150	329	329	156	342	342	168	369	369
temperature range (+72 °C / + 50 °C) [1]																				
	$s_{cr,Np}$	[mm]	270	484	484	282	533	533	294	581	581	300	577	577	312	600	600	336	647	647
	$c_{cr,Np}$	[mm]	135	242	242	141	266	266	147	291	291	150	289	289	156	300	300	168	323	323

Anchor type			FIS EM ⌀ 30			FIS EM ⌀ 32			FIS EM ⌀ 34			FIS EM ⌀ 36			FIS EM ⌀ 40		
eff. anchorage depth	h_{ef}	[mm]	120	280	600	128	300	640	136	300	680	144	350	720	160	400	800
temperature range (+60 °C / + 35 °C) [1]																	
	$s_{cr,Np}$	[mm]	360	759	759	384	810	810	408	860	860	432	911	911	480	1012	1012
	$c_{cr,Np}$	[mm]	180	379	379	192	405	405	204	430	430	216	455	455	240	506	506
temperature range (+72 °C / + 50 °C) [1]																	
	$s_{cr,Np}$	[mm]	360	693	693	384	739	739	408	785	785	432	810	810	480	900	900
	$c_{cr,Np}$	[mm]	180	346	346	192	370	370	204	393	393	216	405	405	240	450	450

[1] (short term temperature / long term temperature)

4.2.2.1 Influence of spacing / combined pull-out and concrete cone failure

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

$s/s_{cr,Np}$	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
$f_{s1,p}$	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

4.2.2.2 Influence of edge distance / combined pull-out and concrete cone failure

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

$c/c_{cr,Np}$	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
$f_{c1,p,A}$	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
$f_{c1,p,B}$ $f_{c2,p}$	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 Concrete cone failure and splitting of the most unfavourable anchor

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

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

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			**FIS EM ⌀ 8**			**FIS EM ⌀10**			**FIS EM ⌀12**			**FIS EM ⌀14**			**FIS EM ⌀16**			**FIS EM ⌀ 18**		
eff. anchorage depth	**h_{ef}**	**[mm]**	**60**	**80**	**160**	**60**	**90**	**200**	**70**	**110**	**240**	**75**	**120**	**280**	**80**	**125**	**320**	**85**	**140**	**360**
non-cracked concrete																				
design resistance	$N^0_{Rd,c}$	[kN]	15.6	24.1	68.1	15.6	28.7	95.2	19.7	38.8	125.2	21.9	44.3	157.7	24.1	47.1	192.7	26.4	55.8	230.0
cracked concrete																				
design resistance	$N^0_{Rd,c}$	[kN]	11.2	17.2	48.6	11.2	20.5	67.9	14.1	27.7	89.2	15.6	31.5	112.4	17.2	33.5	137.4	18.8	39.8	163.9

Anchor type			**FIS EM ⌀ 20**			**FIS EM ⌀ 22**			**FIS EM ⌀ 24**			**FIS EM ⌀ 25**			**FIS EM ⌀ 26**			**FIS EM ⌀ 28**		
eff. anchorage depth	**h_{ef}**	**[mm]**	**90**	**170**	**400**	**94**	**190**	**440**	**98**	**210**	**480**	**100**	**250**	**500**	**104**	**250**	**520**	**112**	**250**	**560**
non-cracked concrete																				
design resistance	$N^0_{Rd,c}$	[kN]	28.7	74.6	269.3	30.7	88.2	310.7	32.7	102.5	354.0	33.7	133.1	376.4	35.7	133.1	399.2	39.9	133.1	446.2
cracked concrete																				
design resistance	$N^0_{Rd,c}$	[kN]	20.5	53.2	192.0	21.9	62.9	221.5	23.3	73.0	252.4	24.0	94.9	268.3	25.5	94.9	284.6	28.4	94.9	318.0

Anchor type			**FIS EM ⌀ 30**			**FIS EM ⌀ 32**			**FIS EM ⌀ 34**			**FIS EM ⌀ 36**			**FIS EM ⌀ 40**		
eff. anchorage depth	**h_{ef}**	**[mm]**	**120**	**280**	**600**	**128**	**300**	**640**	**136**	**300**	**680**	**144**	**350**	**720**	**160**	**400**	**800**
non-cracked concrete																	
design resistance	$N^0_{Rd,c}$	[kN]	44.3	157.7	494.8	48.8	174.9	545.1	53.4	174.9	597.0	58.2	220.4	650.4	68.1	269.3	761.8
cracked concrete																	
design resistance	$N^0_{Rd,c}$	[kN]	31.5	112.4	352.7	34.8	124.7	388.6	38.1	124.7	425.6	41.5	157.1	463.7	48.6	192.0	543.1

fischer Injection mortar FIS EM with rebars

Anchor design according to fischer specification

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 values for design

Anchor type			FIS EM ⌀ 8			FIS EM ⌀ 10			FIS EM ⌀ 12			FIS EM ⌀ 14			FIS EM ⌀ 16			FIS EM ⌀ 18		
eff. anchorage depth	h_{ef}	[mm]	60	80	160	60	90	200	70	110	240	75	120	280	80	125	320	85	140	360
	$s_{cr,N}$	[mm]	180	240	480	180	270	600	210	330	720	225	360	840	240	375	960	255	420	1080
	$c_{cr,N}$	[mm]	90	120	240	90	135	300	105	165	360	113	180	420	120	188	480	128	210	540

Anchor type			FIS EM ⌀ 20			FIS EM ⌀ 22			FIS EM ⌀ 24			FIS EM ⌀ 25			FIS EM ⌀ 26			FIS EM ⌀ 28		
eff. anchorage depth	h_{ef}	[mm]	90	170	400	94	190	440	98	210	480	100	250	500	104	250	520	112	250	560
	$s_{cr,N}$	[mm]	270	510	1200	282	570	1320	294	630	1440	300	750	1500	312	750	1560	336	750	1680
	$c_{cr,N}$	[mm]	135	255	600	141	285	660	147	315	720	150	375	750	156	375	780	168	375	840

Anchor type			FIS EM ⌀ 30			FIS EM ⌀ 32			FIS EM ⌀ 34			FIS EM ⌀ 36			FIS EM ⌀ 40		
eff. anchorage depth	h_{ef}	[mm]	120	280	600	128	300	640	136	300	680	144	350	720	160	400	800
	$s_{cr,N}$	[mm]	360	840	1800	384	900	1920	408	900	2040	432	1050	2160	480	1200	2400
	$c_{cr,N}$	[mm]	180	420	900	192	450	960	204	450	1020	216	525	1080	240	600	1200

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

Characteristic edge distance and spacing for design

Anchor type				FIS EM ⌀ 8			FIS EM ⌀ 10			FIS EM ⌀ 12			FIS EM ⌀ 14			FIS EM ⌀ 16			FIS EM ⌀ 18		
eff. anchorage depth	h_{ef}	[mm]		60	80	160	60	90	200	70	110	240	75	120	280	80	125	320	85	140	360
application with concrete member thickness	$h/h_{ef} \geq 2.0$	$s_{cr,sp}$	[mm]	120	160	320	120	180	400	140	220	480	150	240	560	160	250	640	170	280	720
		$c_{cr,sp}$	[mm]	60	80	160	60	90	200	70	110	240	75	120	280	80	125	320	85	140	360
	$2.0 > h/h_{ef} > 1.3$	$s_{cr,sp}$	[mm]	$f_{scr,sp} \cdot h_{ef}$ ($f_{scr,sp}$ see below)																	
		$c_{cr,sp}$	[mm]	$s_{cr,sp}/2$																	
	$h/h_{ef} \leq 1.3$	$s_{cr,sp}$	[mm]	271	362	723	271	407	904	316	497	1085	339	542	1266	362	565	1446	384	633	1627
		$c_{cr,sp}$	[mm]	136	181	362	136	203	452	158	249	542	170	271	633	181	283	723	192	316	814
		h_{min}	[mm]	100	110	190	100	120	230	100	140	270	105	150	310	120	165	360	135	190	410

Anchor type				FIS EM ⌀ 20			FIS EM ⌀ 22			FIS EM ⌀ 24			FIS EM ⌀ 25			FIS EM ⌀ 26			FIS EM ⌀ 28		
eff. anchorage depth	h_{ef}	[mm]		90	170	400	94	190	440	98	210	480	100	250	500	104	250	520	112	250	560
application with concrete member thickness	$h/h_{ef} \geq 2.0$	$s_{cr,sp}$	[mm]	180	340	800	188	380	880	196	420	960	200	500	1000	208	500	1040	224	500	1120
		$c_{cr,sp}$	[mm]	90	170	400	94	190	440	98	210	480	100	250	500	104	250	520	112	250	560
	$2.0 > h/h_{ef} > 1.3$	$s_{cr,sp}$	[mm]	$f_{scr,sp} \cdot h_{ef}$ ($f_{scr,sp}$ see below)																	
		$c_{cr,sp}$	[mm]	$s_{cr,sp}/2$																	
	$h/h_{ef} \leq 1.3$	$s_{cr,sp}$	[mm]	407	768	1808	425	859	1989	443	949	2170	452	1130	2260	470	1130	2350	506	1130	2531
		$c_{cr,sp}$	[mm]	203	384	904	212	429	994	221	475	1085	226	565	1130	235	565	1175	253	565	1266
		h_{min}	[mm]	140	220	450	154	250	500	158	270	540	160	310	560	174	320	590	182	320	630

Anchor type				FIS EM ⌀ 30			FIS EM ⌀ 32			FIS EM ⌀ 34			FIS EM ⌀ 36			FIS EM ⌀ 40		
eff. anchorage depth	h_{ef}	[mm]		120	280	600	128	300	640	136	300	680	144	350	720	160	400	800
application with concrete member thickness	$h/h_{ef} \geq 2.0$	$s_{cr,sp}$	[mm]	240	560	1200	256	600	1280	272	600	1360	288	700	1440	320	800	1600
		$c_{cr,sp}$	[mm]	120	280	600	128	300	640	136	300	680	144	350	720	160	400	800
	$2.0 > h/h_{ef} > 1.3$	$s_{cr,sp}$	[mm]	$f_{scr,sp} \cdot h_{ef}$ ($f_{scr,sp}$ see below)														
		$c_{cr,sp}$	[mm]	$s_{cr,sp}/2$														
	$h/h_{ef} \leq 1.3$	$s_{cr,sp}$	[mm]	542	1266	2712	579	1356	2893	615	1356	3074	651	1582	3254	723	1808	3616
		$c_{cr,sp}$	[mm]	271	633	1356	289	678	1446	307	678	1537	325	791	1627	362	904	1808
		h_{min}	[mm]	200	360	680	208	380	720	216	380	760	234	440	810	270	510	910

$f_{scr,sp}$

h/h_{ef}	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65	1.7	1.75	1.8	1.85	1.9	1.95	2.0
$f_{scr,sp}$	4.52	4.34	4.16	3.98	3.8	3.62	3.44	3.26	3.08	2.9	2.72	2.54	2.36	2.18	2.0

4.3.3.1 Influence of spacing / concrete splitting failure

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

$s/s_{cr,sp}$	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: $V_{Rd,cp} = k \cdot min\,(N_{Rd,p}\,;\, N_{Rd,c})$

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

5.1 Steel failure for the highest loaded anchor

Design resistance of single anchor

Anchor type			**FIS EM ⌀ 8**	**FIS EM ⌀ 10**	**FIS EM ⌀ 12**	**FIS EM ⌀ 14**	**FIS EM ⌀ 16**	**FIS EM ⌀ 18**	**FIS EM ⌀ 20**	**FIS EM ⌀ 22**	**FIS EM ⌀ 24**
design resistance	$V_{Rd,s}$	[kN]	9.2	14.4	20.7	28.3	36.9	46.7	58.0	70.0	83.3

Anchor type			**FIS EM ⌀ 25**	**FIS EM ⌀ 26**	**FIS EM ⌀ 28**	**FIS EM ⌀ 30**	**FIS EM ⌀ 32**	**FIS EM ⌀ 34**	**FIS EM ⌀ 36**	**FIS EM ⌀ 40**
design resistance	$V_{Rd,s}$	[kN]	90.0	97.3	113.3	130.0	147.3	166.7	186.7	230.7

5.2 Pryout failure for the most unfavourable anchor

$$V_{Rd,cp} = k \cdot min\,(N_{Rd,p}\,;\, N_{Rd,c})$$

k-factor

Anchor type	**FIS EM ⌀ 8 to FIS EM ⌀ 40**
k	2.0

5.3 Concrete edge failure for the most unfavourable anchor

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

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

	$V^{o}_{Rd,c}$ [kN]											
	FIS EM ⌀ 8			FIS EM ⌀ 10			FIS EM ⌀ 12			FIS EM ⌀ 14		
h_{ef}	60	80	160	60	90	200	70	110	240	75	120	280
edge distance [mm]												
40	3.5	3.7	4.4									
45	4.1	4.3	5.1	4.3	4.7	5.8						
50	4.7	5.0	5.8	4.9	5.3	6.6						
55	5.4	5.6	6.6	5.6	6.0	7.4	5.9	6.6	8.2			
60	6.0	6.3	7.3	6.2	6.8	8.2	6.6	7.3	9.1	6.9	7.7	10.0
65	6.7	7.0	8.1	6.9	7.5	9.0	7.3	8.1	10.0	7.6	8.5	11.0
70	7.4	7.8	8.9	7.7	8.3	9.9	8.1	8.9	10.9	8.4	9.4	11.9
75	8.1	8.5	9.7	8.4	9.0	10.8	8.9	9.7	11.8	9.2	10.2	12.9
80	8.9	9.3	10.6	9.2	9.8	11.7	9.7	10.6	12.8	10.0	11.1	14.0
85	9.6	10.1	11.4	9.9	10.7	12.6	10.5	11.4	13.8	10.9	12.0	15.0
90	10.4	10.9	12.3	10.7	11.5	13.5	11.3	12.3	14.8	11.7	12.9	16.0
95	11.2	11.7	13.2	11.5	12.3	14.5	12.1	13.2	15.8	12.6	13.8	17.1
100	12.0	12.6	14.1	12.4	13.2	15.5	13.0	14.1	16.8	13.5	14.8	18.2
120	15.5	16.1	18.0	15.9	16.9	19.5	16.6	17.9	21.1	17.2	18.7	22.7
140	19.1	19.9	22.0	19.6	20.8	23.9	20.5	22.0	25.7	21.1	22.9	27.5
160	23.0	23.9	26.3	23.6	24.9	28.4	24.6	26.3	30.4	25.3	27.3	32.5
180	27.1	28.1	30.9	27.8	29.3	33.2	28.9	30.8	35.4	29.7	31.9	37.7
200	31.4	32.5	35.6	32.1	33.8	38.1	33.4	35.6	40.6	34.3	36.8	43.1
250	43.0	44.3	48.2	43.9	46.0	51.3	45.5	48.2	54.4	46.6	49.7	57.4
300	55.6	57.2	61.9	56.7	59.2	65.6	58.6	61.9	69.2	59.9	63.7	72.8
350	69.2	71.1	76.5	70.5	73.4	80.9	72.7	76.5	85.1	74.3	78.6	89.2
400	83.7	85.8	92.1	85.1	88.5	97.0	87.7	92.0	101.8	89.5	94.5	106.5
450	98.9	101.4	108.4	100.6	104.4	114.0	103.5	108.4	119.4	105.5	111.2	124.6
500	115.0	117.7	125.6	116.8	121.2	131.8	120.1	125.6	137.8	122.4	128.6	143.6
550	131.8	134.8	143.5	133.8	138.6	150.4	137.4	143.5	156.9	139.9	146.9	163.2
600	149.2	152.6	162.1	151.5	156.8	169.6	155.4	162.1	176.8	158.2	165.8	183.7
700		190.1	201.4		195.1	210.2	193.5	201.4	218.5	196.8	205.7	226.5
800		230.2	243.1		235.8	253.2		243.2	262.8	237.9	248.1	272.0
900			287.2		279.0	298.6		287.3	309.4	281.2	292.9	319.7
1000			333.5			346.3		333.6	358.3		339.9	369.8
1200			432.3			447.7		432.3	462.3		440.0	476.1
1400			538.6			556.8			573.9			590.1
1600			652.0			673.0			692.7			711.3
1800						795.8			818.1			839.2
2000						924.7			949.7			973.3
2200									1087.2			1113.3
2400									1230.3			1259.0
2600												1410.1
2800												1566.3

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Anchor design according to fischer specification

	$V^0_{Rd,c}$ [kN]											
	FIS EM ⌀ 16			FIS EM ⌀ 18			FIS EM ⌀ 20			FIS EM ⌀ 22		
h_{ef}	80	125	320	85	140	360	90	170	400	94	190	440
edge distance [mm]												
65	7.9	8.9	12.0									
70	8.7	9.7	13.0									
75	9.5	10.6	14.1	9.9	11.2	15.2						
80	10.4	11.5	15.1	10.7	12.1	16.4						
85	11.2	12.4	16.2	11.6	13.1	17.5	12.0	14.1	18.8			
90	12.1	13.3	17.3	12.5	14.0	18.7	12.9	15.1	20.0			
95	13.0	14.3	18.5	13.4	15.0	19.8	13.8	16.1	21.2	14.1	17.0	22.7
100	13.9	15.2	19.6	14.3	16.0	21.0	14.7	17.2	22.5	15.1	18.0	24.0
120	17.7	19.3	24.3	18.2	20.2	26.0	18.7	21.5	27.6	19.1	22.5	29.3
140	21.7	23.5	29.3	22.3	24.6	31.1	22.9	26.1	33.0	23.4	27.3	34.9
160	26.0	28.1	34.5	26.6	29.2	36.5	27.3	30.9	38.6	27.9	32.3	40.7
180	30.4	32.8	39.9	31.2	34.0	42.2	31.9	36.0	44.4	32.6	37.5	46.7
200	35.1	37.7	45.5	35.9	39.1	48.0	36.7	41.2	50.4	37.5	42.9	52.9
250	47.6	50.8	60.4	48.7	52.6	63.3	49.7	55.2	66.3	50.5	57.2	69.3
300	61.2	65.0	76.3	62.4	67.1	79.8	63.6	70.2	83.3	64.7	72.6	86.7
350	75.8	80.2	93.2	77.2	82.6	97.2	78.6	86.2	101.2	79.8	88.9	105.1
400	91.2	96.3	111.0	92.9	99.1	115.5	94.5	103.2	120.0	95.9	106.2	124.4
450	107.5	113.2	129.7	109.3	116.3	134.7	111.2	120.9	139.7	112.8	124.4	144.6
500	124.5	130.9	149.2	126.6	134.4	154.7	128.6	139.5	160.2	130.4	143.3	165.6
550	142.4	149.4	169.4	144.7	153.2	175.5	146.9	158.8	181.4	148.9	163.0	187.3
600	160.9	168.6	190.4	163.4	172.7	196.9	165.8	178.9	203.4	168.0	183.4	209.8
700	199.9	209.0	234.3	202.9	213.8	241.9	205.8	221.0	249.4	208.3	226.3	256.7
800	241.5	251.9	280.8	244.9	257.5	289.5	248.2	265.7	298.0	251.1	271.8	306.3
900	285.3	297.2	329.7	289.2	303.5	339.4	293.0	312.7	348.9	296.3	319.6	358.2
1000	331.4	344.6	380.9	335.8	351.7	391.6	340.0	362.0	402.1	343.7	369.7	412.4
1200		445.8	489.4		454.4	502.3	440.2	466.9	514.9	444.7	476.1	527.2
1300		499.3	546.6		508.6	560.6		522.2	574.2	498.2	532.2	587.5
1400			605.7		564.7	620.8		579.4	635.4	553.4	590.3	649.7
1600			729.2			746.5		699.1	763.2		711.6	779.5
1800			859.4			878.8		825.4	897.7		839.6	916.0
2000			995.8			1017.5			1038.5		973.8	1058.9
2500			1362.4			1389.7			1416.2			1441.8
3000			1762.2			1795.3			1827.3			1858.2
3500			2192.2			2231.2			2268.8			2305.1
4000									2738.4			2780.2
4500												3281.6

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fischer Injection mortar FIS EM with rebars

Anchor design according to fischer specification

	$V^0_{Rd,c}$ [kN]														
	FIS EM ⌀ 24			FIS EM ⌀ 25			FIS EM ⌀ 26			FIS EM ⌀ 28			FIS EM ⌀ 30		
h_{ef}	98	210	480	100	250	500	104	250	520	112	250	560	120	280	600
edge distance [mm]															
105	16.5	20.1	26.9												
110	17.5	21.2	28.3	17.7	22.6	29.1									
120	19.5	23.6	31.1	19.8	25.1	31.9	20.1	25.3	32.8						
130	21.7	26.0	33.9	21.9	27.6	34.9	22.2	27.8	35.8	22.9	28.3	37.7			
140	23.9	28.5	36.8	24.1	30.1	37.8	24.4	30.4	38.8	25.1	30.9	40.8	25.8	32.4	42.9
160	28.4	33.6	42.8	28.7	35.4	43.9	29.1	35.7	45.0	29.9	36.3	47.2	30.6	38.0	49.4
170	30.8	36.2	45.9	31.1	38.2	47.0	31.5	38.5	48.2	32.3	39.0	50.5	33.1	40.9	52.8
180	33.2	38.9	49.0	33.5	41.0	50.2	33.9	41.3	51.4	34.8	41.9	53.8	35.6	43.8	56.2
190	35.6	41.7	52.2	36.0	43.8	53.4	36.4	44.1	54.7	37.3	44.7	57.2	38.2	46.7	59.7
200	38.2	44.5	55.5	38.5	46.7	56.7	39.0	47.0	58.0	39.9	47.7	60.6	40.9	49.8	63.2
250	51.4	59.1	72.3	51.8	61.8	73.8	52.4	62.2	75.3	53.6	63.0	78.3	54.8	65.5	81.4
300	65.7	74.9	90.2	66.2	78.0	91.9	67.0	78.5	93.7	68.3	79.5	97.2	69.7	82.4	100.7
350	81.0	91.6	109.1	81.6	95.2	111.0	82.5	95.8	113.0	84.1	96.9	117.0	85.7	100.2	120.9
400	97.3	109.3	128.9	97.9	113.4	131.1	98.9	114.0	133.3	100.7	115.2	137.7	102.6	119.0	142.1
450	114.3	127.8	149.5	115.1	132.3	151.9	116.1	133.0	154.4	118.2	134.4	159.2	120.3	138.6	164.1
500	132.2	147.1	170.9	133.0	152.1	173.6	134.2	152.9	176.3	136.5	154.4	181.6	138.8	159.0	186.9
600	170.1	187.9	216.1	171.1	193.9	219.2	172.5	194.8	222.3	175.3	196.6	228.6	178.1	202.1	234.8
700	210.8	231.5	264.0	212.0	238.5	267.6	213.6	239.6	271.2	216.9	241.6	278.3	220.1	248.0	285.4
800	254.0	277.7	314.5	255.4	285.6	318.6	257.3	286.9	322.6	261.0	289.2	330.6	264.7	296.5	338.6
900	299.5	326.3	367.4	301.1	335.1	371.9	303.3	336.6	376.4	307.5	339.2	385.4	311.7	347.4	394.3
1000	347.3	377.1	422.6	349.1	386.9	427.6	351.5	388.5	432.5	356.3	391.5	442.4	360.9	400.5	452.2
1200	449.1	485.1	539.2	451.3	496.9	545.2	454.2	498.7	551.1	460.0	502.4	562.8	465.6	513.1	574.3
1400	558.6	600.8	663.7	561.1	614.6	670.6	564.6	616.8	677.5	571.4	621.0	691.0	578.0	633.6	704.4
1600	675.1	723.7	795.5	678.1	739.4	803.3	682.1	742.0	811.1	689.9	746.9	826.5	697.6	761.3	841.7
1800		853.2	934.0		871.1	942.8		873.9	951.5	815.1	879.5	968.8	823.8	895.7	985.8
2000		989.1	1078.8		1009.0	1088.6		1012.2	1098.3		1018.4	1117.5		1036.5	1136.3
2200		1130.9	1229.7		1152.9	1240.5		1156.5	1251.2		1163.3	1272.2		1183.3	1292.8
2400			1386.4			1398.1			1409.7		1313.9	1432.7		1335.8	1455.2
2600			1548.5			1561.2			1573.8		1470.0	1598.6		1493.7	1623.0
2800			1715.8			1729.6			1743.2			1769.9		1657.0	1796.1
3000			1888.3			1903.0			1917.6			1946.3			1974.4
3500			2340.4			2357.7			2374.7			2408.3			2441.1
4000			2820.8			2840.6			2860.2			2898.7			2936.3
4500			3327.5			3349.9			3372.1			3415.6			3458.0
5000			3859.0			3884.1			3908.8			3957.3			4004.7
5500												4522.7			4575.0
6000															5167.9

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fischer Injection mortar FIS EM with rebars

Anchor design according to fischer specification

	$V^0_{Rd,c}$ [kN]											
	FIS EM ⌀ 32			FIS EM ⌀ 34			FIS EM ⌀ 36			FIS EM ⌀ 40		
h_{ef}	128	300	640	136	300	680	144	350	720	160	400	800
edge distance [mm]												
160	31.4	39.3	51.7									
170	33.9	42.3	55.2	34.7	42.8	57.6						
180	36.5	45.3	58.7	37.3	45.8	61.2	38.2	48.7	63.7			
190	39.1	48.3	62.2	40.0	48.9	64.8	40.9	51.9	67.5			
200	41.8	51.4	65.8	42.7	52.0	68.5	43.6	55.1	71.2	45.5	58.9	76.8
250	55.9	67.5	84.5	57.0	68.2	87.6	58.2	71.9	90.8	60.4	76.4	97.2
300	71.1	84.6	104.2	72.4	85.5	107.8	73.8	89.8	111.4	76.4	95.0	118.7
350	87.3	102.8	124.9	88.8	103.8	128.9	90.4	108.7	133.0	93.4	114.6	141.1
400	104.3	121.9	146.5	106.1	123.1	151.0	107.9	128.5	155.4	111.3	135.1	164.4
450	122.3	141.8	169.0	124.3	143.1	173.8	126.2	149.2	178.7	130.1	156.4	188.5
500	141.0	162.6	192.2	143.2	164.0	197.5	145.4	170.6	202.8	149.7	178.6	213.5
600	180.8	206.3	240.9	183.4	208.0	247.1	186.0	215.8	253.3	191.1	225.2	265.6
700	223.2	252.9	292.5	226.3	254.8	299.5	229.4	263.8	306.5	235.3	274.6	320.5
800	268.3	302.0	346.5	271.8	304.2	354.4	275.3	314.4	362.3	282.1	326.5	377.9
900	315.7	353.5	403.0	319.7	356.1	411.8	323.7	367.4	420.5	331.3	380.9	437.8
1000	365.4	407.4	461.8	369.9	410.1	471.4	374.3	422.7	481.0	382.8	437.6	499.9
1200	471.1	521.3	585.7	476.5	524.7	597.1	481.7	539.6	608.3	492.0	557.4	630.5
1400	584.5	643.1	717.5	590.8	647.1	730.6	597.0	664.4	743.5	609.1	685.0	769.1
1600	705.0	772.2	856.6	712.3	776.7	871.4	719.5	796.5	886.0	733.4	820.0	914.9
1800	832.3	908.0	1002.5	840.5	913.1	1019.0	848.6	935.3	1035.4	864.4	961.7	1067.6
2000	965.8	1050.2	1154.8	975.0	1055.9	1173.1	984.1	1080.6	1191.1	1001.7	1109.9	1226.6
2200		1198.4	1313.2		1204.7	1333.2	1125.5	1231.9	1353.0	1145.0	1264.1	1391.8
2400		1352.3	1477.3		1359.2	1499.1		1388.9	1520.6	1294.1	1424.1	1562.8
2600		1511.7	1646.9		1519.2	1670.5		1551.5	1693.8		1589.6	1739.4
2800		1676.4	1821.9		1684.5	1847.3		1719.3	1872.2		1760.5	1921.2
3000		1846.1	2002.0		1854.9	2029.1		1892.2	2055.9		1936.4	2108.2
3500		2291.5	2473.4		2301.8	2505.0		2345.6	2536.1		2397.4	2597.1
4000			2973.2			3009.4			3045.0		2886.9	3114.6
4500			3499.6			3540.5			3580.5			3658.8
5000			4051.1			4096.5			4141.2			4228.2
5500			4626.2			4676.3			4725.5			4821.4
6000												5437.4
6500												6075.0

5.3.1 Influence of cracked concrete

f_{cr}

	Cracked concrete	Non-cracked concrete
f_{cr}	0.7	1.0

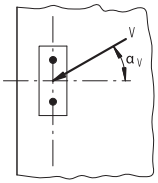
5.3.2 Influence of concrete strength for shear

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

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

5.3.3 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 $\alpha \geq 90°$ 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.

5.3.4 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

5.3.5 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

5.3.6 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

5.3.7 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 Injection mortar FIS EM with rebars

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

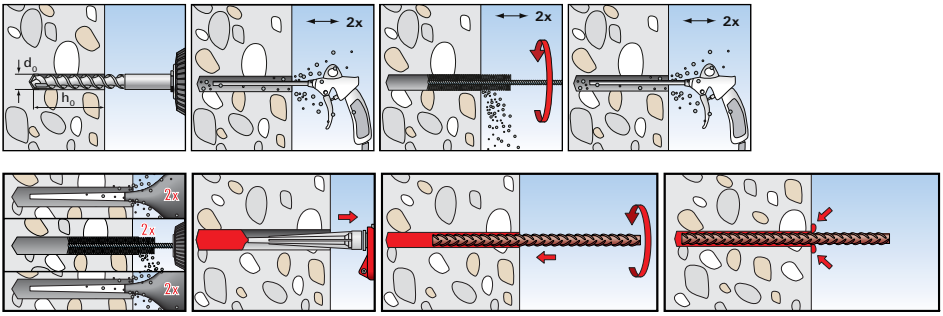
6.3 **Combined tension and shear load:**

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

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



fischer Injection mortar FIS EM with rebars

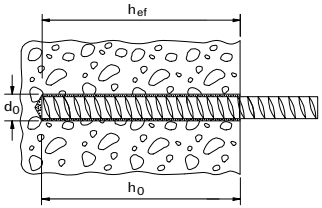
Anchor design according to fischer specification

8. Anchor characteristics

Anchor type			FIS EM ⌀ 8			FIS EM ⌀ 10			FIS EM ⌀ 12			FIS EM ⌀ 14			FIS EM ⌀ 16			FIS EM ⌀ 18		
	h_{ef}	[mm]	60	80	160	60	90	200	70	110	240	75	120	280	80	125	320	85	140	360
diameter of rebar		[mm]	8			10			12			14			16			18		
nominal drill hole diameter	d_0	[mm]	12			14			16			18			20			25		
drill depth	h_0	[mm]	60	80	160	60	90	200	70	110	240	75	120	280	80	125	320	85	140	360
effective anchorage depth	h_{ef}	[mm]	60	80	160	60	90	200	70	110	240	75	120	280	80	125	320	85	140	360
minimum thickness of concrete member	h_{min}	[mm]	100	110	190	100	120	230	100	140	270	105	150	310	120	165	360	135	190	410
minimum spacing	s_{min}	[mm]	40			45			55			60			65			75		
minimum edge distance	c_{min}	[mm]	40			45			55			60			65			75		
mortar filling quantity		[scale unit]	3	4	7	3	5	10	4	6	13	5	8	18	6	9	23	12	20	51

Anchor type			FIS EM ⌀ 20			FIS EM ⌀ 22			FIS EM ⌀ 24			FIS EM ⌀ 25			FIS EM ⌀ 26			FIS EM ⌀ 28		
	h_{ef}	[mm]	90	170	400	94	190	440	98	210	480	100	250	500	104	250	520	112	250	560
diameter of rebar		[mm]	20			22			24			25			26			28		
nominal drill hole diameter	d_0	[mm]	25			30			30			30			35			35		
drill depth	h_0	[mm]	90	170	400	94	190	440	98	210	480	100	250	500	104	250	520	112	250	560
effective anchorage depth	h_{ef}	[mm]	90	170	400	94	190	440	98	210	480	100	250	500	104	250	520	112	250	560
minimum thickness of concrete member	h_{min}	[mm]	140	220	450	154	250	500	158	270	540	160	310	560	174	320	590	182	320	630
minimum spacing	s_{min}	[mm]	85			95			105			110			120			130		
minimum edge distance	c_{min}	[mm]	85			95			105			110			120			130		
mortar filling quantity		[scale unit]	10	19	43	18	37	85	15	32	73	13	33	65	27	64	132	24	52	116

Anchor type			FIS EM ⌀ 30			FIS EM ⌀ 32			FIS EM ⌀ 34			FIS EM ⌀ 36			FIS EM ⌀ 40		
	h_{ef}	[mm]	120	280	600	128	300	640	136	300	680	144	350	720	160	400	800
diameter of rebar		[mm]	30			32			34			36			40		
nominal drill hole diameter	d_0	[mm]	40			40			40			45			55		
drill depth	h_0	[mm]	120	280	600	128	300	640	136	300	680	144	350	720	160	400	800
effective anchorage depth	h_{ef}	[mm]	120	280	600	128	300	640	136	300	680	144	350	720	160	400	800
minimum thickness of concrete member	h_{min}	[mm]	200	360	680	208	380	720	216	380	760	234	440	810	270	510	910
minimum spacing	s_{min}	[mm]	140			160			170			180			200		
minimum edge distance	c_{min}	[mm]	140			160			170			180			200		
mortar filling quantity		[scale unit]	39	91	194	35	81	172	29	64	144	49	119	245	104	260	520



fischer Injection mortar FIS EM with rebars

Anchor design according to fischer specification

9. Gelling and curing times

System temperature	Max. processing time
	FIS EM
+ 5 °C	4 h
> + 5 °C to + 10 °C	2 h
> + 10 °C to + 20 °C	30 min.
> + 20 °C to + 30 °C	14 min.
> + 30 °C to + 40 °C	7 min.

Temperature at anchoring base	Curing time [1]
	FIS EM
+ 5 °C	40 h
+ 10 °C	18 h
+ 20 °C	10 h
≥ 30 °C	5 h

The above times apply from the moment of contact between resin and hardener in the static mixer. For installation, the cartridge temperature must be at least + 5 °C. With temperatures above + 30 °C to + 40 °C the cartridges have to be cooled down to + 15 °C or + 20 °C.
For longer installation times, i.e. when interruptions occur in work, the static mixer shall be replaced.

[1] In wet concrete the curing time has to be doubled.

10. Mechanical characteristics

Anchor type			FIS EM ⌀ 8	FIS EM ⌀ 10	FIS EM ⌀ 12	FIS EM ⌀ 14	FIS EM ⌀ 16	FIS EM ⌀ 18	FIS EM ⌀ 20	FIS EM ⌀ 22	FIS EM ⌀ 24
stressed cross sectional area reinforcing steel	A_s	[mm²]	50	79	113	154	201	254	314	380	452
resisting moment reinforcing steel	W	[mm³]	50	98	170	269	402	573	785	1045	1357
yield strength reinforcing steel	f_{yk}	[N/mm²]	500								
tensile strength reinforcing steel	f_{uk}	[N/mm²]	550								

Anchor type			FIS EM ⌀ 25	FIS EM ⌀ 26	FIS EM ⌀ 28	FIS EM ⌀ 30	FIS EM ⌀ 32	FIS EM ⌀ 34	FIS EM ⌀ 36	FIS EM ⌀ 40
stressed cross sectional area reinforcing steel	A_s	[mm²]	491	531	616	707	804	908	1018	1257
resisting moment reinforcing steel	W	[mm³]	1534	1726	2155	2651	3217	3859	4580	6283
yield strength reinforcing steel	f_{yk}	[N/mm²]	500							
tensile strength reinforcing steel	f_{uk}	[N/mm²]	550							