STAHLFIX

VESF 1

PURE VINYLESTER

STYRENE FREE

New ETA - 5/2013

NEW GENERATION OF CHEMICAL ANCHORS

FOR FIXING OF REBARS AND THREADED STUDS

Brochure Contents

Stahlfix Pure Vinylester Styrene Free with New European Approval (05/2013)

Stahlfix pure vinylester styrene free - 1
(ETA 5/2013)

Product information

Pure Vinylester styrene free resin system is a powerful low odour two-component fast gelling and curing system. Applicable in one action, this resin provides excellent characteristics for fixing in a very corrosive environment and is particularly suitable for very high loads.

Features and benefits

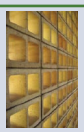
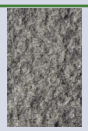
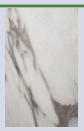
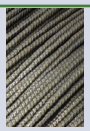
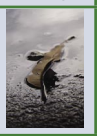
- European Technical Agreement ETA (option 1 & 7).
- Heavy & critical loads (overhead applications).
- Used in dry and wet concrete
- Excellent durability.
- **Guaranteed life of anchor : 50 years.**
- Used in non-cracked and cracked concrete.
- **Recommended for rebar.**
- **F240 (Fire) According to Eurocode 2**

Approvals

INSTYTUT TECHNIKI BUDOWLANEJ
ITB-0974/W

Imperial College London Consultants
SPO/ICON-RT-09-07 VER 4

CSTB le futur en construction

Bricks	Hollow	Concrete	Stone	Marble	Rebar	Damp
						
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CSTB le futur en construction
For rebars

BS6920 Approved for use with potable drinking water

size 400ml

Gel and cure times

Base material temperature (°C)	35	25	15	5	-5	-10
Gel time (min.)	3	5	8	15	40	60
Curing time (min.)	30	45	60	120	90	180

Typical performance data for standard embedment depth (single threaded rod or rebar)

Ø (mm)	Steel grade 5.8 / Concrete, (C20/25)									Standard data			
	Characteristic Resistance (kN)		Design Resistance (kN)		Recommended Load (kN)		Characterstic Edge Distance (mm)		Character-stic Spacing	Ø Hole diameter in concrete	Ø Hole diameter in fixture	Standard embedment	Recom-mended torque
	Tensile (N)	Shear (V)	Tensile (N)	Shear (V)	Tensile (N)	Shear (V)	Tensile (C)	Shear (C)	(mm)	(mm)	(mm)	(mm)	(Nm)
8	19.0	9.5	12.7	7.6	9.1	5.4	80	100	160	10	9	80	11
10	30.2	15.1	19.3	12.1	13.8	8.6	90	130	180	12	11	90	22
12	43.8	21.9	27.2	17.5	19.4	12.5	110	150	220	14	13	110	38
16	81.0	40.8	37.5	32.7	26.8	23.3	125	170	250	18	17	125	95
20	126.0	63.7	50.0	51.0	35.7	36.4	170	190	340	24	22	170	170
24	157.5	91.8	62.5	73.4	44.6	52.4	210	240	420	28	26	210	260
30	183.0	207.1	72.6	166.1	51.9	118.6	280	350	560	35	33	280	480

Typical ultimate physical properties

	N/mm²	Test method	Storage / Shelf life	IMPORTANT
Compressive strength	62.5	(EN ISO 604) / (ASTM 695)	This product should be stored between +5˚C & +25˚C. The Shelf life of the product is 18 months from the manufacture date. Avoid direct sunlight.	The information and data given is based on our own experience, research and testing and is believed to be reliable and accurate. However, as Stahlfix cannot know the varied uses to which its products may be applied, or the methods of application used, no warranty as to the fitness or suitability of its products is given or implied. It is the users responsibility to determine suitability of use. For further information please contact our Technical Department.
Flexural strength	21.95	(EN ISO 178) / (ASTM 795)		
Flexural modulus	2385	"		
Tensile strength	10.64	(EN ISO 527) / (ASTM 638)		
E modulus	22053	"		
VOC Content	0.04 %	-		

STAHLFIX

Stahlfix pure vinylester styrene free - 2
(ETA 5/2013)

Design resistance for single threaded rod and rebar (without edge distance or spacing influence)
Concrete class: C20/25 (According Eurocode 2 : On Cylindre 20N/mm² On Cube : 25N/mm²).

Threaded rod : Steel grade 5.8

Diameter (mm)	Ø hole (mm)	Design resistance (N_{rd}) (Tensile) * (kN)																			hef (mm)	Design resistance (kN)
8	10	8.6	10.7	12.7																	59	12.7
10	12	10.1	12.6	15.1	20.1											=	Steel failure				80	20.1
12	14		14.2	17.0	22.7	28.4	29.2														103	29.2
16	18				29.0	36.2	45.2	54.4													150	54.4
Depth (mm)		40	50	60	80	100	125	160	200	240	280	320										
20	24	32.8	41.1	49.3	61.6	73.9	84.9														207	84.9
24	28		42.2	50.7	63.3	76.0	88.7	101.3	122.4												290	122.4
30	35			52.0	65.0	78.0	91.1	104.1	130.1	151.8	173.4	194.5									449	194.5
36	40				72.4	86.9	101.3	115.8	144.8	168.9	193.0	231.7	283.2								587	283.2
Depth (mm)		80	100	120	150	180	210	240	300	350	400	480	600	720								

Rebar : Yield strength fyk = 500N/mm2

Diameter (mm)	Ø hole (mm)	Design resistance (N_{rd}) (Tensile) * (kN)																				hef (mm)	Design Resistance (kN)
8	12	14.2	17.8	21.4	21.9																	123	21.9
10	14		21.5	25.8	30.0	34.1										=	Steel failure					159	34.1
12	16			29.7	34.7	39.6	44.6	49.2														199	49.2
14	18				38.6	44.1	49.6	55.2	60.7	66.2	66.9											243	66.9
16	22					47.9	53.9	59.9	65.9	71.9	77.9	83.9	87.4									292	87.4
Depth (mm)		80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	450	500			
20	28	58.8	66.2	73.5	80.9	88.2	102.9	117.6	132.3	136.6												465	136.6
25	32			77.2	84.9	92.6	108.0	123.5	138.9	154.4	169.8	185.2	213.4									691	213.4
32	40					82.9	96.8	110.6	124.4	138.2	152.1	165.9	193.5	221.2	248.8	276.5	304.1	331.8	349.7			1265	349.7
40	50							125.7	141.4	157.1	172.8	188.5	219.9	251.4	282.8	314.2	245.6	377.0	408.5	439.9		1739	546.3
Depth (mm)		200	225	250	275	300	350	400	450	500	550	600	700	800	900	1000	1100	1200	1300	1400			

Characteristic (Vrk) & design (Vrd) shear loads for various threaded rod grades + rebar

SIZE	Steel grade 5.8		Steel grade 8.8		Steel grade 10.9		Steel grade A4-70		Steel grade A4-80	
	Vrk (kN)	Vrd (kN)	Vrk (kN)	Vrd (kN)	Vrk (kN)	Vrd (kN)	Vrk (kN)	Vrd (kN)	Vrk (kN)	Vrd (kN)
M8	9.5	7.6	14.6	11.7	19.0	15.2	12.8	8.2	14.6	9.4
M10	15.1	12.1	23.2	18.6	30.2	24.1	20.3	13.0	23.2	14.9
M12	21.9	17.5	33.7	27.0	43.8	35.1	29.5	18.9	33.7	21.6
M16	40.8	32.7	62.8	50.2	81.6	65.3	55.0	32.5	62.8	40.3
M20	63.7	51.0	98.0	78.4	127.4	101.9	85.8	55.0	98.0	62.8
M24	91.8	73.4	141.2	113.0	183.6	146.8	123.6	79.2	141.2	90.5
M30	207.1	166.1	207.6	166.1	269.9	215.9	129.8	64.9	207.6	103.8

Rebar Ø (mm)	Bst 500	
	Vrk (kN)	Vrd (kN)
8	16.6	11.1
10	25.9	17.3
12	37.3	24.9
14	50.8	33.9
16	66.4	44.3
20	103.9	69.3
25	162.0	108.0
32	265.1	176.7
40	414.6	276.4

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Reduction factors : Spacing and edge distance

Spacing reduction factor f_A								Edge reduction factor f_R														
Tensile load / Shear load								Tensile load f_{RN}							Shear load f_{RV}							
Spacing	Ø Threaded rod / Rebar (mm)							Edge distance (mm)	Ø Threaded rod / Rebar (mm)													
	8	10	12	16	20	24	30		8	10	12	16	20	24	30	8	10	12	16	20	24	30
40	0.64							40	0.64							0.25						
50	0.67	0.63						50	0.73	0.63						0.44	0.30					
60	0.70	0.65	0.63					60	0.82	0.70	0.63					0.63	0.48	0.30				
70	0.73	0.68	0.64					70	0.90	0.77	0.68					0.81	0.65	0.44				
80	0.76	0.70	0.66	0.63				80	1.00	0.84	0.74	0.63				1.00	0.83	0.58	0.40			
90	0.79	0.73	0.68	0.64				90		0.91	0.80	0.67					1.00	0.72	0.53			
100	0.82	0.75	0.70	0.65	0.63			100		1.00	0.86	0.72	0.63					0.86	0.67	0.35		
125	0.89	0.81	0.75	0.69	0.66	0.63		110			0.92	0.77	0.66					1.00	0.80	0.44		
150	0.96	0.88	0.80	0.73	0.69	0.65	0.63	120			1.00	0.81	0.70	0.64					1.00	0.58	0.35	
160	1.00	0.90	0.82	0.74	0.70	0.66	0.64	140				0.91	0.78	0.67	0.63					0.72	0.46	0.30
175		0.94	0.85	0.76	0.72	0.68	0.65	160				1.00	0.85	0.73	0.66					0.91	0.62	0.35
200		1.00	0.90	0.80	0.75	0.70	0.68	180					0.93	0.80	0.72					1.00	0.77	0.46
225			0.95	0.84	0.78	0.73	0.70	200					1.00	0.86	0.78						0.92	0.57
240			1.00	0.86	0.80	0.75	0.72	220						0.92	0.84						1.00	0.68
250				0.87	0.81	0.76	0.73	240						1.00	0.90							0.78
275				0.91	0.84	0.78	0.75	265							1.00							1.00
280				0.92	0.85	0.79	0.76															
300				0.95	0.88	0.81	0.78															
320				1.00	0.90	0.83	0.80															
350					0.94	0.86	0.83															
400					1.00	0.92	0.88															
440						0.96	0.92															
480						1.00	0.96															
500							0.98															
525							1.00															

Bond strength factors

(Influence of concrete strength on combined pull out and concrete cone resistance)

Rebar and threaded rods

Concrete Strength N/mm² (Mpa)	C20/25	C20/25	C20/25	C20/25	C20/25	C20/25	C20/25
fc =	1.00	1.06	1.12	1.17	1.23	1.26	1.30
fc =	1.00	1.25	1.05	1.06	1.07	1.08	1.09

Threaded road -
Influence of environmental conditions in non cracked concrete

		M8	M10	M12	M16	M20	M24	M30
Temp I 40°C / 24°C	Dry and Wet	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Temp II 80°C / 50°C	Dry and Wet	0.90	0.88	0.87	0.86	0.85	0.84	0.83

Influence of environmental conditions in cracked concrete

		M8	M10	M12	M16	M20	M24	M30
Temp I 40°C / 24°C	Dry and Wet	n/a	1.00	1.00	1.00	1.00	1.00	1.00
Temp II 80°C / 50°C	Dry and Wet	n/a	0.88	0.87	0.86	0.85	0.84	0.83

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Rebar -
Influence of environmental conditions in non cracked concrete

		Ø 8	Ø 10	Ø 12	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Temp I 40ºC / 24ºC	Dry and Wet	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Temp II 80ºC / 50ºC	Dry and Wet	0.90	0.90	0.88	0.88	0.86	0.86	0.84	0.84

Influence of environmental conditions in cracked concrete

		Ø 8	Ø 10	Ø 12	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Temp I 40ºC / 24ºC	Dry and Wet	n/a	n/a	0.50	0.50	0.50	0.50	n/a	n/a
Temp II 80ºC / 50ºC	Dry and Wet	n/a	n/a	0.44	0.44	0.43	0.43	n/a	n/a

Loads in hollow material (Tensile or shear)

Size	Recommended load (kN)
	Hollow brick 7 N/mm2
M8	0.8
M10	1.7
M12	2.7
M16	3.6

*Design according to Anchor theory **

$$FR_N = \frac{N_{rd}}{1.4} \cdot f_B \cdot f_{RN} \cdot f_A \qquad \textit{(tensile)}$$

$$FR_v = \frac{V_{rd}}{1.4} \cdot f_B \cdot f_{RV} \cdot f_A \qquad \textit{(shear)}$$

FR_α *(shear + tensile)*

$$FR_\alpha = FR_N - (FR_N - FR_V)\frac{\alpha}{90}$$

f_B = *Resistance factor of Concrete*

$f_B = 1 + 0.02\,(1 - \frac{\alpha}{90}) \cdot (f_{cc,eff} - 25)$

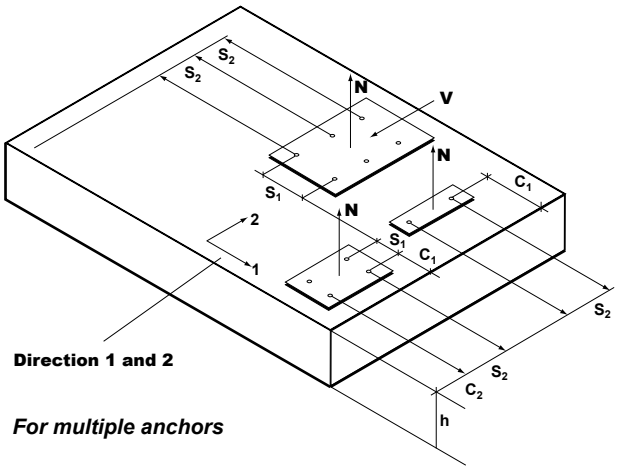
$[15 \le f_{cc,eff} \le 55]$

α = *Angle of load*

f_A = *Reduction factor "Spacing"*

f_{cc} = *Resistance on cube N/mm²*

f_R = *Reduction factor "edge distance"*



Direction 1 and 2

For multiple anchors

$$f_A = f_{A1}(s_1) \cdot f_{A2}(s_2) \cdot f_{Ax}(s_x)$$

$$f_{RN} = f_{RN1}(c_1) \cdot f_{RN2}(c_2) \cdot f_{RNx}(c_x)$$

$$f_{RV} = f_{RV1}(c_1) \cdot f_{RV2}(c_2) \cdot f_{RVx}(c_x)$$

$h = h_{nom} + 40mm$

h_{nom} = *embedment depth*

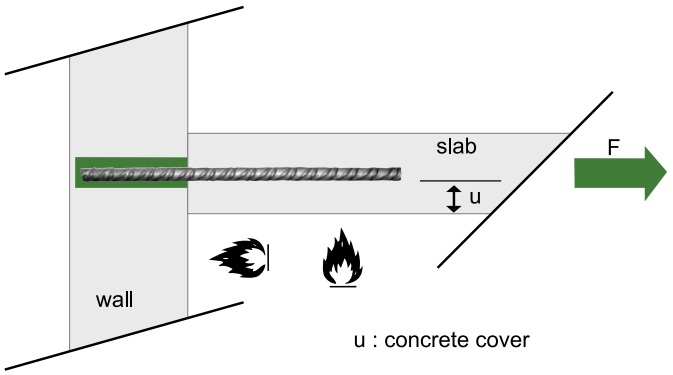
N_{rd} , V_{rd} = *Approved design resistance*

FR_N , FR_V , FR_α = *Recommended loads*

***** Design according to post-installed rebar theory : see design section.***

Stahlfix VESF injection systems in wall to slab connection with concrete reinforcing bar and subjected to fire exposure according to Eurocode 2

RESISTANCE TO FIRE FOR STEEL REINFORCEMENT wall/slab



The present table is aimed at supplying data for the design of the injection anchoring system when exposed to fire. This study does not deal with the mechanical design at ambient temperature, neither does it deal with the design according to other accidental solicitations, these shall be done is addition.

The table below gives performance subjected to fire exposure in wall to slab connection with concrete reinforcing bar, with STAHLFIX VESF resin, in concrete C20/25.

The values in white character specified the proof of requirements to fire is satisfied with ηfi = 0,7 in concrete class C20/25 (see method below).

Design method for resistance to fire according to Eurocode 2: Fire proof using design resistance: $R_{d,fi} \leq E_{d,fi}$

$R_{d,fi}$ Design resistance in the fire situation

$E_{d,fi}$ Design effect of actions in the fire situation. This value could be calculated from the the calculation at normal temperature : **$E_{d,fi} = \eta_{fi} \times F_{Rdu}$**

F_{Rdu} Design ultimate limit load at normal temperature for one rebar sealing at the ls anchorage depth (mm)

η_{fi} Reduction factor for design load level in the fire situation ηfi equal to 0,739

Rebar Ø (mm)	Drill (mm)	Ls (mm)		Fe E500 Rebar maximum load (kN) in case of fire	Design resistance (kN) in case of fire according to Eurocode 2 for a fire duration of 30 to 240 min.					
					Fire duration (minutes)					
					R30	R60	R90	R120	R180	R240
Concrete cover (1) (mm)					**10**	**20**	**25**	**35**	**50**	**70**
		120			6,3	2,7	1,6	1,2	0,8	0,9
		185			16,2	10,1	6,7	5,1	3,3	2,9
		220				16,2	11,3	8,8	6,0	4,9
8	12	250		16,2			16,2	12,8	9,0	7,1
		275						16,2	12,1	9,3
		305							16,2	12,4
		340								16,2
Concrete cover (1) (mm)					**10**	**20**	**25**	**35**	**50**	**70**
		140			10,1	5,3	3,4	2,4	1,5	1,4
		180			19,1	11,3	7,6	5,5	3,4	3,1
		205			25,3	15,8	11,1	8,3	5,3	4,7
10	14	250		25,3		25,3	19,2	15,0	10,3	8,7
		280					25,3	20,7	14,6	12,2
		305						25,3	18,9	15,6
		340							25,3	21,2
		365								25,3
Concrete cover (1) (mm)					**12**	**20**	**25**	**35**	**50**	**70**
		160			16,4	8,6	5,5	3,8	2,8	2,4
		230			36,4	23,3	17,0	11,9	9,0	7,0
		260				31,6	23,8	17,2	13,4	10,5
		280				36,4	28,9	21,4	16,9	13,3
		300					34,5	26,0	20,8	16,5
12	16	310		36,4			36,4	28,5	22,9	18,2
		320						31,1	25,2	20,0
		340						36,4	30,1	24,0
		365							36,4	29,5
		380								33,1
		395								36,4
Concrete cover (1) (mm)					**14**	**20**	**25**	**35**	**50**	**70**
		180			24,0	13,5	9,1	7,1	4,6	3,8
		250			49,6	32,5	25,0	21,6	15,1	11,8
		280				42,1	33,1	28,8	20,9	16,5
14	18	305		49,6		49,6	40,0	35,3	26,3	21,1
		335					49,6	43,7	33,4	27,4
		360						49,6	39,9	33,2
		380							49,6	42,2
		425								49,6

(1) : Minimum concrete cover according Eurocode 2 - partie 1.2

RESISTANCE TO FIRE FOR STEEL REINFORCEMENT wall/slab (continued)

Rebar Ø (mm)	Drill (mm)	Ls (mm)	Fe E500 Rebar maximum load (kN) in case of fire	Design resistance (kN) in case of fire according to Eurocode 2 for a fire duration of 30 to 240 minutes					
				Fire duration (minutes)					
				R30	R60	R90	R120	R180	R240
Concrete cover(1) (mm)				**16**	**20**	**25**	**35**	**50**	**70**
		160		19,9	9,9	5,9	4,9	3,9	3,6
		200		34,8	19,2	12,7	10,1	6,9	5,8
		220		42,7	25,0	17,3	13,9	9,4	7,6
		240		50,9	31,3	22,5	18,2	12,5	10,0
		275		64,8	43,7	33,0	27,3	19,3	15,4
		300			53,6	41,5	34,9	25,3	20,2
16	22	330	64,8		64,8	53,1	45,3	33,6	27,1
		340				57,2	49,0	36,7	29,6
		360				64,8	57,0	43,3	35,1
		380					64,8	50,4	41,2
		400							47,7
		420						64,8	54,8
		450							64,8
Concrete cover(1) (mm)				**20**	**20**	**25**	**35**	**50**	**70**
		200		41,4	19,0	13,0	10,7	8,2	7,2
		240		61,5	34,4	24,9	20,3	14,6	11,7
		280		82,5	51,8	39,5	33,0	24,2	19,4
		315		101,2	68,1	53,9	45,7	34,3	27,8
20	28	380	101,2		101,2	84,1	73,0	57,0	47,7
		415				101,2	89,8	71,4	60,7
		440					101,2	82,7	70,9
		480						101,2	89,0
		505							101,2
Concrete cover(1) (mm)				**25**	**25**	**25**	**35**	**50**	**70**
		250		86,6	44,2	28,4	23,3	17,5	15,2
		310		128,3	79,1	57,3	50,5	36,5	30,3
		360		158,1	110,2	84,8	75,9	57,3	48,1
		400			136,3	108,6	98,1	76,4	64,9
25	32	435	158,1		158,1	130,9	118,8	95,0	81,4
		480				158,1	147,2	121,4	105,1
		500					158,1	134,1	116,6
		540						158,1	140,9
		570							158,1
Concrete cover(1) (mm)				**32**	**32**	**32**	**35**	**50**	**70**
		320		177,9	108,0	70,4	54,4	41,8	35,9
		350		204,1	133,2	93,2	73,8	59,1	50,7
		380		230,4	158,5	116,5	94,8	77,3	66,8
		415		259,0	188,2	144,1	120,2	99,6	86,8
32	40	500	259		259,0	213,2	185,6	159,1	141,1
		555				259,0	230,8	201,5	180,6
		590					259,0	230,1	207,5
		625						259,0	235,8
		655							259,0

(1) : Minimum concrete cover according Eurocode 2 - partie 1.2

Example:

- **Application:**
  - Design of works for Ø16 rebar in park
  - Requirement : fire duation 3 hours
  - Ultimate load : 46 kN.
- **Ambient temperature:** Anchoring depth according to EC2 rules for ultimate load of 46 kN in concrete class C20/25

$$L_s = \frac{F_{Rdu}}{\pi \cdot f_{bd} \cdot \text{ø fer}} = \frac{46,10^3}{\pi \times 2,3 \times 16}$$

Ls = 397 mm

- **Fire proof:** fire duration 3 hours for one anchoring depth equal to 397 mm

$R_{d,fi(180\ min)}$ = 58,2 kN > 32,2 kN [=0,7 x 46 kN]

REINFORCEMENT FRAME WITH 3 layers of reinforcement

The table below gives performance subjected to fire exposure in wall to beam connection (width 20, 30 and «40 cm and more») with concrete reinforcing bar, with STAHLFIX VESF resin, in concrete _ C20/25, in take into account the exposure on 3 sides.

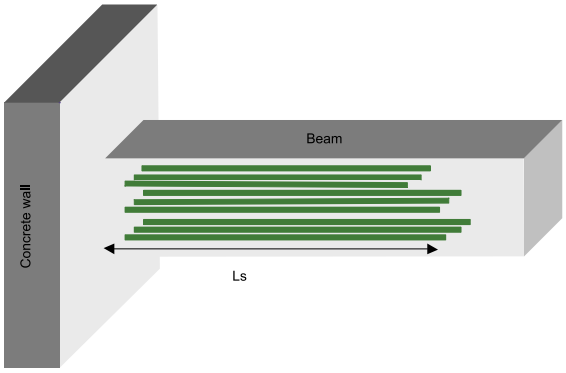
Design method for resistance to fire according to Eurocode 2: Fire proof using design resistance: $R_{d,fi} \leq E_{d,fi}$

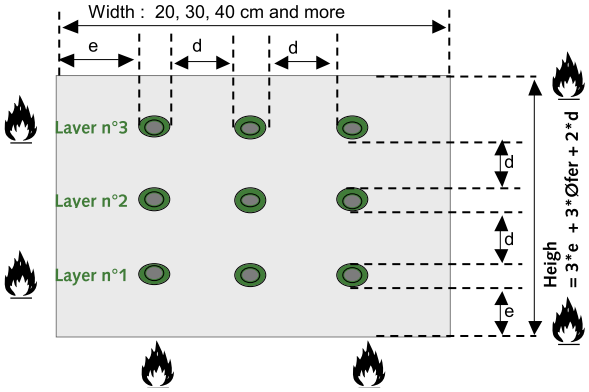
$R_{d,fi}$ Design resistance in the fire situation

$E_{d,fi}$ Design effect of actions in the fire situation. This value could be calculated from the the calculation at normal temperature: **$E_{d,fi} = \eta_{fi} \times F_{Rdu}$**

F_{Rdu} Design ultimate limit load at normal temperature for one rebar sealing at the ls anchorage depth (mm)

η_{fi} Reduction factor for design load level in the fire situationηfi is equal to 0,739





BEAM'S WIDTH = 40 CM

Rebar Ø (mm)	Drilling Ø (mm)	Distance between layers [d] (mm)	$R_{d,fi}$ (kN) Rebar maximum load in case of fire	Layers identification	Rebar anchorage depth (Ls in mm) for all layers for the rebar maximum load in case of fire (Rebar Fe E500)					
					Fire duration (minutes)					
					R30	R60	R90	R120	R180	R240
Concrete cover [e] (mm)					28	52	70	85	110	136
8	12	60	16,2	layer n°1	169	206	233	255	292	321
				layer n°2	160	193	218	239	275	305
				layer n°3	158	189	212	231	266	296
10	14	60	25,3	layer n°1	189	226	255	278	316	348
				layer n°2	179	213	240	262	300	332
				layer n°3	177	209	233	254	291	323
12	16	60	36,4	layer n°1	207	246	275	299	339	373
				layer n°2	197	233	260	283	323	358
				layer n°3	195	228	254	276	314	348
14	18	60	49,6	layer n°1	226	265	294	319	361	395
				layer n°2	216	252	280	303	345	380
				layer n°3	214	247	273	296	336	372
16	22	60	64,8	layer n°1	244	283	313	338	381	417
				layer n°2	234	270	299	323	365	402
				layer n°3	233	266	292	315	356	393
20	28	75	101,2	layer n°1	281	320	350	376	420	457
				layer n°2	270	305	333	357	400	439
				layer n°3	269	303	329	351	392	431
25	32	90	158,1	layer n°1	327	366	397	423	467	503
				layer n°2	316	350	378	402	445	484
				layer n°3	315	349	375	397	439	476
32	40	120	259,0	layer n°1	392	431	461	487	532	568
				layer n°2	380	414	440	464	507	545
				layer n°3	380	413	439	461	502	538

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(ETA 5/2013)

BEAM'S WIDTH = 30 CM

Rebar Ø (mm)	Drilling Ø (mm)	Distance between layers [d] (mm)	$R_{d,fi}$ (kN) Rebar maximum load in case of fire	Layers identification	Rebar anchorage depth (Ls in mm) for all layers for the rebar maximum load in case of fire (Rebar Fe E500)					
					Fire duration (minutes)					
					R30	R60	R90	R120	R180(1)	R240(1)
Concrete cover [e] (mm)					30	55	80	85		
8	12	60	16,2	layer n°1	169	205	228	257		
				layer n°2	158	191	213	243		
				layer n°3	157	187	207	236		
10	14	60	25,3	layer n°1	188	225	250	280		
				layer n°2	178	212	235	266		
				layer n°3	176	207	229	259		
12	16	60	36,4	layer n°1	207	244	270	300		
				layer n°2	196	231	255	287		
				layer n°3	194	227	249	280		
14	18	60	49,6	layer n°1	225	263	289	320		
				layer n°2	215	250	275	307		
				layer n°3	213	246	269	301		
16	22	60	64,8	layer n°1	244	282	308	340		
				layer n°2	233	269	294	326		
				layer n°3	232	265	288	320		
20	28	75	101,2	layer n°1	280	319	346	378		
				layer n°2	269	303	328	361		
				layer n°3	268	301	324	356		
25	32	90	158,1	layer n°1	327	365	392	424		
				layer n°2	315	348	373	406		
				layer n°3	314	347	370	402		
32	40	120	259,0	layer n°1	391	430	457	489		
				layer n°2	379	412	436	468		
				layer n°3	379	412	435	467		

BEAM'S WIDTH = 20 CM

Rebar Ø (mm)	Drilling Ø (mm)	Distance between layers [d] (mm)	$R_{d,fi}$ (kN) Rebar maximum load in case of fire	Layers identification	Rebar anchorage depth (Ls in mm) for all layers for the rebar maximum load in case of fire (Rebar Fe E500)					
					Fire duration (minutes)					
					R30	R60	R90	R120(1)	R180(1)	R240(1)
Concrete cover [e] (mm)					30	55	80			
8	12	60	16,2	layer n°1	169	207	236			
				layer n°2	159	195	226			
				layer n°3	157	192	223			
10	14	60	25,3	layer n°1	188	227	257			
				layer n°2	178	215	248			
				layer n°3	176	212	245			
12	16	60	36,4	layer n°1	207	246	277			
				layer n°2	196	235	268			
				layer n°3	195	231	265			
14	18	60	49,6	layer n°1	225	265	297			
				layer n°2	215	254	287			
				layer n°3	213	250	284			
16	22	60	64,8	layer n°1	244	284	316			
				layer n°2	233	272	306			
				layer n°3	232	269	303			
20	28	75	101,2	layer n°1	281	321	353			
				layer n°2	269	307	342			
				layer n°3	269	306	340			
25	32	90	158,1	layer n°1	327	367	399			
				layer n°2	315	353	388			
				layer n°3	315	352	386			
32	40	120	259,0	layer n°1	391	431	464			
				layer n°2	379	417	451			
				layer n°3	379	416	451			

(1) : The fire duration are limited in accordance with beams' widths, according to Eurocode 2 partie 1.2.

Design according to TR 045; Design under seismic action

The decision of the selection of the seismic performance category is in the responsibility of each individual Member State.
Furthermore, the values of ag.S assigned to the seismicity levels may be different in the National Annexes to EN 1998-1:2004 (EC8) compared to the values given in Table 1.
The recommended category C1 and C2 given in Table 1 are given in the case that no National requirements are defined.

Table 1: Recommended seismic performance categories for anchors

Seismicity level a)		**Importance Class acc. to EN 1998-1:2004, 4.2.5**			
	$a_g \cdot S$ c)	I	II	III	IV
Very low b)	$a_g \cdot S \leq 0{,}05g$	No additional requirement			
Low b)	$0{,}05g < a_g \cdot S \leq 0{,}1g$	C1	C1 d) or C2 e)		C2
> Low b)	$a_g \cdot S > 0{,}1g$	C1	C2		

a) The values defining the seismicity levels may be found in the National Annex of EN 1998-1.
b) Definition according to EN 1998-1:2004, 3.2.1.
c) a_g = Design ground accelaration on Type A ground (EN 1998-1:2004, 3.2.1).
d) C1 attachments of non-structural elements
e) C2 for connections between structural elements of primary and/or secondary seismic members

Calculation of characteristic seismic resistance $R_{k,sels}$

Tension load: $R_{k,sels} = \alpha_{gap} \cdot \alpha_{seis} \cdot \alpha_{N,seis} \cdot R^0_k$

with $R^0_k = N_{Rk,s,}\ N_{Rk,p,}\ N_{Rk,c}.\ N_{Rk,sp}$ (Calculation according to CEN/TS 1992-4 or TR029)

$\alpha_{N,seis}$ = see Table 2 or Table 3 for $N_{Rk,s}$ and $N_{Rk,p}$

$\alpha_{N,seis}$ = 1,0 for $N_{Rk,c}$ and $N_{Rk,sp}$

α_{gap} = see Table 4

α_{sels} = see Table 4

Shear load: $R_{k,sels} = \alpha_{gap} \cdot \alpha_{seis} \cdot \alpha_{V,seis} \cdot R^0_k$

with $R^0_k = V_{Rk,s,}\ V_{Rk,p,}\ V_{Rk,c}.\ V_{Rk,sp}$ (Calculation according to CEN/TS 1992-4 or TR029)

$\alpha_{N,seis}$ = see Table 2 or Table 3 for $V_{Rk,s}$ and $V_{Rk,p}$

$\alpha_{N,seis}$ = 1,0 for $V_{Rk,c}$ and $V_{Rk,sp}$

α_{gap} = see Table 4

α_{sels} = see Table 4

Table 2: Reduction factors $\alpha_{N,seis}$ and $\alpha_{V,seis}$ for seismic design category C1 for threaded rod

Anchor size threaded rods			M 12	M 16	M 20	M 24	M 27	M 30
Tension load								
Steel failure ($N_{Rk,s}$)	$\alpha_{N,seis}$	[-]	1,0					
Combined pull-out and concrete failure ($N_{Rk,s}$)	$\alpha_{N,seis}$	[-]	0,68	0,68	0,68	0,69	0,69	0,69
Shear load								
Shear failure without lever arm ($V_{Rk,s}$)	$\alpha_{V,seis}$	[-]	0,70					

Table 3: Reduction factors $\alpha_{N,seis}$ and $\alpha_{V,seis}$ for seismic design category C1 for reinforcing bar

Anchor size reinforcing bar			Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Tension load									
Steel failure ($N_{Rk,s}$)	$\alpha_{N,seis}$	[-]	1,0						
Combined pull-out and concrete failure ($N_{Rk,s}$)	$\alpha_{N,seis}$	[-]	0,68	0,68	0,68	0,68	0,69	0,69	0,69
Shear load									
Shear failure without lever arm ($V_{Rk,s}$)	$\alpha_{V,seis}$	[-]	0,70						

Table 4: Reduction factors α_{gap} and α_{seis} for resistance under seismic actions

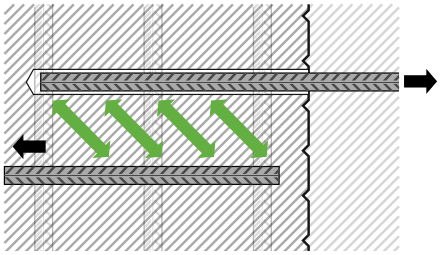
Loading	Failure modes	α_{gap}	α_{seis} Single Fastener	α_{seis} Fastener group
Tension	Steel failure	1,0	1,0	1,0
	Pull out failure	1,0	1,0	0,85
	Combined pull-out and concrete failure	1,0	1,0	0,85
	Concrete cone failure	1,0	0,85	0,75
	Splitting failure	1,0	1,0	0,85
Shear	Steel failure without lever arm	0,5 [1)]	1,0	0,85
	Steel failure with lever arm	NPD [2)]	NPD [2)]	NPD [2)]
	Concrete edge failure	0,5 [1)]	1,0	0,85
	Concrete pry-out failure	0,5 [1)]	0,85	0,75

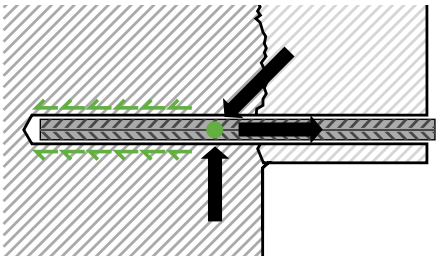
1) The limitation for size of the clearance hole is given in TR 029 Table 4.1, α_{gap} in case of no clearance between fastener and fixture

2) No Performance Determined

Structural rebar applications

Approved per CSTB seismic pre-qualification





Post-installed structural rebar

Reinforced concrete design assumes that concrete has negligible tensile strength while allowing for the design of rebar development length and avoiding brittle concrete failure, in the following two situations:

- Transferring tensile loads from one bar to another (overlap splice)
- Development length of the tensile force in a bar beyond a node in equilibrium.

Design*:

- The formulas applicable are those of Eurocode 2
- Seismic accidental stress is determined by the design department over regulatory acceleration in Eurocode 8.
- Under accidental load Fe 500 irons can work at maximum resistance that is to say 500 N/mm^2
- Adherence calculation under seismic loading, fbd, sism is given in the DTA and varies 2.3 to 4.0 N / mm^2 depending on the diameter of the iron (8 to 40) and the class concrete (C20/25 to C45/55).

*Design according to post-installed rebar theory see:

www.sogivaswiss.com

Stahlfix / design sections / post-installed rebar theory

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