

Rebar anchoring system



EPOBAR

- EPOXY acrylate resin
- Fast cure time
- Storage time 16 months
- Usable in wet environments
- Good fire performance
- Cartridge compatible with standard injection gun
- Usable with XTD dust free drill bit

FIRE BEHAVIOUR

- see page 164 to 167



Mechanical characteristics of rebars

Nominal steel rebar Ø		Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø25	Ø32	Ø40
Sections (cm ²)		0,503	0,785	1,13	1,54	2,01	3,14	4,91	8,04	12,57
Min. resistances to failure (kN)	Fe E400	21,13	32,97	47,46	64,68	84,42	131,88	206,22	337,68	527,94
	Fe E500	25,90	40,43	58,20	79,31	103,52	161,71	252,87	414,06	647,36
Ultimate limit load N _{Rd} (kN)	Fe E500	21,85	34,15	49,17	66,93	87,42	136,59	213,43	349,56	546,36

The mechanical characteristics of the high adhesion rebars are defined in the NFA 35-016 and NFA 35-017 standards.

Setting time

Temperature	Max. time for installation	Curing time	
		Dry concrete	Wet concrete
40°C	3 min	50 min.	1 h 40 min.
30°C to 39°C	3 min.	1 h 5 min.	2 h 10 min.
20°C to 29°C	6 min.	1 h 50 min.	3 h 40 min.
10°C to 19°C	11 min.	3 h 10 min.	6 h 20 min.
5°C to 9°C	22 min.	4 h 10 min.	8 h 20 min.
0°C to 4°C ⁽¹⁾	48 min.	5 h 15 min.	10 h 30 min.
-5°C to -1°C ⁽¹⁾	120 min.	6 h 40 min.	13 h 20 min.

⁽¹⁾ the cartridge temperature must be ≥ to 5°C

Sizing rules for steel reinforcement fixings for concrete according to eurocode 2 regulations and ETA 08/0201

The basic anchorage length $L_{b,reqd}$ (mm) for the ultimate limit load for rebar F_{Rd} (N) is given by following equation:

$$L_{b,reqd} = \frac{F_{Rd}}{\Pi \cdot \emptyset \cdot \eta_1 \cdot \eta_2 \cdot f_{bd}}$$

The design anchorage length L_{bd} (mm) is determined as follow:

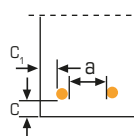
$$L_{bd} = L_{b,reqd} \cdot \alpha_2 \cdot \alpha_5$$

- F_{Rd} : Design ultimate load (N)
- f_{bd} : Design value of the bond strength in N/mm²
- \emptyset : Rebar diameter (mm)
- η_1 : depends on bond conditions - $\eta_1 = 1$ ("good bond" conditions). See § 8.4.2 (EN 1992-1-1)
- η_2 : depends on rebar diameter - $\eta_2 = 1$ for $\emptyset_{rebar} \leq 32$ mm

with α_2 : Influence of concrete minimum cover

$$\alpha_2 = 1 - 0,15 (C_d - \emptyset_{rebar}) / \emptyset_{rebar} \geq 0,7$$

$$C_d = \min \left(C ; C_1 ; \frac{a}{2} \right)$$



with α_5 : Influence of the confinement by transverse pressure

The factor α_5 take into account of the effect of the pressure transverse to the plane of splitting along the design length.

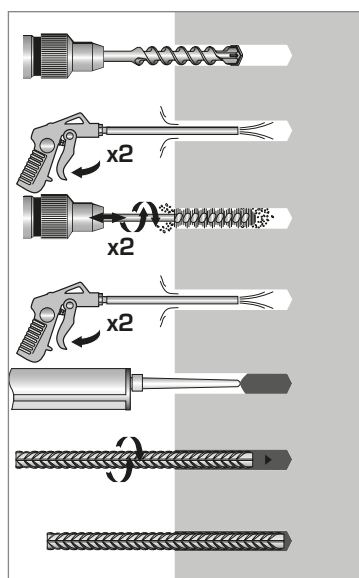
$$\alpha_5 = 1 - 0,04 \cdot p \geq 0,7$$

where p is the transverse pressure at the ultimate limit state along L_{bd} in MPa.

Concrete class	f_{ck} (MPa)	f_{bd} (MPa)
C20/25	20	2,3
C25/30	25	2,7
C30/37	30	3,0
C35/45	35	3,4
C40/50	40	3,7
C45/55	45	4,0
C50/60	50	4,3

p (MPa)	α_5
3	0,88
5	0,8
7	0,72

INSTALLATION*



*Premium cleaning :

- 2 blowing with compressed air
- 2 brushing with brushed fitted on a drilling machine
- 2 blowing with compressed air

Limit of this formula

The max. anchor depth will be limited to 900 mm with pneumatic injection tool.



Eurocode 2 table for straight rebar anchoring

CONCRETE C25/30 - HAMMER DRILLING



Rebar \varnothing (mm)	Drilling \varnothing d_0 (mm)	Length of anchor L_{bd} (mm)	Ultimate limit load (daN)		Number of sealings per SPIT EPOBAR cartridge ⁽³⁾	
			without influence of center distance and/or edge ⁽¹⁾ ($\alpha_2 = 0,7$)	with influence of center distance and/or edge ⁽²⁾ ($\alpha_2 = 1$)	410 ml	825 ml
8	10	100	969	679	120,8	243,2
		190	1842	1289	63,6	128,0
		225	2185	1530	53,6	107,9
		322	-	2185	37,5	75,5
10	12	121	1466	1026	81,7	164,4
		230	2787	1951	43,0	86,5
		282	3415	2391	35,1	70,6
		403	-	3415	24,6	49,4
12	15	145	2108	1476	37,0	74,5
		280	4072	2850	19,2	38,6
		338	4917	3442	15,9	32,0
		483	-	4917	11,1	22,4
14	18	169	2867	2007	20,1	40,5
		330	5598	3919	10,3	20,7
		395	6693	4685	8,6	17,3
		564	-	6693	6,0	12,1
16	20	193	3742	2619	15,7	31,5
		370	7174	5022	8,2	16,4
		451	8742	6119	6,7	13,5
		644	-	8742	4,7	9,4
20	25	242	5865	4105	8,0	16,1
		470	11391	7973	4,1	8,3
		564	13659	9561	3,4	6,9
		805	-	13659	2,4	4,8
25	30	302	9149	6404	3,6	7,3
		550	16662	11663	2,0	4,0
		704	21342	14939	1,5	3,1
		1006	-	21342	1,1	2,2
28	35	338	11468	8028	2,9	5,9
		600	20358	14250	1,6	3,3
		789	26770	18739	1,3	2,5
		1127	-	26770	0,9	1,8
32	40	386	14968	10477	2,0	3,9
		750	29082	20358	1,0	2,0
		900	34956	24469	0,8	1,7
		1200	-	32572	0,6	1,3

⁽¹⁾ Absence of edge distances greater than or equal to $7 \cdot \varnothing$

⁽²⁾ Presence of edge distances and/or centre distances less than $7 \cdot \varnothing$

⁽³⁾ The number of fixings per cartridge is calculated taking into account an increasing by 20% the real volume of sealing.

$$1,2 \times (d_0^2 - \varnothing_{\text{rebar}}^2) \times \Pi \times L_{bd} / 4$$

Rebar anchoring system

EPOBAR/EPOMAX

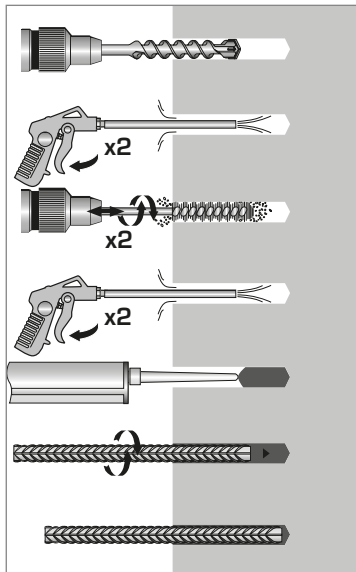
- EPOXY acrylate resin
- Quick drying time
- Storage time 16 months
- Usable in wet environments
- Good fire performance
- Cartridge compatible with standard injection gun

Sizing rules for steel reinforcement fixings for concrete using the bond strength

With SPIT EPOBAR resin, the adhesion design calculations can be used to determine the anchoring lengths in the case of application without influence of edge or spacing distances.

Tensile tests are generally performed on site to validate the minimum anchoring lengths.

INSTALLATION*



*Premium cleaning :

- 2 blowing with compressed air
- 2 brushing with brushed fitted on a drilling machine
- 2 blowing with compressed air

Setting time

Temperature	Max. time for installation	Curing time	
		Dry concrete	Wet concrete
40°C	3 min.	50 min.	1 h 40 min.
30°C to 39°C	3 min.	1 h 5 min.	2 h 10 min.
20°C to 29°C	6 min.	1 h 50 min.	3 h 40 min.
10°C to 19°C	11 min.	3 h 10 min.	6 h 20 min.
5°C to 9°C	22 min.	4 h 10 min.	8 h 20 min.
0°C to 4°C ⁽¹⁾	48 min.	5 h 15 min.	10 h 30 min.
-5°C to -1°C ⁽¹⁾	120 min.	6 h 40 min.	13 h 20 min.

⁽¹⁾ the cartridge temperature must be \geq to 5°C

Mechanical characteristics of rebars

Nominal steel rebar \varnothing		$\varnothing 8$	$\varnothing 10$	$\varnothing 12$	$\varnothing 14$	$\varnothing 16$	$\varnothing 20$	$\varnothing 25$	$\varnothing 32$	$\varnothing 40$
Sections (cm²)		0,503	0,785	1,13	1,54	2,01	3,14	4,91	8,04	12,57
Min. resistances to failure (kN)	Fe E400	21,13	32,97	47,46	64,68	84,42	131,88	206,22	337,68	527,94
	Fe E500	25,90	40,43	58,20	79,31	103,52	161,71	252,87	414,06	647,36
Ultimate limit load N_{Rd} (kN)	Fe E500	21,85	34,15	49,17	66,93	87,42	136,59	213,43	349,56	546,36

The mechanical characteristics of the high adhesion rebars are defined in the NFA 35-016 and NFA 35-017 standards.

Anchorage length calculated from the bond strength

From the bond strength of the SPIT EPOBAR Resin, the table below gives the minimum anchorage length for rebar Fe E500, in concrete class \geq C20/25.

Nominal steel rebar \varnothing	$\varnothing 8$	$\varnothing 10$	$\varnothing 12$	$\varnothing 14$	$\varnothing 16$	$\varnothing 20$	$\varnothing 25$	$\varnothing 32$	$\varnothing 40$
Drilling \varnothing (mm)	10	12	15	18	20	25	30	40	50
Minimum anchorage length (mm)	120	150	180	210	245	305	380	485	605
Ultimate limit N_{Rd} (kN)	21,85	34,15	49,17	66,93	87,42	136,59	213,43	349,56	546,36
Nb. of sealing/cart. 410 ml	100	66	30	16	12	6	3	1,6	0,8
Nb. of sealing/cart. 825 ml	202	132	60	32	25	13	6	3,1	1,6



Calculation method

▪ Characteristic bond strength :

τ_{Rk} : 17,85 N/mm² issues from tests and from the calculation using the rebar diameter (available for rebar diameter Ø8 to Ø40 mm) [$\tau_{Rk} = \tau_{Rk,m} \times 0,75$].

▪ Design bond strength τ_{Rd} :

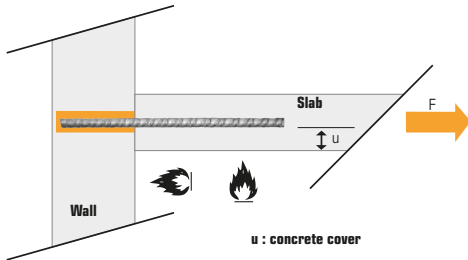
$$\tau_{Rk} = \frac{\tau_{Rk}}{\gamma_M = 2,16} \quad (\gamma_M : \text{safety partial factor})$$

▪ Calculation of the minimum anchorage length of the rebar :

$$l_s = \frac{A_s \cdot f_{yk}}{\Pi \cdot \varnothing_{rebar} \cdot \tau_{Rd}}$$

SPIT EPOBAR injection systems in wall to slab connection with concrete reinforcing bar and subjected to fire exposure according to the TEST REPORT ref. 26007642/a

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 in addition.

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

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

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

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

$E_{d,fi}$: Design effect of actions in the fire situation. This value could be calculated from the 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 L_s anchorage depth (ambient temperature condition)

η_{fi} : Reduction factor for design load level in the fire situation η_{fi} equal to 0,7

Rebar Ø (mm)	Drilling Ø (mm)	L_s (mm)	Design resistance F_{Rdu} (kN) for Fe E500 rebar according to ETA in concrete class C20/25	Maximum load (kN) for Fe E500 rebar in case of fire	Design resistance $R_{d,fi}$ (kN) in case of fire according to Eurocode 2 for fire duration of 30 to 240 minutes					
					Fire duration (minutes)					
					R30	R60	R90	R120	R180	R240
Concrete cover ⁽¹⁾ (mm)					10	20	25	35	50	70
8	10	120	6,9	16,2	6,3	2,7	1,6	1,2	0,8	0,9
		185	10,7		16,2	10,1	6,7	5,1	3,3	2,9
		220	12,7			16,2	11,3	8,8	6,0	4,9
		250	14,5				16,2	12,8	9,0	7,1
		275	15,9					16,2	12,1	9,3
		305	17,6						16,2	12,4
		340	19,7						16,2	
Concrete cover ⁽¹⁾ (mm)					10	20	25	35	50	70
10	12	140	10,1	25,3	10,1	5,3	3,4	2,4	1,5	1,4
		180	13,0		19,1	11,3	7,6	5,5	3,4	3,1
		205	14,8		25,3	15,8	11,1	8,3	5,3	4,7
		250	18,1			25,3	19,2	15,0	10,3	8,7
		280	20,2				25,3	20,7	14,6	12,2
		305	22,0					25,3	18,9	15,6
		340	24,6						25,3	21,2
		365	26,4						25,3	
Concrete cover ⁽¹⁾ (mm)					12	20	25	35	50	70
12	16	160	13,9	36,4	16,4	8,6	5,5	3,8	2,8	2,4
		230	19,9		36,4	23,3	17,0	11,9	9,0	7,0
		260	22,5			31,6	23,8	17,2	13,4	10,5
		280	24,3			36,4	28,9	21,4	16,9	13,3
		300	26,0				34,5	26,0	20,8	16,5
		310	26,9				36,4	28,5	22,9	18,2
		320	27,7					31,1	25,2	20,0
		340	29,5					36,04	30,1	24,0
		365	31,6						36,4	29,5
		380	32,9							33,1
		395	34,2						36,4	
Concrete cover ⁽¹⁾ (mm)					14	20	25	35	50	70
14	18	180	18,2	49,6	24,0	13,5	9,1	7,1	4,6	3,8
		250	25,3		49,6	32,5	25,0	21,6	15,1	11,8
		280	28,3			42,1	33,1	28,8	20,9	16,5
		305	30,9			49,6	40,0	35,3	26,3	21,1
		335	33,9				49,6	43,7	33,4	27,4
		360	36,4					49,6	39,9	33,2
		380	38,4						49,6	42,2
		425	43,0							49,6

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



Resistance to fire for steel reinforcement wall/slab

Rebar Ø (mm)	Drilling Ø (mm)	L _s (mm)	Design resistance F _{Rdu} (kN) for Fe E500 rebar according to ETA in concrete class C20/25	Maximum load (kN) for Fe E500 rebar in case of fire	Design resistance R _{d,fi} (kN) in case of fire according to Eurocode 2 for fire duration of 30 to 240 minutes						
					Fire duration (minutes)						
					R30	R60	R90	R120	R180	R240	
Concrete cover ⁽¹⁾ (mm)					10	20	25	35	50	70	
16	20	160	18,5	64,8	19,9	9,9	5,9	4,9	3,9	3,6	
		200	23,1		34,8	19,2	12,7	10,1	6,9	5,8	
		220	25,4		42,7	25,0	17,3	13,9	9,4	7,6	
		240	27,7		50,9	31,3	22,5	18,2	12,5	10,0	
		275	31,8		64,8	43,7	33,0	27,3	19,3	15,4	
		300	34,7			53,6	41,5	34,9	25,3	20,2	
		330	38,2			64,8	53,1	45,3	33,6	27,1	
		340	39,3				57,2	49,0	36,7	29,6	
		360	41,6				64,8	57,0	43,3	35,1	
		380	43,9					64,8	50,4	41,2	
		400	46,2						58,2	47,7	
		420	48,6						64,8	54,8	
450	52,0						64,8				
Concrete cover ⁽¹⁾ (mm)					20	20	25	35	50	70	
20	25	200	28,9	101,2	41,4	19,0	13,0	10,7	8,2	7,2	
		240	34,7		61,5	34,4	24,9	20,3	14,6	11,7	
		280	40,5		82,5	51,8	39,5	33,0	24,2	19,4	
		315	45,5		101,2	68,1	53,9	45,7	34,3	27,8	
		380	54,9			101,2	84,1	73,0	57,0	47,7	
		415	60,0				101,2	89,8	71,4	60,7	
		440	63,6					101,2	82,7	70,9	
		480	69,4						101,2	89,0	
		505	73,0							101,2	
Concrete cover ⁽¹⁾ (mm)					25	25	25	35	50	70	
25	30	250	45,2	158,1	86,6	44,2	28,4	23,3	17,5	15,2	
		310	56,0		128,3	79,1	57,3	50,5	36,5	30,3	
		360	65,0		158,1	110,2	84,8	75,9	57,3	48,1	
		400	72,3				136,3	108,6	98,1	76,4	64,9
		435	78,6				158,1	130,9	118,8	95,0	81,4
		480	86,7					158,1	147,2	121,4	105,1
		500	90,3						158,1	134,1	116,6
		540	97,5							158,1	140,9
		570	103,0								158,1
Concrete cover ⁽¹⁾ (mm)					32	32	32	35	50	70	
32	40	320	74,0	259	177,9	108,0	70,4	54,4	41,8	35,9	
		350	80,9		204,1	133,2	93,2	73,8	59,1	50,7	
		380	87,9		230,4	158,5	116,5	94,8	77,3	66,8	
		415	96,0		259,0	188,2	144,1	120,2	99,6	86,8	
		500	115,6				259,0	213,2	185,6	159,1	141,1
		555	128,3					259,0	230,8	201,5	180,6
		590	136,4						259,0	230,1	207,5
		625	144,5							259,0	235,8
		655	151,4								259,0
Concrete cover ⁽¹⁾ (mm)					40	40	40	40	50	70	
40	50	400	115,6	404,7	322,5	222,5	165,3	125,2	92,3	80,9	
		430	124,3		359,3	257,9	196,8	153,9	121,1	101,0	
		460	133,0		395,2	292,8	228,9	183,9	148,5	126,4	
		470	135,8		404,7	304,3	239,7	193,9	157,8	135,0	
		560	161,9				404,7	336,5	285,8	242,9	215,4
		625	180,6					404,7	361,2	312,2	284,0
		675	195,1						404,7	357,2	326,1
		725	209,5							404,7	377,1
		755	218,2								404,7

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

Example :

Application :

- Design of works for Ø16 rebar in park
- Requirement : fire duration 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

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

$$L_s = 397 \text{ mm}$$

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

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

SPIT EPOBAR injection systems in wall to beam connection with concrete reinforcing bar and subjected to fire exposure according the TEST REPORT n° 26007642/a from CSTB



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 SPIT EPOBAR resin, in concrete C20/25, in take into account the exposure on 3 sides.

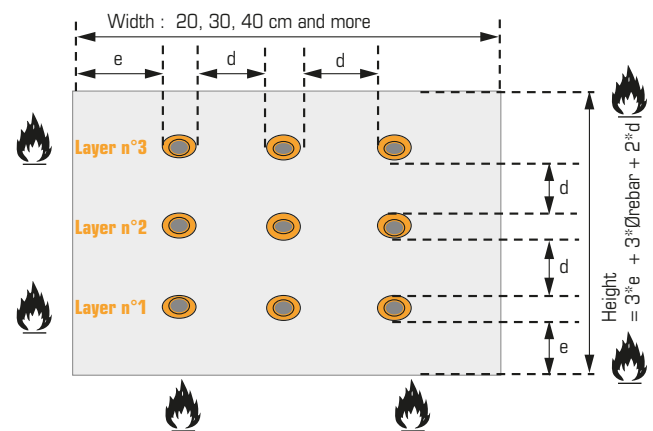
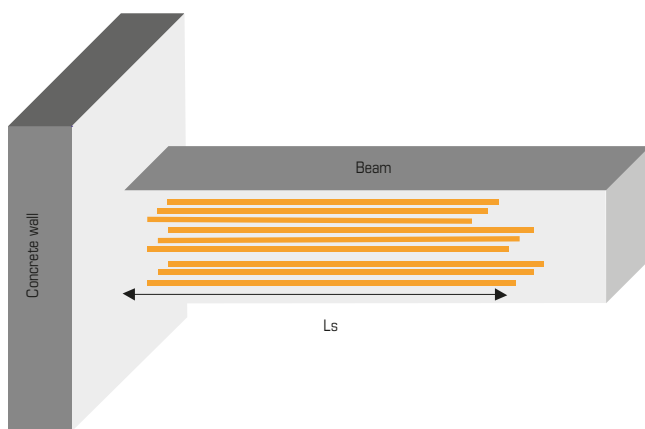
Design method for resistance to fire according to Eurocode 2: Fire proof using design resistance $R_{d,fi} \geq E_{d,fi}$

$R_{d,fi}$: 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 L_s anchorage depth (ambient temperature condition)

η_{fi} : Reduction factor for design load level in the fire situation η_{fi} equal to 0,7



Beam's width = 40 cm and more

Rebar \varnothing (mm)	Drilling \varnothing (mm)	Distance between layers (mm)	Rebar maximum load $R_{d,fi}$ in case of fire (kN)	Layers identification	Rebar anchorage depth (L_s in mm) for layers 1, 2 and 3 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	10	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	12	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	20	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	25	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	30	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
40	47	141	404,7	layer n°1	466	505	535	561	606	642
				layer n°2	454	487	513	537	579	617
				layer n°3	454	487	513	535	574	609



Beam's width = 30 cm

Rebar \varnothing (mm)	Drilling \varnothing (mm)	Distance between layers (mm)	Rebar maximum load $R_{d,fi}$ in case of fire (kN)	Layers identification	Rebar anchorage depth (L_s in mm) for layers 1, 2 and 3 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	10	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	12	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	215	250	275	307		
16	20	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	25	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	30	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		
40	47	141	404,7	layer n°1	465	503	530	562		
				layer n°2	453	486	509	541		
				layer n°3	453	485	508	540		

Beam's width = 20 cm

Rebar \varnothing (mm)	Drilling \varnothing (mm)	Distance between layers (mm)	Rebar maximum load $R_{d,fi}$ in case of fire (kN)	Layers identification	Rebar anchorage depth (L_s in mm) for layers 1, 2 and 3 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	10	60	16,2	layer n°1	169	207	236			
				layer n°2	159	195	226			
				layer n°3	157	192	223			
10	12	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	20	60	64,8	layer n°1	244	284	316			
				layer n°2	233	272	306			
				layer n°3	232	269	303			
20	25	75	101,2	layer n°1	281	321	353			
				layer n°2	269	307	342			
				layer n°3	269	306	340			
25	30	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			
40	47	141	404,7	layer n°1	465	505	538			
				layer n°2	453	490	525			
				layer n°3	453	490	525			

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