CSTB
le futur en construction

fischer injection system EB II for post-installed rebar connections under fire conditions

Fire Evaluation Report No. SMP AI21FISCHQ-04529 D

23/12/2021 – CSTB/SMP/Omar Al-Mansouri

EVALUATION REPORT No. SMP AI21FISCHQ-04529 D

on fischer injection system EB II injection system
for post-installed rebar connections under fire conditions

according to EAD 330087-01-0601

REQUESTED BY:

Fischerwerke GmbH & Co. KG

Otto-Hahn-Straße 15

79211 Denzlingen

Germany

The laboratories of the SAFETY, STRUCTURES, and FIRE Department of the CSTB Experimentation Division are accredited by COFRAC's Test Section, French Accreditation Committee, for the following programs, defined in Agreement 1-0301:

- No. 3 (tests on hydraulic concrete and its components)

- No. 39, part 2 (tests of mechanical fastening elements, tests of expansion anchors)

"As a signatory to the ILAC MRA, ICBO ES recognizes the technical equivalence of COFRAC accreditation of CSTB for the tests contained in this report."

Conference of Building Officials (ICBO):5360 Workman Mill Road Whittier, CA 90601 USA

The reproduction of this report is only authorized in the form of an integral photographic facsimile, unless otherwise specified by CSTB.

This report comprises 26 pages numbered from 1/26 to 26/26.

Table of content

1. Topic

When subjected to fire conditions, construction elements performances are reduced by the effect of the temperature increase. At the fischer company request, CSTB has performed a study aimed at the evaluation of the fire behaviour of the fischer injection system EB II used in conjunction with concrete reinforcing bars (d 8 to 32 mm).

The present study is aimed at supplying data for the design of the injection anchoring system when exposed to fire. This report presents values of bond capacities and load capacities respectively for an overlap joint application and for an anchorage application using the mortar product injection system EB **II**.

WARNING
This report does not deal with the mechanical design at ambient temperature; neither does it deal with the design according to other accidental solicitations. Design at ambient temperature shall be carried out before fire design.

2. References

2.1. Laboratories referred to in the Evaluation report

Main Institutes and laboratories referred to in this report:

CSTB (Centre Scientifique et Technique du Bâtiment)

84 avenue Jean Jaurès, Champs sur Marne, 77 447 Marne la Vallée, Cedex 2, France

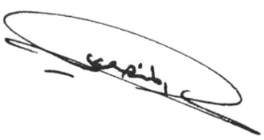
2.2. Literature

[1]	EAD 330087-01-0601, Systems for post-installed rebar connections with mortar, December 2020.
[2]	Test report No. EEM 21-04529-A On fire testing of post-installed rebar connections with FIS EB II injection mortar, November 2021.
[3]	EN 1991-1-2. Eurocode 1, Part 1-2: Actions on structures: general actions – actions on the structures exposed to fire. 2002.
[4]	EN 1992-1-1. Eurocode 2, Part 1-1: Design of concrete structures - General rules and rules for buildings. 2005.
[5]	EN 1992-1-2. Eurocode 2, Part 1-2: Design of concrete structures – General rules and structural fire design. 2005.
[6]	Evaluation report No. SMP AI21FISCHQ-04529 C – fischer injection system FIS EB II for post-installed rebar connections under fire conditions, December 2021.
[7]	Test report No. 21DE-03232 On specific rib area of rebars according to EN ISO 15630-1:2011-02, December 2021.

3. Author

Marne-la-Vallée, France

On December 23, 2021

Studies and Assessment Engineer

Dr. Eng. Omar Al-Mansouri

4. Background

4.1. Fire design method

Fire design is performed with three steps:

1) First, an experimental program of pull-out tests at high temperatures (test series 18 according to EAD 330087-01-0601 [1]) is carried out to determine the relationship between bond strength and temperature [2]. This relationship is then expressed by a temperature reduction factor $0 < k_{fi}(\theta) < 1$ which describes the decrease of resistance of the bond system (see Section 5).
2) Secondly, a thermal calculation using the method described in EN 1991-1-2, Section 3 [3] is performed to determine the temperature distribution along the post-installed rebar for each fire duration and for a given structural configuration.
3) Finally, at each time during the exposure to fire conditions, the values of bond strength are determined along the post-installed rebar. For the anchor application, the bond resistance is calculated by integrating the bond resistances along the embedded depth.

Figure 4-1 presents the steps of the fire design method and the corresponding sections of the report.

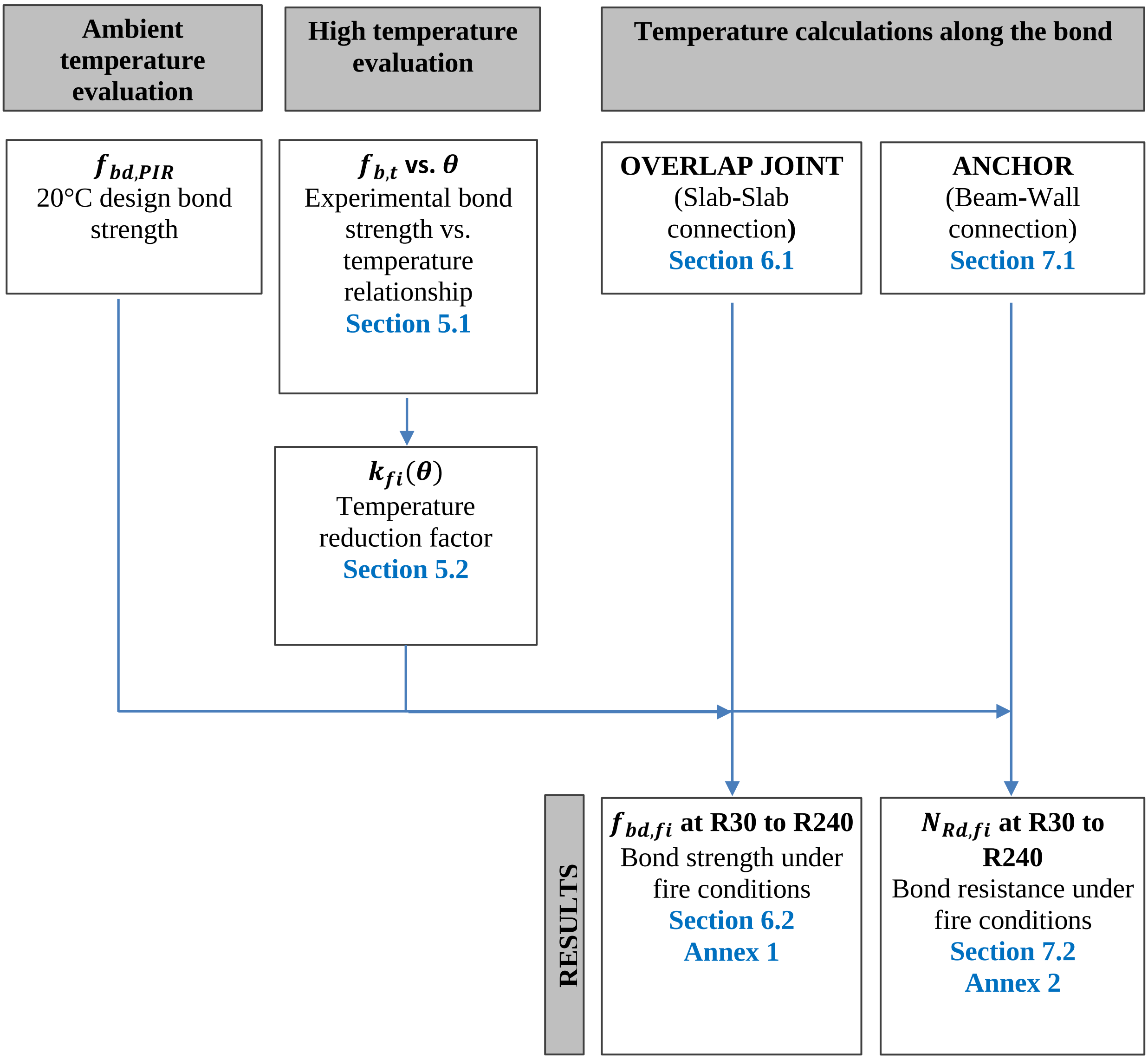


Figure 4-1: Used method for fire design of post-installed rebars

The design covers two structural uses of post-installed rebars in concrete (Figure 4-2): i) the overlap joint application and ii) the anchor application.

i. In the overlap joint application for a slab-slab configuration where the lower surface is exposed to fire conditions, the temperature is uniform. The bond resistance is uniform along the embedment depth and depends on the concrete cover and the duration of the fire (Section 6.2).

ii. In the anchor application for a beam-wall configuration where at least one side of the wall is exposed to fire, the temperature along the embedment depth (inside the wall) is not uniform. This leads to different bond strength values and the bond resistance of the connection is calculated by integration of the bond resistances along the segments of the rebar (Section 7.2).

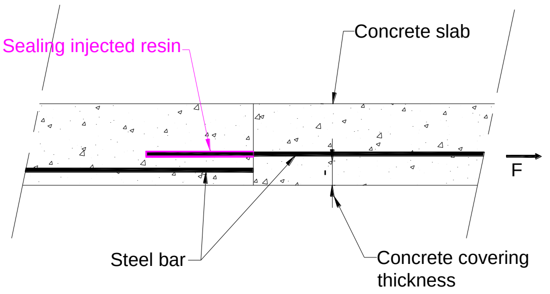
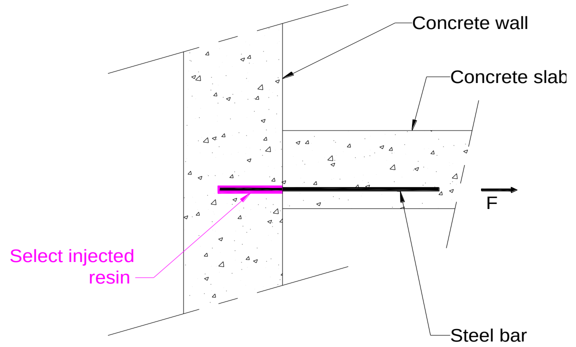
Overlap joint (Slab-Slab connection)	**Anchor (Beam-Wall connection)**
	

Figure 4-2: Sketches of a Slab-Slab connection (left) and of a Beam-Wall connection (right)

4.2. Scope of application

The values of bond strength and bond resistance presented in this report are applicable for given parameters: Concrete class, structural configuration, fire duration, bar diameter, bond length, concrete cover and maximum temperatures. The result tables are provided in annexes 1 and 2.

i. Concrete class

The fire evaluation is applicable for C20/25 concrete. According to the EAD [1], the design bond strength for a cast-in rebar in C20/25 concrete is $f_{bd,PIR} = 2.30\ N/mm^2$ for bar diameters between 8 and 32 mm.

ii. Structural configuration

Fire design covers slab-slab and beam-wall configurations for beams with a width higher than 40 cm. The bond strength of the slab-slab configuration **SHALL NOT** be applied to a beam-beam configuration.

iii. Fire duration

The bond strength and bond resistance values are provided for 30, 60, 90, 120, 180 and 240 min of exposure to standard ISO 834-1 fire conditions. The thermal loading is calculated using the method described in EN 1991-1-2, Section 3 [3].

iv. Bar diameter

The fire design covers steel rebars with diameters of 8, 10, 12, 14, 16, 20, 25, 28 and 32 mm with a yield strength of $f_y = 500\ N/mm^2$.

v. Anchorage length

For the slab-slab configuration, the bond strength values are provided. The calculation of the anchorage length shall be carried out in accordance with EN 1992-1-1, Section 8 [4].

For the beam-wall connection, the load capacities are calculated for lengths between the minimum length $l_{b,min}$ and the maximum anchorage length conditioned by the yielding of steel. The minimum anchorage length $l_{b,min}$ is calculated in accordance with EN 1992-1-1, Section 8 [4] (see equation below).

$$l_{fi,min} = l_{b,min} = \max\left(0,3 \cdot l_{b,rqd}; 10 \cdot d; 100\ mm\right)$$

Where:

$l_{b,rqd}$ is the basic required anchorage length

$$l_{b,rqd} = \frac{d}{4} \cdot \frac{\sigma_{sd}}{f_{bd,PIR}} = \frac{d}{4} \cdot \frac{f_{yk}}{\gamma_S \cdot f_{bd,PIR}}$$

Where:

f_{yk} = 500 N/mm² is the characteristic steel yield strength of the rebar

γ_s = 1,15 is the partial safety factor for steel

$f_{bd,PIR}$ = 2,3 N/mm² is the design bond strength in C20/25 concrete

d = the diameter of the rebar

$$N_{sd} = \frac{f_{yk}}{\gamma_s} \cdot \pi \cdot \left(\frac{d}{2}\right)^2$$

Where:

f_{yk} = 500 N/mm² is the characteristic steel yield strength of the rebar

N_{sd} = the design steel strength of the rebar

γ_s = 1,15 is the partial safety factor for steel

d = the diameter of the rebar

Table 4-1 presents the minimum anchorage length and steel yield strength values.

Rebar diameter	[mm]	**8**	**10**	**12**	**14**	**16**	**20**	**25**	**28**	**32**
Required anchorage length $l_{b,rqd}$	[mm]	290	362	435	507	580	725	906	1014	1159
Minimum anchorage length $l_{b,min}$	[mm]	100	109	130	152	174	217	272	304	348
Design yield strength of the steel rebar	[kN]	16,8	26,2	37,7	51,3	67,0	104,7	163,6	205,3	268,1

Table 4-1: Minimum anchorage length and steel strength

vi. Concrete cover

Choice of the concrete cover shall be carried out in accordance with EN 1992-1-1, Section 4 [4]. In this evaluation, concrete cover is only considered for the thermal protection it brings to the rebar.

For the slab-slab configuration, bond strength values are provided for different concrete covers starting at 40 mm.

For the beam-wall connection, the concrete cover in the beam influences the temperature distribution along the rebar in the thickness of the wall. The bond resistance values are provided for concrete covers inside the beam of 10, 20, 30 and 40 mm. Results are only provided for concrete covers larger than the diameter of the bar in accordance with EN 1992-1-1, Section 4 [4].

vii. Maximum temperatures

In accordance with EN 1992-1-2, Section 5 [5], steel resistance remains constant between 20°C and 350°C for bar laminated at high temperature. Therefore, resistances are only considered along the parts of the bond below 350°C. Furthermore, the resistance is considered equal to zero above the temperature θ_{max} (described in Section 5.1) linked to the mortar behavior.

5. Bond strength vs. temperature relationship

5.1. Experimental bond strength

A pull-out test campaign was carried out at high temperature on a minimum of 20 samples using rebars with a diameter of 12 mm and an embedment depth of 120 mm (test series 18 according to EAD 330087-01-0601 [1]). The test procedure and results of this campaign are described in the test report [2]. The installation was conducted according to the Manufacturer's Printed Installation Instructions (MPII) using hammer drilling with carbide drill bit (nominal drill bit diameter = 16 mm) set in rotation hammer mode and manual cleaning using only the fischer blow out pump AB G: blowing twice, brushing twice (steel brush diameter = 20 mm) and blowing twice. Injection of the mortar was conducted without extension tube after placing the cartridge in a manual dispenser. The evalution of these tests is reported in [6].

The experimental bond strength values $f_{b,t}$ are determined directly from the applied load N_{test} using the following equation.

$$f_{b,t} = \frac{N_{test}}{\pi \cdot d \cdot l_v} \cdot \left(\frac{0{,}08}{f_R}\right)^{0,4}$$

Where:

$f_{b,t}$ is the bond strength

N_{test} is the applied load during the heating

d is the bar diameter

l_v is the embedment length

f_R is the relative rib area of the tested rebar according to EN ISO 15630-1, see report [7]

For the fischer injection system EB II, the a, b and θ_{max} parameters are presented in Table 5-2.

The load values were chosen during the test campaign to ensure that the maximum distance between two data points was lower than 1,0 N/mm² and lower than 50°C between two neighboring data points. Figure 5-1 presents the experimental bond strength vs. temperature. A power trend curve is used to best describe the bond strength vs. temperature relationship analytically using the fallowing equation (see justification in Table 5-1).

Trend curve	Equation	cv
Power trend	$f_{bm}(\theta) = a \cdot \theta^{-b}$	35,27%
Exponential trend	$f_{bm}(\theta) = a \cdot e^{-b \cdot \theta}$	60,78%

Table 5-1: Justification for choice of trend curve

$$f_{bm}(\theta) = a \cdot \theta^{-b}$$

Where:

$f_{bm}(\theta)$ is the mean bond strength at the temperature θ (in N/mm²)

θ is the temperature of the bond

a and b are the power fitting curve constants

The maximum temperature reached during the tests is identified as θ_{max}. For the fischer injection system EB II, θ_{max} was calculated as the mean of the maximum three tested temperatures.

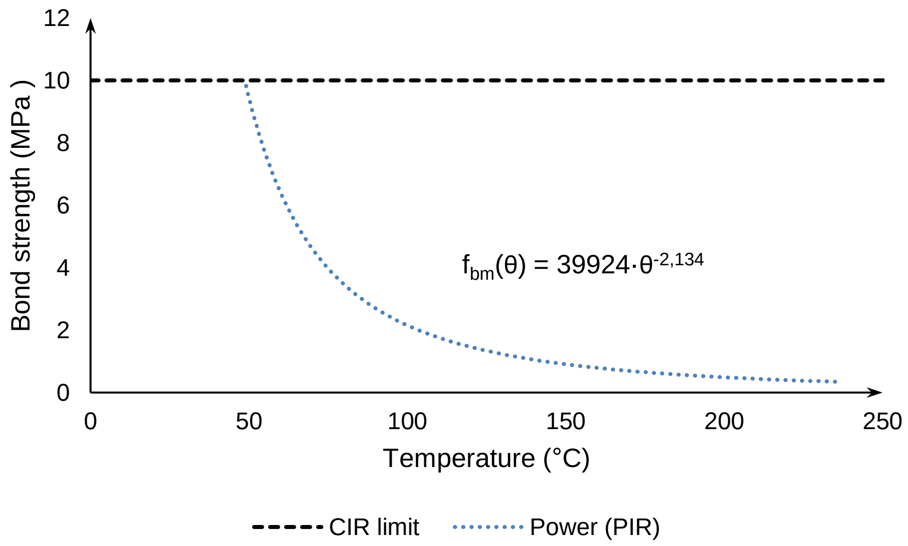


Figure 5-1: Bond strength vs. temperature relationship

For the injection system EB II injection system, the a, b and θ_{max} parameters are presented in Table 5-2.

$f_{bm}(\theta)$ parameters	
a	39924
b	2,134
θ_{max}	200°C

Table 5-2: Parameters of the mean bond strength vs. temperature curve

5.2. Temperature reduction factor

The temperature reduction factor $k_{fi}(\theta)$ is determined from the fitted curve $f_{bm}(\theta)$ to describe the variation of bond strength with temperature. It is calculated using the following equations.

$$k_{fi}(\theta) = \frac{f_{bm}(\theta)}{f_{bd,PIR} \cdot 4{,}3} \leq 1 \quad for \quad 20°C \leq \theta \leq \theta_{max}$$

$$k_{fi}(\theta) = 0 \quad for \quad \theta > \theta_{max}$$

Where:

$k_{fi}(\theta)$	= temperature reduction factor
$f_{bm}(\theta)$	= the mean bond strength at the temperature θ
$f_{bd,PIR}$	= 2,3 N/mm² for C20/25
θ	= the temperature of the bond
θ_{max}	= maximum temperature measured during the tests

Figure 5-2 presents the variation of the temperature reduction factor vs. temperature for the fischer injection system EB II.

No extrapolation beyond test temperatures is allowed. For temperatures higher than the maximum measured temperature during the tests (θ_{max}), the reduction factor $k_{fi}(\theta)$ is equal to zero.

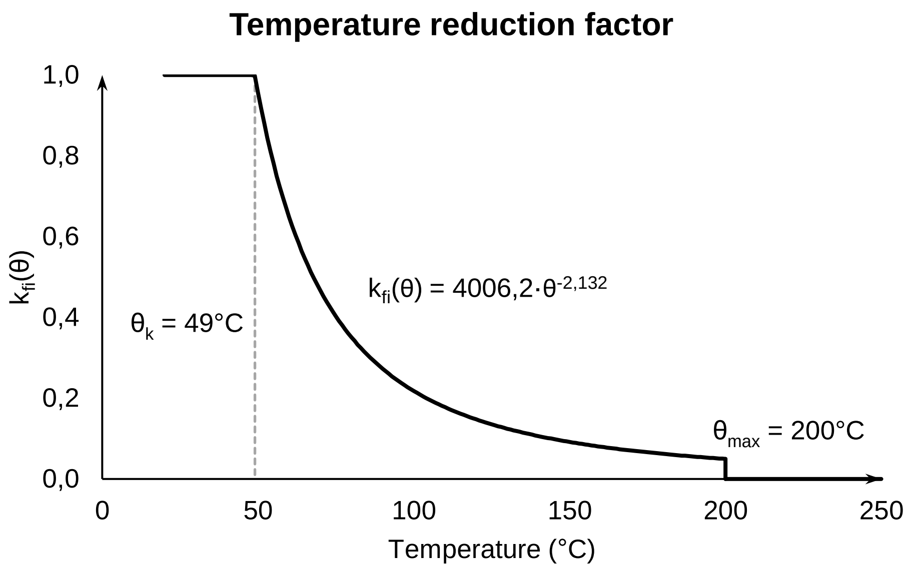


Figure 5-2: Temperature reduction factor $k_{fi}(\theta)$ vs. temperature θ

6. Overlap joint application

6.1. Temperature fields

The knowledge of the fire behaviour of traditional concrete structures to assess the temperature distribution for every fire duration by modeling the thermal exchanges inside concrete elements. The temperature profile depends on the configuration of the connection: slab-slab or beam-wall. These temperatures are calculated using the finite element method in accordance with EN 1991-1-2, Section 3 [3] with the CAST3M software.

At the initial time (t=0) every element temperature is supposed equal to 20°C.

The fire is modeled by a heat flux on the boundaries of the structure. The standard temperature-time curve is used for the temperature analysis at the fire exposed surfaces (EN 1991-1-2, Section 3 [3]).

$$\theta_g = 20 + 345 log_{10}(8t + 1)$$

Where:

θ_g is the gas temperature in the fire compartment

t is the time (min)

On the boundaries, the net heat flux $\dot{h}_{net}$ should be determined by considering heat transfer by convection and radiation as:

$$\dot{h}_{net} = \dot{h}_{net,c} + \dot{h}_{net,r} \quad \text{(W/m}^2\text{)},$$

Where:

convective heat flux: $\dot{h}_{net,c} = \alpha_c \cdot (\theta_g - \theta_m)$ (W/m²),

radiative heat flux: $\dot{h}_{net,r} = \phi \cdot \varepsilon_m \cdot \varepsilon_f \cdot \sigma \cdot (\theta_r^4 - \theta_m^4)$ (W/m²).

Where:

ϕ is the configuration factor (= 1,0)

ε_m is the emissivity of the concrete member (= 0,7)

ε_f is the emissivity of the fire (= 1,0)

σ is the Stefan Boltzmann constant (= $5{,}67 \cdot 10^{-8}$ W/m²K⁴)

θ_s is the surface temperature of the member (°C)

θ_r is the effective radiation temperature of the fire (°C)

α_c is the coefficient of heat transfer by convection (= 25 W/m²K for the fire exposed surfaces; = 4 for the unexposed surfaces)

In this study, only concrete is considered in the thermal calculation (EN 1992-1-2, Section 4 [5]). The concrete thermal properties are provided by EN 1992-1-2, Section 3 [5]. The variations of thermal conductivity, mass density and specific heat are represented in Figure 6-1. The peak of the specific heat corresponds to a concrete having a water percentage of 1,5% in accordance with EN 1992-1-2, Annex A [5].

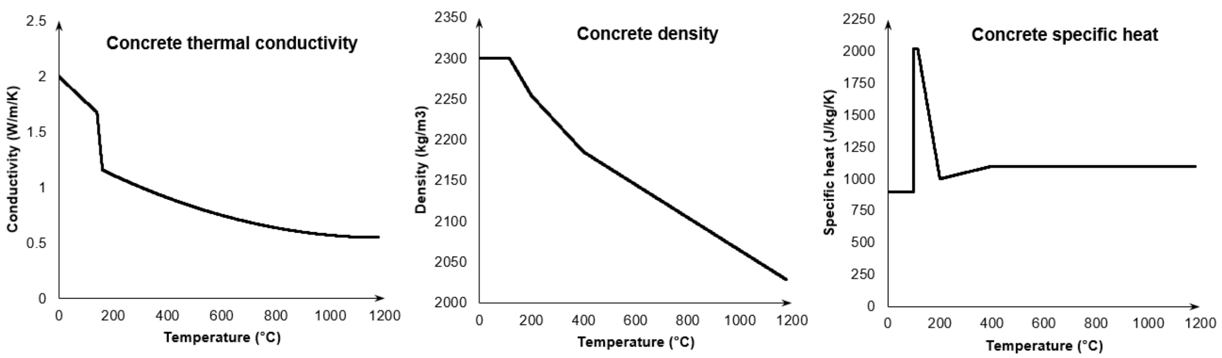


Figure 6-1: Variations of thermal conductivity, density and specific heat of concrete according to EN 1992-1-2 [5]

For a slab-slab connection (Figure 4-2), the thermal calculation is carried out on a two-dimensional mesh by applying the fire heat flux as boundary condition on the lower surface. No boundary condition at 20°C is applied on the upper surface to be conservative.

The isotherms are horizontal implying that the temperature is uniform along the bonding interface and equal to the temperature in a slab at a depth equivalent to the concrete cover. Figure 6-2 presents the temperature versus concrete cover at 0, 30, 60, 90, 120, 180 and 240 min during an ISO 834-1 fire. The same temperature curves are provided in EN 1992-1-2, Annex A [5].

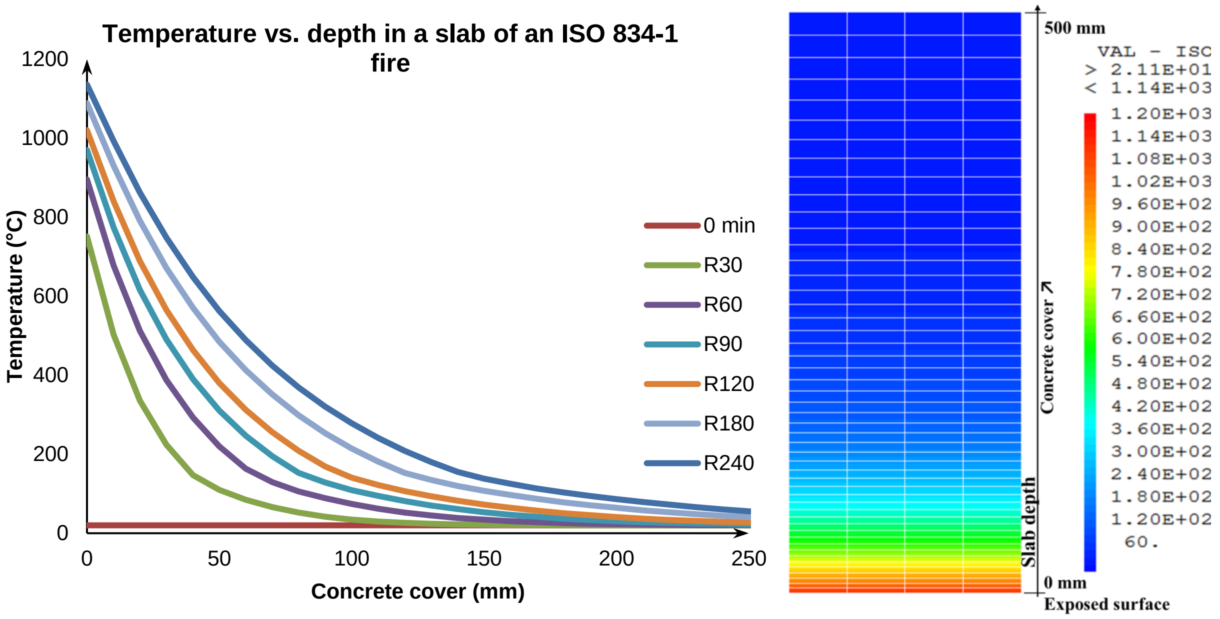


Figure 6-2: Temperature vs. concrete cover temperature at 0, 30, 60, 90, 120, 180 and 240 min during an ISO 834-1 fire

6.2. Design bond strength

From the temperature curves (Section 6.1, Figure 6-2) and the temperature reduction factor $k_{fi}(\theta)$ (Section 5.2, **Error! Reference source not found.**), the values of the design bond strength $f_{bk,fi}$ are d etermined using the following equation.

$$f_{bd,fi}(\theta) = k_{fi}(\theta) \cdot f_{bd,PIR} \cdot \gamma_c / \gamma_{M,fi}$$

Where:

$f_{bd,fi}(\theta)$	is the design bond strength that depends on temperature
$f_{bd,PIR}$	= 2,3 for C20/25 concrete is the design bond strength at 20°C
$\gamma_{M,fi}$	= 1,0 is the partial safety factor for concrete in fire design
γ_c	= 1,5 is the partial safety factor for concrete at ultimate state for persistent & transient design situations
$k_{fi}(\theta)$	is the temperature reduction factor

Annex 1 presents values of the design bond strength for different concrete covers at 30, 60, 90, 120, 180 and 240 min during an ISO 834-1 fire.

The partial safety factor for concrete in fire design is equal to 1,0 according to EN 1992-1-2, Section 2 [5], while the partial safety factor for concrete at ultimate state for persistent & transient design situations is equal to 1,5. This leads to obtaining higher values of bond resistances at the beginning of a fire in fire design in comparison to ambient temperature design for the same rebar geometry. Design at ambient temperature shall be carried out before fire design.

7. Anchor application (beam-wall connection)

7.1. Temperature fields

For a beam-wall connection (Figure 4-2) where the post-installed rebar is installed inside the wall, where temperature gradient exists along the thickness of the wall. The temperature along the embedment depth is not uniform and depends on the fire duration. Therefore, the temperature profiles along the embedment depth are determined for each fire duration, for each embedment length and for the concrete cover inside the beam of 10, 20, 30 and 40 mm.

A three-dimensional mesh was used. Due to symmetry considerations only half of the structure is meshed (Figure 7-1). The same calculation parameters (material thermal and physical properties, standard temperature-time curve, convective and radiative heat fluxes) as the ones described in Section 6.1 are applied.

The boundary conditions are:

- On the lower and lateral sides of the beam: convection and radiation of the ISO 834-1 fire are applied to the elements.
- On the side of the wall where the beam is connected: convection and radiation of the ISO 834-1 fire are applied to the elements.
- No heat exchange condition is applied on the other sides (adiabatic surfaces).

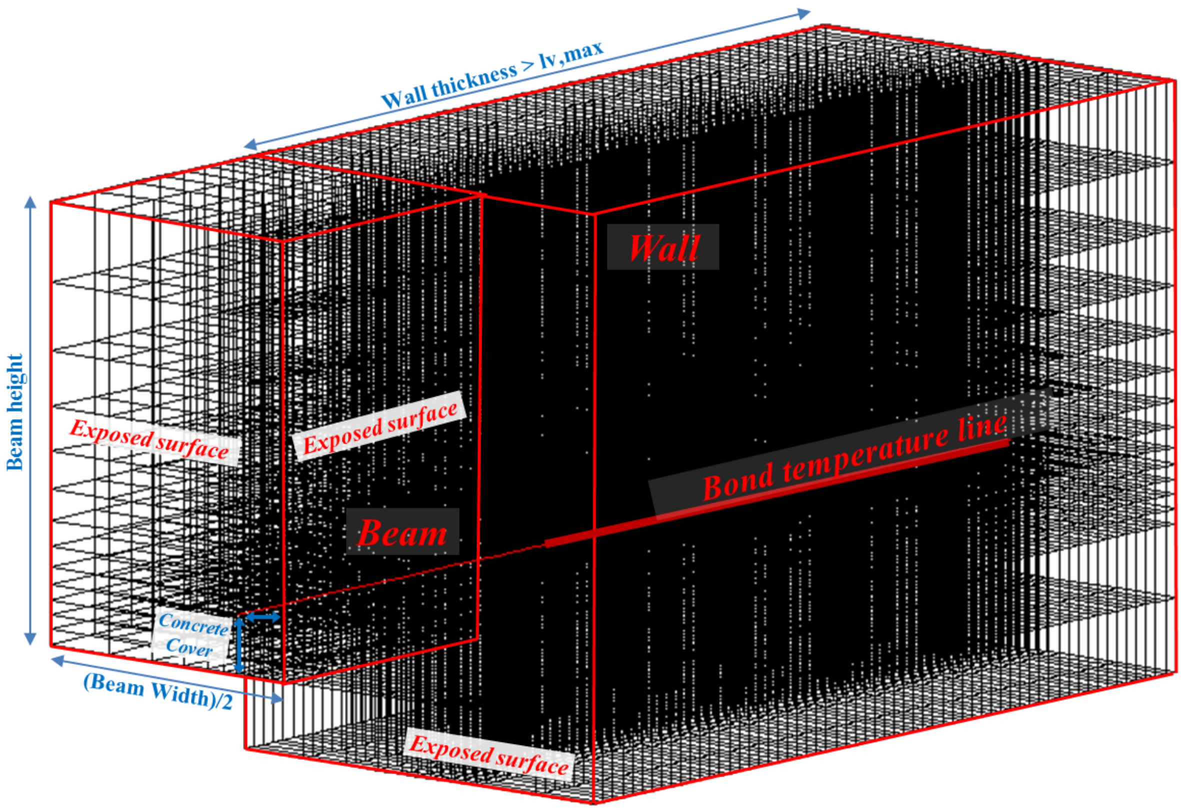


Figure 7-1: Used mesh for thermal calculations for the beam-wall connection

Figure 7-2 presents the calculated thermal fields at 30, 90 and 240 min. The geometry of the mesh of the beam used for calculations is taken large enough so that the isotherms at 240 min of heating are parallel to the concrete surfaces (Figure 7-2). This implies that the same temperature profiles along the embedment depth of the post-installed rebar would be obtained for larger and higher beams. The beam height was equal to 300 mm and the beam width was equal to 400 mm.

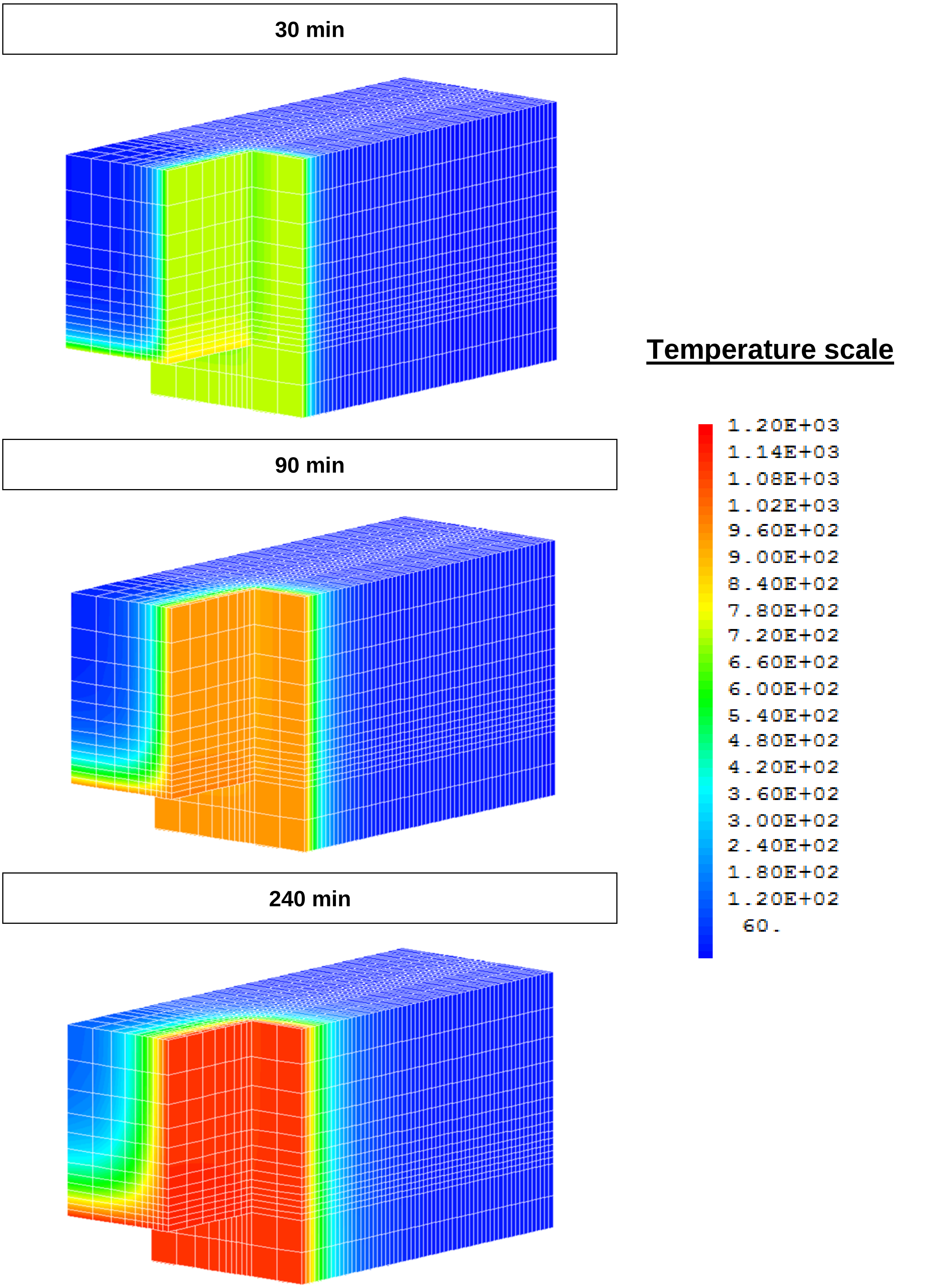


Figure 7-2: Temperature fields at 30, 90 and 240 min during an ISO 834-1 fire for the beam-wall connection

7.2. Design bond resistances

From the calculated temperature profiles and from the temperature reduction factor $k_{fi}(\theta)$ (Section 5.2, **Error! Reference source not found.**), the values of design load capacities $N_{Rd,fire}$ are determined by i ntegration of the design bond resistances.

$$N_{Rd,fi} = \pi \cdot d \cdot \int_0^{l_v} f_{bd,fi}(\theta(x)) \cdot dx = \pi \cdot d \cdot f_{bd,PIR} \cdot \frac{\gamma_c}{\gamma_{M,fi}} \cdot \int_0^{l_v} k_{fi}(\theta(x)) \cdot dx$$

Where:

$N_{Rd,fi}$ is the design bond resistance at a given time during the fire

$f_{bd,PIR}$ = 2,3 for C20/25 concrete is the design bond strength at 20°C

$\gamma_{M,fi}$ = 1,0 is the partial safety factor for concrete in fire design

γ_c = 1,5 is the partial safety factor for concrete at ultimate state for persistent & transient design situations

$k_{fi}(\theta)$ is the temperature reduction factor

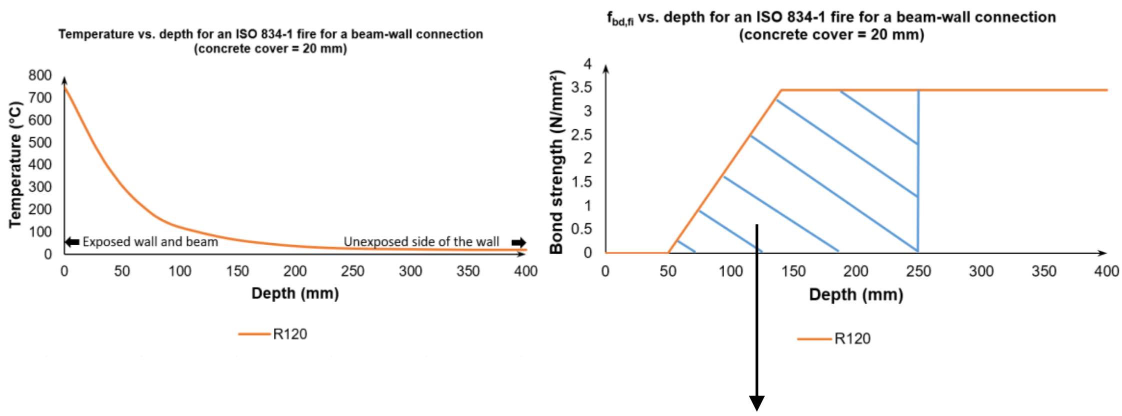
l_v is the embedment depth of the post-installed rebar

The integration is performed by finite differences using the following equation.

$$N_{Rd,fi} \approx \pi \cdot d \cdot f_{bd,PIR} \cdot \frac{\gamma_c}{\gamma_{M,fi}} \cdot \sum_0^{l_v} k_{fi}(\theta_i) \cdot \Delta x$$

For the calculation, the value of Δx was taken equal to 10 mm and the maximum temperature reduction factor $k_{fi}(\theta_i)$ on the length of Δx was taken into account.

Figure 7-3 presents a general example (not from the injection system EB II mortar) of the calculation of the design bond resistance by integration of $f_{bd,fi}(\theta)$ on a bond length of 250 mm by using the temperature profile along the bond at 120 min during an ISO 834-1 fire with a concrete cover of 20 mm in the beam.



$$N_{Rd,fi} = \pi \cdot d \cdot \int_0^{250} f_{bd,fi}(\theta) \cdot dx$$

Figure 7-3: General example of the calculation of the design bond resistance by integration of $f_{bd,fi}$

Annexes 2.1, 2.2, 2.3 and 2.4 present the values of $N_{Rd,fi}$ at different fire durations for different bond lengths respectively for concrete covers of 10 mm, 20 mm, 30 mm and 40 mm. The minimal and maximum values of bond lengths are in accordance with Section 4.2.

8. List of annexes

Annex 1: Design bond strength for an overlap joint application (slab-slab connection)

Annex 2.1: Design bond resistances for an anchoring application (beam-wall connection) with a concrete cover of 10 mm for diameters 8 and 10 mm

Annex 2.2: Design bond resistances for an anchoring application (beam-wall connection) with a concrete cover of 20 mm for diameters 8, 10, 12, 14, 16 and 20 mm

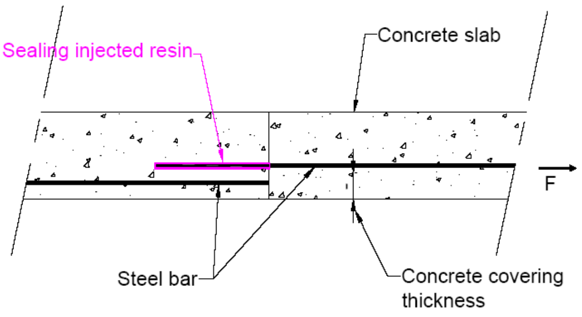
Annex 2.3: Design bond resistances for an anchoring application (beam-wall connection) with a concrete cover of 30 mm for diameters 8, 10, 12, 14, 16, 20, 25 and 28 mm

Annex 2.4: Design bond resistances for an anchoring application (beam-wall connection) with a concrete cover of 40 mm for diameters 8, 10, 12, 14, 16, 20, 25, 28 and 32 mm

Annex 1: Maximum applicable bond strength for an overlap joint application

The table presents design bond strength (f_{bd}) for a **Slab-Slab connection** using **C20/25 concrete** and rebars with a yield strength f_y = **500 N/mm²** in an **ISO 834-1 fire** (at 30, 60, 90, 120, 180 and 240 min) for concrete covers between 30 and 230 mm.

The bond strength values shall not be applied for beam-beam connections. Post-installed rebars shall be designed in ambient temperature conditions before being designed in fire conditions.



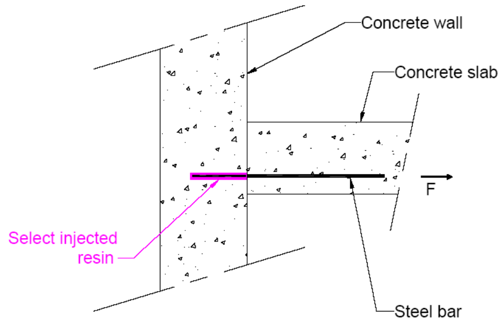
Fire Design Bond Strength $f_{bd,fi}$ (N/mm²)						
Concrete Cover (mm)	**R30**	**R60**	**R90**	**R120**	**R180**	**R240**
40	0,3	0,0	0,0	0,0	0,0	0,0
50	0,6	0,0	0,0	0,0	0,0	0,0
60	1,1	0,3	0,0	0,0	0,0	0,0
70	1,8	0,4	0,2	0,0	0,0	0,0
80	3,0	0,7	0,3	0,0	0,0	0,0
90	3,5	1,0	0,4	0,2	0,0	0,0
100	3,5	1,4	0,6	0,4	0,0	0,0
120	3,5	2,9	1,2	0,7	0,3	0,0
140	3,5	3,5	2,1	1,1	0,5	0,3
160	3,5	3,5	3,5	1,9	0,8	0,5
180	3,5	3,5	3,5	3,2	1,2	0,7
200	3,5	3,5	3,5	3,5	1,9	1,0
220	3,5	3,5	3,5	3,5	2,9	1,5
240	3,5	3,5	3,5	3,5	3,5	2,2
260	3,5	3,5	3,5	3,5	3,5	3,1
280	3,5	3,5	3,5	3,5	3,5	3,5

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.

Annex 2.1: Maximum applicable loads for an anchoring application (beam-wall connection) with a concrete cover of 10 mm for diameters 8 and 10 mm

The table presents design bond resistances $(N_{Rd,fi})$ for a **Beam-Wall connection** using **C20/25 concrete** and rebars with a yield strength f_y = **500 N/mm²** in an **ISO 834-1 fire** (at 30, 60, 90, 120, 180 and 240 min) for a **concrete cover of 10 mm** and for diameters 8 and 10 mm.

The design load values may be used safely for a slab-wall connection. Post-installed rebars shall be designed in ambient temperature conditions before being designed in fire conditions.



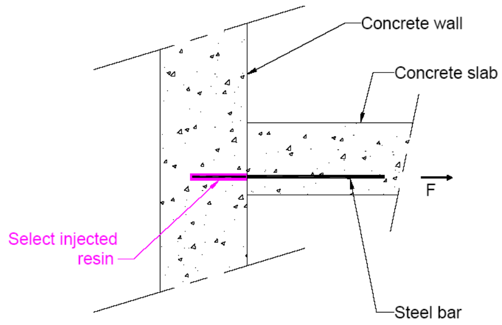
Concrete Cover = 10 mm		Fire Design Bond Resistance $N_{Rd,fi}$ (kN)					
Diameter (mm)	**Length l_v (mm)**	**R30**	**R60**	**R90**	**R120**	**R180**	**R240**
8	**100**	3,9	1,3	0,0	0,0	0,0	0,0
	140	7,4	4,5	2,3	1,2	0,0	0,0
	180	10,9	8,0	5,8	3,9	1,7	0,9
	220	14,4	11,5	9,2	7,4	4,3	2,3
	260	15,2	14,9	12,7	10,9	7,8	5,2
	300	16,1	16,8	16,2	14,3	11,3	8,7
	320	16,8	16,8	16,8	16,1	13,0	10,4
	350	16,8	16,8	16,8	16,8	15,6	13,0
	390	16,8	16,8	16,8	16,8	16,8	16,5
	420	16,8	16,8	16,8	16,8	16,8	16,8
10	**110**	6,0	2,4	1,0	0,5	0,2	0,0
	140	9,3	5,7	2,9	1,5	0,6	0,0
	180	13,6	10,0	7,2	4,9	2,1	1,1
	220	17,9	14,3	11,6	9,2	5,4	2,9
	250	21,2	17,6	14,8	12,5	8,7	5,4
	280	24,4	20,8	18,1	15,7	11,9	8,7
	310	26,2	24,1	21,3	19,0	15,2	12,0
	340	26,2	26,2	24,6	22,2	18,4	15,2
	370	26,2	26,2	26,2	25,5	21,7	18,5
	400	26,2	26,2	26,2	26,2	24,9	21,7
	430	26,2	26,2	26,2	26,2	26,2	25,0
	470	26,2	26,2	26,2	26,2	26,2	26,2

Calculations are carried out taking the minimum concrete cover (CSTB report n°26048096). Intermediate values may be interpolated linearly. Extrapolation is not possible. 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.

Annex 2.2: Maximum applicable loads for an anchoring application (beam-wall connection) with a concrete cover of 20 mm for diameters 8, 10, 12, 14, 16 and 20 mm

The table presents design bond resistances $(N_{Rd,fi})$ for a **Beam-Wall connection** using **C20/25 concrete** and rebars with a yield strength f_y = **500 N/mm²** in an **ISO 834-1 fire** (at 30, 60, 90, 120, 180 and 240 min) for a **concrete cover of 20 mm** and for diameters 8, 10, 12, 14, 16 and 20 mm

The design load values may be used safely for a slab-wall connection. Post-installed rebars shall be designed in ambient temperature conditions before being designed in fire conditions.



Concrete Cover = 20 mm		Fire Design Bond Resistance $N_{Rd,fi}$ (kN)					
Diameter (mm)	**Length l_v (mm)**	**R30**	**R60**	**R90**	**R120**	**R180**	**R240**
8	**100**	4,2	1,4	0,0	0,0	0,0	0,0
	150	8,5	5,6	3,4	1,8	0,8	0,0
	190	12,0	9,1	6,9	5,0	2,3	1,2
	230	15,5	12,5	10,3	8,4	5,4	3,0
	260	16,8	15,1	12,9	11,0	8,0	5,4
	290	16,8	16,8	15,5	13,7	10,6	8,0
	320	16,8	16,8	16,8	16,3	13,2	10,6
	350	16,8	16,8	16,8	16,8	15,8	13,2
	380	16,8	16,8	16,8	16,8	16,8	15,8
	420	16,8	16,8	16,8	16,8	16,8	16,8
10	**110**	6,3	2,7	1,1	0,6	0,2	0,1
	150	10,7	7,0	4,2	2,3	0,9	0,0
	190	15,0	11,3	8,6	6,2	2,8	1,6
	240	20,4	16,7	14,0	11,6	7,8	4,7
	280	24,8	21,1	18,3	16,0	12,1	8,9
	310	26,2	24,3	21,6	19,2	15,4	12,2
	340	26,2	26,2	24,8	22,5	18,6	15,5
	370	26,2	26,2	26,2	25,7	21,9	18,7
	390	26,2	26,2	26,2	26,2	24,1	20,9
	430	26,2	26,2	26,2	26,2	26,2	25,2
	460	26,2	26,2	26,2	26,2	26,2	26,2

The table continues on the next page.

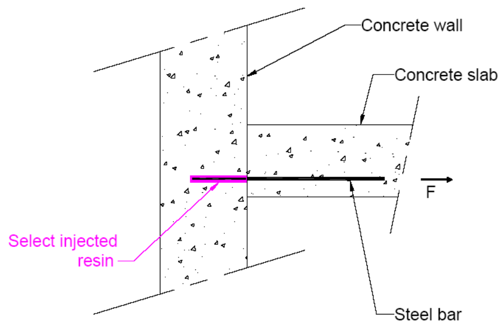
Concrete Cover = 20 mm		Fire Design Bond Resistance $N_{Rd,fi}$ (kN)					
Diameter (mm)	**Length l_v (mm)**	**R30**	**R60**	**R90**	**R120**	**R180**	**R240**
12	**140**	11,5	7,1	3,8	2,0	0,8	0,4
	170	15,4	11,0	7,7	4,9	2,0	1,1
	210	20,6	16,2	12,9	10,1	5,5	3,0
	250	25,8	21,4	18,1	15,3	10,7	6,8
	300	32,3	27,9	24,6	21,8	17,2	13,3
	350	37,7	34,4	31,1	28,3	23,7	19,8
	390	37,7	37,7	36,3	33,5	28,9	25,0
	420	37,7	37,7	37,7	37,4	32,8	28,9
	440	37,7	37,7	37,7	37,7	35,4	31,5
	480	37,7	37,7	37,7	37,7	37,7	36,7
	510	37,7	37,7	37,7	37,7	37,7	37,7
14	**160**	16,5	11,3	7,5	4,3	1,8	1,0
	200	22,5	17,4	13,5	10,2	5,0	2,8
	240	28,6	23,4	19,6	16,3	10,9	6,5
	280	34,7	29,5	25,7	22,4	17,0	12,5
	330	42,3	37,1	33,3	30,0	24,6	20,1
	370	48,3	43,2	39,3	36,0	30,6	26,2
	400	51,3	47,7	43,9	40,6	35,2	30,7
	440	51,3	51,3	50,0	46,6	41,3	36,8
	470	51,3	51,3	51,3	51,2	45,8	41,4
	490	51,3	51,3	51,3	51,3	48,8	44,4
	530	51,3	51,3	51,3	51,3	51,3	50,5
	560	51,3	51,3	51,3	51,3	51,3	51,3
16	**180**	22,3	16,4	12,0	8,2	3,5	1,9
	220	29,2	23,3	18,9	15,2	9,0	4,9
	270	37,9	32,0	27,6	23,8	17,7	12,6
	320	46,6	40,7	36,3	32,5	26,3	21,3
	370	55,2	49,3	45,0	41,2	35,0	29,9
	410	62,2	56,3	51,9	48,1	42,0	36,9
	450	67,0	63,2	58,8	55,0	48,9	43,8
	490	67,0	67,0	65,8	62,0	55,8	50,7
	520	67,0	67,0	67,0	67,0	61,0	55,9
	540	67,0	67,0	67,0	67,0	64,5	59,4
	580	67,0	67,0	67,0	67,0	67,0	66,3
	610	67,0	67,0	67,0	67,0	67,0	67,0
20	**220**	36,5	29,2	23,7	19,0	11,3	6,2
	280	49,5	42,2	36,7	32,0	24,3	17,9
	340	62,5	55,2	49,7	45,0	37,3	30,9
	400	75,5	68,2	62,7	58,0	50,3	43,9
	460	88,6	81,2	75,7	71,0	63,3	56,9
	510	99,4	92,0	86,5	81,8	74,1	67,8
	550	104,7	100,7	95,2	90,5	82,8	76,4
	580	104,7	104,7	101,7	97,0	89,3	82,9
	610	104,7	104,7	104,7	103,5	95,8	89,4
	630	104,7	104,7	104,7	104,7	100,1	93,8
	670	104,7	104,7	104,7	104,7	104,7	102,4
	710	104,7	104,7	104,7	104,7	104,7	104,7

Calculations are carried out taking the minimum concrete cover (CSTB report n°26048096). Intermediate values may be interpolated linearly. Extrapolation is not possible. 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.

Annex 2.3: Maximum applicable loads for an anchoring application (beam-wall connection) with a concrete cover of 30 mm for diameters 8, 10, 12, 14, 16, 20, 25 and 28 mm

The table presents design bond resistances $(N_{Rd,fi})$ for a **Beam-Wall connection** using **C20/25 concrete** and rebars with a yield strength f_y = **500 N/mm²** in an **ISO 834-1 fire** (at 30, 60, 90, 120, 180 and 240 min) for a **concrete cover of 30 mm** and for diameters 8, 10, 12, 14, 16, 20, 25 and 28 mm

The design load values may be used safely for a slab-wall connection. Post-installed rebars shall be designed in ambient temperature conditions before being designed in fire conditions.



Concrete Cover = 30 mm		Fire Design Bond Resistance $N_{Rd,fi}$ (kN)					
Diameter (mm)	**Length l_v (mm)**	**R30**	**R60**	**R90**	**R120**	**R180**	**R240**
8	**100**	4,7	1,7	0,7	0,4	0,1	0,0
	140	8,1	5,1	2,8	1,5	0,6	0,3
	180	11,6	8,5	6,2	4,4	1,9	1,0
	220	15,1	12,0	9,7	7,9	4,7	2,6
	250	16,8	14,6	12,3	10,5	7,3	4,7
	290	16,8	16,8	15,8	13,9	10,8	8,2
	320	16,8	16,8	16,8	16,5	13,4	10,8
	340	16,8	16,8	16,8	16,8	15,1	12,5
	380	16,8	16,8	16,8	16,8	16,8	16,0
	400	16,8	16,8	16,8	16,8	16,8	16,8
10	**110**	6,9	3,1	1,2	0,7	0,2	0,1
	150	11,3	7,4	4,6	2,5	1,1	0,5
	190	15,6	11,7	8,9	6,6	3,0	1,6
	230	19,9	16,1	13,2	10,9	7,0	4,0
	270	24,3	20,4	17,6	15,2	11,3	8,1
	300	26,2	23,7	20,8	18,5	14,6	11,3
	340	26,2	26,2	25,1	22,8	18,9	15,7
	370	26,2	26,2	26,2	26,1	22,2	18,9
	390	26,2	26,2	26,2	26,2	24,4	21,1
	430	26,2	26,2	26,2	26,2	26,2	25,4
	460	26,2	26,2	26,2	26,2	26,2	26,2

The table continues on the next page.

Concrete Cover = 30 mm		Fire Design Bond Resistance $N_{Rd,fi}$ (kN)					
Diameter (mm)	Length l_v (mm)	R30	R60	R90	R120	R180	R240
12	140	12,2	7,6	4,2	2,2	0,9	0,5
	180	17,4	12,8	9,4	6,6	2,9	1,5
	230	23,9	19,3	15,9	13,1	8,4	4,8
	270	29,1	24,5	21,1	18,3	13,6	9,7
	320	35,6	31,0	27,6	24,8	20,1	16,2
	350	37,7	34,9	31,5	28,7	24,0	20,1
	390	37,7	37,7	36,7	33,9	29,2	25,3
	420	37,7	37,7	37,7	37,7	33,1	29,2
	440	37,7	37,7	37,7	37,7	35,7	31,8
	480	37,7	37,7	37,7	37,7	37,7	37,0
	510	37,7	37,7	37,7	37,7	37,7	37,7
14	160	17,3	11,9	7,9	4,7	2,0	1,0
	200	23,4	18,0	14,0	10,7	5,4	2,9
	240	29,4	24,0	20,0	16,8	11,3	6,8
	280	35,5	30,1	26,1	22,9	17,4	12,9
	320	41,6	36,2	32,2	28,9	23,5	18,9
	370	49,2	43,7	39,8	36,5	31,1	26,5
	400	51,3	48,3	44,3	41,1	35,6	31,1
	440	51,3	51,3	50,4	47,1	41,7	37,1
	460	51,3	51,3	51,3	50,2	44,7	40,2
	490	51,3	51,3	51,3	51,3	49,3	44,7
	530	51,3	51,3	51,3	51,3	51,3	50,8
	560	51,3	51,3	51,3	51,3	51,3	51,3
16	180	23,2	17,0	12,5	8,8	3,8	2,0
	230	31,9	25,7	21,2	17,5	11,2	6,4
	270	38,8	32,7	28,1	24,4	18,2	13,0
	310	45,8	39,6	35,0	31,3	25,1	19,9
	360	54,4	48,3	43,7	40,0	33,8	28,6
	410	63,1	56,9	52,4	48,7	42,4	37,2
	440	67,0	62,1	57,6	53,9	47,6	42,4
	480	67,0	67,0	64,5	60,8	54,6	49,4
	510	67,0	67,0	67,0	66,0	59,8	54,6
	540	67,0	67,0	67,0	67,0	65,0	59,8
	570	67,0	67,0	67,0	67,0	67,0	65,0
	610	67,0	67,0	67,0	67,0	67,0	67,0
20	220	37,7	30,0	24,3	19,7	11,9	6,4
	280	50,7	43,0	37,3	32,7	24,9	18,4
	340	63,7	56,0	50,3	45,7	37,9	31,4
	390	74,6	66,8	61,1	56,5	48,7	42,2
	450	87,6	79,8	74,1	69,5	61,7	55,2
	510	100,6	92,8	87,1	82,5	74,7	68,2
	540	104,7	99,3	93,6	89,0	81,2	74,7
	580	104,7	104,7	102,3	97,7	89,9	83,4
	610	104,7	104,7	104,7	104,2	96,4	89,9
	630	104,7	104,7	104,7	104,7	100,7	94,2
	670	104,7	104,7	104,7	104,7	104,7	102,9
	700	104,7	104,7	104,7	104,7	104,7	104,7

The table continues on the next page.

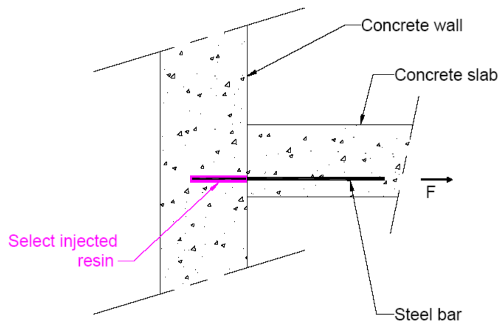
Concrete Cover = 30 mm		**Fire Design Bond Resistance $N_{Rd,fi}$ (kN)**					
Diameter (mm)	**Length l_v (mm)**	**R30**	**R60**	**R90**	**R120**	**R180**	**R240**
25	**280**	63,4	53,7	46,6	40,8	31,1	23,0
	340	79,6	70,0	62,9	57,1	47,3	39,2
	400	95,9	86,3	79,1	73,3	63,6	55,5
	470	114,9	105,2	98,1	92,3	82,6	74,4
	530	131,1	121,5	114,3	108,6	98,8	90,7
	580	144,7	135,0	127,9	122,1	112,4	104,2
	630	158,2	148,6	141,4	135,7	125,9	117,8
	660	163,6	156,7	149,6	143,8	134,0	125,9
	700	163,6	163,6	160,4	154,6	144,9	136,8
	730	163,6	163,6	163,6	162,8	153,0	144,9
	750	163,6	163,6	163,6	163,6	158,4	150,3
	790	163,6	163,6	163,6	163,6	163,6	161,1
	830	163,6	163,6	163,6	163,6	163,6	163,6
28	**310**	80,1	69,3	61,3	54,8	43,9	34,8
	380	101,3	90,5	82,5	76,1	65,1	56,1
	460	125,6	114,8	106,8	100,4	89,4	80,3
	520	143,8	133,0	125,0	118,6	107,6	98,5
	580	162,0	151,2	143,2	136,8	125,8	116,8
	650	183,3	172,5	164,5	158,0	147,1	138,0
	700	198,5	187,6	179,7	173,2	162,3	153,2
	730	205,3	196,7	188,8	182,3	171,4	162,3
	770	205,3	205,3	200,9	194,4	183,5	174,4
	800	205,3	205,3	205,3	203,5	192,6	183,5
	830	205,3	205,3	205,3	205,3	201,7	192,6
	860	205,3	205,3	205,3	205,3	205,3	201,7
	900	205,3	205,3	205,3	205,3	205,3	205,3

Calculations are carried out taking the minimum concrete cover (CSTB report n°26048096). Intermediate values may be interpolated linearly. Extrapolation is not possible. 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.

Annex 2.4: Maximum applicable loads for an anchoring application (beam-wall connection) with a concrete cover of 40 mm for diameters 8, 10, 12, 14, 16, 20, 25, 28 and 32 mm

The table presents design bond resistances $(N_{Rd,fi})$ for a **Beam-Wall connection** using **C20/25 concrete** and rebars with a yield strength $f_y = $ **500 N/mm²** in an **ISO 834-1 fire** (at 30, 60, 90, 120, 180 and 240 min) for a **concrete cover of 40 mm** and for diameters 8, 10, 12, 14, 16, 20, 25, 28 and 32 mm

The design load values may be used safely for a slab-wall connection. Post-installed rebars shall be designed in ambient temperature conditions before being designed in fire conditions.



Concrete Cover = 40 mm		Fire Design Bond Resistance $N_{Rd,fi}$ (kN)					
Diameter (mm)	**Length l_v (mm)**	**R30**	**R60**	**R90**	**R120**	**R180**	**R240**
8	**100**	5,3	2,0	0,8	0,4	0,1	0,0
	140	8,8	5,5	3,1	1,6	0,7	0,3
	190	13,1	9,8	7,5	5,5	2,6	1,4
	240	16,8	14,2	11,8	9,9	6,7	4,1
	290	16,8	16,8	16,1	14,2	11,0	8,4
	320	16,8	16,8	16,8	16,8	13,6	11,0
	340	16,8	16,8	16,8	16,8	15,4	12,8
	380	16,8	16,8	16,8	16,8	16,8	16,2
	400	16,8	16,8	16,8	16,8	16,8	16,8
10	**110**	7,7	3,6	1,5	0,8	0,3	0,1
	160	13,1	9,0	6,1	3,7	1,5	0,8
	210	18,6	14,4	11,5	9,1	5,1	2,7
	260	24,0	19,9	16,9	14,5	10,6	7,3
	290	26,2	23,1	20,2	17,7	13,8	10,5
	330	26,2	26,2	24,5	22,1	18,1	14,9
	360	26,2	26,2	26,2	25,3	21,4	18,1
	390	26,2	26,2	26,2	26,2	24,6	21,4
	430	26,2	26,2	26,2	26,2	26,2	25,7
	460	26,2	26,2	26,2	26,2	26,2	26,2

The table continues on the next page.

Concrete Cover = 40 mm		**Fire Design Bond Resistance $N_{Rd,fi}$ (kN)**					
Diameter (mm)	**Length l_v (mm)**	**R30**	**R60**	**R90**	**R120**	**R180**	**R240**
12	**140**	13,2	8,2	4,7	2,5	1,0	0,5
	180	18,4	13,4	9,9	7,0	3,1	1,6
	230	24,9	19,9	16,4	13,5	8,8	5,0
	270	30,1	25,1	21,6	18,7	14,0	10,0
	310	35,3	30,3	26,8	23,9	19,2	15,2
	340	37,7	34,2	30,7	27,8	23,1	19,1
	380	37,7	37,7	35,9	33,0	28,3	24,3
	410	37,7	37,7	37,7	36,9	32,2	28,2
	440	37,7	37,7	37,7	37,7	36,1	32,1
	480	37,7	37,7	37,7	37,7	37,7	37,3
	510	37,7	37,7	37,7	37,7	37,7	37,7
14	**160**	18,4	12,6	8,5	5,1	2,1	1,1
	210	26,0	20,2	16,1	12,7	7,2	3,8
	260	33,6	27,8	23,7	20,3	14,8	10,2
	320	42,7	36,9	32,8	29,4	23,9	19,3
	360	48,7	43,0	38,9	35,5	30,0	25,4
	390	51,3	47,5	43,4	40,0	34,5	29,9
	430	51,3	51,3	49,5	46,1	40,6	36,0
	460	51,3	51,3	51,3	50,6	45,1	40,5
	480	51,3	51,3	51,3	51,3	48,2	43,6
	520	51,3	51,3	51,3	51,3	51,3	49,6
	560	51,3	51,3	51,3	51,3	51,3	51,3
16	**180**	24,5	17,9	13,2	9,3	4,1	2,2
	230	33,2	26,6	21,9	18,0	11,7	6,7
	270	40,1	33,5	28,8	24,9	18,6	13,4
	310	47,0	40,4	35,7	31,9	25,6	20,3
	350	54,0	47,4	42,7	38,8	32,5	27,2
	400	62,6	56,0	51,4	47,5	41,2	35,9
	440	67,0	63,0	58,3	54,4	48,1	42,8
	480	67,0	67,0	65,2	61,3	55,0	49,8
	510	67,0	67,0	67,0	66,5	60,2	55,0
	530	67,0	67,0	67,0	67,0	63,7	58,5
	570	67,0	67,0	67,0	67,0	67,0	65,4
	600	67,0	67,0	67,0	67,0	67,0	67,0
20	**220**	39,3	31,0	25,2	20,3	12,4	6,8
	290	54,5	46,2	40,3	35,5	27,6	21,0
	340	65,3	57,1	51,2	46,3	38,5	31,9
	390	76,1	67,9	62,0	57,2	49,3	42,7
	440	87,0	78,7	72,9	68,0	60,1	53,6
	500	100,0	91,7	85,9	81,0	73,1	66,6
	530	104,7	98,2	92,4	87,5	79,6	73,1
	580	104,7	104,7	103,2	98,4	90,5	83,9
	600	104,7	104,7	104,7	102,7	94,8	88,2
	630	104,7	104,7	104,7	104,7	101,3	94,7
	670	104,7	104,7	104,7	104,7	104,7	103,4
	700	104,7	104,7	104,7	104,7	104,7	104,7

The table continues on the next page.

Concrete Cover = 40 mm		Fire Design Bond Resistance $N_{Rd,fi}$ (kN)					
Diameter (mm)	**Length l_v (mm)**	**R30**	**R60**	**R90**	**R120**	**R180**	**R240**
25	**280**	65,4	55,1	47,7	41,6	31,8	23,6
	350	84,3	74,0	66,7	60,6	50,8	42,6
	410	100,6	90,3	82,9	76,9	67,0	58,8
	470	116,8	106,5	99,2	93,1	83,3	75,1
	530	133,1	122,8	115,5	109,4	99,6	91,3
	580	146,6	136,3	129,0	122,9	113,1	104,9
	620	157,5	147,2	139,8	133,8	123,9	115,7
	650	163,6	155,3	148,0	141,9	132,1	123,9
	700	163,6	163,6	161,5	155,5	145,6	137,4
	730	163,6	163,6	163,6	163,6	153,8	145,5
	750	163,6	163,6	163,6	163,6	159,2	151,0
	790	163,6	163,6	163,6	163,6	163,6	161,8
	820	163,6	163,6	163,6	163,6	163,6	163,6
28	**310**	82,3	70,8	62,6	55,8	44,7	35,5
	380	103,5	92,0	83,8	77,0	66,0	56,8
	460	127,8	116,3	108,1	101,3	90,3	81,1
	520	146,0	134,5	126,3	119,5	108,5	99,3
	580	164,2	152,7	144,5	137,7	126,7	117,5
	640	182,5	170,9	162,7	155,9	144,9	135,7
	690	197,6	186,1	177,9	171,1	160,1	150,9
	730	205,3	198,2	190,0	183,2	172,2	163,0
	770	205,3	205,3	202,2	195,4	184,3	175,1
	800	205,3	205,3	205,3	204,5	193,4	184,2
	820	205,3	205,3	205,3	205,3	199,5	190,3
	860	205,3	205,3	205,3	205,3	205,3	202,4
	890	205,3	205,3	205,3	205,3	205,3	205,3
32	**350**	107,9	94,8	85,4	77,6	65,0	54,5
	440	139,1	126,0	116,6	108,8	96,2	85,7
	530	170,4	157,2	147,8	140,0	127,4	116,9
	610	198,1	184,9	175,5	167,8	155,2	144,7
	680	222,4	209,2	199,8	192,0	179,5	168,9
	740	243,2	230,0	220,6	212,9	200,3	189,7
	790	260,5	247,4	238,0	230,2	217,6	207,1
	820	268,1	257,8	248,4	240,6	228,0	217,5
	870	268,1	268,1	265,7	257,9	245,4	234,8
	890	268,1	268,1	268,1	264,9	252,3	241,8
	920	268,1	268,1	268,1	268,1	262,7	252,2
	960	268,1	268,1	268,1	268,1	268,1	266,1
	990	268,1	268,1	268,1	268,1	268,1	268,1

Calculations are carried out taking the minimum concrete cover (CSTB report n°26048096). Intermediate values may be interpolated linearly. Extrapolation is not possible. 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.

END OF REPORT

———

Le futur en construction

Établissement public au service de l'innovation dans le bâtiment, le CSTB, Centre Scientifique et Technique du Bâtiment, exerce quatre activités clés : la recherche et expertise, l'évaluation, la certification et la diffusion des connaissances, organisées pour répondre aux enjeux de la transition énergétique dans le monde de la construction. Son champ de compétence couvre les produits de construction, les bâtiments et leur intégration dans les quartiers et les villes.

Avec plus de 900 collaborateurs, ses filiales et ses réseaux de partenaires nationaux, européens et internationaux, le groupe CSTB est au service de l'ensemble des parties prenantes de la construction pour faire progresser la qualité et la sécurité des bâtiments.

Centre Scientifique et Technique du Bâtiment

Siège social > 84 avenue Jean Jaurès – Champs-sur-Marne – 77447 Marne-la-Vallée cedex 2

Tél. : +33 (0)1 64 68 82 82 – www.cstb.fr