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Institute of Building Materials, Concrete Construction and Fire Safety | Braunschweig Civil Engineering Materials Testing Institute

Expert Opinion

– Translation –

Document number:	(2103/121/21) – CM dated 15/07/2021
Customer:	fischerwerke GmbH & Co. KG Otto-Hahn-Straße 15 79211 Denzlingen
Order date:	14/12/2020
Order ref.:	-
Order received:	16/12/2020
Subject:	Assessment of loaded FHB / FHB dyn / FDA bonded expansion fasteners installed in reinforced concrete with regard to their fire behaviour, in order to determine the fire resistance under exposure to fire along the standard temperature-time curve (ETK) in accordance with DIN EN 1363-1
Basis for assessment:	See Section 1

This expert opinion comprises 6 pages including cover sheet and 9 annexes.

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Notified body (0761-CPR) -
Approved as a civil engineering testing, inspection and certifying body as well as notified as a civil engineering testing and certifying body.

1 General

With letter of 14/12/2020, fischerwerke GmbH & Co. KG, 79211 Denzlingen, commissioned the preparation of an expert opinion for the assessment of FHB / FHB dyn / FDA bonded expansion fasteners in conjunction with solid structural elements (reinforced concrete) under exposure to fire on one side.

The documents serving as basis for the expert opinion on the constructions to be assessed are listed below:

[1] DIN EN 1363-1 : 2020-05, Fire resistance tests - Part 1: General Requirements,

[2] DIN 4102-4, Fire Behaviour of Building Materials and Components,

[3] Test Report No. 3038/8141 dated 02/05/2001, issued by MPA Braunschweig; and

[4] ETA-06/0171 dated 23/06/2021, Highbond anchors FHB / FHB dyn / FDA, issued by DIBt, Berlin

The assessment for the bonded expansion fasteners was conducted on the basis of the fire tests carried out with the anchors installed in solid structural elements (reinforced concrete). According to fischerwerke GmbH & Co. KG, 79211 Denzlingen, there is currently no complete building authority certificate (e.g., aBG) for the Highbond anchors (bonded expansion fasteners) [4] in conjunction with reinforced concrete that lays down the regulations to be met by the execution described here in the event of fire.

2 Description of the constructions

The expert opinion refers to the following bonded expansion fasteners:

1. Highbond anchor FHB with anchor rod FHB-A and the related fastening elements (e.g. washer, nut, … in accordance with [4]) and injection mortar FIS HB.
2. Highbond anchor FHB dyn with anchor rod FHB-A dyn and the related fastening elements (e.g. centring sleeve, conical wascher, spherical washer, nut, … in accordance with [4]) and injection mortar FIS HB.
3. Highbond anchor FDA with anchor rod FDA-A and the related fastening elements (e.g. centring sleeve, washer, nut, … in accordance with [4]) and injection mortar FIS HB.

The anchor rods and the fastening elements according to [4] mainly consist of steel. The bonded expansion fastener is set into the underground (reinforced concrete of strength class ≥ C20/25 ≤ C50/60) together with the injection mortar FIS HB. The loads applied are transferred into the anchoring base via the anchor rods and the mortar.

For the normal purpose of use, the related technical information for the bonded expansion fasteners can be taken, according to the customer, from the related technical data sheets from fischerwerke GmbH & Co. KG, 79211 Denzlingen [4].

This fire-safety assessment is restricted to mainly stationary (static) loads combined with solid structural elements under exposure to fire.

The tables below and the annexes summarise the design data (from the manufacturer) of the bonded expansion fasteners.

Table 1: Highbond anchor FHB

Highbond anchor FHB		**Sizes**					**Anchoring base/ underground**
Effective embedment depth h_{ef}	[mm]	≥ 60	≥ 80	≥ 125	≥ 170	≥ 220	
FIS HB with FHB-A /-A N[1)] and fastening elements acc.to [4]		M10	M12	M16	M20	M24	Reinforced concrete (strength class ≥ C20/25 ≤ C50/60)
FIS HB with FHB-A R/-A N R[1)] and fastening elements acc.to [4]. - stainless steel -		M10	M12	M16	M20	M24	
FIS HB with FHB-A HCR /-A N HCR[1)] and fastening elements acc.to [4] - highly corrosion-resistant steel -		M10	M12	M16	M20	M24	

[1)] The structural design of anchor rods FHB-A-N / FHB-A-N R / FHB-A-N HCR corresponds to the related structural design of anchor rods FHB-A / FHB-A R / FHB-A HCR.

Table 2: Highbond anchor FHB dyn

Highbond anchor FHB dyn		**Sizes**				**Anchoring base/ underground**
Effective embedment depth h_{ef}	[mm]	≥ 100	≥ 125	≥ 170	≥ 220	
FIS HB with FHB-A dyn and fastening elements acc.to [4]		M12	M16	M20	M24	Reinforced concrete (strength class ≥ C20/25 ≤ C50/60)
FIS HB with FHB-A dyn HCR and fastening elements acc.to [4] - highly corrosion-resistant steel -		M12	M16	-	-	

Table 3: Highbond anchor FDA

Highbond anchor FDA		**Sizes**		**Anchoring base/ underground**
Effective embedment depth h_{ef}	[mm]	≥ 100	≥ 125	
FIS HB with FDA-A and fastening elements acc.to [4]		M12	M16	Reinforced concrete (strength class ≥ C20/25 ≤ C50/60)

For a more detailed description of the constructions, reference is made to the annexes [4] from fischerwerke GmbH & Co. KG, 79211 Denzlingen.

3 Assessment of the bonded expansion fasteners in conjunction with solid structural elements

The subject matter of this fire-safety-related assessment is the loadbearing behaviour of the bonded expansion fasteners / Highbond anchors FHB / FHB dyn / FDA in conjunction with anchoring bases made of reinforced concrete (strength class ≥ C20/25 ≤ C50/60) under exposure to fire in accordance with DIN EN 1363-1.

If for the normal purpose of use, smaller loads apply according to [4], these shall be binding. Irrespective of the fire-safety-related assessment, the suitability of the anchors for the anchoring base and the application must also be proved for the cold as-installed condition.

With regard to the loadbearing behaviour under exposure to fire, it can be distinguished between steel failure, extraction from the underground, and underground failure.

For the Highbond anchors assessed here, steel failure and extraction from the underground were decisive. In terms of fire safety, it may be assumed with sufficient reliability that a failure of the underground examined here in the event of fire will not be decisive, provided the required edge distances and spacing are adhered to.

$F_{fire(t)}$ ⇒ design value for the Highbond anchor as a function of the fire resistance time, the anchor rod dimensions and the effective embedment depth

The spacing to be applied for a one-side exposure to fire of the Highbond anchors FHB / FHB dyn / FDA is the distance that excludes a failure of the underground (e.g. $s \geq 4h_{ef}$; h_{ef} acc. to Table 1), which means the failure of the fastening system will be decisive.

Further parameters (geometry, moisture, spalling, eccentricity, position in the structural element, and further influencing variables) possibly have to be considered separately for the design of the fastening

system. For example, the maximum loads stated can also be applied, as a function of the installation situation, for reinforced concrete components in case of a multi-side exposure to fire, if the distances to the component edge are increased (e.g., $s \geq 300$ mm and $s \geq 2h_{ef}$ with a fire load of 90 minutes, or $s \geq 350$ mm and $s \geq 2h_{ef}$ with a fire load of 120 minutes) (h_{ef} according to Table 1).

The design values for the Highbond anchors FHB / FHB dyn / FDA under tensile load and one-side exposure to fire in accordance with DIN EN 1363-1 can be taken from Annexes 6 to 9.

4 Special notes

4.1 This Expert Opinion is not subject to notification and is no substitute for a classification report.

4.2 This Expert Opinion is no certificate of suitability for use in a building control procedure. The expert opinion can be used, for example, for general preliminary planning or to support in the assessment of the principles of execution / the construction. The manufacturer/erector of the construction is obliged to furnish the respective proof.

4.3 When applying for a project-related design approval (vBG), the preparation of a project-related expert opinion will be required, taking the individually prevailing boundary conditions for planning into account.

4.4 This Expert Opinion applies only in terms of fire protection. Further requirements may result from the applicable technical building regulations for service installations and the individual state building code and regulations for special constructions, e.g. with regard to building physics, statics, electrical engineering, ventilation engineering, and similar.

4.5 The above assessment applies only for Highbond anchors FHB / FHB dyn / FDA in conjunction with solid structural elements (reinforced concrete according to Section 3), taking the boundary conditions from the technical data sheets [4] from fischerwerke GmbH & Co. KG, 79211 Denzlingen, into account.

4.6 The above assessment applies for an exposure to fire on one side along the standard temperature-time curve in accordance with DIN EN 1363-1. The underground must have at least the same fire resistance as the individual Highbond anchor (bonded expansion fastener).

4.7 Modifications and supplements of structural details (derived from this Expert Opinion) may only be made after prior consultation with MPA Braunschweig.

4.8 The proper execution is exclusively within the responsibility of the executing companies.

4.9 The structural details as shown in the annexes shall be binding for the above assessment. Only those details were verified that are relevant for the fire safety assessment.

4.10 The validity of this Expert Opinion No. (2103/121/21) – CM dated 15/07/2021 ends on 15/07/2026 at the latest. The validity can be extended as a function of the state of the art.

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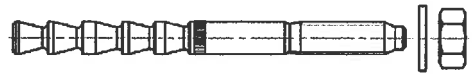
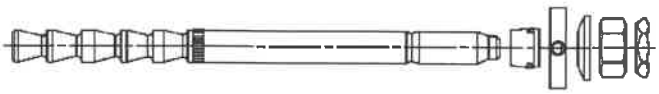
Technical data of the Highbond anchors FHB / FHB dyn / FDA (manufacturer data)

Example FHB- anchor rod



Example FHB dyn- anchor rod



Example FDA- anchor rod

Table 4: Material data of the Highbond anchors FHB / FHB dyn / FDA

Execution	Size	Material
Anchor rod FHB-A /-A-N with fastening elements acc.to [4]	M10 - M16	Galvanised steel Strength class 8.8 (DIN EN ISO 898-1)
Anchor rod FHB-A /-A-N with fastening elements acc.to [4]	M20 - M24	Galvanised steel f_{uk} = 550 N/mm² / f_{yk} = 440 N/mm² (DIN EN ISO 898-1)
Anchor rod FHB-A R/-A-N R with fastening elements acc.to [4]	M10 - M16	Stainless steel f_{uk} = 800 N/mm² / f_{yk} = 640 N/mm² (EN ISO 3506) Material no 1.4401, 1.4404, 1.4578, 1.4571, 1.4439, 1.4362, 1.4062, 1.4662, 1.4462 (DIN EN 10088-21) (DIN EN 10088-21)
Anchor rod FHB-A R/-A-N R with fastening elements acc.to [4]	M20 - M24	Stainless steel f_{uk} = 700 N/mm² / f_{yk} = 560 N/mm² (EN ISO 3506) Material no. 1.4401, 1.4404, 1.4578, 1.4571, 1.4439, 1.4362, 1.4062, 1.4662, 1.4462 (DIN EN 10088-21)
Anchor rod FHB-A HCR /-A-N HCR with fastening elements acc.to [4]	M10 - M24	Highly corrosion-resistant steel f_{uk} = 700 N/mm² / f_{yk} = 560 N/mm² (EN ISO 3506) Material no. 1.4529 (DIN EN 10088-21)
Anchor rod FHB-A dyn with fastening elements acc.to [4]	M12 - M24	Galvanised steel Strength class 8.8 (DIN EN ISO 898-1)
Anchor rod FHB-A dyn HCR with fastening elements acc.to [4]	M12 HCR – M16 HCR	Highly corrosion-resistant steel $f_{uk} \geq$ 700 N/mm² (EN ISO 3506) Material no. 14529 (DIN EN 10088-21)
Anchor rod FDA-A with fastening elements acc.to [4]	M12 – M16	Galvanised steel Strength class 8.8 (DIN EN ISO 898-1)
Injection mortar FIS HB	-	Two-component mortar

1) Manufacturer data (see also Section 2 and [4])

Technical data of the Highbond anchors FHB (manufacturer data)

Installation conditions:

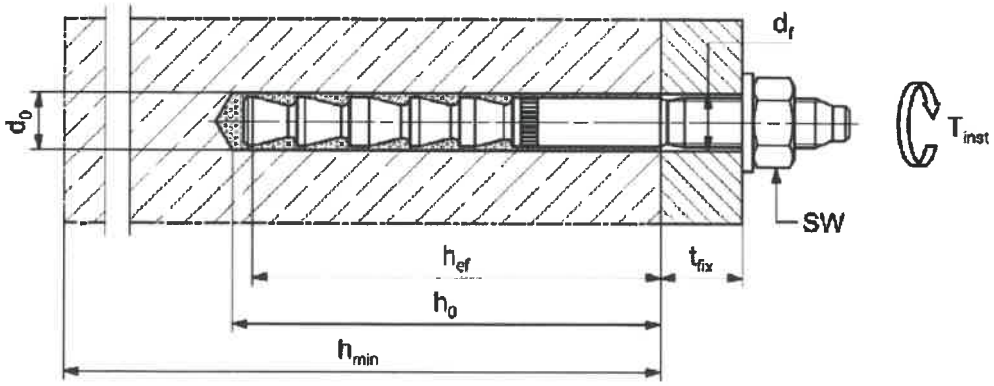


Table 5: Installation parameters of the Highbond anchor FHB

Installation parameters			**Underground: reinforced concrete (strength class C20/25)**					
Highbond anchor FHB			Anchor rod[2)]					
			FHB-A / FHB-A-N					
			FHB-A R / FHB-A-N R					
			FHB-A HCR / FHB-A-N HCR					
			10x60	12x80	12x100	16x125	20x170	24x220
Wrench size	SW	[mm]	17	19		24	30	36
Nominal drill diameter	d_0		12	14		18	24	28
Drill hole depth	h_0		65	85	105	130	175	225
Effective embedment depth	h_{ef}		60	80	100	125	170	220
Minimum spacing and edge distance	s_{min} = c_{min}		The necessary spacing and edge distances must be determined according to [4], taking the additional requirements for cases of fire into account.					
Diameter of clearance hole in mounting part	d_f		Execution according to [4]					
Minimum thickness of concrete component	h_{min}		The component must be selected according to [4], taking the fire-safety-related design of the component into account.					
Maximum torque of installation	$T_{inst,max}$	[Nm]	20	40		60	100	120
Related steel brush	d_b	[mm]	13	16		20	26	30

[2)] The allocation of the related anchor rod to the Highbond anchor is to be taken from Table 1.

Technical data of the Highbond anchors FHB dyn (manufacturer data)

Installation conditions: (picture without centering sleeve; pre-positioned installation)

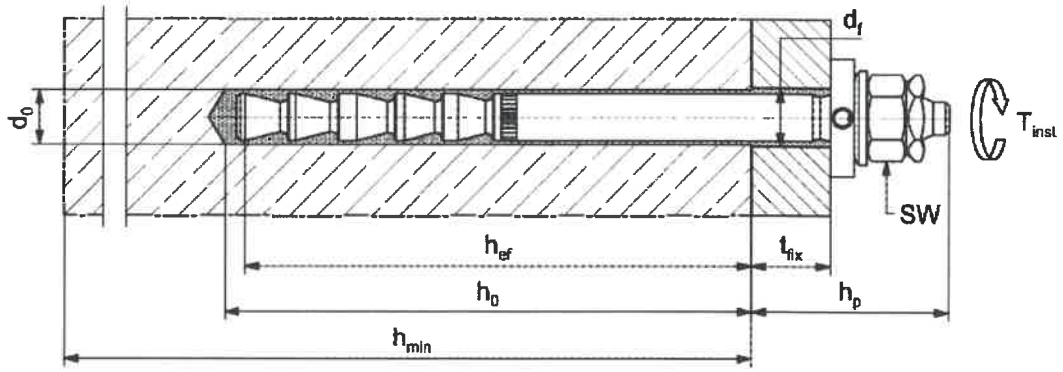


Table 6: Installation parameters of the Highbond anchor FHB dyn

Installation parameters			**Underground: reinforced concrete (strength class C20/25)**			
Highbond anchor FHB dyn			Anchor rod[2)]			
			FHB-A dyn			
			FHB-A dyn HCR			
			-	12x100	16x125	20x170	24x220
Wrench size	SW	[mm]		19	24	30	36
Nominal drill diameter	d_0			14	18	24	28
Drill hole depth	h_0			105	130	175	225
Effective embedment depth	h_{ef}			100	125	170	220
Minimum spacing and edge distance	s_{min} = c_{min}		The necessary spacing and edge distances must be determined according to [4], taking the additional requirements for cases of fire into account.				
Diameter of clearance hole in mounting part	d_f		Execution according to [4]				
Minimum thickness of concrete component	h_{min}		The component must be selected according to [4], taking the fire-safety-related design of the component into account.				
Maximum torque of installation	$T_{inst,max}$	[Nm]	-	40	60	100	120
Related steel brush	d_b	[mm]		16	20	26	30

[2)] The allocation of the related anchor rod to the Highbond anchor is to be taken from Table 1.

Technical data of the Highbond anchors FDA (manufacturer data)

Installation conditions:

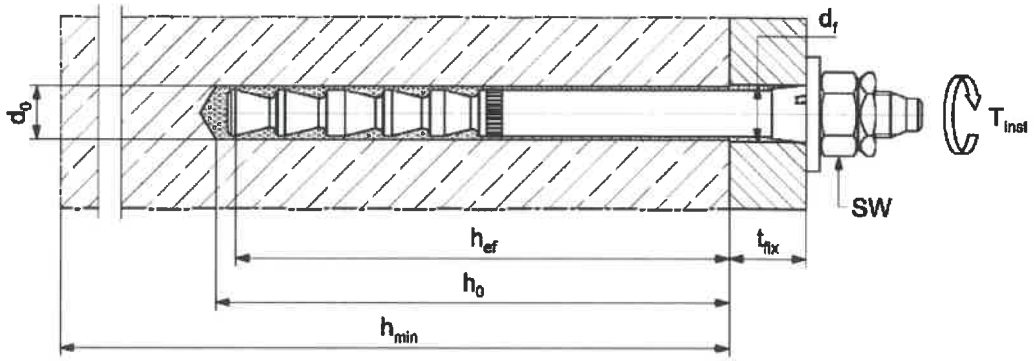


Table 7: Installation parameters of the Highbond anchor FDA

Installation parameters			**Underground: reinforced concrete (strength class C20/25)**			
Highbond anchor FDA			Anchor rod			
			FDA-A			
			-	12x100	16x125	-
Wrench size	SW	[mm]		19	24	
Nominal drill diameter	d_0			14	18	
Drill hole depth	h_0			105	130	
Effective embedment depth	h_{ef}			100	125	
Minimum spacing and edge distance	s_{min} = c_{min}		The necessary spacing and edge distances must be determined according to [4], taking the additional requirements for cases of fire into account.			
Diameter of clearance hole in mounting part	d_f		Execution according to [4]			
Minimum thickness of concrete component	h_{min}		The component must be selected according to [4], taking the fire-safety-related design of the component into account.			
Maximum torque of installation	$T_{inst,max}$	[Nm]	-	40	60	-
Related steel brush	d_b	[mm]		16	20	

Installation instruction for the Highbond anchors FHB / FHB dyn / FDA (manufacturer data)

The drill hole is cleaned in accordance with [4] using the admissible BS steel brushes and by blowing the drill hole clean:

Drilling
2x blowing
2x brushing
2x blowing

The drill hole is filled in accordance with [4] using fischer injection mortar FIS HB.

Table 8: Curing times of fischer injection mortar FIS HB

Temperature in the anchoring base [1]	Maximum processing time t_{work}	Minimum curing time [2] t_{cure}
-5 to 0 [3]	-	6 h
> 0 to 5 [3]	-	3 h
> 5 to 10	15 min	90 min
> 10 to 20	6 min	35 min
> 20 to 30	4 min	20 min
> 30 to 40	2 min	12 min

1) The temperature in the anchoring base must not be lower than -5°C during curing
2) The curing time must be doubled in case of wet concrete or water-filled drill holes
3) Minimum cartridge temperature +5°C

For further data, see Section 2 and [4] (Installation Instructions)

Design values for the Highbond anchor FHB under exposure to fire in accordance with DIN EN 1363-1 installed in reinforced concrete (strength class ≥ C20/25 ≤ C50/60)

Table 9: Design values for the Highbond anchor FHB set in undergrounds made of reinforced concrete (strength class ≥ C20/25 ≤ C50/60) under exposure to fire in accordance with DIN EN 1363-1

Highbond anchor FHB in conjunction with reinforced concrete (strength class ≥ C20/25 ≤ C50/60)					
Maximum load max. $F_{fire(t)}$ [1) 2)] [kN] as a function of fire resistance time, the dimensions of the anchor rod, and the effective embedment depth					
Fire resistance time	**M10 (gvz)**	**M12 (gvz)**	**M16 (gvz)**	**M20 (gvz)**	**M24 (gvz)**
	Strength class 8.8 (DIN EN ISO 898-1)			f_{uk} = 550 N/mm² / f_{yk} = 440 N/mm² (DIN EN ISO 898-1)	
	Effective embedment depth			**Effective embedment depth**	
[min]	**≥ 60 mm**	**≥ 80 mm**	**≥ 125 mm**	**≥ 170 mm**	**≥ 220 mm**
30	2.95	4.50	9.25	7.50	10.90
60	1.65	3.50	7.10	5.70	8.20
90	0.35	2.50	5.00	3.90	5.60
120	-	2.00	3.90	3.00	4.30

1) If for the normal purpose of use, smaller loads apply according to the Technical Data Sheets [4] from fischerwerke GmbH & Co. KG, 79211 Denzlingen, these shall be binding. Irrespective of the fire-safety-related assessment, the suitability of the anchors for the underground/anchoring base and the application must also be proved for the cold as-installed condition.

2) The maximum tensile load/shear load can be applied as centric tensile load (N), shear load (V), or as a combination of both (oblique tension).

Design values for the Highbond anchor FHB under exposure to fire in accordance with DIN EN 1363-1 installed in reinforced concrete (strength class ≥ C20/25 ≤ C50/60)

Table 10: Design values for the Highbond anchor FHB set in undergrounds made of reinforced concrete (strength class ≥ C20/25 ≤ C50/60) under exposure to fire in accordance with DIN EN 1363-1

Highbond anchor FHB in conjunction with reinforced concrete (strength class ≥ C20/25 ≤ C50/60)					
Maximum load max. $F_{fire(t)}$ [1) 2)] [kN] as a function of fire resistance time, the dimensions of the anchor rod, and the effective embedment depth					
Fire resistance time	**M10 R M10 HCR**	**M12 R M12 HCR**	**M16 R M16 HCR**	**M20 R M20 HCR**	**M24 R M24 HCR**
	Effective embedment depth				
[min]	**≥ 60 mm**	**≥ 80 mm**	**≥ 125 mm**	**≥ 170 mm**	**≥ 220 mm**
30	2.95	4.50	9.25	13.00	18.75
60	1.65	3.50	7.10	10.00	14.40
90	0.35	2.50	5.00	7.00	10.05
120	-	2.00	3.90	5.50	7.90

1) If for the normal purpose of use, smaller loads apply according to the Technical Data Sheets [4] from fischerwerke GmbH & Co. KG, 79211 Denzlingen, these shall be binding. Irrespective of the fire-safety-related assessment, the suitability of the anchors for the underground/anchoring base and the application must also be proved for the cold as-installed condition.

2) The maximum tensile load/shear load can be applied as centric tensile load (N), shear load (V), or as a combination of both (oblique tension).

Design values for the Highbond anchor FHB dyn under exposure to fire in accordance with DIN EN 1363-1 installed in reinforced concrete (strength class ≥ C20/25 ≤ C50/60)

Table 11: Design values for the Highbond anchor FHB dyn set in undergrounds made of reinforced concrete (strength class ≥ C20/25 ≤ C50/60) under exposure to fire in accordance with DIN EN 1363-1

Highbond anchor FHB dyn in conjunction with reinforced concrete (strength class ≥ C20/25 ≤ C50/60)				
Maximum load max. $F_{fire(t)}$ [1) 2)] [kN] as a function of fire resistance time, the dimensions of the anchor rod, and the effective embedment depth				
Fire resistance time	**M12 (gvz) M12 HCR**	**M16 (gvz) M16 HCR**	**M20 (gvz)**	**M24 (gvz)**
	Effective embedment depth			
[min]	**≥ 100 mm**	**≥ 125 mm**	**≥ 170 mm**	**≥ 220 mm**
30	4.50	9.25	13.00	18.75
60	3.50	7.10	10.00	14.40
90	2.50	5.00	7.00	10.05
120	2.00	3.90	5.50	7.90

1) If for the normal purpose of use, smaller loads apply according to the Technical Data Sheets [4] from fischerwerke GmbH & Co. KG, 79211 Denzlingen, these shall be binding. Irrespective of the fire-safety-related assessment, the suitability of the anchors for the underground/anchoring base and the application must also be proved for the cold as-installed condition.

2) The maximum tensile load/shear load can be applied as centric tensile load (N), shear load (V), or as a combination of both (oblique tension).

Design values for the Highbond anchor FDA under exposure to fire in accordance with DIN EN 1363-1 installed in reinforced concrete (strength class ≥ C20/25 ≤ C50/60)

Table 12: Design values for the Highbond anchor FDA set in undergrounds made of reinforced concrete (strength class ≥ C20/25 ≤ C50/60) under exposure to fire in accordance with DIN EN 1363-1

Highbond anchor FDA in conjunction with reinforced concrete (strength class ≥ C20/25 ≤ C50/60)		
Maximum load max. $F_{fire(t)}$ [1) 2)] [kN] as a function of fire resistance time, the dimensions of the anchor rod, and the effective embedment depth		
Fire resistance time	**M12 (gvz)**	**M16 (gvz)**
	Effective embedment depth	
[min]	**≥ 100 mm**	**≥ 125 mm**
30	4.50	9.25
60	3.50	7.10
90	2.50	5.00
120	2.00	3.90

1) If for the normal purpose of use, smaller loads apply according to the Technical Data Sheets [4] from fischerwerke GmbH & Co. KG, 79211 Denzlingen, these shall be binding. Irrespective of the fire-safety-related assessment, the suitability of the anchors for the underground/anchoring base and the application must also be proved for the cold as-installed condition.

2) The maximum tensile load/shear load can be applied as centric tensile load (N), shear load (V), or as a combination of both (oblique tension).