

Assessment Report

Project **22154_2**

**Fire resistance of B+BTec Injection system BIS-HY
GEN2 under fire exposure acc. 1363-1**

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1 General information

B+BTec authorized the evaluation of the fire resistance of the chemical anchor system BIS-HY GEN2 for axial tension and shear loads. The evaluation is based on tests that were conducted by the Technical University Kaiserslautern under fire exposure according to DIN EN 1363-1:2012 [2] and Technical Report 020 [1]. The test results are summarized in test report 17027MR15552 [3].

This evaluation provides fire resistances which covers anchors with fire attack from one side only.

2 Reference documents

- [1] Evaluation of Anchorages in Concrete Concerning Resistance to fire, EOTA TR 020, Edition May 2004
 - [2] Feuerwiderstandsprüfungen – Teil 1: Allgemeine Anforderungen, DIN EN 1363-1; Edition Oktober 2012
 - [3] Report on fire tests according TR020, Test Report 17027MR15552, TU Kaiserslautern, June 2017
 - [4] Report on fire tests for post installed rebars according to EAD 330087-00-0601, Test Report 15025CT15541, TU Kaiserslautern, December 2016
 - [5] DIN EN 1992-4:2019-04: Eurocode 2. Design of concrete structures – Part 4: Design of fastenings for use in concrete.
 - [6] European Technical Assessment ETA-16/0018: “Chemofast Injection system UM-H for concrete”, EOTA, October 2020
 - [7] C. Thiele, M. Reichert: “Qualifikation von Verbunddübeln im Brandfall”, TU Kaiserslautern, DIBt, June 2017
 - [8] Fire tests for post installed rebars according to EAD 330087-00-0601, TU Kaiserslautern, April 2017
 - [9] Feuerwiderstände von Edelstahl im Brandfall, TU Kaiserslautern 21036CT15511, 17.7.2021
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3 Product description

The B+BTec Injection system BIS-HY Gen2 adhesive is a bonded anchor system consisting of a plastic cartridge containing the injection mortar and a steel part.

The injection system BIS-HY GEN2 is designed for the use in concrete according to the European Technical Assessment ETA-19/0131 [6].

4 Scope of evaluation

The present evaluation of fire resistance for B+BTec Injection system BIS-HY GEN2 anchor systems in concrete is assessed with respect to its fire resistance properties as anchor applications in walls and ceilings. The tests which this evaluation refers to, are executed with vertical arranged anchors and axial load application. Furthermore, the anchors were exposed to the standard temperature-time curve (ETK) [2]. In the tests a fixture according to TR020 was used, therefore the following fire resistances cover only anchors protected from fire by attachments similar to the fixture according to TR020 [1]. The assessment of steel failure and concrete cone failure is carried out in dependence on TR020 [1]. Additionally the failure type pullout failure is assessed as explained in below.

- a. Steel failure:
Steel failure is assessed according to TR020 [1]. In some cases more than one anchor size is assessed together
- b. Pullout failure:
Pullout failure is assessed by the current state of scientific knowledge according to the research report "Qualifikation von Verbunddübeln im Brandfall" [7] A combination of thermal simulation and assessment of test results was used.
- c. Concrete cone failure:
Concrete cone failure is assessed according to TR020 [1].

For internally threaded rods steel failure has to be proven with using the internal thread diameter. The outer diameter of the internally threaded rods can be used to verify the pullout capacity.

4.1 Steel failure

4.1.1 General – commercially available threaded rods

The values below are valid for the use of carbon steel (minimum grade 5.8 acc. to ISO 898-1), stainless steel (1.4401, 1.4404, 1.4571, 1.4572 acc. to EN 10088, minimum grade 70 acc. to ISO 3506) or high corrosion resistant steel (HCR 1.4529, 1.4565 acc. to EN 10088, minimum grade 70 acc. to ISO 3506) anchor rods.

The given values are also valid for steel failure caused by shear loads.

Table 4-1: Maximum tension load $N_{Rk,s,fi(t)}$

thread diameter	tensile stress area	maximum tension load $N_{Rk,s,fi(t)}$ depending on the fire resistance			
		30	60	90	120
[mm]	[mm ²]	[min]	[min]	[min]	[min]
8	36,6	1,10	0,88	0,66	0,51
10	58	1,74	1,39	1,04	0,81
12	84,3	3,03	2,28	1,60	1,18
16	157	5,65	4,24	2,98	2,20
20	245	8,82	6,62	4,66	3,43
24	353	12,71	9,53	6,71	4,94
30	561	20,20	15,15	10,66	7,85

4.1.2 Steel Failure for CF AKS - A4 from B+BTec acc. [9]

The values below are valid only for stainless steel (1.4401, 1.4404, 1.4541, 1.4571 und 1.4578 acc. to EN 10088, minimum grade 70 acc. to ISO 3506) anchor rods CF AKS -A4. The fire resistances for steel failure cover axial loads and shear loads as well.

Table 4-1: Maximum tension load $N_{Rk,s,fi(t)}$, CF AKS – A4

thread diameter	tensile stress area	Maximum tension load $N_{Rk,fi(t)}$, [kN] depending on the fire resistance time			
		30	60	90	120
[mm]	[mm ²]	[min]	[min]	[min]	[min]
8	36,6	2,45	1,94	1,46	1,21
10	58	3,89	3,07	2,32	1,91
12	84,3	8,43	6,15	3,79	2,61
16	157	15,70	11,46	7,07	4,87
20	245	24,50	17,89	11,03	7,60
24	353	35,30	25,77	15,89	10,94
27	459	45,90	33,51	20,66	14,23
30	561	56,10	40,95	25,25	17,39

4.1.3 Rebars

The values below are valid for the use of rebars according DIN EN 1992-1 with $f_{yk} \geq 500\text{N/mm}^2$.

The fire resistances for steel failure cover axial loads and shear loads as well.

rebar	tensile stress area	Maximum tension load $N_{Rk,fi(t)}$, [kN] depending on the fire resistance time			
		30	60	90	120
[mm]	[mm ²]	[min]	[min]	[min]	[min]
8	50	1,51	1,01	0,75	0,50
10	79	2,36	1,57	1,18	0,79
12	113	3,39	2,26	1,70	1,13
16	201	6,03	4,02	3,02	2,01
20	314	9,42	6,28	4,71	3,14
25	491	14,73	9,82	7,36	4,91
28	616	18,47	12,32	9,24	6,16
32	804	24,13	16,08	12,06	8,04

4.2 Pullout failure for non-cracked concrete

In the following tables the characteristic pullout resistances non-cracked concrete are given. The given values are valid for the specified anchorage depths as well as for larger anchorage depths. The specified values can also be applied for rebars. Therefore choose the anchor size equal or smaller than the nominal diameter of the rebars. The maximum anchorage depth is given in [6].

Table 4-2: Fire resistance concerning pullout failure in non-cracked concrete, M8 – M16 and d8-d16

anchorage depth $h_{ef} \geq$	Anchor size/ rebar	pullout resistance in case of fire $N_{Rk,p,ucr,fi(t)}$ for different fire durations			
		30	60	90	120
[mm]	[mm]	[min]	[min]	[min]	[min]
60	M8 / d8	4,38	0,78	0,14	0,14
65		5,75	1,18	0,29	0,15
70		7,22	1,69	0,50	0,16
75		8,91	2,33	0,77	0,24
80		10,74	3,12	1,12	0,43
85		12,49	4,08	1,56	0,66
90		14,08	5,17	2,10	0,95
95		15,67	6,42	2,76	1,32
100		17,23	7,82	3,55	1,77
120		23,38	14,56	8,02	4,59
60		M10 / d10	3,96	0,58	0,17
65	5,29		0,95	0,18	0,18
70	6,87		1,43	0,34	0,20
80	10,68		2,81	0,94	0,28
85	12,92		3,76	1,36	0,52
90	15,23		4,89	1,90	0,81
100	19,42		7,71	3,36	1,62
125	29,17		17,77	9,69	5,58
150	38,64		27,88	19,80	13,01
200	57,48		46,91	39,48	33,36
70	M12 / d12 , d14		6,28	1,15	0,24
75		8,09	1,71	0,40	0,25
80		10,16	2,43	0,72	0,27
90		15,04	4,41	1,62	0,61
100		20,59	7,22	3,02	1,39
110		25,63	10,90	5,05	2,56
115		28,04	13,04	6,33	3,33
125		32,74	17,93	9,45	5,32
175		55,48	42,54	33,26	24,92
240		84,88	72,06	63,20	55,99
80	M16 / d16	8,72	1,66	0,36	0,36
90		13,64	3,34	1,02	0,41
100		19,71	5,85	2,21	0,83
110		27,04	9,34	3,99	1,86
120		34,29	13,86	6,53	3,36
130		40,92	19,41	9,93	5,48
150		53,54	33,42	19,47	12,03
200		83,91	65,82	53,23	42,26
250		114,07	96,17	84,12	74,32
300		144,22	126,34	114,36	104,72

Table 4-3: Fire resistance concerning pullout failure in non-cracked concrete, M20 – M30, d20-d32

anchorage depth $h_{ef} \geq$	Anchor size/ rebar	pullout resistance in case of fire $N_{Rk,p,ucr,fi(t)}$ for different fire durations			
		30	60	90	120
[mm]	[mm]	[min]	[min]	[min]	[min]
90	M20 / d20	12,09	2,45	0,51	0,51
100		18,14	4,60	1,47	0,57
110		25,69	7,70	2,98	1,15
120		34,30	11,90	5,18	2,46
130		43,99	17,29	8,24	4,30
140		52,47	23,81	12,28	6,86
150		60,63	31,50	17,36	10,27
200		99,20	74,72	57,23	41,43
250		136,98	113,17	97,38	84,49
300		174,65	150,96	135,46	123,07
95		M24 / d25	13,55	2,52	0,64
110	24,04		6,23	2,07	0,75
125	37,90		12,33	5,18	2,32
140	54,89		21,23	10,22	5,40
155	70,61		33,04	17,65	10,25
170	85,17		47,64	27,69	17,27
180	94,57		58,93	35,83	23,28
200	113,07		80,40	55,43	38,50
250	158,54		127,78	107,43	90,57
300	203,80		173,36	153,76	138,23
110	M27 / d28		22,80	5,27	1,43
120		31,77	8,72	3,15	0,92
135		47,94	16,12	7,02	3,32
150		67,29	26,57	13,09	7,10
165		85,03	40,14	21,75	12,84
180		101,43	56,63	33,19	20,95
200		122,41	82,05	52,66	35,71
230		153,45	116,00	89,71	66,36
270		194,28	157,95	134,30	114,99
300		224,82	188,75	165,69	147,42
120		M30 / d32	30,64	7,62	2,42
135	47,13		14,53	5,94	2,52
140	53,43		17,51	7,53	3,50
145	60,13		20,84	9,37	4,63
150	67,30		24,53	11,48	5,95
165	88,66		37,81	19,59	11,18
180	107,51		54,26	30,55	18,73
195	125,44		73,76	44,45	28,88
210	143,04		95,45	61,20	41,75
300	245,44		203,13	176,13	154,67

4.3 Pullout failure for cracked concrete

The test results according test report 17027MR15552 [3] shows no significant reduction between cracked and non-cracked concrete. However a reduction factor between cracked and non-cracked concrete of 0,75 was determined and has to be used.

$$N_{Rk,p,cr,fi} = 0,75 \cdot N_{Rk,p,ucr,fi}$$

4.4 Concrete cone failure

The resistance against concrete cone failure was calculated according equation 2.6 and 2.7 of TR 020 [1] or equations D.2 und D.3 of DIN EN 1992-4 and equation 7.2 of DIN EN 1992-4 [5] as given below.

$$N_{Rk,c,fi(90)}^0 = \frac{h_{ef}}{200} \cdot N_{Rk,c}^0 \leq N_{Rk,c}^0$$

$$N_{Rk,c,fi(120)}^0 = 0,8 \cdot \frac{h_{ef}}{200} \cdot N_{Rk,c}^0 \leq N_{Rk,c}^0$$

$$\text{with } N_{Rk,c}^0 = 7,7 \cdot h_{ef}^{1,5} \cdot f_{ck}^{0,5}$$

5 Summary

The listed fire resistances are valid for single anchors with an edge distance of more than $c_{cr}=2 h_{ef}$ and a spacing to the adjacent anchor of $s= 2 c_{cr}= 4 h_{ef}$. Edge and spacing distances have to be chosen so that steel – or pullout failure are decisive.

Pirmasens, 27.8.2021



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