Assessment Report

Project **22142**

Fire resistance of VJ Technology Injection system V420+ under fire exposure acc. 1363-1

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1 General information

VJ Technololgy Ltd.authorized the evaluation of the fire resistance of the chemical anchor system V420+, V420+ V3 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-ETA-17/0570: “VJ Technology Injection system V420+ for concrete”, EOTA, 7. May 2021

[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

3 Product description

The VJ Technology Injection system V420+ adhesive is a bonded anchor system consisting of a plastic cartridge containing the injection mortar and a steel part.

The injection system V420+, V420+ V3 is designed for the use in concrete according to the European Technical Assessment ETA-ETA-17/0570 [6].

4 Scope of evaluation

The present evaluation of fire resistance for VJ Technology Injection system V420+ 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 "Qualfikation 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

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]	[mm²]	[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

4.2 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 maximum anchorage depth is given in [6].

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

anchorage depth h_{ef} ≥	threaded rod	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	8	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	10	3,96	0,58	0,17	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	12	6,28	1,15	0,24	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	16	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

anchorage depth h_{ef} ≥	threaded rod	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	20	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	24	13,55	2,52	0,64	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	27	22,80	5,27	1,43	0,84
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	30	30,64	7,62	2,42	1,02
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.

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

4.4 Concrete cone failure

The resistance against concrete cone failure has to be 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.

$$N^0_{Rk,c,fi(90)} = \frac{h_{ef}}{200} \cdot N^0_{Rk,c} \le N^0_{Rk,c}$$

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

$$with \quad N^0_{Rk,c} = 7{,}7 \cdot h_{ef}^{1,5} \cdot f_{ck}^{0,5}$$

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.

The values 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.

Pirmasens, 27.05.2021

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