

Assessment Report

Project **22126**

**Fire resistance of Friulsider injection sytem KEM EP
under fire exposure acc. 1363-1**

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1 General information

Friulsider S.p.A. authorized the evaluation of the fire resistance of the chemical anchor system KEM EP 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 TR 020 [1]. The test results are summarized in test report 17061MR15557 [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 17061MR15557_2, TU Kaiserslautern, May 2018
 - [4] Report on fire tests for post installed rebars according to EAD 330087-00-0601, Test Report 17061MR15557_1, TU Kaiserslautern, May 2017
 - [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-20/1284: “Friulsider injection system KEM EP for concrete”, EOTA, 9 March 2021.
 - [7] C. Thiele, M. Reichert: “Qualifikation von Verbunddübeln im Brandfall”, TU Kaiserslautern, DIBt, June 2017.
 - [8] Report on fire tests according TR020, Test Report 17027MR15552, TU Kaiserslautern, June 2017
 - [9] Assessment report on fire resistance under fire exposure acc. 1363-1, Assessment Report 21737 (August 2017) and 21834 (28.11.2020) , Ingenieurbüro Thiele,
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3 Product description

The Friulsider injection system KEM EP adhesive is a bonded anchor system consisting of a plastic cartridge containing the injection mortar and a steel part.

The injection system Friulsider S.p.A. is designed for the use in concrete according to the European Technical Assessment ETA-20/1284[6].

4 Scope of evaluation

The present evaluation of fire resistance for Friulsider injection system KEM EP 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

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

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]
6	20,1	0,29	0,23	0,17	0,14
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
27	459	16,52	12,39	8,72	6,43
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 for threaded rods, M8 – M12

Anchorage depth $h_{ef} \geq$	Anchor size	Maximum tension load $N_{Rk,p,ucr,fi(t)}$, [kN] depending on the fire resistance time			
		30	60	90	120
[mm]	[mm]	[min]	[min]	[min]	[min]
80	8	3,26	1,37	0,44	0,00
85		3,77	1,65	0,73	0,02
90		4,28	1,94	1,01	0,25
95		4,92	2,24	1,28	0,56
100		6,30	2,61	1,55	0,83
105		8,19	3,01	1,83	1,10
110		10,19	3,45	2,11	1,37
115		11,99	3,92	2,40	1,64
120		13,65	4,40	2,73	1,91
160		13,65	4,40	2,73	1,91
90		10	4,60	2,06	0,87
95	5,24		2,42	1,23	0,20
100	5,91		2,79	1,58	0,64
105	6,76		3,21	1,93	1,01
110	8,54		3,69	2,29	1,36
115	11,99		3,92	2,40	1,64
125	15,80		5,39	3,39	2,40
140	21,99		7,32	4,87	3,46
170	33,50		19,36	8,57	6,49
200	37,19	25,82	16,70	10,65	
100	12	6,20	2,92	1,45	0,14
105		6,99	3,36	1,89	0,70
110		7,80	3,82	2,32	1,17
115		8,92	4,37	2,75	1,60
120		11,08	4,98	3,18	2,03
130		17,16	6,35	4,06	2,88
140		22,59	7,84	5,13	3,74
170		36,79	18,38	9,33	7,00
200		50,46	33,91	20,22	11,44
240		68,57	52,33	40,52	30,15

Table 4-3: Fire resistance concerning pullout failure in non-cracked concrete for treaded rods, M16 – M24

Anchorage depth $h_{ef} \geq$	Anchor size	Maximum tension load $N_{Rk,p,ucr,fi(t)}$, [kN] depending on the fire resistance time			
		30	60	90	120
[mm]	[mm]	[min]	[min]	[min]	[min]
110	16	8,27	3,98	1,89	0,09
115		9,27	4,58	2,50	0,73
120		10,31	5,18	3,10	1,44
125		11,40	5,80	3,69	2,06
130		12,49	6,54	4,28	2,66
160		33,39	12,19	8,31	6,17
180		46,56	18,50	12,06	9,07
200		58,97	34,16	16,28	12,78
250		89,29	66,58	50,22	34,86
300		119,45	96,92	81,32	68,39
120		20	10,67	5,22	2,43
130	13,21		6,73	3,97	1,73
140	15,84		8,29	5,47	3,33
150	19,09		10,27	6,97	4,84
160	27,22		12,54	8,47	6,32
170	37,76		15,01	10,26	7,81
180	47,16		17,62	12,38	9,30
190	55,67		20,35	14,72	11,13
250	102,28		71,27	47,46	27,15
300	140,01		109,96	89,54	72,33
130	24		13,56	6,67	3,07
140		16,53	8,49	4,97	2,07
150		19,69	10,31	6,80	4,06
160		22,99	12,52	8,61	5,91
170		29,47	15,13	10,42	7,72
180		40,96	18,00	12,36	9,52
190		53,85	21,05	14,74	11,31
200		64,84	24,25	17,42	13,26
250		112,76	70,10	36,10	27,29
300		158,26	118,89	92,01	67,75

Table 4-4: Fire resistance concerning pullout failure in non-cracked concrete for treaded rods, M27 – M30

Anchorage depth $h_{ef} \geq$	Anchor size	Maximum tension load $N_{Rk,p,ucr,fi(t)}$, [kN] depending on the fire resistance time			
		30	60	90	120
[mm]	[mm]	[min]	[min]	[min]	[min]
135	27	15,25	7,40	3,08	0,01
150		20,22	10,49	6,33	2,99
165		25,68	13,75	9,43	6,26
180		34,77	18,01	12,50	9,34
195		54,76	22,90	15,94	12,39
200		62,03	24,63	17,32	13,41
210		74,86	28,21	20,30	15,56
225		92,06	33,97	25,21	19,62
275		144,87	95,18	54,53	36,60
300		170,45	122,76	89,04	56,41
140		30	17,15	8,19	3,07
150	20,69		10,50	5,60	1,24
160	24,57		12,80	7,96	4,14
170	28,59		15,12	10,27	6,58
175	30,66		16,48	11,41	7,74
185	36,04		19,58	13,69	10,04
190	41,35		21,26	14,83	11,18
210	72,56		28,65	20,18	15,72
250	123,85		52,53	34,71	27,66
300	181,85		124,24	79,48	48,26

4.3 Pullout failure for cracked concrete

The test results according test report 17061MR15557_2 [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 considered.

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

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.

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

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

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

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.

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.

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