Assessment Report

Project	**21735_2**
	Fire resistance of the anchor system Hilti HVU2 under fire exposure acc. DIN EN 1363-1
Employer	**Hilti AG Liechtenstein** **Feldkircherstraße 100** **9494 Schaan** **Fürstentum Liechtenstein**
Date	**01.08.2017**
Validity	**01.08.2022**
Pages	**9**

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1 General information

Hilti Deutschland AG authorized the evaluation of the fire resistance of the bonded fastener HVU2 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 16056MR15542 [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 with HVU2 foil capsule, Test Report 16056MR15542, TU Kaiserslautern, June 2017

[4] Guideline for European technical approval of metal anchors for use in concrete, EOTA ETAG 001, Edition April 2013

[5] Europäische Technische Bewertung ETA-160515: “Hilti HVU2 mit HAS und HIS Elementen“, EOTA, DIBt, August 2017

[6] C. Thiele, M. Reichert: „Qualifizierung von Verbunddübeln im Brandfall“, TU Kaiserslautern, DIBt, June 2017

3 Product description

The bonded fastener HVU2 is designed for the use in concrete according to the European Technical Assessment ETA-16/0515 [5].

4 Scope of assessment

The present evaluation of fire resistance for Hilti HVU2 anchor systems in concrete was assessed with respect to its fire resistance properties as anchor applications in walls and ceilings. The tests 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 covers 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 was assessed according to TR020 [1]. In some cases more than one anchor size was assessed together

b. Pullout failure:
   Pullout failure was assessed by the current state of scientific knowledge in accordance to the research report “Qualifizierung von Verbunddübeln im Brandfall” [6]. A combination of thermal simulations and assessment of test results was used.

c. Concrete cone failure:
   Concrete cone failure was assessed according to TR020 [1].

The fire resistances, which are given in chapter 5 cover axial loads and shear loads as well.

5 Summary

The values given below are valid for the drilling methods diamond drilling (DD), hammer drilling (TE) and hammer drilling with hollow drill bit (HDB).

Table 5-1 to Table 5-8 show the decisive fire resistances for the use of the anchor system HVU2 in **cracked** and **non-cracked concrete**. The failure modes steel failure, concrete cone failure and bond failure were considered. For the values coloured grey steel failure was decisive.

The given fire resistances covers axial and shear loads. The listed fire resistances are valid for single anchors with an edge distance of more than $c_{cr} = 2 \times h_{ef}$ and a spacing to the adjacent anchor of $s = 2 \times c_{cr} = 4 \times h_{ef.}$

*Table 5-1: Summary of the characteristic resistance for **non-cracked** concrete, HAS, carbon steel (strength class higher than 5.8)*

Anchorage depth h_{ef}	Anchor diameter	Maximum tension laod $N_{Rd,fi(t)}$ depending on the fire resistance time			
		30	60	90	120
[mm]	[mm]	[min]	[min]	[min]	[min]
80	8	1,83	1,39	0,58	0,28
90	10	2,90	2,20	0,97	0,47
110	12	4,22	3,20	2,19	1,31
125	16	7,85	5,97	3,98	2,22
170	20	12,25	9,31	6,37	4,41
210	24	17,65	13,41	9,18	6,35
240	27	22,95	17,44	11,93	8,26
270	30	28,05	21,32	14,59	10,10

*Table 5-2: Summary of the characteristic resistance for **non-cracked** concrete, HAS, stainless steel (strength class 70)*

Anchorage depth h_{ef}	Anchor diameter	Maximum tension laod $N_{Rd,fi(t)}$ depending on the fire resistance time			
		30	60	90	120
[mm]	[mm]	[min]	[min]	[min]	[min]
80	8	4,19	1,51	0,58	0,28
90	10	6,64	2,33	0,97	0,47
110	12	9,65	4,88	2,49	1,31
125	16	17,08	7,40	3,98	2,22
170	20	28,05	19,67	11,29	7,11
210	24	40,42	28,35	16,27	10,24
240	27	52,56	36,86	21,16	13,31
270	30	64,23	45,05	25,86	16,27

*Table 5-3: Summary of the characteristic resistance for **cracked** concrete, HAS, carbon steel (strength class higher than 5.8)*

Anchorage depth h_{ef}	Anchor diameter	Maximum tension laod $N_{Rd,fi(t)}$ depending on the fire resistance time			
		30	60	90	120
[mm]	[mm]	[min]	[min]	[min]	[min]
80	8	0,00	0,00	0,00	0,00
90	10	2,90	1,75	0,73	0,35
110	12	4,22	3,20	1,87	0,99
125	16	7,85	5,55	2,98	1,66
170	20	12,25	9,31	6,37	4,41
210	24	17,65	13,41	9,18	6,35
240	27	22,95	17,44	11,93	8,26
270	30	28,05	21,32	14,59	10,10

*Table 5-4: Summary of the characteristic resistance for **cracked** concrete, HAS, stainless steel (strength class 70)*

Anchorage depth h_{ef}	Anchor diameter	Maximum tension laod $N_{Rd,fi(t)}$ depending on the fire resistance time			
		30	60	90	120
[mm]	[mm]	[min]	[min]	[min]	[min]
80	8	0,00	0,00	0,00	0,00
90	10	4,98	1,75	0,73	0,35
110	12	8,97	3,66	1,87	0,99
125	16	12,81	5,55	2,98	1,66
170	20	28,05	16,28	10,14	6,89
210	24	40,42	28,35	16,27	10,24
240	27	52,56	36,86	21,16	13,31
270	30	64,23	45,05	25,86	16,27

*Table 5-5: Summary of the characteristic resistance for **non-cracked** concrete, HIS-N, carbon steel*

Anchorage depth h_{ef}	outer diameter of the sleeve	Anchor diameter	Maximum tension laod $N_{Rd,fi(t)}$ depending on the fire resistance time			
			30	60	90	120
[mm]	[mm]	[mm]	[min]	[min]	[min]	[min]
90	12,5	8	1,83	1,39	0,85	0,43
110	16,5	10	2,90	2,20	1,51	1,02
125	20,5	12	4,22	3,20	2,19	1,52
170	25,4	16	7,85	5,97	4,08	2,83
205	27,6	20	12,25	9,31	6,37	4,41

*Table 5-6: Summary of the characteristic resistance for **non-cracked** concrete, HIS-N, stainless steel*

Anchorage depth h_{ef}	outer diameter of the sleeve	Anchor diameter	Maximum tension laod $N_{Rd,fi(t)}$ depending on the fire resistance time			
			30	60	90	120
[mm]	[mm]	[mm]	[min]	[min]	[min]	[min]
90	12,5	8	4,19	2,18	0,85	0,43
110	16,5	10	6,64	4,47	2,04	1,02
125	20,5	12	9,65	6,77	3,35	1,75
170	25,4	16	17,98	12,61	7,24	4,55
205	27,6	20	28,05	19,67	11,29	7,11

*Table 5-7: Summary of the characteristic resistance for **cracked** concrete, HIS-N, carbon steel*

Anchorage depth h_{ef}	outer diameter of the sleeve	Anchor diameter	Maximum tension laod $N_{Rd,fi(t)}$ depending on the fire resistance time			
			30	60	90	120
[mm]	[mm]	[mm]	[min]	[min]	[min]	[min]
90	12,5	8	1,83	1,39	0,64	0,33
110	16,5	10	2,90	2,20	1,51	0,76
125	20,5	12	4,22	3,20	2,19	1,31
170	25,4	16	7,85	5,97	4,08	2,83
205	27,6	20	12,25	9,31	6,37	4,41

*Table 5-8: Summary of the characteristic resistance for **cracked** concrete, HIS-N, stainless steel*

Anchorage depth h_{ef}	outer diameter of the sleeve	Anchor diameter	Maximum tension laod $N_{Rd,fi(t)}$ depending on the fire resistance time			
			30	60	90	120
[mm]	[mm]	[mm]	[min]	[min]	[min]	[min]
90	12,5	8	4,19	1,63	0,64	0,33
110	16,5	10	6,64	3,35	1,53	0,76
125	20,5	12	9,65	5,12	2,51	1,31
170	25,4	16	17,98	12,61	7,24	4,55
205	27,6	20	28,05	19,67	11,29	7,11

Pirmasens, 1st of August 2017

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