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Title:

The Fire Performance of Various Types Of Mechanical and Plastic Anchor Fixing Systems for Use in Concrete Structures

WF Assessment Report No:

327804/A Issue 2

Prepared for:

Hilti Entwicklungsgesellschaft mbH

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Date:

10th July 2013

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Executive Summary

Objective

This report provides a considered opinion regarding the fire performance of various types of mechanical and plastic anchor fixing systems for use in concrete structures, when subjected to tests utilising the general principles of BS 476: Part 20: 1987.

Report Sponsor

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Summary of Conclusions

Should the recommendations given in this report be followed, it can be concluded that Hilti anchor systems, as detailed in this report, should be capable of supporting the loads detailed in the tables within this report, for periods of up to 180 minutes, when fixed into structural concrete (or other materials specifically detailed within this report), if subjected to the heating conditions of BS 476: Part 22: 1987.

Valid until

1st August 2018

Introduction

This report provides a considered opinion regarding the fire performance of various types of mechanical and plastic anchor fixing systems for use in concrete structures, when subjected to tests utilising the general principles of BS 476: Part 20: 1987.

The report considers the test procedures and subsequent data obtained from tests conducted at the Institut Für Baustoffe Massivbau und Brandschutz, Technische Universität Braunschweig (IBMB), Germany, tests conducted at MFPA Leipzig GmbH, Baulicher Brandschutz, Hans Weigel Strasse 2b, 04 379 Leipzig and the general principles of BS 476: Part 20: 1987.

FTSG

The data referred to in the supporting data section has been considered for the purpose of this appraisal which has been prepared in accordance with the Fire Test Study Group Resolution No. 82: 2001.

Assumptions

It is assumed that the concrete elements into which the various types of rebar are installed will be constructed in accordance with BS 8110: Part 2: 1985 and have a minimum compressive strength of 25 N/mm².

The fire performance rating of the fixing systems is assumed to apply to reinforced concrete elements which have been designed to give at least the same period of fire resistance as that for the injection system.

The injection systems are assumed to be installed correctly and in accordance with Hilti Entwicklungsgesellschaft mbH installation instructions.

Proposals

It is proposed to provide various types of Hilti anchor fixing systems, into structural grade concrete (or other materials specifically detailed within this report), which are supporting a load and are capable of providing this support whilst being subjected to the heating conditions of BS 476: Part 20: 1987, for periods ranging from 30 up to 180 minutes. An index of the proposed anchors is provided below:

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List of Basic Evidence

Mechanical Fixings				
Fixings	**Report**		**Fixings**	**Report**
HUS	ETA-08/0307		HSL-GR	IBMB 3027/0274-5
HUS-HR	IBMB 3707/983/11		HUS HR	PB111/08-354
HST	ETA -98/0001		HSL-3, HSL-3-G, HSL-3-B, SL-3-SH, HSL-3-SK	IBMB 3041/1663
HST-R	ETA- 98/0001		HLC, HLC-H, HLC-L, HLC-EC	IBMB 3093/517
HST-HCR	ETA-98/0001 IBMB 3332/0881-2		HDA, HDA-F, HDA-R	IBMB 3039/8151
HSA, HSA-R	IBMB 3215/229/12		DBZ 6/4,5, DBZ 6/35	ETA-06/0179(Part6)
HSC-A, HSC-AR, HSC-I, HSC-IR	IBMB 3177/1722-1		HT8L, HT10L, HT10S	IBMB 3016/1114
HKD, HKD-SR	IBMB 3027/0274-4		HPD, HPD-I	IBMB 3077/3602
HKD, HKD-wol(HKV)	ETA -06/0047(Part6)		HKH, HKH-L	IBMB 3606/8892
HKD-SR, HKD-ER	ETA- 06/0047(Part6)		HK, HK-L	ETA-04/0043(part6)
HA8, HA8 R1, HA8 H1, HA8 L1	IBMB 3245/1817-5			

Plastic Anchor	
Fixings	**Report**
HRD-U8 and U10	MFPA GS 3.2/10-157-1 table 1

Assessed Performance

This report provides an analysis of the ability of each particular type of fixing to support a range of loads, for various periods of fire test exposure.

There is not currently a British Standard relating to the testing of mechanical or plastic anchors under fire conditions and therefore a number of test reports, primarily conducted by IBMB, have been cited in support of this appraisal. All of the cited evidence has been conducted utilising the heating conditions specified in DIN 4102-2 or EN 1363-1, both of which are based upon the ISO 834 heating curve, which is also the basis for the heating conditions given in BS 476: Part 20 1987.

The heating conditions to which the tested anchors were subjected would therefore be expected to be equal to those of a BS 476: Part 20 test and the results of these tests would therefore be expected to be comparable with those that would be achieved if the anchors were subjected to the heating conditions of BS 476: Part 20: 1987.

The analysis with respect to fixing diameter takes into account a limited amount of extrapolation to fixing diameters larger than those tested. This extrapolation is considered acceptable because the core temperature of these fixings would be expected to be lower compared with the smaller tested fixings and the test evidence is based on the type of first failure, which will be at least similar to anchors with a greater diameter.

The following sections give a brief descriptions of each anchor system tested and its associated performance:

1) Mechanical Systems

HUS

The Hilti Universal Screws (HUS), were subjected to tests in accordance with EOTA TR 020, as detailed within ETA- 08/0307. The performance ratings given in the ETA are as follows:

Characteristic values to tension loads under fire exposure in cracked and non-cracked concrete C20/25 to C50/60:

Nominal anchor diameter				6		8				10				14	
Type			HUS-	AHIP	HR	H		HR		H		HR		HR	
Nominal anchorage depth		h_{nom}	[mm]	55		60	75	60	80	70	85	70	90	70	110
Steel failure															
Characteristic resistance	R30	$N_{Rk,s,fi}$	[kN]	1,6	4,9	3,1		9,3		5,0		18,5		41,7	
	R60	$N_{Rk,s,fi}$	[kN]	1,2	3,3	2,2		6,3		3,6		12,0		26,9	
	R90	$N_{Rk,s,fi}$	[kN]	0,8	1,8	1,3		3,2		2,2		5,4		12,2	
	R120	$N_{Rk,s,fi}$	[kN]	0,7	1,0	0,8		1,7		1,5		2,4		5,4	
Concrete Pullout failure															
Characteristic resistance	R30 R60 R90	$N_{Rk,p,fi}$	[kN]	1,5	1,3	1,5	2,3	1,5	3,0	1,9	4,0	2,3	4,0	3,0	6,3
	R120	$N_{Rk,p,fi}$	[kN]	1,2	1,0	1,2	1,8	1,2	2,4	1,5	3,2	1,8	3,2	2,4	5,0
Edge distance	R30	$c_{cr,N}$	[mm]	$2\ h_{ef}$											
	R60 R90 R120	c_{min}	[mm]	Fire attack from one side : $c_{min} = 2\ h_{ef}$ Fire attack from more then one side: $c_{min} \geq 300$ mm											
Anchor spacing	R30	$s_{cr,N}$	[mm]	$4\ h_{ef}$											
	R60 R90 R120	s_{min}	[mm]	35		55		45	50	50				50	60

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi} = 1,0$ is recommended.

Characteristic values to shear loads under fire exposure in cracked and non-cracked conrete C20/25 to C50/60

Nominal anchor diameter				6		8		10		14	
Type			HUS-	AHIP	HR	H	HR	H	HR	HR	
Nominal anchorage depth		h_{nom}	[mm]	55		60	75	60	80	70	85	70	90	70	110
Steel failure without leaver arm															
Characteristic resistance	R30	$V^0_{Rk,s,fi}$	[kN]	1,6	4,9	3,1		9,3		5,0		18,5		41,7	
	R60	$V^0_{Rk,s,fi}$	[kN]	1,2	3,3	2,2		6,3		3,6		12,0		26,9	
	R90	$V^0_{Rk,s,fi}$	[kN]	0,8	1,8	1,3		3,2		2,2		5,4		12,2	
	R120	$V^0_{Rk,s,fi}$	[kN]	0,7	1,0	0,8		1,7		1,5		2,4		5,4	
Steel failure with leaver arm															
Characteristic resistance	R30	$M^0_{Rk,s,fi}$	[Nm]	1,4	4,0	3,3		8,2		6,3		19,4		65,6	
	R60	$M^0_{Rk,s,fi}$	[Nm]	1,1	2,7	2,3		5,5		4,6		12,6		42,4	
	R90	$M^0_{Rk,s,fi}$	[Nm]	0,7	1,4	1,4		2,8		2,8		5,7		19,2	
	R120	$M^0_{Rk,s,fi}$	[Nm]	0,6	0,8	0,9		1,5		1,9		2,5		8,5	
Concrete pry-out failure															
factor in eq. (5.6) of ETAG 001 Annex C, 5.2.3.3	R30 R60 R90 R120	k		1,5		2									
Concrete edge failure															
Characteristic resistance in C20/25 to C50/60 under fire exposure	R30 R60 R90	$V^0_{Rk,c,fi}$	[kN]	$0,25 \times V^0_{Rk,c}$											
	R120	$V^0_{Rk,c,fi}$	[kN]	$0,20 \times V^0_{Rk,c}$											
With $V^0_{Rk,c}$ as initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.															

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi} = 1,0$ is recommended.

HUS-HF

The Hilti HUS-HF series of anchors, were subjected to tests in accordance with DIN 4102-2: 1977-09, as reported under the reference IBMB 3707/983/11 The performance ratings given in this report are as follows:

Anchor Size	Maximum tensile load (kN) for requested fire resistance duration (mins)			
HUS-HF	**30**	**60**	**90**	**120**
M8	7	2.65	1.5	1
M10	9	3.3	1.8	1.2
M14	9	3.3	1.8	1.2

HUS-HR

The Hilti HUS-HR series of anchors, were subjected to tests in accordance with RABT ZTV (tunnel fire), as reported under the reference PB 111/08-354. The performance ratings given in this report are as follows:

Anchor Size	**Maximum tensile load (kN)**
M6	0.2
M8	0.3
M10	0.5
M14	1.1

HST
HST-R
HST-HCR

The Hilti HST, HST-R and HSY-HCR stud anchors, were subjected to tests in accordance with EOTA TR 020, as detailed within ETA 98/0001. The performance ratings given in the ETA are as follows:

Characteristic values to tension loads under fire exposure in cracked and non-concrete C20/25 to C50/60

Anchor type / size				**M8**	**M10**	**M12**	**M16**	**M20** HST, HST-R only	**M24** HST, HST-R only
Steel failure									
HST (steel galvanised)									
Characteristic resistance	R30	$N_{Rk,s,fi}$	[kN]	0,9	2,5	5	9	15	20
	R60	$N_{Rk,s,fi}$	[kN]	0,7	1,5	3,5	6	10	15
	R90	$N_{Rk,s,fi}$	[kN]	0,6	1	2	3,5	6	8
	R120	$N_{Rk,s,fi}$	[kN]	0,5	0,7	1	2	3,5	5
HST-R (stainless steel) and **HST-HCR** (high corrosion resistant steel)									
Characteristic resistance	R30	$N_{Rk,s,fi}$	[kN]	4,9	11,8	17,2	32	49,9	71,9
	R60	$N_{Rk,s,fi}$	[kN]	3,6	8,4	12,2	22,8	35,5	51,2
	R90	$N_{Rk,s,fi}$	[kN]	2,4	5	7,3	13,5	21,1	30,4
	R120	$N_{Rk,s,fi}$	[kN]	1,7	3,3	4,8	8,9	13,9	20
Pullout failure									
HST (steel galvanised)									
Characteristic resistance in concrete ≥ C20/25	R30 R60 R90	$N_{Rk,p,fi}$	[kN]	1,3	2,3	3	5	7,5	10
	R120	$N_{Rk,p,fi}$	[kN]	1,0	1,8	2,4	4	6	8
HST-R (stainless steel) and **HST-HCR** (high corrosion resistant steel)									
Characteristic resistance in concrete ≥ C20/25	R30 R60 R90	$N_{Rk,p,fi}$	[kN]	1,3	2,3	3	6,3	7,5	10
	R120	$N_{Rk,p,fi}$	[kN]	1	1,8	2,4	5	6	8
Concrete cone failure									
all types (HST, HST-R, HST-HCR)									
Characteristic resistance in concrete ≥ C20/25	R30 R60 R90	$N^0_{Rk,c,fi}$	[kN]	2,7	5	7,4	11	18,5	31,4
	R120	$N^0_{Rk,c,fi}$	[kN]	2,2	4	5,9	8,8	14,8	25,2
Spacing		$s_{cr,N}$	[mm]	4 x h_{ef}					
		s_{min}	[mm]	40	55	60	70	100	125
Edge distance		$c_{cr,N}$	[mm]	2 x h_{ef}					
		c_{min}	[mm]	Fire attack from one side: 2 x h_{ef} Fire attack from more than one side: ≥ 300					

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi}$ = 1,0 is recommended.

Characteristic values to shear loads under fire exposure in cracked and non-cracked concrete C20/25 to C50/60

Anchor type / size				M8	M10	M12	M16	M20 HST, HST-R only	M24 HST, HST-R only
Steel failure without lever arm									
HST (steel galvanised)									
Characteristic resistance	R30	$V^0_{Rk,s,fi}$	[kN]	0,9	2,5	5	9	15	20
	R60	$V^0_{Rk,s,fi}$	[kN]	0,7	1,5	3,5	6	10	15
	R90	$V^0_{Rk,s,fi}$	[kN]	0,6	1,0	2	3,5	6	8
	R120	$V^0_{Rk,s,fi}$	[kN]	0,5	0,7	1	2	3,5	5
HST-R (stainless steel) and **HST-HCR** (high corrosion resistant steel)									
Characteristic resistance	R30	$V^0_{Rk,s,fi}$	[kN]	4,9	11,8	17,2	32	49,9	71,9
	R60	$V^0_{Rk,s,fi}$	[kN]	3,6	8,4	12,2	22,8	35,5	51,2
	R90	$V^0_{Rk,s,fi}$	[kN]	2,4	5	7,3	13,5	21,1	30,4
	R120	$V^0_{Rk,s,fi}$	[kN]	1,7	3,3	4,8	8,9	13,9	20
Steel failure with lever arm									
HST (steel galvanised)									
Characteristic resistance	R30	$M^0_{Rk,s,fi}$	[Nm]	1,0	3,3	8,1	20,6	40,2	69,5
	R60	$M^0_{Rk,s,fi}$	[Nm]	0,8	2,4	5,7	14,4	28,1	48,6
	R90	$M^0_{Rk,s,fi}$	[Nm]	0,7	1,6	3,2	8,2	16	27,7
	R120	$M^0_{Rk,s,fi}$	[Nm]	0,6	1,2	2	5,1	9,9	17,2
HST-R (stainless steel) and **HST-HCR** (high corrosion resistant steel)									
Characteristic resistance	R30	$M^0_{Rk,s,fi}$	[Nm]	5	15,2	26,6	67,7	132,3	228,6
	R60	$M^0_{Rk,s,fi}$	[Nm]	3,7	10,8	19	48,2	94,1	162,6
	R90	$M^0_{Rk,s,fi}$	[Nm]	2,4	6,4	11,3	28,6	55,9	96,6
	R120	$M^0_{Rk,s,fi}$	[Nm]	1,8	4,2	7,4	18,9	36,8	63,7
Concrete pryout failure									
all types (HST, HST-R, HST-HCR)									
Factor in equation (5.6) of ETAG 001 Annex C, 5.2.3.3		k	[-]	2,0	2,0	2,2	2,5	2,5	2,5
Characteristic resistance	R30 R60 R90	$V^0_{Rk,cp,fi}$	[kN]	5,4	10	16	27,2	49,4	84,5
	R120	$V^0_{Rk,cp,fi}$	[kN]	4,4	8	12,9	21,7	39,6	67,5
Concrete edge failure									
all types (HST, HST-R, HST-HCR)									
The initial value $V^0_{Rk,c,fi}$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by: $V^0_{Rk,c,fi} = 0,25 \times V^0_{Rk,c}$ (≤ R90) $V^0_{Rk,c,fi} = 0,20 \times V^0_{Rk,c}$ (R120) with $V^0_{Rk,c}$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.									

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi} = 1,0$ is recommended.

Further test evidence is available for the use of the HST-HCR anchors when subjected to the significantly more severe RABT ZTV 'Tunnel Fire' heating conditions in the report referenced IBMB 3332/0881-2. The performance ratings given in this report are as follows:

Anchor Size	Maximum tensile load (kN)
M8	1.0
M10	1.5
M12	2.5
M16	6.0

HSA

The Hilti HSA series of stud anchors, were subjected to tests in accordance with DIN 4102-2: 1977-09, as reported under the reference IBMB 3215/229/12. The performance ratings given in this report are as follows:

Anchor Reference	Anchor Size	Maximum tensile load (kN) for requested fire resistance duration (mins)			
		30	60	90	120
HSA	M6	0.2	0.18	0.14	0.1
HSA	M8	0.37	0.33	0.26	0.18
HSA	M10	0.87	0.75	0.58	0.46
HSA	M12	1.69	1.26	1.1	0.84
HSA	M16	3.14	2.36	2.04	1.57
HSA	M20	4.9	3.68	3.19	2.45

HSC-A, HSC-AR, HSC-I, HSC-IR

The Hilti HSC series of stud anchors, were subjected to tests in accordance with DIN 4102-2: 1977-09, as reported under the reference IBMB 3177/1722-1. The performance ratings given in this report are as follows:

Anchor Reference	Anchor Size	Maximum tensile load (kN) for requested fire resistance duration (mins)			
		30	60	90	120
HSC-A	M8	-	-	1.5	-
HSC-A	M10	-	-	1.5	-
HSC-A	M12	-	3.5	2.0	-
HSC-AR	M8	-	-	1.5	-
HSC-AR	M10	-	-	1.5	-
HSC-AR	M12	-	-	3.5	3.0
HSC-I	M8	-	-	1.5	-
HSC-I	M10	-	-	2.5	-
HSC-I	M12	-	-	2.0	-
HSC-IR	M8	-	-	1.5	-
HSC-IR	M10	-	-	2.5	-
HSC-IR	M12	-	-	3.5	3.0

HKD, HKD-woL (HKV)

The Hilti HKD & HKD-woL stud anchors, were subjected to tests in accordance with EOTA TR 020, as detailed within ETA 06/0047(Part6). The performance ratings given in the ETA are as follows:

Characteristic values under fire exposure in concrete C20/C25 to C50/60 in any load direction

Fire resistance class	HKD, HKD-woL			M6x25	M8x25	M8x30	M8x40	M10x25	M10x30	M10x40	M12x25	M12x50	M16x65
R 30	Characteristic resistance	$F^0_{Rk,fi}$ [1]	[kN]	0,5	0,6	0,9	1,3	0,6	0,9	1,8	0,6	2,3	4,0
R 60	Characteristic resistance	$F^0_{Rk,fi}$ [1]	[kN]	0,4	0,6	0,9	1,3	0,6	0,9	1,8	0,6	2,3	4,0
R 90	Characteristic resistance	$F^0_{Rk,fi}$ [1]	[kN]	0,3	0,6	0,9	1,3	0,6	0,9	1,8	0,6	2,3	4,0
R 120	Characteristic resistance	$F^0_{Rk,fi}$ [1]	[kN]	0,2	0,5	0,7	0,7	0,5	0,7	1,5	0,5	1,8	3,2
R 30 to R 120	Spacing	$s_{cr,fi}$	[mm]	160	160	120	160	120	120	160	160	200	260
	Edge distance	$c_{cr,fi}$	[mm]	140	140	105	140	105	105	140	140	175	230
In case of fire attack from more than one side, the minimum edge distance shall be ≥ 300 mm. The anchorage depth has to be increased for wet concrete by at least 30 mm compared to the given value.													

[1] In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{m,fi}$ = 1,0 is recommended.

HKD-SR, HKD-ER

The Hilti HKD-S & HKD-E stud anchors, were subjected to tests in accordance with EOTA TR 020, as detailed within ETA 06/0047(Part6). The performance ratings given in the ETA are as follows:

Characteristic values under fire exposure in concrete C20/C25 to C50/60 in any load direction

Fire resistance class	HKD-SR, HKD-ER (stainless steel)			M6x30	M8x30	M10x40	M12x50
R 30	Characteristic resistance	$F^0_{Rk,fi}$ [1)]	[kN]	0,5	0,9	1,8	2,3
R 60	Characteristic resistance	$F^0_{Rk,fi}$ [1)]	[kN]	0,5	0,9	1,8	2,3
R 90	Characteristic resistance	$F^0_{Rk,fi}$ [1)]	[kN]	0,4	0,9	1,8	2,3
R 120	Characteristic resistance	$F^0_{Rk,fi}$ [1)]	[kN]	0,3	0,7	1,5	1,8
R 30 to R 120	Spacing	$s_{cr,fi}$	[mm]	120	120	160	200
	Edge distance	$c_{cr,fi}$	[mm]	105	105	140	175
In case of fire attack from more than one side, the minimum edge distance shall be ≥ 300 mm. The anchorage depth has to be increased for wet concrete by at least 30 mm compared to the given value.							

[1)] In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{m,fi}$ = 1,0 is recommended.

Further test evidence is available for the use of the HKD-SR anchors when subjected to the significantly more severe RABT ZTV 'Tunnel Fire' heating conditions in the report referenced IBMB 3027/0274-4. The performance ratings given in this report are as follows:

Anchor Size	Maximum tensile load (kN)
M8	0.5
M10	0.8
M12	2.5
M16	5.0
M20	6.0

HA8, HA8 R1, HA8 H1, HA8 L1

The Hilti HA8 series anchors, were subjected to tests in accordance with DIN 4102-2: 1977-09, as reported under the reference IBMB 3245/1817-5. The performance ratings given in this report are as follows:

Anchor Reference	Anchor Size	Maximum tensile load (kN) for requested fire resistance duration (mins)			
		30	60	90	120
HA8 HA8 R1 HA8 H1 HA8 L1	8 mm	0.35	0.2	0.1	0.05

HSL-GR

The Hilti HSL-GR anchors, were subjected to tests in accordance with DIN 4102-2: 1977-09, as reported under the reference IBMB 3027/0274-5. The performance ratings given in this report are as follows:

Anchor Size	Maximum tensile load (kN) for requested fire resistance duration (mins)			
	30	**60**	**90**	**120**
M8	6.9	6.9	2.0	0.8
M10	10.4	10.4	4.0	2.0
M12	15.0	15.0	6.0	3.0
M16	25.7	25.7	8.0	6.0
M20	34.6	34.6	12.0	10.0

HSL-3, HSL-3-G, HSL-3-B, HSL-3-SH, HSL-3-SK

The Hilti HSL-3 series of anchors, were subjected to tests utilising the heating conditions of DIN EN 1363-1, as reported under the reference IBMB 3041/1663. The performance ratings given in this report are as follows:

Anchor Reference	Anchor Size	Maximum tensile load (kN) for requested fire resistance duration (mins)			
		30	60	90	120
HSL-3 HSL-3-G HSL-3-SK	M8	3.00	1.1	0.6	0.4
HSL-3-SH		1.9			
HSL-3 HSL-3-G HSL-3-SK	M10	7.0	2.0	1.3	0.8
HSL-3-SH		4.5			
HSL-3 HSL-3-G HSL-3-B HSL-3-SK	M12	10.0	3.5	2.0	1.2
HSL-3-SH		8.5			
HSL-3 HSL-3-G HSL-3-B	M16	19.4	6.6	3.5	2.2
HSL-3 HSL-3-G HSL-3-B	M20	30.0	10.3	5.4	3.5
HSL-3 HSL-3-G HSL-3-B	M24	43.0	14.8	7.9	5.0

HLC, HLC-H, HLC-L, HLC-EC

The Hilti HLC series of anchors, were subjected to tests utilising the heating conditions of DIN EN 1363-1, as reported under the reference IBMB 3093/517-07. The performance ratings given in this report are as follows:

Anchor Reference	Anchor Size	Maximum tensile load (kN) for requested fire resistance duration (mins)			
		30	60	90	120
HLC	M5	0.53	0.29	0.21	0.17
HLC	M6	0.93	0.51	0.37	0.3
HLC	M8	1.94	0.99	0.67	0.51
HLC	M10	3.08	1.57	1.07	0.81
HLC	M12	4.0	2.28	1.55	1.18
HLC	M16	4.0	3.75	2.7	2.2
HLC-H	M6	0.93	0.51	0.37	0.3
HLC-H	M8	1.94	0.99	0.67	0.51
HLC-H	M10	3.08	1.57	1.07	0.81
HLC-H	M12	4.0	2.28	1.55	1.18
HLC-L	M8	1.94	0.99	0.67	0.51
HLC-EC	M8	0.93	0.51	0.37	0.3
HLC-EC	M10	1.94	0.99	0.67	0.51
HLC-EC	M16	1.94	0.99	0.67	0.51

HDA, HDA-F, HDA-R

The Hilti HDA series anchors, were subjected to tests in accordance with DIN 4102-2: 1977-09, as reported under the reference IBMB 3039/8151. The performance ratings given in this report are as follows:

Anchor Reference	Anchor Size	Maximum tensile load (kN) for requested fire resistance duration (mins)				
		30	60	90	120	180
HDA	M10	4.5	2.2	1.3	1.0	0.7
HDA	M12	10.0	3.5	1.8	1.2	1.0
HDA	M16	15.0	7.0	4.0	3.0	2.5
HDA	M20	25.0	9.0	7.0	5.0	3.7
HDA-F	M10	4.5	2.2	1.3	1.0	0.7
HDA-F	M12	10.0	3.5	1.8	1.2	1.0
HDA-F	M16	15.0	7.0	4.0	3.0	2.5
HDA-R	M10	20.0	9.0	4.0	2.0	1.0
HDA-R	M12	30.0	12.0	5.0	3.0	2.1
HDA-R	M16	50.0	15.0	7.5	6.0	4.7

DBZ 6/4,5, DBZ 6/35

The Hilti DBZ series anchors, were subjected to tests in accordance with EOTA TR 020, as detailed within ETA 06/0179(Part6). The performance ratings given in the ETA are as follows:

Characteristic values under fire exposure in concrete C20/C25 to C50/60 in any load direction without lever arm

Fire resistance class	Hilti wedge anchor			DBZ 6/4,5 and DBZ 6/35
R 30	Characteristic resistance	$F^0_{Rk,fi}$ [1]	[kN]	0,6
R 60	Characteristic resistance	$F^0_{Rk,fi}$ [1]	[kN]	0,5
R 90	Characteristic resistance	$F^0_{Rk,fi}$ [1]	[kN]	0,3
R 120	Characteristic resistance	$F^0_{Rk,fi}$ [1]	[kN]	0,2
R 30 to R 120	Spacing	$s_{cr,fi}$	[mm]	200
	Edge distance	$c_{cr,fi}$	[mm]	150
In case of fire attack from more than one side, the edge distance shall be ≥ 300 mm.				

HT8L, HT10L, HT10S

The Hilti HT series of anchors, were subjected to tests utilising the heating conditions of DIN EN 1363-1, as reported under the reference IBMB 3016/1114. The performance ratings given in this report are as follows:

Anchor Reference	Anchor Size	Maximum tensile load (kN) for requested fire resistance duration (mins)			
		30	60	90	120
HT8L	8 mm	0.85	0.44	0.27	0.19
HT10L	10 mm	0.74	0.41	0.3	0.24
HT10S	10 mm	0.74	0.41	0.3	0.24

HPD, HPD-I

The Hilti HPD series anchors, were subjected to tests in accordance with DIN 4102-2: 1977-09, as reported under the reference IBMB 3077/3602. The performance ratings given in this report are as follows:

Anchor Reference	Anchor Size	Maximum tensile load (kN) for requested fire resistance duration (mins)			
		30	60	90	120
HPD/HPD-I	M6	0.85	0.50	0.35	0.30
HPD/HPD-I	M8	1.40	0.70	0.45	0.35
HPD/HPD-I	M10	2.20	1.30	0.95	0.75
HPD-I	M12	2.20	1.30	0.95	0.75

HKH, HKH-L

The Hilti HKH series of anchors, were subjected to tests utilising the heating conditions of DIN EN 1363-1, as reported under the reference IBMB 3606/8892. The performance ratings given in this report are as follows:

Anchor Reference	Anchor Size	Maximum tensile load (kN) for requested fire resistance duration (mins)			
		30	60	90	120
HKH/HKH-L	M6	1.20	0.65	0.45	0.35
HKH/HKH-L	M8	1.90	0.95	0.65	0.50
HKH/HKH-L	M10	3.20	1.65	1.10	0.85

HK, HK-L

The Hilti HK series anchors, were subjected to tests in accordance with EOTA TR 020, as detailed within ETA 04/0043. The performance ratings given in the ETA are as follows:

Characteristic values under fire exposure in concrete C20/C25 to C50/60 in any load direction without lever arm

Fire resistance class	Anchor typ			HK6, HK6-R, HK6-HCR	HK6L, HK6-L-R, HK6-L-HCR	HK8, HK8-R, HK8-HCR
R30	Characteristic resistance		$F_{Rk,fi(30)}$ [kN]	0,3	0,6	1,2
R60	Characteristic resistance		$F_{Rk,fi(60)}$ [kN]	0,3	0,5	1,0
R90	Characteristic resistance		$F_{Rk,fi(90)}$ [kN]	0,3	0,3	0,6
R120	Characteristic resistance		$F_{Rk,fi(120)}$ [kN]	0,2	0,2	0,4
R30 - R120	Spacing		$s_{cr} = s_{min}$ [mm]	200		
	Edge distance for fire attack from	one side only	$c_{cr} = c_{min}$ [mm]	150		
		more than one side	$c_{cr} = c_{min}$ [mm]	300		

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi} = 1,0$ is recommended.

2) Plastic Systems

HRD-U8 and U10

The Hilti HRD were subjected to tests in accordance with EOTA TR 020, as detailed within GS 3.2/10-157-1. The performance ratings are as follows:

Table 1: maximum shear load under fire exposure

Hilti frame anchor HRD			HRD 8	HRD 10
Screw diameter [mm]			**6**	**7**
Stressed cross section A_s [mm²]			**22,9**	**35,3**
Steel failure				
Characteristic steel strength				
30 min	$\sigma_{Rk,s,fi(30)}$	[N/mm²]	83,6	83,6
60 min	$\sigma_{Rk,s,fi(60)}$	[N/mm²]	63,9	63,9
90 min	$\sigma_{Rk,s,fi(90)}$	[N/mm²]	44,1	44,1
120 min	$\sigma_{Rk,s,fi(120)}$	[N/mm²]	34,2	34,2
Characteristic shear load				
30 min	$V_{Rk,p,fi(30)}$	[kN]	1,9	
60 min	$V_{Rk,p,fi(60)}$	[kN]	1,4	
90 min	$V_{Rk,p,fi(90)}$	[kN]	1,0	
120 min	$V_{Rk,p,fi(120)}$	[kN]	0,7	

The characteristic values for other failure modes under shear load can be determined according the simplified design method of TR020.

Conclusions

Hilti anchor systems, as detailed in this report, should be capable of supporting the loads detailed in the tables within this report, for periods of up to 240 minutes, when fixed into structural concrete (or other materials specifically detailed within this report), if subjected to the heating conditions of BS 476: Part 22: 1987.

Validity

This assessment is issued on the basis of test data and information available at the time of issue. If contradictory evidence becomes available to EXOVA **warrington**fire the assessment will be unconditionally withdrawn and Hilti Entwicklungsgesellschaft mbH will be notified in writing. Similarly the assessment is invalidated if the assessed construction is subsequently tested because actual test data is deemed to take precedence over an expressed opinion. The assessment is valid initially for a period of five years i.e. until 1st July 2018, after which time it is recommended that it be returned for re-appraisal.

The appraisal is only valid provided that no other modifications are made to the tested construction other than those described in this report.

Summary of Primary Supporting Data

The following tests were conducted by Institut Für Baustoffe Massivbau und Brandschutz, Technische Universität Braunschweig (IBMB), Germany and MFPA Leipzig GmbH, Baulicher Brandschutz, Hans Weiger Strasse 2b, 04 379 Leipsig on mechanical and chemical anchor systems as discussed in this report:

Mechanical Fixings				
Fixings	**Report**		**Fixings**	**Report**
HUS	ETA-08/0307		HSL-GR	IBMB 3027/0274-5
HUS-HR	IBMB 3707/983/11		HUS HR	PB111/08-354
HST	ETA -98/0001		HSL-3, HSL-3-G, HSL-3-B, SL-3-SH, HSL-3-SK	IBMB 3041/1663
HST-R	ETA- 98/0001		HLC, HLC-H, HLC-L, HLC-EC	IBMB 3093/517
HST-HCR	ETA-98/0001 IBMB 3332/0881-2		HDA, HDA-F, HDA-R	IBMB 3039/8151
HSA, HSA-R	IBMB 3215/229/12		DBZ 6/4,5, DBZ 6/35	ETA-06/0179(Part6)
HSC-A, HSC-AR, HSC-I, HSC-IR	IBMB 3177/1722-1		HT8L, HT10L, HT10S	IBMB 3016/1114
HKD, HKD-SR	IBMB 3027/0274-4		HPD, HPD-I	IBMB 3077/3602
HKD, HKD-wol(HKV)	ETA -06/0047(Part6)		HKH, HKH-L	IBMB 3606/8892
HKD-SR, HKD-ER	ETA- 06/0047(Part6)		HK, HK-L	ETA-04/0043(part6)
HA8, HA8 R1, HA8 H1, HA8 L1	IBMB 3245/1817-5			

Plastic Anchor	
Fixings	**Report**
HRD-U8 and U10	MFPA GS 3.2/10-157-1 table 1

Declaration by Hilti Entwicklungsgesellschaft mbH

We the undersigned confirm that we have read and complied with the obligations placed on us by the UK Fire Test Study Group Resolution No. 82: 2001.

We confirm that the component or element of structure, which is the subject of this assessment, has not to our knowledge been subjected to a fire test to the Standard against which the assessment is being made.

We agree to withdraw this assessment from circulation should the component or element of structure be the subject of a fire test to the Standard against which this assessment is being made.

We are not aware of any information that could adversely affect the conclusions of this assessment.

If we subsequently become aware of any such information we agree to cease using the assessment and ask EXOVA **warringtonfire** to withdraw the assessment.

Signed:

For and on behalf of:

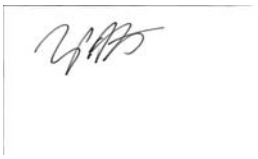
Dr. Arne Reinheimer

Head of Development Chemical Anchors

Hilti Entwicklungs-
gesellschaft mbH
Hiltistr. 2
86916 Kaufering

Germany

Signatories



Responsible Officer

C Abbott* - Senior Certification Engineer

Approved

A Kearns* - Technical Manager

* For and on behalf of EXOVA **warringtonfire**.

Report Issued: 10th July 2013

The assessment report is not valid unless it incorporates the declaration duly signed by the applicant.