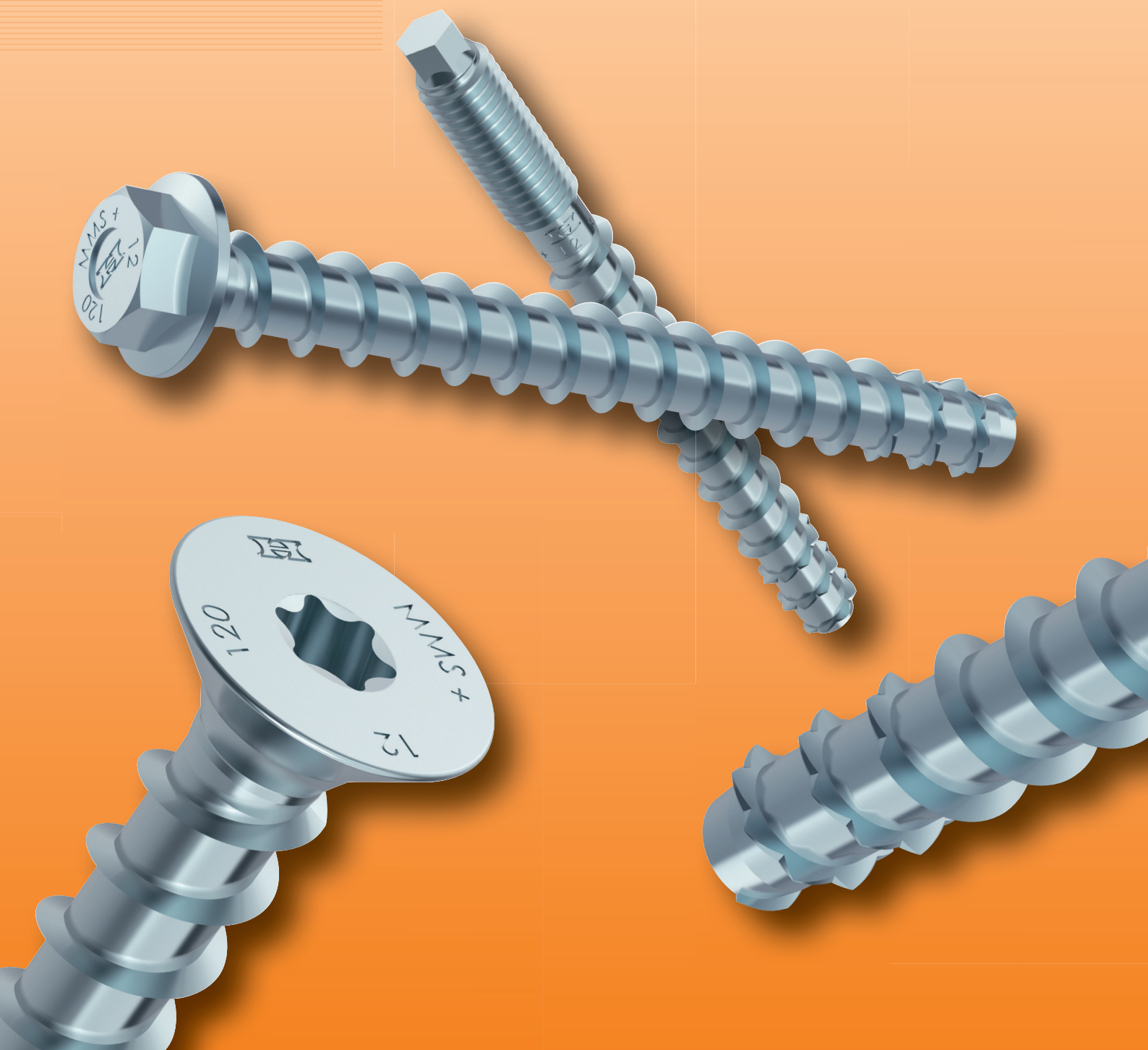


# MULTI-MONTI<sup>®</sup>-plus and MULTI-MONTI<sup>®</sup>

## Fire experts report for use in masonry wall

Screw anchors MMS-plus and MMS in masonry walls KS, KSL and Mz





**Experts report**  
Fire resistance of  
MMS Multi Monti screw anchor and  
MMS Plus screw anchor  
in masonry wall made of KS, KSL and Mz

Client: HECO-Schrauben GmbH & Co. KG  
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## **1**     **INTRODUCTION**

The HECO-Schrauben GmbH & Co. KG wants to use the screw anchors

- HECO HMS screw anchor with the sizes Ø5
- HECO MMS screw anchor with the sizes Ø7.5 to Ø12
- HECO MMS-plus screw anchor Ø6 to Ø12

for fire applications in masonry walls. The tests are performed according to the provisions of EOTA TR20 [G4] in masonry wall units [see R4]. The screw anchors HECO MMS provide a national approval Z 21-1-1503 [G6] and an ETA 05/0010 [G8]. The screw anchors HECO MMS-plus provide an ETA 15/0784 [G7]. The screw anchor HECO HMS (size Ø5) provides no approval.

Only tests with the gvz version under fire exposure in masonry made of KS, KSL and Mz were performed. The tests are done at iBMB MPA Braunschweig with the screw anchors Multi Monti MMS (gvz-version) with the size Ø6 and Ø7.5 as well with the HMS screw anchor with a size Ø5. The tests with the screw anchor HECO MMS-plus are omitted due to the fact that the screws anchors Multi Monti MMS and MMS-plus are identical in terms of material, production and dimension. The load bearing behaviour can be assumed to be equivalent for both type of anchors.

The tests were performed to qualify the anchors and to derive the steel resistance under fire only. The resistances for the other failure modes are not taken into account in the tests. Therefore, the characteristic resistance is evaluated using the results of the tests in concrete showing equivalency. The evaluated characteristic resistances are only valid, if the anchors are suitable for cracked anchoring material or if the anchoring material remains non-cracked in cases of fire exposure.

## **2**      **LITERATURE**

### **2.1**    **Test reports**

- [R1]    Evaluation Report No. 15\_86-3: Evaluation report for Heco Screw Anchor MMS-plus characteristic resistance under fire. 2015-12-22, IEA GmbH & Co. KG, 70569 Stuttgart.
- [R2]    Test Report PB 111/8-06-140 vom 01.08.2006 Prüfstelle für Baustoffe, Bauteile und Bauarten MFPA Leipzig GmbH.
- [R3]    Ergänzung-Test Report PB 111/8-06-140 vom 01.08.2006 Prüfstelle für Baustoffe, Bauteile und Bauarten MFPA Leipzig GmbH.
- [R4]    Untersuchungsbericht Nr. 3815/0592-Nau(13.12.2002), Prüfung von in Mauerwerk KSL, KSV und Vz gesetzte, auf zentrischen Zug belastete HECO-Multi-Monti-Schraubanker HMS/MMS der Dimension M5 bis M12 auf Brandverhalten in Anlehnung an DIN 4102-2: 1977-09 zur Ermittlung der Feuerwiderstandsdauer, MPA Braunschweig.

### **2.2**    **General**

- [G1]    ETAG 001 used as an EAD Guideline for European Technical Approval of Metal Anchors for use in Concrete, Part 1, Brussel 2013.
- [G2]    ETAG 001 used as an EAD Guideline for European Technical Approval of Metal Anchors for use in Concrete. Part 3, Brüssel 2013.
- [G3]    European Organisation for Standardisation: CEN/TC 250, prEN 1992-4 Eurocode 2: Design of concrete structures, Part 4 Design of fastenings for use in concrete, 24.04.2015.
- [G4]    EOTA TR 20, Evaluation of Anchorages in Concrete concerning Resistance to Fire, Edition May 2004.
- [G5]    Allgemeine bauaufsichtliche Zulassung Z-21.1-1549, HECO Multi-Monti-Schraubanker MMS zur Verankerung im gerissenen und ungerissenen Beton, DIBt, Berlin, 16. August 2002.
- [G6]    Allgemeine bauaufsichtliche Zulassung Z-21.1-1503, HECO Multi-Monti-Schraubanker MMS zur Verankerung im ungerissenen Beton und zur Verankerung leichter Deckenbekleidungen und Unterdecken im Beton DIBt, Berlin, 28.09.2015.
- [G7]    Europäische Technische Bewertung ETA-15/0784, MULTI-MONTI-plus, Schraubanker in den Größen 6, 7.5, 10 und 12 mm zur Verankerung im gerissenen und ungerissenen Beton DIBt, Berlin, 19. Mai 2016.
- [G8]    Europäische Technische Bewertung ETA-05/0010, HECO MULTI-MONTI MMS, Betonschraube zur Verankerung im Beton, DIBt, Berlin, 21 . Januar 2015.
- [G9]    Technische Anlagen „MULTI-MONTI<sup>®</sup>“, Stand 06/2015 der HECO-Schrauben GmbH & Co. KG.

### 3 DESCRIPTION OF THE PRODUCT

#### 3.1 Product used for the tests in masonry

For the fire tests in masonry screw anchors of the type HMS (Ø5) and MMS (Ø6 and Ø7,5) with a hexagonal nut were used. The screw anchors tested under fire are made of galvanised steel. The product MMS-plus is qualified for the use in cracked and non-cracked concrete for the size Ø6 to Ø12 according to the current approval [G7]. Due to geometrical equivalence the test results with the screw type MMS are also valid for the screw type MMS-plus. The tested screw type HMS with the size Ø5 is not qualified according to an ETAG procedure. More details are given in [R1].

#### 3.2 Installation parameters for masonry

The screw anchors MMS with the size Ø6 to size Ø7.5 were installed according to the manufacture's product-installation-instruction (MPII) given in [R1]. The embedment depth was  $h_{ef} = 30\text{mm}$  for all tested sizes (Ø5, Ø6, Ø7.5). Additional  $h_{ef} = 40\text{mm}$  for the size Ø7.5 was tested. The most important installation parameters are summarised in the following table 3-1. More details are given in [R4].

Size HMS / MMS			5	6	7,5
Nominal drilling diameter	$d_0$	[mm]	4,0	5,0	6,0
	$h_{ef}$	[mm]	> 30	> 30	> 30 / > 40
Depth of the borehole	$h_1 \geq$	[mm]	> $h_{nom} + d_0$		
Hole diameter of the fixture	$d_f \leq$	[mm]	$\leq 6.0$	$\leq 7.0$	$\leq 8.5$
Minimum member thickness	$h_{min}$	[mm]	80	90	100
Maximum torque moment	$T_{inst}$	[Nm]	8	12	20
Fire exposure	Min. spacing	$s_{min}$	200	200	200
	Min. edge distance	$c_{min}$	100	100	100

Table 3-1: Installation parameters of the MMS-plus used for fire applications.

The hole was cleaned with a hand pump and a vacuum cleaner for the fire tests.

##### 3.2.1 Drilling und drill hole depth

The drilling of the holes was done with a standard drilling machine using the corresponding drill bit hammer drilling. This corresponds with the provision of ETAG 001, Annex C used as an EAD.

## 4 CHARACTERISTIC FIRE RESISTANCE IN MASONRY

### 4.1 Summary of the characteristic values under fire exposure

In table 4-1 the results of the evaluated characteristic resistances under fire exposure are summarised for the different failure modes. For most of the characteristic resistances pullout failure is decisive up to fire duration of 120 min.

Size MMS-plus				Ø5	Ø6	Ø7,5	Ø10	Ø12
Embedment depth in concrete $h_{ef}$ [mm]				30	30	40	48	55
<b>Steel failure for Tension and Shear resistance</b>								
Characteristic resistance	R30	$F_{Rk,s,fi}$	[kN]	0,23	1,12	1,77	3,2	5,0
	R60	$F_{Rk,s,fi}$	[kN]	0,11	0,53	0,79	1,4	2,2
	R90	$F_{Rk,s,fi}$	[kN]	0,07	0,34	0,47	0,8	1,3
	R120	$F_{Rk,s,fi}$	[kN]	0,05	0,24	0,30	0,6	0,9
	R30	$M^0_{Rk,s,fi}$	[Nm]	0,11	0,70	1,41	3,46	6,70
	R60	$M^0_{Rk,s,fi}$	[Nm]	0,06	0,33	0,63	1,55	3,00
	R90	$M^0_{Rk,s,fi}$	[Nm]	0,04	0,21	0,37	0,91	1,76
	R120	$M^0_{Rk,s,fi}$	[Nm]	0,03	0,15	0,24	0,59	1,15
<b>Other failure modes for tension and shear for Mz</b>								
Characteristic resistance	R30	$N_{Rk,p,fi}$	[kN]	0,16	0,26	0,42	0,53	0,63
	R60							
	R90							
	R120							
<b>Other failure modes for tension and shear for KSV / KSL</b>								
Characteristic resistance	R30	$N_{Rk,p,fi}$	[kN]	0,26	0,58	0,74	1,10	1,31
	R60							
	R90							
	R120							
<b>Edge distance</b>								
R30 to R120	$C_{cr,fi}$	[mm]	$2 \cdot h_{ef}$					
$C_{min} = 2 \cdot h_{ef}$ if fire attack is from more than on side, the edge distance of the anchor has to be bigger than 300 mm.								
<b>Spacing</b>								
R30 to R120	$S_{cr,fi}$	[mm]	$2 \cdot C_{cr,fi}$					

Table 4-1: Evaluated characteristic resistances for screw anchors used in masonry Mz, KSL and KSV.

The above given values do not considering other effect that may affect the characteristic resistance of the anchor like e.g. the spalling off the concrete cover or larger crack width due to higher thermal stresses. This needs special consideration or embedment depths larger than  $h_{ef} = 40$  mm to  $h_{ef} = 60$  mm depending on the masonry stone and masonry wall configuration.

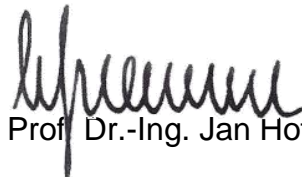


## 5 SUMMARY

The HECO-Schrauben GmbH & Co. KG wants to assess the screw anchor MMS plus with the sizes Ø6 to Ø12 and HMS Ø5 for fire applications in masonry. The evaluated characteristic fire resistances is valid for all sizes as well as for all material versions (gvz-, A4- and C-version) and was done on the basis of EOTA TR 20, [G4].

The screw anchors are assessed in the report [R1] for the sizes Ø6 to size Ø12 for static loading. The results of the fire tests are given in [R3] and [R4]. The results show that the anchor is suitable for the use under fire exposure and because the screw anchor is qualified for the use in cracked concrete. Therefore in masonry the same tests were performed to show equivalence with the behaviour in concrete.

The evaluated test results are valid for steel failure without lever arm for tension and shear loading. In addition the characteristic bending moments under fire exposure were calculated. For all other failure modes the admissible loads given in the manufactures technical specification are taken to derive the characteristic resistances under fire exposure. The evaluated resistances for fire exposure however are only valid if the characteristic resistance under non-fire conditions are achieved.



Prof. Dr.-Ing. Jan Hofmann

**Nomenclature:**

$h_{ef}$ :	Embedment depth
$h_{nom}$ :	Nominal length
$h_1$ :	Length of the bore hole
$h_{min}$ :	Minimum member thickness
$d_0$ :	Nominal diameter of the bore hole
$d_f$ :	Diameter of the hole in the fixture
$c_{min}$ :	Minimum edge distance
$c_{cr}$ :	Characteristic edge distance for ambient temperature
$c_{cr,fi}$ :	Characteristic edge distance for fire exposure
$s_{min}$ :	Minimum spacing
$s_{cr}$ :	Characteristic spacing for ambient temperature
$s_{cr,fi}$ :	Characteristic spacing for fire exposure
$T_{inst}$ :	Installation torque moment
$f_{b,nom}$ :	Nominal strength of the masonry unit
$A_s$ :	Cross section area of the screw
$\rho$ :	Specific weight
$\sigma_s$ :	Steel stress
$t_u$ :	Time to failure under fire exposure
$\sigma_{Rk,s,fi(x)}$ :	Characteristic steel stress under fire exposure for a fire duration of x minutes
$F_{Rk,s,fi}$ :	Characteristic steel resistance under fire exposure for all load directions
$M_{Rk,s,fi}$ :	Characteristic bending resistance under fire exposure
$N_{Rk,p,fi}$ :	Characteristic pull out resistance under fire exposure





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