MFPA Leipzig GmbH

Leipzig Institute for Materials Research and Testing

Testing, Inspection and Certification Authority for Construction Products and Construction Types

Center for Innovation and Calculation

Head of Division:
Dr.-Ing. Susanne Reichel
Tel.: +49 (0) 341-6582-106
Fax: +49 (0) 341-6582-135
s.reichel@mfpa-leipzig.de

Work Group - FEM

Contact Person:
Dr.-Ing. Susanne Reichel
Tel.: +49 (0) 341-6582-106
s.reichel@mfpa-leipzig.de

Advisory Opinion No. GS 6.1/24-036-2

13.09.2024

Translation of the original German document GS 6.1/24-036-2

Object:	Assessment of the load-bearing behaviour of metal frame fixing F-M under tension and shear load as well as one-sided fire loading according to the standard temperature time curve in combination with concrete substrates - abbreviated version
Client:	**fischerwerke GmbH & Co. KG** Klaus-Fischer-Straße 1 72178 Waldachtal Germany
Prepared by:	Dr.-Ing. Susanne Reichel

This document covers 10 pages, including 0 appendices.

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1 Order

MFPA Leipzig GmbH was commissioned by fischerwerke GmbH & Co. KG to carry out an evaluation of the load-bearing behaviour of metal frame fixings F-M under tension and shear load as well as one-sided fire loading according to the standard temperature-time curve (STTC) according to [N1]. The assessment is based on the results of fire tests and calculations.
The present document includes a summary of the design concept for fire design and the associated characteristic performance properties. For a detailed derivation of the performance characteristics, please refer to [G1].

2 Description of the construction

The fischer metal frame fixing F-M is a special plug consisting of a metal sleeve and a zinc-plated steel screw which is set by push-through installation. When the screw is tightened, the cone is pulled into the plug sleeve so that anchoring in the substrate is achieved via force-controlled expansion.
fischer F-M metal frame fixings are available in sizes F8M and F10M and in the following lengths (the value given in each case refers to the length ℓ_1 of the metal sleeve)

- F8M
  - F8M 72,
  - F8M 92,
  - F8M 112,
  - F8M 132,
- F10M
  - F10M 72,
  - F10M 92,
  - F10M 112,
  - F10M 132,
  - F10M 152,
  - F10M 182,
  - F10M 202

and according to the manufacturer's instructions may be anchored in the substrates

- concrete,
- hollow brick,
- hollow brick made of lightweight concrete,
- perforated sand-lime brick,
- solid sand-lime brick,
- aerated concrete,
- solid brick made of lightweight concrete and
- solid brick.

The present advisory opinion regarding the load-bearing behaviour in case of fire is only valid for anchoring in reinforced normal weight concrete of strength class at least C20/25 and at most C50/60 according to [N2].
The manufacturer's instructions must be observed when installing the metal frame fixings.
Figure 1 shows a schematic diagram of the metal frame fixings F-M in the installed state.

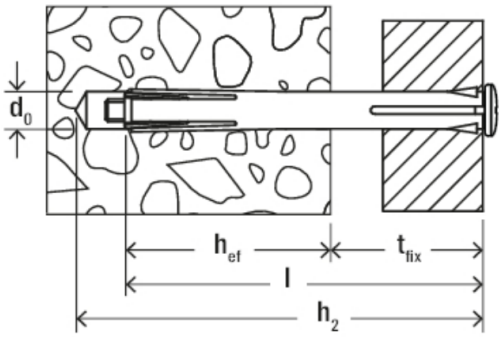

Figure 1: fischer metal frame fixings F-M: Principle sketch of the geometry in the installed state

The geometry parameters of the metal frame fixings can be found in the manufacturer's instructions. The anchoring depth h_{ef} is variable considering $h_{ef} \geq 30mm$.

3 References

3.1 Utilised guidelines, rules and standards

The analyses are based on the following guidelines, rules and standards:

[N1] DIN EN 1363-1:2020-05: Fire resistance tests - Part 1: General Requirements; German version EN 1363-1:2020

[N2] DIN EN 206:2021-06: Concrete - Specification, performance, production and conformity; German version EN 206:2013+A2:2021

[N3] EAD 330232-01-0601: Mechanical fasteners for use in concrete; 12/2019

[N4] DIN EN 1992-4:2019-04: Eurocode 2 - Design of concrete structures - Part 4: Design of fastenings for use in concrete; German version EN 1992-4:2018

[N5] DIN EN 1992-1-2:2010-12: Eurocode 2: Design of concrete structures - Part 1-2: General rules - Structural fire design; German version EN 1992-1-2:2004 + AC:2008

3.2 Reference documents

The analyses are based on the following additional documents:

3.2.1 Assessment and test reports

[G1] Gutachterliche Stellungnahme Nr. GS 6.1/24-036-1: Bewertung des Tragverhaltens von Metallrahmendübeln F-M unter Zug- und Querzugbeanspruchung sowie einseitiger Brandbeanspruchung gemäß Einheitstemperaturzeitkurve in Kombination mit Betonkonstruktionen. – MFPA Leipzig GmbH; 13.09.2024

4 Evaluation of the performance properties

4.1 Design concept

The characteristic load-bearing capacity of a metal frame fixing under tension load and fire loading has to be determined as the minimum value of the load-bearing capacities for the failure modes steel failure, pull-out failure and concrete cone failure

$$N_{Rk,fi}(t) = min\left[N_{Rk,s,fi}(t), \quad N_{Rk,p,fi}(t), \quad N_{Rk,c,fi}(t)\right]. \tag{1}$$

In case of shear load, the characteristic load-bearing capacity has to be determined as the minimum value of the load-bearing capacities for the failure modes steel failure, concrete pry-out failure and concrete edge failure

$$V_{Rk,fi}(t) = min\left[V_{Rk,s,fi}(t), \quad V_{Rk,cp,fi}(t), \quad V_{Rk,c,fi}(t)\right]. \tag{2}$$

4.2 Characteristic load-bearing capacity under centric tension load

The characteristic load-bearing capacities $N_{Rk,fi}(t)$ $[kN]$ under centric tension load based on Equation (1) are summarized in Table 1. The values shown in Table 1 apply to non-cracked concrete of strength class $\geq$ C20/25 and correspond to the performance properties of an undisturbed single fastener. The influence of adjacent fastening elements and component edges is to be considered additionally depending on the specific design in accordance with [N4], Chapter 7.2.1.4 and Annex D.4.2.2.

	fire duration t $[min]$			
	30	60	90	120
F8M	0.356	0.302	0.248	0.221
F10M	0.422	0.365	0.307	0.279

Table 1: fischer metal frame fixings F-M: Characteristic load-bearing capacities $N_{Rk,fi}(t)$ $[kN]$ of an undisturbed single fastener in case of fire under centric tension load

4.3 Characteristic load-bearing capacity under shear load

The characteristic load-bearing capacities $V_{Rk,fi}(t)$ $[kN]$ and $M^0_{Rk,s,fi}(t)$ $[Nm]$ under shear load with and without lever arm based on Equation (2) are summarized in Tables 2 and 3. The values shown in Table 2 apply to cracked and non-cracked concrete of strength class $\geq$ C20/25 and edge distances in load direction

- $c_1 \geq 22mm$

and correspond to the performance properties of an undisturbed single fastener. The influence of adjacent fastening elements and component edges is to be considered additionally depending on the specific design in accordance with [N4], Chapter 7.2.2.5 and Annex D.4.3.3.

	fire duration t $[min]$			
	30	60	90	120
F8M	0.356	0.302	0.248	0.221
F10M	0.422	0.365	0.307	0.279

Table 2: fischer metal frame fixings F-M: Characteristic load-bearing capacities $V_{Rk,fi}(t)$ $[kN]$ of an undisturbed single fastener in case of fire under shear load

	fire duration t $[min]$			
	30	60	90	120
F8M	0.227	0.193	0.158	0.141
F10M	0.321	0.277	0.233	0.212

Table 3: fischer metal frame fixings F-M: Characteristic load-bearing capacities $M^0_{Rk,s,fi}(t)$ $[Nm]$ for steel failure in case of fire under shear load with lever arm

5 Special notes/Limits of application

The advisory opinion at hand applies to metal frame fixings F-M of sizes F8M and F10M manufactured by fischerwerke GmbH & Co. KG, which are installed in compliance with the installation instructions. The mechanical loading must not exceed the load-bearing capacities under ambient climate specified by the manufacturer. According to the client, these are

- F8M: $F_{rec} = 1.0kN$,
- F10M: $F_{rec} = 1.4kN$.

The performance properties specified in the framework of the document at hand apply to all fixing lengths and embedment depths $h_{ef} \geq 30mm$.

The performance properties specified in the framework of the document at hand were determined for one-sided fire loading according to the standard temperature-time-curve. Following [N4], Annex D.1(5), the values may also be applied to multi-sided fire loading, provided that $c \geq 300mm$ and $c \geq 2 \cdot h_{ef}$ apply to the edge distance of the metal frame fixing.

The assessment at hand is valid for constructions of reinforced normal-weight concrete of the strength class $\geq$ C20/25 and $\leq$ C50/60 according to [N2], which exhibit at least the same fire resistance class as the utilised fasteners. The design of the concrete construction has to be carried out according to [N5].

The performance properties specified in the framework of the document at hand for centric tension loading explicitly apply only to anchoring in non-cracked concrete.

The performance properties specified in the framework of the document at hand are determined assuming that no explosive concrete spalling occurs and are only valid under this condition. Evidence on the prevention of explosive concrete spalling is given in [N5], Chapter 4.5.

6 Signatures

The results of the tests relate exclusively to the items tested. This document does not replace a certificate of conformity or suitability according to national and European building codes.

Leipzig, 13.09.2024

Dr.-Ing. S. Reichel
Head of Business Division