# Assessment Report

Project **21843_3enshort**

**Fire resistance of fischer injection system FIS V under fire exposure acc. to DIN EN 1363-1**

Employer **Fischerwerke GmbH & Co. KG**
**Otto-Hahn-Straße 15**
**D – 79211 Denzlingen**

Pages 15

Author

INGENIEURBÜRO THIELE
TRAGWERKSPLANUNG GMBH

UNTERER SOMMERWALDWEG 1 66953 PIRMASENS
TRAGWERK@INGENIEURBUEROTHIELE.DE TEL. 06331 55470

Table of contents

## 1 General information

Fischerwerke GmbH & Co. KG authorized the evaluation of the fire resistance of the chemical anchor system FIS V 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 TR020 [1]. The test results are summarized in test report 18049HK15563 [3].

This evaluation provides fire resistances, which cover anchors with fire attack from one side only.

## 2 Reference documents

[1] Evaluation of Anchorages in Concrete Concerning Resistance to fire, EOTA TR020, Edition May 2004

[2] Feuerwiderstandsprüfungen – Teil 1: Allgemeine Anforderungen, DIN EN 1363-1; Edition Oktober 2012

[3] Report on fire tests according to TR020 with FIS V 360 S adhesive, Test Report 18049HK15563, TU Kaiserslautern, April 2019

[4] Report on fire tests for post installed rebars according to EAD 330087-00-0601 with the fischer FIS V 360 S adhesive, Test Report 18048HK15562_1, TU Kaiserslautern, August 2018

[5] Eurocode 2 – Bemessung und Konstruktion von Stahlbeton- und Spannbetontragwerken – Teil 4: Bemessung der Verankerung von Befestigungen in Beton; EN 1992-4:2018

[6] Europäisch Technische Bewertung ETA-02/0024: “fischer FIS V”, EOTA, DIBt, February 2017

[7] C. Thiele, M. Reichert: “Qualifikation von Verbunddübeln im Brandfall”, TU Kaiserslautern, DIBt, June 2017

[8] P. Nause, J. Wesche: “Untersuchungsbericht NR. 3038/8141-3: Prüfung und Bewertung von in der Zugzone von Stahlbetondeckenabschnitten gesetzten, auf zentrischen Zug belasteten fischer Injektionsankern FIS V der Dimensionen M8 bis M30 auf Brandverhalten bei Brandbeanspruchung nach DIN 4102 – 2 : 1977-09 zur Ermittlung der Feuerwiderstandsdauer”, MPA Braunschweig Januar 2002

[9] Report on fire tests for post installed rebars according to EAD 330087-00-0601 with the fischer FIS V, fischer FIS VS and fischer VW injection system, TU Kaiserslautern, Dezember 2018

## 3 Product description

The fischer FIS V adhesive is a bonded anchor system in a 2 component cartridge system for use in cracked and non-cracked normal weight concrete. Due to the almost identical high temperature properties of the fischer FIS V, fischer FIS VS and fischer FIS VW injection system, the report applies to all mentioned products [9].

The injection system FIS V is designed for the use in concrete according to the European Technical Assessment ETA-02/0024 [6].

## 4 Scope of evaluation

The present evaluation of fire resistance for fischer FIS V anchor system 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 [1] 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 is carried out in dependence on “Qualifizierung von Verbunddübeln im Brandfall” [7] which is based on the TR020 [1]. The assessment of concrete cone failure is carried out in dependence on TR020 [1]. Additionally the failure type pullout failure is assessed.

a. Steel failure:
   Steel failure is assessed according to the research report “Qualifikation von Verbunddübeln im Brandfall” [7].

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].

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

# 5 Fire resistance loads for threaded rods

## 5.1 Galvanized steel (gvz.)

Table 5-1 to Table 5-4 are showing the decisive fire resistances of the injection system FIS V for use in **cracked** and **non-cracked concrete** for pullout, steel and concrete failure. The given fire resistances cover axial and shear loads.

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

For the grey coloured values steel failure is decisive.

*Table 5-1: Summary of the characteristic resistance for **non-cracked** concrete, M8-M20*

| Anchorage depth $h_{ef}$ | Anchorage size | Maximum characteristic tension load $N_{Rk,fi(t)}$, and shear load $V_{Rk,fi(t)}$, [kN] depending on the fire resistance time | | | |
|---|---|---|---|---|---|
| | | 30 [min] | 60 [min] | 90 [min] | 120 [min] |
| [mm] | [mm] | [kN] | [kN] | [kN] | [kN] |
| 75 | 8 | 0,73 | 0,55 | 0,39 | 0,08 |
| 80 | | 0,73 | 0,55 | 0,40 | 0,19 |
| 85 | | 0,73 | 0,55 | 0,40 | 0,33 |
| 75 | 10 | 1,45 | 1,10 | 0,28 | 0,00 |
| 80 | | 1,45 | 1,10 | 0,47 | 0,08 |
| 85 | | 1,45 | 1,10 | 0,72 | 0,22 |
| 90 | | 1,45 | 1,10 | 0,81 | 0,39 |
| 95 | | 1,45 | 1,10 | 0,81 | 0,60 |
| 100 | | 1,45 | 1,10 | 0,81 | 0,64 |
| 85 | 12 | 2,53 | 1,89 | 0,56 | 0,08 |
| 90 | | 2,53 | 1,94 | 0,85 | 0,25 |
| 95 | | 2,53 | 1,94 | 1,22 | 0,45 |
| 100 | | 2,53 | 1,94 | 1,35 | 0,70 |
| 105 | | 2,53 | 1,94 | 1,35 | 1,01 |
| 110 | | 2,53 | 1,94 | 1,35 | 1,10 |
| 115 | | 2,53 | 1,94 | 1,35 | 1,10 |
| 95 | 16 | 4,71 | 2,53 | 0,76 | 0,10 |
| 100 | | 4,71 | 3,38 | 1,14 | 0,34 |
| 105 | | 4,71 | 3,61 | 1,62 | 0,60 |
| 110 | | 4,71 | 3,61 | 2,20 | 0,92 |
| 115 | | 4,71 | 3,61 | 2,51 | 1,32 |
| 120 | | 4,71 | 3,61 | 2,51 | 1,81 |
| 125 | | 4,71 | 3,61 | 2,51 | 2,04 |
| 130 | | 4,71 | 3,61 | 2,51 | 2,04 |
| 105 | 20 | 7,35 | 3,38 | 1,06 | 0,16 |
| 110 | | 7,35 | 4,43 | 1,54 | 0,47 |
| 115 | | 7,35 | 5,64 | 2,13 | 0,80 |
| 120 | | 7,35 | 5,64 | 2,86 | 1,22 |
| 125 | | 7,35 | 5,64 | 3,71 | 1,71 |
| 130 | | 7,35 | 5,64 | 3,92 | 2,30 |
| 135 | | 7,35 | 5,64 | 3,92 | 3,02 |
| 140 | | 7,35 | 5,64 | 3,92 | 3,19 |
| 145 | | 7,35 | 5,64 | 3,92 | 3,19 |

*Table 5-2: Summary of the characteristic resistance for **non-cracked** concrete, M24-M30*

| Anchorage depth $h_{ef}$ | Anchorage size | Maximum characteristic tension load $N_{Rk,fi(t)}$, and shear load $V_{Rk,fi(t)}$, [kN] depending on the fire resistance time | | | |
|---|---|---|---|---|---|
| | | 30 [min] | 60 [min] | 90 [min] | 120 [min] |
| [mm] | [mm] | [kN] | [kN] | [kN] | [kN] |
| 115 | 24 | 10,59 | 4,49 | 1,45 | 0,27 |
| 120 | | 10,59 | 5,74 | 2,04 | 0,65 |
| 125 | | 10,59 | 7,21 | 2,77 | 1,07 |
| 130 | | 10,59 | 8,12 | 3,63 | 1,57 |
| 135 | | 10,59 | 8,12 | 4,65 | 2,17 |
| 140 | | 10,59 | 8,12 | 5,65 | 2,88 |
| 145 | | 10,59 | 8,12 | 5,65 | 3,72 |
| 150 | | 10,59 | 8,12 | 5,65 | 4,59 |
| 155 | | 10,59 | 8,12 | 5,65 | 4,59 |
| 160 | | 10,59 | 8,12 | 5,65 | 4,59 |
| 120 | 27 | 13,77 | 4,87 | 1,53 | 0,20 |
| 125 | | 13,77 | 6,20 | 2,16 | 0,63 |
| 130 | | 13,77 | 7,73 | 2,91 | 1,08 |
| 135 | | 13,77 | 9,49 | 3,81 | 1,61 |
| 140 | | 13,77 | 10,56 | 4,87 | 2,22 |
| 145 | | 13,77 | 10,56 | 6,10 | 2,97 |
| 150 | | 13,77 | 10,56 | 7,34 | 3,82 |
| 155 | | 13,77 | 10,56 | 7,34 | 4,83 |
| 160 | | 13,77 | 10,56 | 7,34 | 5,97 |
| 165 | | 13,77 | 10,56 | 7,34 | 5,97 |
| 170 | | 13,77 | 10,56 | 7,34 | 5,97 |
| 120 | 30 | 16,83 | 4,13 | 1,05 | 0,00 |
| 125 | | 16,83 | 5,34 | 1,63 | 0,11 |
| 130 | | 16,83 | 6,75 | 2,29 | 0,59 |
| 135 | | 16,83 | 8,38 | 3,10 | 1,09 |
| 140 | | 16,83 | 10,24 | 4,04 | 1,65 |
| 145 | | 16,83 | 12,37 | 5,15 | 2,31 |
| 150 | | 16,83 | 12,90 | 6,43 | 3,08 |
| 155 | | 16,83 | 12,90 | 7,90 | 3,97 |
| 160 | | 16,83 | 12,90 | 8,98 | 5,01 |
| 165 | | 16,83 | 12,90 | 8,98 | 6,21 |
| 170 | | 16,83 | 12,90 | 8,98 | 7,29 |
| 175 | | 16,83 | 12,90 | 8,98 | 7,29 |
| 180 | | 16,83 | 12,90 | 8,98 | 7,29 |

*Table 5-3: Summary of the characteristic resistance for **cracked** concrete, M10-M20*

| Anchorage depth $h_{ef}$ | Anchorage size | Maximum characteristic tension load $N_{Rk,fi(t)}$, and shear load $V_{Rk,fi(t)}$, [kN] depending on the fire resistance time | | | |
|---|---|---|---|---|---|
| | | 30 [min] | 60 [min] | 90 [min] | 120 [min] |
| [mm] | [mm] | [kN] | [kN] | [kN] | [kN] |
| 75 | 10 | 1,45 | 0,85 | 0,21 | 0,00 |
| 80 | | 1,45 | 1,10 | 0,35 | 0,06 |
| 85 | | 1,45 | 1,10 | 0,54 | 0,17 |
| 90 | | 1,45 | 1,10 | 0,78 | 0,29 |
| 95 | | 1,45 | 1,10 | 0,81 | 0,45 |
| 100 | | 1,45 | 1,10 | 0,81 | 0,64 |
| 85 | 12 | 2,53 | 1,42 | 0,42 | 0,06 |
| 90 | | 2,53 | 1,93 | 0,64 | 0,19 |
| 95 | | 2,53 | 1,94 | 0,92 | 0,34 |
| 100 | | 2,53 | 1,94 | 1,27 | 0,53 |
| 105 | | 2,53 | 1,94 | 1,35 | 0,76 |
| 110 | | 2,53 | 1,94 | 1,35 | 1,05 |
| 115 | | 2,53 | 1,94 | 1,35 | 1,10 |
| 95 | 16 | 4,71 | 1,90 | 0,57 | 0,07 |
| 100 | | 4,71 | 2,54 | 0,86 | 0,25 |
| 105 | | 4,71 | 3,30 | 1,21 | 0,45 |
| 110 | | 4,71 | 3,61 | 1,65 | 0,69 |
| 115 | | 4,71 | 3,61 | 2,19 | 0,99 |
| 120 | | 4,71 | 3,61 | 2,51 | 1,36 |
| 125 | | 4,71 | 3,61 | 2,51 | 1,80 |
| 130 | | 4,71 | 3,61 | 2,51 | 2,04 |
| 105 | 20 | 7,35 | 2,54 | 0,79 | 0,12 |
| 110 | | 7,35 | 3,32 | 1,15 | 0,35 |
| 115 | | 7,35 | 4,25 | 1,60 | 0,60 |
| 120 | | 7,35 | 5,32 | 2,14 | 0,91 |
| 125 | | 7,35 | 5,64 | 2,78 | 1,28 |
| 130 | | 7,35 | 5,64 | 3,55 | 1,73 |
| 135 | | 7,35 | 5,64 | 3,92 | 2,26 |
| 140 | | 7,35 | 5,64 | 3,92 | 2,89 |
| 145 | | 7,35 | 5,64 | 3,92 | 3,19 |

*Table 5-4: Summary of the characteristic resistance for **cracked** concrete, M24-M30*

| Anchorage depth $h_{ef}$ | Anchorage size | Maximum characteristic tension load $N_{Rk,fi(t)}$, and shear load $V_{Rk,fi(t)}$, [kN] depending on the fire resistance time | | | |
|---|---|---|---|---|---|
| | | 30 [min] | 60 [min] | 90 [min] | 120 [min] |
| [mm] | [mm] | [kN] | [kN] | [kN] | [kN] |
| 115 | 24 | 10,59 | 3,36 | 1,09 | 0,21 |
| 120 | | 10,59 | 4,31 | 1,53 | 0,49 |
| 125 | | 10,59 | 5,41 | 2,08 | 0,81 |
| 130 | | 10,59 | 6,67 | 2,72 | 1,18 |
| 135 | | 10,59 | 8,10 | 3,49 | 1,63 |
| 140 | | 10,59 | 8,12 | 4,38 | 2,16 |
| 145 | | 10,59 | 8,12 | 5,40 | 2,79 |
| 150 | | 10,59 | 8,12 | 5,65 | 3,51 |
| 155 | | 10,59 | 8,12 | 5,65 | 4,36 |
| 160 | | 10,59 | 8,12 | 5,65 | 4,59 |
| 120 | 27 | 13,77 | 3,65 | 1,14 | 0,15 |
| 125 | | 13,77 | 4,65 | 1,62 | 0,47 |
| 130 | | 13,77 | 5,79 | 2,18 | 0,81 |
| 135 | | 13,77 | 7,11 | 2,86 | 1,20 |
| 140 | | 13,77 | 8,63 | 3,65 | 1,67 |
| 145 | | 13,77 | 10,34 | 4,58 | 2,23 |
| 150 | | 13,77 | 10,56 | 5,64 | 2,87 |
| 155 | | 13,77 | 10,56 | 6,86 | 3,62 |
| 160 | | 13,77 | 10,56 | 7,34 | 4,49 |
| 165 | | 13,77 | 10,56 | 7,34 | 5,49 |
| 170 | | 13,77 | 10,56 | 7,34 | 5,97 |
| 120 | 30 | 14,21 | 3,10 | 0,79 | 0,00 |
| 125 | | 16,80 | 4,01 | 1,22 | 0,08 |
| 130 | | 16,83 | 5,06 | 1,72 | 0,44 |
| 135 | | 16,83 | 6,29 | 2,32 | 0,81 |
| 140 | | 16,83 | 7,68 | 3,03 | 1,24 |
| 145 | | 16,83 | 9,28 | 3,86 | 1,73 |
| 150 | | 16,83 | 11,05 | 4,82 | 2,31 |
| 155 | | 16,83 | 12,90 | 5,93 | 2,98 |
| 160 | | 16,83 | 12,90 | 7,19 | 3,76 |
| 165 | | 16,83 | 12,90 | 8,61 | 4,65 |
| 170 | | 16,83 | 12,90 | 8,98 | 5,68 |
| 175 | | 16,83 | 12,90 | 8,98 | 6,84 |
| 180 | | 16,83 | 12,90 | 8,98 | 7,29 |

## 5.2 Stainless steel (A4)

Table 5-5 to Table 5-8 are showing the decisive fire resistances of the injection system FIS V for use in **cracked** and **non-cracked concrete** for pullout, steel and concrete failure. The given fire resistances cover axial and shear loads.

The listed fire resistances are valid for single anchors with an edge distance of more than $c_{cr,fi}=2\ h_{ef}$ and a spacing to the adjacent anchor of $s= 2\ c_{cr,fi}= 4\ h_{ef.}$ 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 stainless steel (1.4401, 1.4404, 1.4571, 1.4439, 1.4362, 1.4062, 1.4662, 1.4462 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.

For the grey coloured values steel failure was decisive.

*Table 5-5: Summary of the characteristic resistance for **non-cracked** concrete, M8-M20*

| Anchorage depth $h_{ef}$ | Anchorage size | Maximum characteristic tension load $N_{Rk,fi(t)}$, and shear load $V_{Rk,fi(t)}$, [kN] depending on the fire resistance time | | | |
|---|---|---|---|---|---|
| | | 30 [min] | 60 [min] | 90 [min] | 120 [min] |
| [mm] | [mm] | [kN] | [kN] | [kN] | [kN] |
| 75 | 8 | 0,73 | 0,59 | 0,39 | 0,08 |
| 80 | | 0,73 | 0,59 | 0,44 | 0,19 |
| 85 | | 0,73 | 0,59 | 0,44 | 0,33 |
| 90 | | 0,73 | 0,59 | 0,44 | 0,37 |
| 75 | 10 | 1,45 | 1,14 | 0,28 | 0,00 |
| 80 | | 1,45 | 1,16 | 0,47 | 0,08 |
| 85 | | 1,45 | 1,16 | 0,72 | 0,22 |
| 90 | | 1,45 | 1,16 | 0,93 | 0,39 |
| 95 | | 1,45 | 1,16 | 0,93 | 0,60 |
| 100 | | 1,45 | 1,16 | 0,93 | 0,81 |
| 85 | 12 | 2,53 | 1,89 | 0,56 | 0,08 |
| 90 | | 2,53 | 2,11 | 0,85 | 0,25 |
| 95 | | 2,53 | 2,11 | 1,22 | 0,45 |
| 100 | | 2,53 | 2,11 | 1,69 | 0,70 |
| 105 | | 2,53 | 2,11 | 1,69 | 1,01 |
| 110 | | 2,53 | 2,11 | 1,69 | 1,35 |
| 115 | | 2,53 | 2,11 | 1,69 | 1,35 |
| 95 | 16 | 10,21 | 2,53 | 0,76 | 0,10 |
| 100 | | 10,21 | 3,38 | 1,14 | 0,34 |
| 105 | | 10,21 | 4,40 | 1,62 | 0,60 |
| 110 | | 10,21 | 5,60 | 2,20 | 0,92 |
| 115 | | 10,21 | 6,99 | 2,92 | 1,32 |
| 120 | | 10,21 | 7,38 | 3,78 | 1,81 |
| 125 | | 10,21 | 7,38 | 4,55 | 2,40 |
| 130 | | 10,21 | 7,38 | 4,55 | 3,10 |
| 135 | | 10,21 | 7,38 | 4,55 | 3,14 |
| 105 | 20 | 13,66 | 3,38 | 1,06 | 0,16 |
| 110 | | 15,93 | 4,43 | 1,54 | 0,47 |
| 115 | | 15,93 | 5,66 | 2,13 | 0,80 |
| 120 | | 15,93 | 7,09 | 2,86 | 1,22 |
| 125 | | 15,93 | 8,74 | 3,71 | 1,71 |
| 130 | | 15,93 | 10,59 | 4,73 | 2,30 |
| 135 | | 15,93 | 11,52 | 5,91 | 3,02 |
| 140 | | 15,93 | 11,52 | 7,11 | 3,85 |
| 145 | | 15,93 | 11,52 | 7,11 | 4,84 |
| 150 | | 15,93 | 11,52 | 7,11 | 4,90 |

*Table 5-6: Summary of the characteristic resistance for **non-cracked** concrete, M24-M30*

| Anchorage depth $h_{ef}$ | Anchorage size | Maximum characteristic tension load $N_{Rk,fi(t)}$, and shear load $V_{Rk,fi(t)}$, [kN] depending on the fire resistance time | | | |
|---|---|---|---|---|---|
| | | 30 [min] | 60 [min] | 90 [min] | 120 [min] |
| [mm] | [mm] | [kN] | [kN] | [kN] | [kN] |
| 115 | 24 | 17,79 | 4,49 | 1,45 | 0,27 |
| 120 | | 20,94 | 5,74 | 2,04 | 0,65 |
| 125 | | 22,95 | 7,21 | 2,77 | 1,07 |
| 130 | | 22,95 | 8,89 | 3,63 | 1,57 |
| 135 | | 22,95 | 10,80 | 4,65 | 2,17 |
| 140 | | 22,95 | 12,94 | 5,83 | 2,88 |
| 145 | | 22,95 | 15,33 | 7,20 | 3,72 |
| 150 | | 22,95 | 16,59 | 8,77 | 4,68 |
| 155 | | 22,95 | 16,59 | 10,24 | 5,81 |
| 160 | | 22,95 | 16,59 | 10,24 | 7,06 |
| 120 | 27 | 19,91 | 4,87 | 1,53 | 0,20 |
| 125 | | 23,30 | 6,20 | 2,16 | 0,63 |
| 130 | | 26,92 | 7,73 | 2,91 | 1,08 |
| 135 | | 29,84 | 9,49 | 3,81 | 1,61 |
| 140 | | 29,84 | 11,50 | 4,87 | 2,22 |
| 145 | | 29,84 | 13,78 | 6,10 | 2,97 |
| 150 | | 29,84 | 16,24 | 7,52 | 3,82 |
| 155 | | 29,84 | 19,02 | 9,15 | 4,83 |
| 160 | | 29,84 | 21,57 | 10,97 | 5,99 |
| 165 | | 29,84 | 21,57 | 13,01 | 7,32 |
| 170 | | 29,84 | 21,57 | 13,31 | 8,83 |
| 175 | | 29,84 | 21,57 | 13,31 | 9,18 |
| 120 | 30 | 18,94 | 4,13 | 1,05 | 0,00 |
| 125 | | 22,40 | 5,34 | 1,63 | 0,11 |
| 130 | | 26,01 | 6,75 | 2,29 | 0,59 |
| 135 | | 30,00 | 8,38 | 3,10 | 1,09 |
| 140 | | 34,30 | 10,24 | 4,04 | 1,65 |
| 145 | | 36,47 | 12,37 | 5,15 | 2,31 |
| 150 | | 36,47 | 14,74 | 6,43 | 3,08 |
| 155 | | 36,47 | 17,39 | 7,90 | 3,97 |
| 160 | | 36,47 | 20,28 | 9,59 | 5,01 |
| 165 | | 36,47 | 23,44 | 11,47 | 6,21 |
| 170 | | 36,47 | 26,37 | 13,61 | 7,57 |
| 175 | | 36,47 | 26,37 | 15,95 | 9,13 |
| 180 | | 36,47 | 26,37 | 16,27 | 10,87 |
| 185 | | 36,47 | 26,37 | 16,27 | 11,22 |

*Table 5-7: Summary of the characteristic resistance for **cracked** concrete, M10-M20*

| Anchorage depth $h_{ef}$ | Anchorage size | Maximum characteristic tension load $N_{Rk,fi(t)}$, and shear load $V_{Rk,fi(t)}$, [kN] depending on the fire resistance time | | | |
|---|---|---|---|---|---|
| | | 30 [min] | 60 [min] | 90 [min] | 120 [min] |
| [mm] | [mm] | [kN] | [kN] | [kN] | [kN] |
| 75 | 10 | 1,45 | 0,85 | 0,21 | 0,00 |
| 80 | | 1,45 | 1,16 | 0,35 | 0,06 |
| 85 | | 1,45 | 1,16 | 0,54 | 0,17 |
| 90 | | 1,45 | 1,16 | 0,78 | 0,29 |
| 95 | | 1,45 | 1,16 | 0,93 | 0,45 |
| 100 | | 1,45 | 1,16 | 0,93 | 0,65 |
| 105 | | 1,45 | 1,16 | 0,93 | 0,81 |
| 85 | 12 | 2,53 | 1,42 | 0,42 | 0,06 |
| 90 | | 2,53 | 1,93 | 0,64 | 0,19 |
| 95 | | 2,53 | 2,11 | 0,92 | 0,34 |
| 100 | | 2,53 | 2,11 | 1,27 | 0,53 |
| 105 | | 2,53 | 2,11 | 1,69 | 0,76 |
| 110 | | 2,53 | 2,11 | 1,69 | 1,05 |
| 115 | | 2,53 | 2,11 | 1,69 | 1,35 |
| 95 | 16 | 7,83 | 1,90 | 0,57 | 0,07 |
| 100 | | 9,46 | 2,54 | 0,86 | 0,25 |
| 105 | | 10,21 | 3,30 | 1,21 | 0,45 |
| 110 | | 10,21 | 4,20 | 1,65 | 0,69 |
| 115 | | 10,21 | 5,24 | 2,19 | 0,99 |
| 120 | | 10,21 | 6,42 | 2,83 | 1,36 |
| 125 | | 10,21 | 7,38 | 3,58 | 1,80 |
| 130 | | 10,21 | 7,38 | 4,45 | 2,33 |
| 135 | | 10,21 | 7,38 | 4,55 | 2,95 |
| 140 | | 10,21 | 7,38 | 4,55 | 3,14 |
| 105 | 20 | 10,24 | 2,54 | 0,79 | 0,12 |
| 110 | | 12,26 | 3,32 | 1,15 | 0,35 |
| 115 | | 14,42 | 4,25 | 1,60 | 0,60 |
| 120 | | 15,93 | 5,32 | 2,14 | 0,91 |
| 125 | | 15,93 | 6,56 | 2,78 | 1,28 |
| 130 | | 15,93 | 7,95 | 3,55 | 1,73 |
| 135 | | 15,93 | 9,48 | 4,43 | 2,26 |
| 140 | | 15,93 | 11,19 | 5,46 | 2,89 |
| 145 | | 15,93 | 11,52 | 6,62 | 3,63 |
| 150 | | 15,93 | 11,52 | 7,11 | 4,48 |
| 155 | | 15,93 | 11,52 | 7,11 | 4,90 |

*Table 5-8: Summary of the characteristic resistance for **cracked** concrete, M24-M30*

| Anchorage depth $h_{ef}$ | Anchorage size | Maximum characteristic tension load $N_{Rk,fi(t)}$, and shear load $V_{Rk,fi(t)}$, [kN] depending on the fire resistance time | | | |
|---|---|---|---|---|---|
| | | 30 [min] | 60 [min] | 90 [min] | 120 [min] |
| [mm] | [mm] | [kN] | [kN] | [kN] | [kN] |
| 115 | 24 | 13,35 | 3,36 | 1,09 | 0,21 |
| 120 | | 15,71 | 4,31 | 1,53 | 0,49 |
| 125 | | 18,24 | 5,41 | 2,08 | 0,81 |
| 130 | | 20,98 | 6,67 | 2,72 | 1,18 |
| 135 | | 22,95 | 8,10 | 3,49 | 1,63 |
| 140 | | 22,95 | 9,71 | 4,38 | 2,16 |
| 145 | | 22,95 | 11,49 | 5,40 | 2,79 |
| 150 | | 22,95 | 13,45 | 6,58 | 3,51 |
| 155 | | 22,95 | 15,59 | 7,90 | 4,36 |
| 160 | | 22,95 | 16,59 | 9,38 | 5,33 |
| 165 | | 22,95 | 16,59 | 10,24 | 6,44 |
| 170 | | 22,95 | 16,59 | 10,24 | 7,06 |
| 120 | 27 | 14,93 | 3,65 | 1,14 | 0,15 |
| 125 | | 17,48 | 4,65 | 1,62 | 0,47 |
| 130 | | 20,19 | 5,79 | 2,18 | 0,81 |
| 135 | | 23,15 | 7,11 | 2,86 | 1,20 |
| 140 | | 26,33 | 8,63 | 3,65 | 1,67 |
| 145 | | 29,83 | 10,34 | 4,58 | 2,23 |
| 150 | | 29,84 | 12,18 | 5,64 | 2,87 |
| 155 | | 29,84 | 14,27 | 6,86 | 3,62 |
| 160 | | 29,84 | 16,52 | 8,23 | 4,49 |
| 165 | | 29,84 | 18,95 | 9,76 | 5,49 |
| 170 | | 29,84 | 21,55 | 11,45 | 6,62 |
| 175 | | 29,84 | 21,57 | 13,31 | 7,90 |
| 180 | | 29,84 | 21,57 | 13,31 | 9,18 |
| 120 | 30 | 14,21 | 3,10 | 0,79 | 0,00 |
| 125 | | 16,80 | 4,01 | 1,22 | 0,08 |
| 130 | | 19,51 | 5,06 | 1,72 | 0,44 |
| 135 | | 22,50 | 6,29 | 2,32 | 0,81 |
| 140 | | 25,72 | 7,68 | 3,03 | 1,24 |
| 145 | | 29,16 | 9,28 | 3,86 | 1,73 |
| 150 | | 32,84 | 11,05 | 4,82 | 2,31 |
| 155 | | 36,47 | 13,04 | 5,93 | 2,98 |
| 160 | | 36,47 | 15,21 | 7,19 | 3,76 |
| 165 | | 36,47 | 17,58 | 8,61 | 4,65 |
| 170 | | 36,47 | 20,15 | 10,20 | 5,68 |
| 175 | | 36,47 | 22,90 | 11,96 | 6,84 |
| 180 | | 36,47 | 25,86 | 13,89 | 8,16 |
| 185 | | 36,47 | 26,37 | 16,01 | 9,61 |
| 190 | | 36,47 | 26,37 | 16,27 | 11,22 |

Pirmasens, 12st of August 2019

C. Thiele

apl. Prof. Dr.-Ing. Catherina Thiele

Heiner Kruse, M.Sc.