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Institute of Building Materials, Concrete Construction and Fire Protection | Braunschweig Civil Engineering Materials Testing Institute

Materialprüfanstalt für das Bauwesen · Beethovenstr. 52 · D-38106 Braunschweig

Hilti AG
BU Direct Fastening
Mr Peter Grzesik
Feldkircherstraße 100
9494 SCHAAN
Liechtenstein

Letter **4850/2018**

Our Ref.:	(2100/943/17)-CM
Customer ID:	7084
Engineer/Official in charge:	Mr Maertins
Department:	BS
Contact:	0531-391-8265 c.maertins@ibmb.tu-bs.de
Your ref.:	Mr Grzesik
Your letter of:	01/02/2018
Date:	25/04/2018

Expert Opinion on the fire behaviour of lightweight partitions with gypsum plasterboard cladding on both sides in accordance with DIN EN 520 and DIN 18180 and a substructure in accordance with DIN 18182-1, with the substructure fastened with Hilti nails, when exposed to fire on one side along the standard temperature/time curve (ETK) in accordance with DIN EN 1363-1 : 2012-10.

18 annexes

Dear Sir/Madam,

With your letter of 01/02/2018, Hilti AG, 9494 Schaan (Liechtenstein) commissioned the Civil Engineering Materials Testing Institute MPA Braunschweig to prepare an Expert Opinion on the fire behaviour of lightweight partitions with gypsum plasterboard cladding on both sides in accordance with DIN EN 520 and DIN 18180 and a substructure in accordance with DIN 18182-1, with the substructure fastened with Hilti nails, when exposed to fire on one side along the standard temperature/time curve (ETK) in accordance with DIN EN 1363-1 : 2012-10.

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Notified body (0761-CPR) –
Approved as a civil engineering testing, inspection and certifying body as well as notified as a civil engineering testing and certifying body.

1 Basis for the expert opinion and documentation

The expert opinion for the construction to be assessed is prepared on the basis of the following documents:

(1) DIN EN 1363-1 : 2012-10, Fire resistance tests - Part 1: General Requirements

(2) DIN 4102-4 : 1994-03, Fire Behaviour of Building Materials and Components; synopsis and application of classified building materials, components and special components

(3) The customer's technical data sheets

(4) Examination Report No. 2101/681/16 dated 07/12/2016 on the fire behaviour of loaded Hilti nails and plastic anchors with regard to steel failure, under exposure to fire in accordance with DIN EN 1363-1, issued by MPA Braunschweig

(5) Test Report No. 2101/108/16 dated 30/11/2016 on the fire behaviour of loaded Hilti nails and plastic anchors with regard to steel failure, under exposure to fire in accordance with DIN EN 1363-1, issued by MPA Braunschweig

(6) Test Report No. 3091/313/14 dated 07/03/2014 on the fire behaviour of loaded Hilti nails and plastic anchors with regard to steel failure, under exposure to fire in accordance with DIN EN 1363-1, issued by MPA Braunschweig.

In addition to these documents, the ample testing experience of MPA Braunschweig made with fasteners from Hilti AG and lightweight partition constructions was incorporated in the assessment in terms of fire protection.

2 Description of the construction

This expert opinion refers only to the lightweight partition constructions listed in the following of fire resistance classes F30, F60 and F90, which were fastened to solid substructures (reinforced concrete) by means of Hilti nails at a fastener spacing of a ≤ 300 mm according to Section 2.2, instead of using the plastic anchors according to Section 2.1 (maximum fastener spacing a = 500 mm and a = 1000 mm).

2.1 Description of the partition construction using anchors

The basic constructions for assessment are only the lightweight partition constructions described in the following, which have achieved the corresponding fire resistance in a test performed in accordance with DIN 4102-2 and DIN EN 1363-1 and which have to fulfil the requirements of the fire resistance classes F30, F60 and F90 in accordance with DIN 4102-2, and, respectively, EI30, EI60 and EI90 in accordance with DIN EN 13501-2.

The partitions have to be executed connected with a substructure in accordance with DIN 18182-1. The partition sections (metal rim sections: UW sections and CW sections) are fastened using plastic anchors (diameter D = 6 mm, length L = 35 – 40 mm, see also Annex 17) at a maximum fastener spacing of a = 500 mm and a = 1000 mm to solid substructures. The separating partitions have to be clad on both sides with gypsum plasterboards in accordance with DIN EN 520 and DIN 18180 (for example: "Knauf Gipsplatten" or "Siniat Gipsplatten" both in accordance with DIN EN 520 and DIN 18180, "Rigips Feuerschutzplatten" (type DF in accordance with DIN EN 520 and type GKF in accordance with DIN 18180) or similar), and a mineral wool insulation in accordance with DIN EN 13162 (see Annex 16).

Apart from that, the execution complies with the respective proof of usability taking the individually applicable product/application standards into account (e.g., DIN 18183-1, DIN 18182-1, ...).

2.2 Description of the fastening system using Hilti nails

The partition sections (metal rim sections: UW sections and CW sections) of lightweight partitions with cladding on both sides and mineral wool insulation according to Section 2.1 are fastened with Hilti nails at a fastener spacing of a ≤ 300 mm to solid elements (reinforced concrete, strength as a function of the Hilti installation system), which is deviating from the fastening as described in Section 2.1 using plastic anchors.

The fastening systems used are mainly Hilti nails combined with Hilti battery-actuated fastening tools for nails, or Hilti gas-actuated fastening tools (with gas cartridges) for nails, or Hilti powder-actuated fastening tools for nails (with powder cartridges), which may be executed using the nails specified in Table 1.

Table 1: Overview of Hilti nails and Hilti fastening tools for nails

Designation	**Designation**	**Nail diameter** Ø	**Nominal minimum nail embedment depth in reinforced concrete** h_{nom}	**Annexes**
Hilti setting tool	**Hilti nails**	**[mm]**	**[mm]**	
Hilti battery-actuated fastening tool for nails Hilti BX3	Hilti nails X-C B3	3	12	1 to 3
	Hilti X-P B3	3	12	
Hilti gas-actuated fastening tool for nails Hilti GX3	Hilti nails X-C G3.	3	12	4 to 6
	Hilti X-P G3	3	12	
Hilti gas-actuated fastening tool for nails Hilti GX-120	Hilti nails X-GN	3	12	7 to 9
	X-GHP	3	12	
Hilti powder-actuated fastening tool for nails Hilti DX5 / Hilti-DX-460 / DX 351	Hilti nails X-C	4	12	10 to 14
	Hilti X-P	4	12	
	Hilti X-U	4	12	

Further details are to be taken from the annexes to this expert opinion.

Example: System-referred designation of the nails for the Hilti gas-actuated fastening tool Hilti GX3:

- X-C xx G3 MX; with 22 = 22 mm nail shank length, collated nail

The nominal embedment depth for Hilti nails in substructures (reinforced concrete) has to be $\mathbf{h_{nom} \geq 12\ mm}$. The nail length has to be selected as a function of the thickness of the attachment part, while taking the nominal minimum embedment depth into account.

The attachment part thickness (total attachment part thickness $t_{fix} = t_1 + t_2$) is composed of the metal rim section (max t_1 = 2 mm) and the backing insulation strip (max t_2 = 10 mm). The attachment part thickness (t_{fix} = metal rim section (**max t = 2 mm**) plus backing insulation strip) for fastening is $\mathbf{t_{fix} \leq 14\ mm}$.

Except for the type and distance of the fasteners used for connecting the partitions to the solid substructure, execution is in compliance with the respective proof of usability taking the individually applicable product/application standards into account (e.g., DIN 18183-1, DIN 18182-1, ...)

It is assumed that the fastening and the design of the partition were proved before for the normal purpose of use ("cold application" without exposure to fire). For normal purposes of use, the related information (e.g., mounting instruction) for Hilti nails are to be observed as included in the technical data sheets in the Hilti Manual of direct fastening for anchorages in reinforced concrete (strength class ≥ C 20/25).

The requirements for normal purposes of use for fastening using Hilti nails are not subject of this expert opinion; they have to be tested in a corresponding structural analysis (e.g., jobsite tests).

3 Assessment with regard to fire protection

Hilti nails as described in Section 2.2 shall be used instead of the fasteners tested in combination with lightweight partitions of fire resistance classes F30, F60 and F90 in accordance with DIN 4102-2, and EI30, EI60 and EI90 in accordance with DIN EN 13501-2 (plastic anchors, with diameter D = 6 mm, length L = 35 – 40 mm) according to Section 2.1.

Based on the present test results obtained from an exposure to fire along the standard temperature/time curve (ETK) under centric tensile load and shear load using Hilti nails (according to Section 2.2) in direct comparison to plastic anchors (according to Section 2.1) and further loadbearing capacity tests in conjunction with Hilti nails, there are no objections with regard to fire protection against the use of the above stated Hilti nails for the connection of partition sections (metal rim sections: UW sections and CW sections) of lightweight partitions to solid elements (reinforced concrete), provided the manufacturer's structural design data for the partitions, a minimum embedment depth of 12 mm (h_{nom} ≥ 12 mm) and a nail spacing of a ≤ 300 mm are observed.

The fire resistance of the lightweight partitions according to Section 2.1 is not impaired by the use of the Hilti nails described in Section 2.2. and shown in Annexes 1 to 15, provided the boundary conditions of Section 2.2 are observed otherwise.

The assessment of Hilti nails, which shall be used as fasteners for lightweight partitions instead of metal anchors or larger or longer plastic anchors to solid elements is not subject of this assessment.

4 Special notes

4.1 This Expert Opinion is no substitute for the certificate of suitability for use (abP, abZ, ETA). As proof of usability for the type of construction 'lightweight partition', the individually applicable national technical building regulations are to be observed (proofs in Germany are , for example, an execution in accordance with DIN 4102-4 or a valid general appraisal certificate).

4.2 This Export Opinion applies only with regard to fire protection. Further requirements may arise from the technical building regulations applicable for lightweight partitions with two-side cladding (according to Section 2) and the respective state building regulations, or the regulations for special constructions – for example, with regard to structural physics, statics, electrical engineering, ventilation engineering, or similar.

4.3 The above mentioned assessment with regard to fire protection applies only, if the loadbearing (load-transferring and reinforcing) components have at least the same fire resistance as the lightweight partitions.

4.4 Changes to and supplements of design details (derived from this Expert Opinion) may only be made following consultation with MPA Braunschweig.

4.5 The executing company shall be exclusively responsible for the proper execution.

This document is the translated version of Expert Opinion No. 2100/943/18 – CM dated 25/04/2018. The legally binding text is the aforementioned German Expert Opinion.

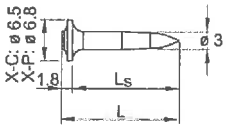
Kind regards,

i. A.
ORR Dr.-Ing. Blume
Head of Testing Laboratory

i. A.
Dipl.-Ing. Maertins
Engineer/Official in Charge

Nails

(For fastening to concrete)
X-P 17/20/24 B3 MX
X-P 30/36 B3 P7
X-C 20/24 B3 MX



General information

Material specifications	
X-P B3, X-S 3 nails	Carbon steel, HRC 57.5, 2-10 µm zinc coating
X-C B3 nails	Carbon steel, HRC 56.5, 5-13 µm zinc coating

Collated nail

X-C B3

Range of lengths:
X-C 20 B3 MX, X-C 24 B3 MX

X-P B3

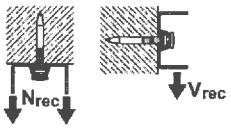
Range of lengths:
X-P 17 B3 MX, X-P 20 B3 MX, X-P 24 B3 MX

Hilti fastening tool Hilti BX3 with
Hilti nails X-C xx B3 MX and X-P xx B3 MX

BX 3 system

Load data

Recommended loads (nails and threaded studs only)



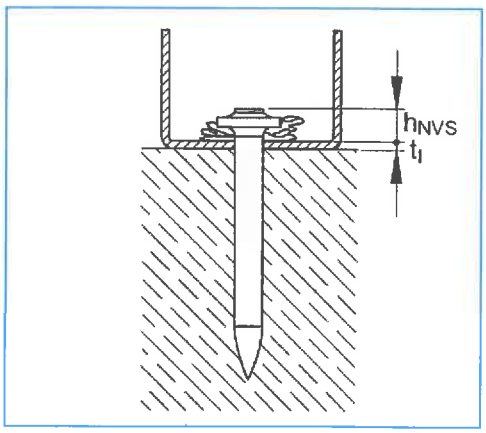
X-P B3 and X-C B3 nails (Base material: concrete / sand-lime masonry)

N_{rec} [kN]	V_{rec} [kN]	h_{ET} [mm]
0.4	0.4	≥ 27
0.3	0.3	≥ 22
0.2	0.2	≥ 18
0.1	0.1	≥ 14

Design conditions

- Minimum 5 fastenings per fastened unit
- All visible failures must be replaced

Setting parameters in reinforced concrete (a ≤ 300 mm t_I ≤ 2 mm))

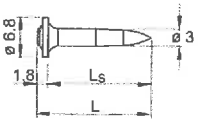


h_{NVS} = 2–5 mm

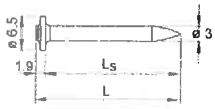
Hilti fastening tool Hilti BX3 with
Hilti nails X-C xx B3 MX and X-P xx B3 MX

Nails (For fastening to concrete)

X-P 17/20/24 G3 MX



X-C 20/27/32 G3 MX



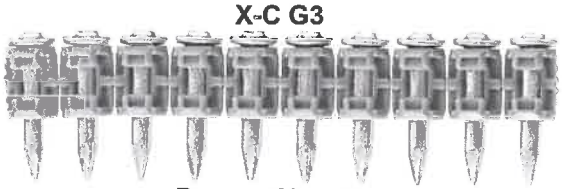
General information

Material specifications: B3 threaded studs

Material specifications	
X-P G3 MX, X-S G3 MX	Carbon steel, HRC 57.5, 2-10 µm zinc coating
X-C G3 MX	Carbon steel, HRC 56.5, 5-13 µm zinc coating

Collated nail

X-C G3



Range of lengths:
X-C 20 G3 MX, X-C 27 G3 MX, X-C 32 G3 MX

X-P G3

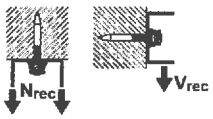
Range of lengths:
X-P 17 G3 MX, X-P 20 G3 MX, X-P 24 G3 MX

Hilti fastening tool Hilti GX3 with

Hilti nails X-C xx G3 MX and X-P xx G3 MX

Load data

Recommended loads (nails and threaded studs only)



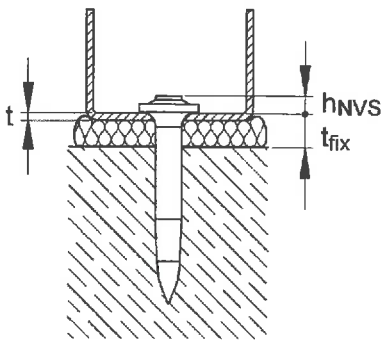
X-P G3 and X-C G3 Nails (Base Material: Concrete / Sandlime Masonry)

N_{rec} [kN]	V_{rec} [kN]	h_{ET} [mm]
0.4	0.4	≥ 27
0.3	0.3	≥ 22
0.2	0.2	≥ 18
0.1	0.1	≥ 14

Design conditions

- Minimum 5 fastenings per fastened unit
- All visible failures must be replaced

Setting parameters in reinforced concrete (a ≤ 300 mm t_i ≤ 2 mm))



h_{NVS} = 2–5 mm

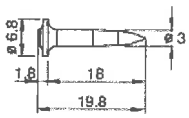
Hilti fastening tool Hilti GX3 with
Hilti nails X-C xx G3 MX and X-P xx G3 MX

Fastening tool Hilti GX 120

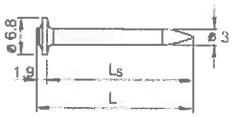
Product data

Dimensions

X-GHP 18



X-GN 20/27/32



Energy:

GC 21 and GC 22

General information

Material specifications

Carbon steel shank:	X-EGN HRC 58 X-GHP HRC 58 X-GN HRC 53.5
Zinc coating	X-GHP 2-10 µm, X-GN 5-13 µm

Fastening tool

GX 120, GX 120-ME
GX 100, GX 100 E

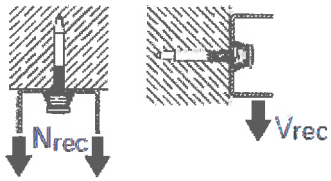
X-GHP 18 MX	340228	18	19.8	3.0
X-GHP 20 MX	285724	20	21.8	3.0
X-GHP 24 MX	438945	24	25.8	3.0
X-GN 20 MX	340232	19	20.9	3.0
X-GN 27 MX	340230	27	28.9	3.0
X-GN 32 MX	340233	32	33.9	3.0

Hilti fastening tool Hilti GX-120 with
Hilti nails X-GN xx MX and X-GHP xx MX

Load data

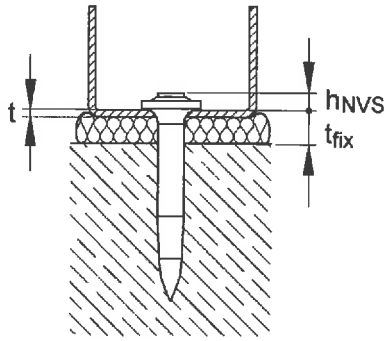
Design data

Recommended loads



Concrete $N_{rec} = V_{rec} = 0.4$ kN for $h_{ET} \geq 27$ mm
0.3 kN for $h_{ET} \geq 22$ mm
0.2 kN for $h_{ET} \geq 18$ mm
0.1 kN for $h_{ET} \geq 14$ mm

Setting parameters in reinforced concrete (a ≤ 300 mm t_i ≤ 2 mm))



h_{NVS} = 2–5 mm

Hilti fastening tool Hilti GX-120 with
Hilti nails X-GN xx MX and X-GHP xx MX

Cartridge-operated fastening tool for nails Hilti DX 5 MX

Cartridge-fired pins (nails)
X-P MX

X-U MX

X-C MX

Hilti fastening tool Hilti DX5 MX with

Hilti nails X-U xx MX and X-P xx MX and X-C xx MX

Cartridge-operated fastening tool for nails Hilti DX 5 F8

Single nails

X-P P8

X-U P8

X-C P8

Cartridges

Cartridge 6.8/11M10 and 6.8/11M40[1] (.27 caliber short)	Color code*
	High precision
	brown
	white [brown]
	green
	yellow
	red
	black [purple]

Hilti fastening tool Hilti DX5 F8 with

Hilti nails X-U xx P8 and X-P xx P8 and X-C xx P8

Cartridge-operated fastening tool for nails Hilti DX 460-F8

Single nails

X-P P8

X-U P8

X-C P8

Cartridges

Cartridge 6.8/11M10 and 6.8/11M40' (.27 caliber short)	Color code'
	High precision
	brown
	white [brown]
	green
	yellow
	red
	black [purple]

Hilti fastening tool Hilti-DX-460 with

Hilti nails X-C xx P8 and X-P xx P8 and X-U xx P8

Cartridge-operated fastening tool for nails Hilti DX 460-MX

Collated nail
X-P MX

X-U MX

X-C MX

Hilti fastening tool Hilti-DX-460 with
Hilti nails X-C xx MX and X-P xx MX and X-U xx MX

Cartridge-operated fastening tool for nails Hilti DX 351

Single nails

X-P P8

X-U P8

X-C P8

Cartridges

Cartridge 6.8/11M10 and 6.8/11M40[1] (.27 caliber short)	Color code[4]
	High precision
	brown
	white [brown]
	green
	yellow
	red
	black [purple]

Hilti fastening tool DX 351 with

Hilti nails X-U xx P8 and X-P xx P8 and X-C xx P8

Cartridge-operated fastening tool for nails Hilti DX 351 with nail magazine X-MX27

Collated nail

X-P MX

X-U MX

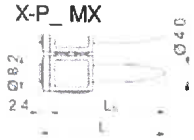
X-C MX

Hilti fastening tool DX 351 with

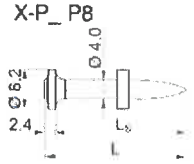
Hilti nails X-C xx MX and X-P xx MX and X-U xx MX

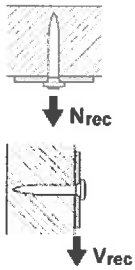
Technical data for Hilti X-P nails

X-P_ MX



X-P_ P8





Embedment h_{ET} [mm]	Recommended Loads [kN]				Typical cartridge color selection Type 6.8/11	
	Tension N_{rec}		Shear V_{rec}			
	Concrete Toughness					
	Soft	Tough	Soft	Tough	Soft	Tough
≥ 27	0.40	0.20	0.80	0.40	Red	Red / Black
≥ 22	0.30	0.15	0.60	0.30		
≥ 18	0.20	0.10	0.40	0.20	Green/ Yellow	Red
≥ 14	0.10	0.05	0.20	0.10		

Material Specifications

Carbon Steel 59 HRC
Zinc Coating 5-20µm

4mm shank diameter

Long Conical Tip

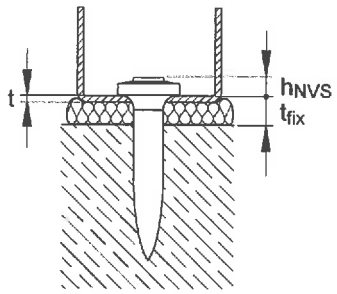
Single nails: X-P P8

Range of lengths:
X-P 22 P8, X-P 27 P8, X-P 34 P8, X-P 40 P8,
X-P 47 P8, X-P 52 P8, X-P 57 P8, X-P 62 P8,
X-P 72 P8

Collated nail: X-P MX

Range of lengths:
X-P 22 MX, X-P 27 MX, X-P 34 MX, X-P 40 MX,
X-P 47 MX, X-P 52 MX, X-P 57 MX, X-P 62 MX, X-P 72 MX

Setting parameters in reinforced concrete (a ≤ 300 mm t_i ≤ 2 mm))

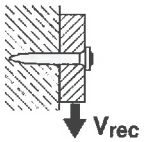


h_{NVS} = 2–5 mm

Hilti X-P nails

Technical data

Technical data for Hilti X-U nails



Loads depending on embedment depth h_{ET}:

$N_{rec} = V_{rec} = 0.4$ kN for $h_{ET} \geq 27$ mm

$N_{rec} = V_{rec} = 0.3$ kN for $h_{ET} \geq 22$ mm

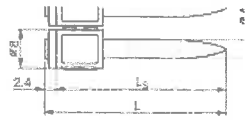
$N_{rec} = V_{rec} = 0.2$ kN for $h_{ET} \geq 18$ mm

$N_{rec} = V_{rec} = 0.1$ kN for $h_{ET} \geq 14$ mm

Product data

Dimensions

X-U__MX



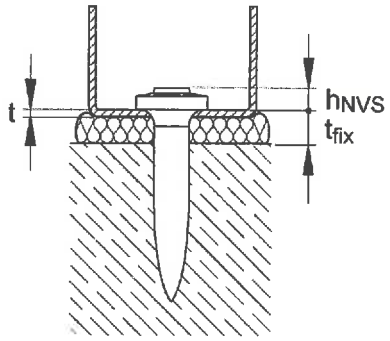
X-U__P8

General information

Material specifications

Carbon steel shank:	HRC 58
	HRC 59 (X-U 15)
Zinc coating:	5–13 µm

Setting parameters in reinforced concrete (a ≤ 300 mm t_i ≤ 2 mm))

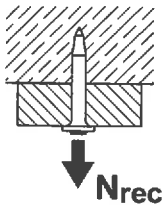


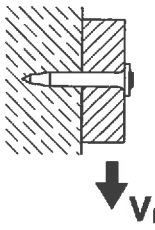
h_{NVS} = 2–5 mm

Hilti X-U nails

Technical data

Technical data for Hilti X-C nails



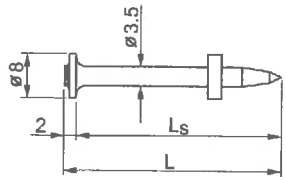


$N_{rec} = V_{rec} =$ **0,4 kN** für $h_{ET} \geq 27$ mm
0,3 kN für $h_{ET} \geq 22$ mm
0,2 kN für $h_{ET} \geq 18$ mm
0,1 kN für $h_{ET} \geq 14$ mm

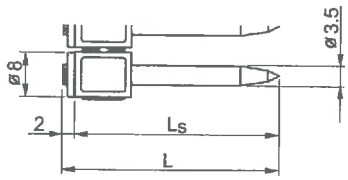
Produktdaten

Abmessungen

X-C __ P8



X-C __ MX



Generelle Informationen

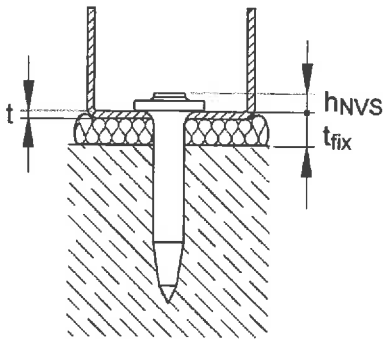
Materialdaten

C-Stahl Nagelschaft: HRC 56.5
HRC 58 *)

Zinkbeschichtung: 5–20 µm

*) X-C 82, 97 und 117 P8 (d_{nom} = 3,7 mm)

Setting parameters in reinforced concrete (a ≤ 300 mm t_i ≤ 2 mm))



h_{NVS} = 2–5 mm

Hilti X-C nails

Technical data

Table 2: Overview of material characteristics for plastic anchors

Plastic sleeve	**Anchor 1**	**Anchor 2**	**Anchor 3**
			
Nominal length [mm¨]	40	35	40
Outer diameter [mm]	6	6	6
Material	Nylon	Nylon	Nylon
Rotating pin	**Achor 1**	**Achor 2**	**Achor 3**
Shank diameter below the head [mm]	3.7	3.7	3.8
Head diameter [mm]	9.0	9.3	8.9
Shank length [mm]	38.6	39.4	39.6
Material	C steel, galvanized	C steel, galvanized	C steel, galvanized
Embedment depth [mm]	36	35	37

Table 3: Overview of material characteristics for the partition

Component	**Designation**
1	Gypsum boards in accordance with DIN EN 520 and DIN 18180, fastening (steel screws, filled)
2	Substructure in accordance with DIN 18182-1, fastening (shrunk, or via fastening of gypsum boards
3	Mineral wool insulation in accordance with DIN EN 13162 (non-combustible, melting point ≥ 1000 °C, b ≥ 40 mm)

Plastic achor / partition

Technical data