Deutsches Institut für Bautechnik

Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

European Technical Assessment ETA-20/1042 of 28 April 2021

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	Hilti threaded studs X-BT-MR and X-BT-GR
Product family to which the construction product belongs	Threaded studs for connection of materials to structural steel and aluminium members
Manufacturer	Hilti Aktiengesellschaft Feldkircherstrasse 100 9494 SCHAAN FÜRSTENTUM LIECHTENSTEIN
Manufacturing plant	Hilti AG - Plant 1
This European Technical Assessment contains	18 pages including 14 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 333037-00-0602

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Specific part

1 Technical description of the product

The Hilti X-BT power-actuated threaded studs are mechanical fasteners made of corrosion resistant stainless steel with metric threads M6, M8 or M10 or imperial threads W6 or W10 allowing connection of fixtures by means of a nut (Annex A1 to Annex A2). The studs feature a blunt tip with a nominal shank diameter of 5.2 mm which connects the stud with the supporting steel.

The Hilti X-BT power-actuated threaded studs require a pre-drilled hole with a diameter of 4.7 mm in the supporting steel. For pre-drilling that hole in the base material, the corresponding stepped drill bit Hilti TX-BT 4.7/7 shall be used to achieve a defined hole geometry.

The studs are then driven by means of the powder-actuated fastening tool Hilti DX 351 BT(G) or the battery-actuated fastening tool Hilti BX 3-BT(G) into the base material.

The Hilti X-BT threaded studs are equipped with a sealing washer, which consists of a metal washer with a sealing ring made of chloroprene rubber. The purpose of the sealing washer is to protect the pre-drilled location in the base material against corrosion.

The product description, installation condition as well as the description of the components of the power-actuated fastening systems are given in Annex A1 to Annex A5.

2 Specification of the intended use in accordance with the applicable 333037-00-0602

The intended use of Hilti threaded studs X-BT is specified in Annex B1. Fastenings are made to construction steel only.

The performances given in Annex C1 to Annex C4 are only valid if the threaded studs are used in compliance with the specifications and conditions given in Annex B1 to Annex B5.

The verification and assessment methods on which the European Technical Assessment is based lead to the assumption of a working life of the threaded studs of at least 25 years. The indications given on the working life cannot be interpreted as a guarantee given by the manufacturer but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	**Performance**
Tension resistance	see Annex C1 and C2
Shear resistance of individual threaded studs	see Annex C1 and C2
Shear Resistance of groups of threaded stud connections	see Annex C1 and C2
Bending moment resistance	see Annex C1 and C2
Resistance in case of combined loading (interaction)	see Annex B3
Application limits	see Annex C1 and C2
Fatigue classification of base material	see Annex C4

3.2 Safety in case of fire (BWR 2)

Essential characteristic	**Performance**
Reaction to fire	Class A1 - EN 13501-1
Resistance to fire	See Annex C3

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with EAD No. 333037-00-0602 the applicable European legal act is: 1998/214/EC amended by 2001/596/EC

The system to be applied is: 2+

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 28 April 2021 by Deutsches Institut für Bautechnik

Dr.-Ing. Ronald Schwuchow
Head of Section

beglaubigt:
Hahn

Deutsches Institut für Bautechnik DIBt

Product description: Hilti blunt-tip threaded studs X-BT-MR, X-BT-GR M8

Figure A1: X-BT-MR

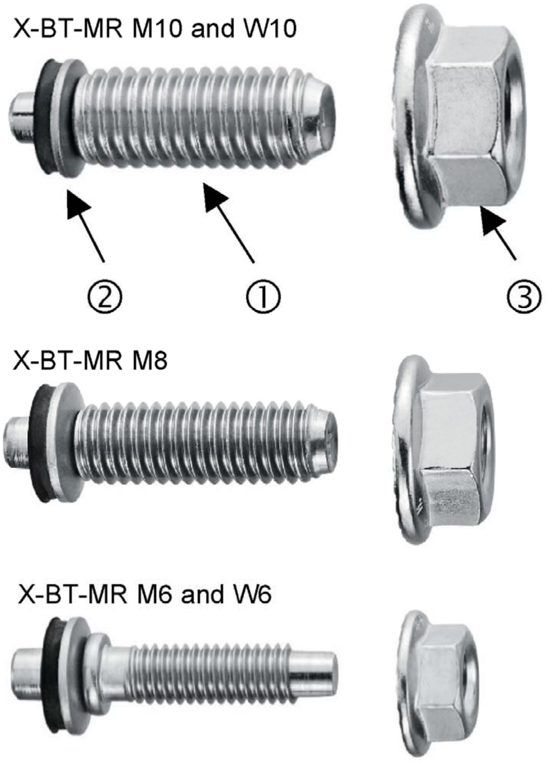
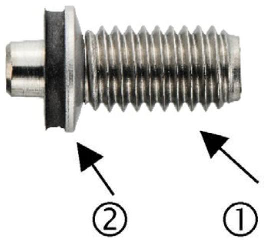


Figure A2: X-BT-GR M8



The type X-BT-GR M8 is intended for fixing gratings or floor plates and is supplied without a nut. (Remark: Grating and checker plate fasteners are not part of this ETA.)

The types X-BT-MR are supplied with a flange nut, which shall be used for connecting the fixed material.

In order to fit into the fastening tool, the X-BT-MR types M6, W6 and M8 are equipped with a plastic sleeve (Annex A3) which is required to center the stud in the fastening tool. After fastener installation the plastic sleeve is removed by the operator.

Table A1: Product description

Position	Description
①	Threaded stud with blunt tip and threaded section (M6, M8, M10, W6 and W10 thread sizes)
②	Sealing washer consisting of sealing ring made of chloroprene rubber vulcanized to a metal cap on top
③	Flange nut (M6, M8, M10, W6 and W10)

Hilti threaded studs X-BT-MR and X-BT-GR	Annex A1
Product description	

Installed condition

Figure A3: X-BT-MR

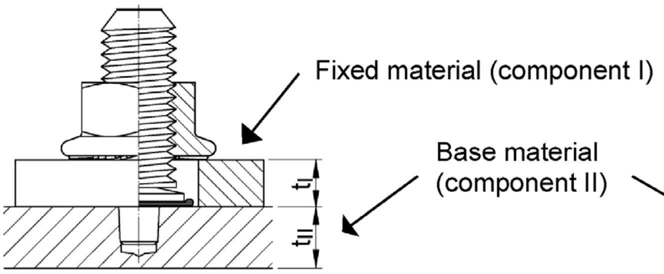
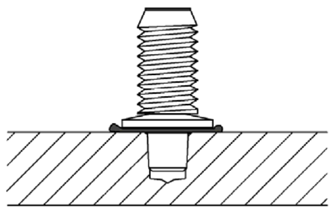


Figure A4: X-BT-GR M8



Terms and symbols

Fixed material (component I) = component to be fixed to the base material

- t_I = thickness of fixed material (component I)
- d_c = diameter of the clearance hole in the fixed material (component I)

Base material (component II) = member made from steel into which the threaded studs are driven

- t_{II} = thickness of base material (component II)
- t_c = coating thickness of base material (component II)

Threaded stud and threaded stud connections

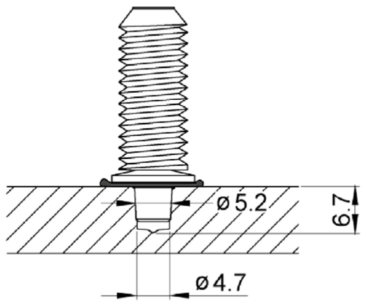
- c = edge distance of threaded stud
- s = spacing between threaded studs
- h_{NVS} = fastener stand-off: distance from top of the threaded stud to the surface of either coated or uncoated base material

Group fastenings:

Row Setup: Positioning of maximum 4 studs in a row with shear load introduction along the row

Rectangular Plate Setup: Positioning of maximum 4 studs each in the corner of a rectangular plate with shear load introduction in the center of the plate

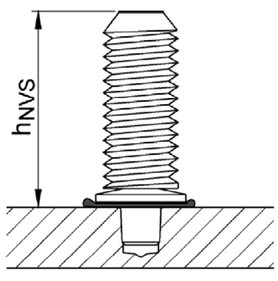
Figure A5: Pilot hole dimensions, fastener stand-off and clearance hole



Pilot hole dimensions:

- Diameter = 4.7 mm
- Drill depth in center = 6.7 mm

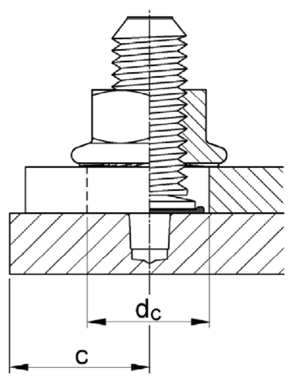
Nominal shank diameter of X-BT threaded stud = 5.2 mm



Fastener stand-off h_{NVS}

for X-BT-GR M8:
h_{NVS} = 15.7 – 16.8 mm

for all X-BT-MR types:
h_{NVS} = 25.7 – 26.8 mm

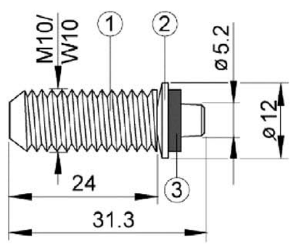
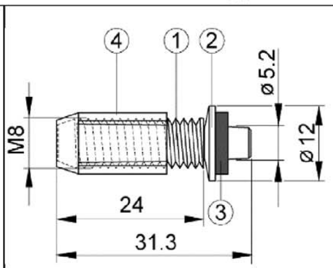
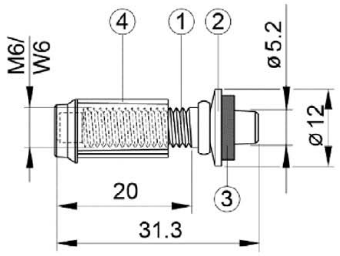
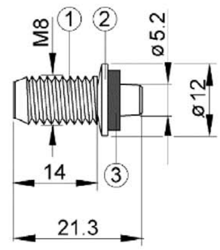


Clearance hole d_c
Edge distance c

Hilti threaded studs X-BT-MR and X-BT-GR	Annex A2
Installed condition, terms and symbols	

X-BT threaded stud types, dimensions and materials

Table A2: X-BT threaded stud types and dimensions, fixed material dimensions

X-BT types and dimensions [1]			
			
X-BT-MR M10/15 SN 8 X-BT-MR W10/15 SN 8	X-BT-MR M8/14 SN 8	X-BT-MR M6/10 SN 8 X-BT-MR W6/10 SN 8	X-BT-GR M8/7 SN 8
Fixed material thickness range t_l [mm]			
$2 \leq t_l \leq 15$	$2 \leq t_l \leq 14$	$2 \leq t_l \leq 10$	$2 \leq t_l \leq 7$ [2]
Maximum clearance hole d_c [mm] for use of flange nuts			
18 [3]	14	11	14 [2]

[1] The thickness of the metal cap (2) of the sealing washer amounts to 1.0 mm.
[2] In case the X-BT-GR M8/7 SN 8 stud is used in combination with an M8 flange nut.
[3] Conditions related with group fastenings loaded in shear, see Annex C1 and Annex C2.

Table A3: Dimensions of flange nuts

Flange nut	d_a	Thread type	AF
M6	15.0 mm	M6	10 mm
W6	15.0 mm	1/4 UNC	7/16"
M8	17.9 mm	M8	13 mm
M10	21.8 mm	M10	15 mm
W10	21.8 mm	3/8 UNC	9/16"

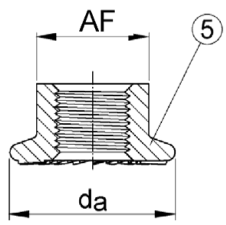


Table A4: Materials

Designation	Position	Material of X-BT-MR and X-BT-GR
Threaded stud	1	Stainless steel 1.4462 - EN 10088-1
Sealing washer – metal cap	2	Stainless steel 1.4404 - EN 10088-1
Sealing washer – rubber	3	Vulcanized sealing ring made of chloroprene rubber CR 3.1107
Guidance sleeve	4	Plastic (PE)
Flange nut	5	Stainless steel A4-70 - EN ISO 3506-2

Hilti threaded studs X-BT-MR and X-BT-GR	Annex A3
Threaded stud types, dimensions and materials	

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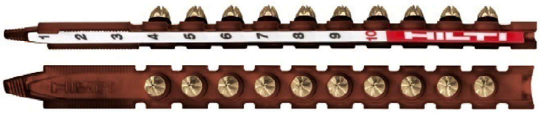
Powder-actuated Hilti X-BT fastening system

Table A5: Fastening tool, system components and X-BT threaded stud allocation

Fastening tool	 DX 351 BT		 DX 351 BTG
Fastener guide	 X-351-BT FG M1024	 X-351-BT FG W1024	 X-351-BT FG G
Piston	 X-351-BT P 1024 (length = 155 mm)		 X-351-BT P G (length = 176 mm)
Threaded stud	X-BT-MR M6/10 SN 8 X-BT-MR M8/14 SN 8 X-BT-MR M10/15 SN 8	X-BT-MR W6/10 SN 8 X-BT-MR W10/15 SN 8	X-BT-GR M8/7 SN 8
Cartridge			6.8/11 M10 brown (energy scale 2)
Drill bits [1)2)]			TX-BT 4.7/7-80 TX-BT 4.7/7-110 TX-BT 4.7/7-150

1) Hilti drills: SF BT 22-A or SF BT 18-A

2) Different lengths of drill bits (80, 110 and 150 mm) are available. Related with the pilot hole in the base material all drill bits are equivalent, pilot hole dimensions, see Figure A5.

Detail of wheel on tool allowing continuous regulation of the driving energy:

Setting 1: Minimum energy

Setting 3: Maximum energy

Hilti threaded studs X-BT-MR and X-BT-GR	Annex A4
Powder-actuated Hilti X-BT fastening system – DX 351 BT and DX 351 BTG	

Battery-actuated Hilti X-BT fastening system

Table A6: Fastening tool, system components and X-BT threaded stud allocation

Fastening tool	 BX 3-BT		 BX 3-BTG
Fastener guide	 X-FG B3-BT M	 X-FG B3-BT W	 X-FG B3-BTG
Piston	integrated in tool [3]		
Threaded stud	X-BT-MR M6/10 SN 8 X-BT-MR M8/14 SN 8 X-BT-MR M10/15 SN 8	X-BT-MR W6/10 SN 8 X-BT-MR W10/15 SN 8	X-BT-GR M8/7 SN 8
Drill bits [1)2)]			TX-BT 4.7/7-80 TX-BT 4.7/7-110 TX-BT 4.7/7-150

1) Hilti drills: SF BT 22-A or SF BT 18-A

2) Different lengths of drill bits (80, 110 and 150 mm) are available. Related with the pilot hole in the base material all drill bits are equivalent, pilot hole dimensions, see Figure A5.

3) No piston exchange possible by the tool operator.

The fastener guide of the tool allows adjustment of the fastener embedment depth. The front part can be turned varying between the positions 1, 2, 3 and 4.

A smaller number leads to a lower embedment depth of the X-BT in the steel or to a higher stand-off h_{NVS}, respectively.

Hilti threaded studs X-BT-MR and X-BT-GR	Annex A5
Battery-actuated Hilti X-BT fastening system – BX 3-BT and BX 3-BTG	

Specifications of intended use

The X-BT threaded studs are intended to be used for redundant multiple fastening and group fastening of non-structural components.

Examples:

- Fastening of non-structural components in mechanical and electrical installations (e.g. pipes, cable conduits, installation channels etc.)
- Group fastenings (base plates of brackets or footings or other members e.g. electrical switch box)
- Fastening floor gratings and floor plates in conjunction with grating fasteners or checker plate fasteners
- Fastening of the substructure of suspended ceilings or cladding

Use of the fastening:

- Static and quasi-static loading

Material of the fixed material (component I):

- Non-alloy structural steel covered by EN 1993-1-1 and the material codes given there, and EN 10346
- Corrosion resistant steel according to EN 10088-2

Material and coating of the base material (component II):

- Non-alloy structural steel covered by EN 1993-1-1 and the material codes given there
- Non-alloy structural steel covered by EN 1993-1-12 and EN 10025-6
- The base material may be paint coated, hot-dipped galvanized or duplex coated (duplex = paint applied over zinc coating) up to a maximum coating thickness of 0.5 mm.

Use conditions (environmental conditions):

- Use in dry internal conditions and in corrosive environments. The threaded studs are allocated to the corrosion resistance class CRC IV according to EN 1993-1-4.
- All X-BT threaded studs can be used in the temperature range from −40 °C to +100 °C.

Design:

- The fasteners are designed under the responsibility of an engineer experienced in fasteners work.
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the threaded studs, their designation and the ETA number is indicated on the design drawings.
- The verification concept in EN 1990:2002 + A1:2005 + A1:2005/AC:2010 is used for the design of connections with X-BT threaded studs.
- The partial factors γ_M and γ_{MII} specified in Annex C1 and Annex C2 are used provided no other values are given in national regulations of the member states.

Hilti threaded studs X-BT-MR and X-BT-GR	Annex B1
Specifications of intended use	

Design (continued)

- The design tension resistance N_{Rd} shall be determined as follows:

$$N_{Rd} = \min \begin{cases} N_{Rd,I} \\ N_{Rd,II} \end{cases} \qquad N_{Rd,I} = \frac{N_{Rk,I}}{\gamma_{M2}} \qquad N_{Rd,II} = \frac{N_{Rk,II}}{\gamma_M \cdot \gamma_{MII}}$$

For thin fixed material ($2 \leq t_I \leq 3$ mm) $N_{Rk,I}$ shall be calculated according to EN 1993-1-3, Table 8.3 applying γ_{M2} according to EN 1993-1-3 for design.

$N_{Rk,I}$ = characteristic pull-over resistance of fixed material (component I)
$N_{Rk,II}$ = characteristic tension resistance, addressing pull-out from base material (component II) and fastener failure (Annex C1 and Annex C2)

- The design shear resistance V_{Rd} and $V_{Rd,g}$ shall be determined as follows:

V_{Rd} for a single threaded stud:

$$V_{Rd} = \min \begin{cases} V_{Rd,I} \\ V_{Rd,II} \end{cases}$$

$$V_{Rd,I} = \frac{V_{Rk,I}}{\gamma_{M2}} \qquad V_{Rd,II} = \frac{V_{Rk,II}}{\gamma_M \cdot \gamma_{MII}}$$

$V_{Rd,g}$ for a group of threaded studs:

$$V_{Rd,g} = \min \begin{cases} n \cdot V_{Rd,I} \\ V_{Rd,II,g} \end{cases}$$

$$V_{Rd,II,g} = \frac{V_{Rk,II,g}}{\gamma_M \cdot \gamma_{MII}} \qquad V_{Rk,II,g} = \alpha \cdot n \cdot V_{Rk,II}$$

For thin fixed material ($2 \leq t_I \leq 3$ mm) $V_{Rk,I}$ shall be calculated according to EN 1993-1-3, Table 8.4 applying γ_{M2} according to EN 1993-1-3.

In order to develop a joint group resistance, the shear force of every stud of the group is introduced via the sealing washer into the stud (Annex B4).

$V_{Rk,I}$ = characteristic bearing resistance of fixed material (component I)
$V_{Rk,II}$ = characteristic shear resistance, addressing failure of base material (component II) and fastener failure (Annex C1 and Annex C2)
$V_{Rk,II,g}$ = characteristic shear resistance of a group of fasteners, addressing failure of base material (component II) and fastener failure
$V_{Rd,II,g}$ = design shear resistance of a group of fasteners, addressing failure of base material (component II) and fastener failure
α = reduction factor to consider the group effect (Annex C1 and Annex C2)
n = total number of threaded studs in a group of fasteners, $n_{max} = 4$

- The design moment resistance shall be determined as follows:

$$M_{Rd} = \frac{M_{Rk}}{\gamma_M}$$

M_{Rk} = characteristic bending resistance per Table C1 and Table C2
M_{Rd} = design bending resistance

Design (continued)

- In case of combined tension and shear loading, the resistance of thin fixed material ($2 \le t_I \le 3$ mm) shall be calculated by the interaction formula given in EN 1993-1-3.
- In case of combined tension and shear loading and/or bending moment, the resistance – related with failure of the base material (component II) and the fastener failure – can be calculated by the interaction formulas in Table B1.

Table B1: Interaction

Load combination	Interaction provision
Shear - Tension	$\frac{V_{Ed}}{V_{Rd}} + \frac{N_{Ed}}{N_{Rd}} \le 1.2$
Shear – Bending moment	$\frac{V_{Ed}}{V_{Rd}} + \frac{M_{Ed}}{M_{Rd}} \le 1.0$
Tension – Bending moment	$\frac{N_{Ed}}{N_{Rd}} + \frac{M_{Ed}}{M_{Rd}} \le 1.0$
Shear – Tension – Bending moment	$\frac{V_{Ed}}{V_{Rd}} + \frac{N_{Ed}}{N_{Rd}} + \frac{M_{Ed}}{M_{Rd}} \le 1.0$

N_{Ed} = design value of the acting tensile force
V_{Ed} = design value of the acting shear force
M_{Ed} = design value of the acting bending moment

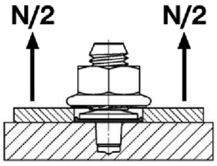
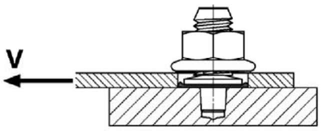
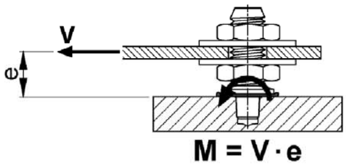
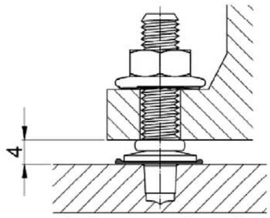
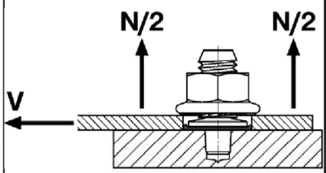
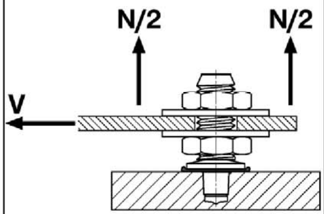
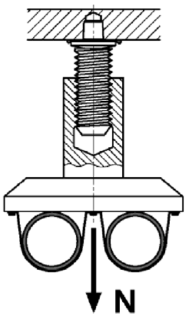
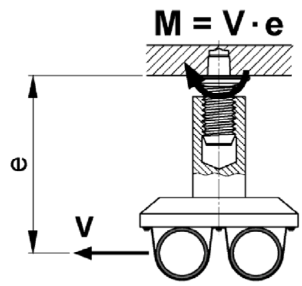
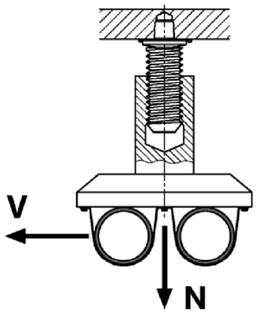
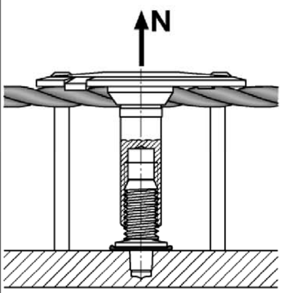
- When using X-BT-MR or X-BT-GR threaded studs installed into structural steel members that are subjected to fatigue loading, the effect of the threaded studs on the fatigue strength of the steel base material must be considered. The design is carried out according to EN 1993-1-9:2005.

  The construction detail „Steel base material with X-BT threaded studs" and the corresponding detail category $\Delta\sigma_C$ is listed in Annex C4, Table C4.

Installation:

- The installation is only carried out according to the manufacturer's instructions, Annex B5.
- Threaded stud installation is carried out by appropriately qualified personnel and under the supervision of the person responsible for the technical matters of the site.
- In case of X-BT-MR M8, X-BT-MR M10 and X-BT-MR W10 threaded studs the fixed material must directly sit on the base material.
- In case of the X-BT-MR M6 and X-BT-MR W6 the fixed material may also sit on the collar of the stud (Annex B4, geometric details are given in manufacturer instructions). In case the fixed material sits directly on the base material, an additional washer with a maximum thickness of 4 mm needs to be used in combination with the M6 and W6 flange nut.

Table B2: Type of connections and loading conditions

Fastening of components to base material with nut			
Tensile loading	Lateral shear loading (Introduction of the shear load via the sealing washer)	Bending loading (Introduction of the shear load via the thread)	Interaction
		4 mm distance when fixed material sits on collar of X-BT-MR M6/W6 threaded stud	
Fastening of components in mechanical and electrical installations [1)]			
Tensile loading		Bending loading	Interaction
	-		
Fastening of gratings and floor plates [1)]			
Tensile loading			
	-	-	-

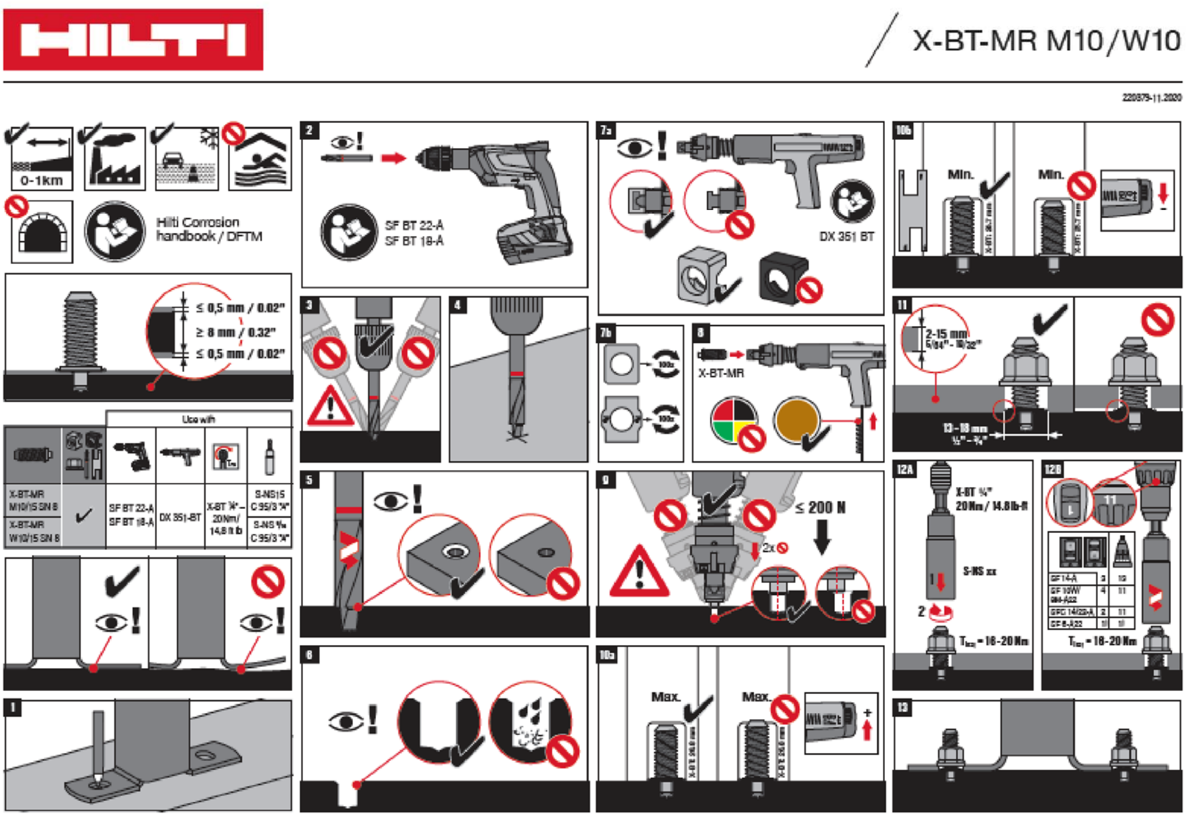
[1)] The components for fastening mechanical and electrical installations, grating plate fastener and checker plate fastener are not part of this ETA.

Hilti threaded studs X-BT-MR and X-BT-GR	Annex B4
Type of connections and loading conditions	

Instructions for use

- For the preparation of the drilled hole in the base material the drill bits Hilti TX-BT 4.7/7-80, TX-BT 4.7/7-110 or TX-BT 4.7/7-150 (Annex A4 and Annex A5) in combination with the Hilti drill SF BT-22A or SF BT-18A are used. Proper drilling depth is achieved when the stop shoulder of the step shank drill bit grinds a shiny ring on the surface.
- The X-BT threaded stud is either driven by means of the powder-actuated fastening system Hilti DX 351 BTG or DX 351 BT (Annex A4) or the battery-actuated fastening system BX 3-BT or BX 3-BTG (Annex A5).
- For the powder-actuated fastening tools DX 351 BT and DX 351 BTG (Annex A4) the tool energy setting = 1 in combination with the brown cartridge 6.8/11 is recommended. If required to meet the fastener stand-off range h_{NVS} the tool energy setting on the tool is increased.
- For the battery-actuated fastening tools BX 3-BT and BX 3-BTG (Annex A5) the embedment depth adjustment on the fastener guide is recommended to set = 3. If required to meet the fastener stand-off range h_{NVS} the embedment depth adjustment is adjusted, possible positions are 1, 2, 3 and 4.
- The application limits (minimum base material thickness and maximum coating thickness) are observed.
- The tightening torque T of the flange nut is applied up to maximum 20 Nm for base material thickness t_{II} ≥ 6 mm and up to maximum 8 Nm for base material thickness 4 mm ≤ t_{II} < 6 mm.
- Figure B1 shows one example of instructions for use which are supplied with every box of fasteners.

Figure B1: Example of instructions for use



Note: The selection shows one example: X-BT-MR M10/W10 in combination with DX 351 BT powder-actuated fastening tool.

Hilti threaded studs X-BT-MR and X-BT-GR	Annex B5
Instructions for use	

Performances for base material thickness ≥ 8 mm

Table C1: Hilti threaded studs X-BT-MR and X-BT-GR
Characteristic tension, shear and bending resistance, partial factors

Performances		**S235, S275**	**S355 to S960** [1]
Characteristic tension resistance	$N_{Rk,II}$ [kN]	10.0	13.0
Characteristic shear resistance	$V_{Rk,II}$ [kN]	12.0	15.0
Reduction factor considering group effect in shear	α (n=4) [2] [-]	1.0	
Characteristic bending resistance	M_{Rk} [Nm]	35.0	
Spacing	s [mm]	≥ 15	
Edge distance	c [mm]	≥ 10	
Coating thickness of steel base material	t_c [mm]	≤ 0.5	
Partial factor [3]	γ_M [-]	1.25	
Partial factor to consider base material variations [3]	γ_{MII} [-]	1.60	

[1] Remark: EN 1993 is currently valid only up to S700

[2] Conditions:
- The maximum clearance hole d_c in the fixed material amounts to 14 mm.
- The shear force is introduced via the sealing washer as shown in Annex B4.
- The value α covers the group patterns "Row Setup" and "Rectangular Plate Setup" up to 4 studs.
- In case the hole clearance exceeds 14 mm, the following reduction factors α apply:
  for "Row Setup": α (n) = 1/n
  for "Rectangular Plate Setup": α (n=4) = 0.5

[3] In the absence of national regulations

Application limit (for t_{II} ≥ 8 mm)

The performances apply within the entire strength range of the steel grades S235 to S960.
There is no upper maximum thickness limit for the construction steel base materials.

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Performances for base material thickness 4 mm ≤ t_{II} < 8 mm

Table C2: Hilti threaded studs X-BT-MR and X-BT-GR
Characteristic tension, shear and bending resistance, partial factors

Performances		**S235, S275**	**S355 to S960** [1]
Characteristic tension resistance	$N_{Rk,II}$ [kN]	$\beta_{II} \cdot 10.0$	$\beta_{II} \cdot 13.0$
Characteristic shear resistance	$V_{Rk,II}$ [kN]	$\beta_{II} \cdot 12.0$	$\beta_{II} \cdot 15.0$
Reduction factor considering group effect in shear	α (n=4) [2] [-]	1.0	
Characteristic bending resistance	M_{Rk} [Nm]	$\beta_{II} \cdot 35.0$	
Reduction factor β_{II} to consider base metal thickness	β_{II} [-]	$\beta_{II} = \frac{t_{II} - 2}{6}$	
Spacing	s [mm]	≥ 15	
Edge distance	c [mm]	≥ 10	
Coating thickness of steel base material	t_c [mm]	uncoated	
Partial factor [3]	γ_M [-]	1.25	
Partial factor to consider base material variations [3]	γ_{MII} [-]	1.60	

[1] Remark: EN 1993 is currently valid only up to S700

[2] Conditions:
- The maximum clearance hole d_c in the fixed material amounts to 14 mm.
- The shear force is introduced via the sealing washer as shown in Annex B4.
- The value α covers the group patterns "Row Setup" and "Rectangular Plate Setup" up to 4 studs.
- In case the hole clearance exceeds 14 mm, the following reduction factors α apply:
  for "Row Setup": α (n) = 1/n
  for "Rectangular Plate Setup": α (n=4) = 0.5

[3] In the absence of national regulations

Application limit

The performances apply within the entire strength range of the steel grades S235 to S960.

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Resistance at elevated temperatures

Table C3: Temperature dependent strength reduction factor

Temperature Θ of base material and X-BT	Temperature reduction factor $k_{u,\Theta,TS}$
≤ 100°C	1.00
100°C < Θ ≤ 200°C	0.85
200°C < Θ ≤ 400°C	0.70
400°C < Θ ≤ 600°C	0.34

The temperature reduction factor $k_{u,\Theta,TS}$ can be applied to the X-BT-MR and X-BT-GR threaded studs in case of fire design.

The reduction factor $k_{u,\Theta,TS}$ is applicable to the characteristic tension, shear and bending resistance given in Annex C1 and Annex C2.

Characteristic tension resistance $N_{fi,II,Rk}$ at elevated temperature:

$$N_{fi,II,Rk} = k_{u,\theta,TS} \cdot N_{Rk,II}$$

with:

$N_{Rk,II}$ …. characteristic tension resistance of X-BT-MR and X-BT-GR at room temperature according to Annex C1 and Annex C2

Characteristic shear resistance $V_{fi,II,Rk}$ at elevated temperature:

$$V_{fi,II,Rk} = k_{u,\theta,TS} \cdot V_{Rk,II}$$

with:

$V_{Rk,II}$ …. characteristic shear resistance of X-BT-MR and X-BT-GR at room temperature according to Annex C1 and Annex C2

Characteristic bending resistance $M_{fi,Rk}$ at elevated temperature:

$$M_{fi,Rk} = k_{u,\theta,TS} \cdot M_{Rk}$$

with:

M_{Rk} …. characteristic bending resistance of X-BT-MR and X-BT-GR at room temperature according to Annex C1 and Annex C2

The design resistances result to:

$$N_{fi,II,Rd} = \frac{1}{\gamma_{M,fi} \cdot \gamma_{M,II}} \cdot N_{fi,II,Rk} \qquad V_{fi,II,Rd} = \frac{1}{\gamma_{M,fi} \cdot \gamma_{M,II}} \cdot V_{fi,II,Rk} \qquad M_{fi,Rd} = \frac{1}{\gamma_{M,fi}} \cdot M_{fi,Rk}$$

with

$\gamma_{M,fi}$ …. partial factor for the fire strength according to EN 1993-1-2

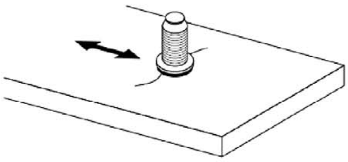
$\gamma_{M,II}$ …. partial factor to consider base material variations

In the absence of national regulations $\gamma_{M,II}$ = 1.6 applies.

Hilti threaded studs X-BT-MR and X-BT-GR	Annex C3
Characteristic and design resistances at elevated temperatures	

Fatigue classification of base material for thickness $t_{II} \geq 8$ mm

Table C4: Construction detail „Steel base material with Hilti X-BT threaded studs“ in compliance with EN 1993-1-9:2005

Detail category	Construction detail	Description	Requirements
100 m = 5		Hilti X-BT-MR and X-BT-GR power-actuated threaded studs with pre-drilled hole in structural steel base material.	$\Delta\sigma$ to be calculated on the gross cross section. Installation, static loading and spacing of X-BT threaded studs in accordance with Annex B5 and Annex C1. Base material thickness $t_{II} \geq 8$ mm. Edge distance $c \geq 15$ mm. Steel base material S235 up to S960 [1)] according to EN 10025.

[1)] Remark: EN 1993 is currently valid only up to S700

$\Delta\sigma_C$ = reference value of the fatigue strength at $N_C = 2 \cdot 10^6$ cycles, $\Delta\sigma_C = 100$ N/mm²

m = slope of fatigue strength curve, m = 5

Hilti threaded studs X-BT-MR and X-BT-GR	Annex C4
Fatigue classification of base material – Detail category	