

Approval body for construction products
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and
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European Technical Assessment

ETA-12/0471
of 15 November 2016

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the
European Technical Assessment:

Trade name of the construction product

Product family
to which the construction product belongs

Manufacturer

Manufacturing plant

This European Technical Assessment
contains

This European Technical Assessment is
issued in accordance with Regulation (EU)
No 305/2011, on the basis of

This version replaces

Deutsches Institut für Bautechnik

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM
Quick Drill III, BM DT Quick Drill and BM FT Quick Drill
screws

BM Quick Drill screws for use in timber constructions

Bi-Mirth Corporation
No. 3, Alley 7, Lane 96, Ping Der Road
TAI-CHUNG
TAIWAN R.O.C

Werk 1
Plant 1

25 pages including 5 annexes which form an integral part
of this assessment

European Assessment Document (EAD)
130118-00-0603

ETA-12/0471 issued on 13 June 2013

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Specific Part

1 Technical description of the product

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws are self-tapping screws made from special carbon steel. The screws are hardened. The screws have a corrosion protection according to Annex A.2.6 and an antifriction coating. The outer thread diameter is not less than 6.0 mm and not greater than 14.0 mm. The overall length of the screws is ranging from 40 mm to 1500 mm. Further dimensions are shown in Annex 5.

The washers are made from carbon steel. The dimensions of the washers are given in Annex 5.

2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the screws are used in compliance with the specifications and conditions given in Annex 1 and 2.

Durability is only ensured if the specifications of intended use according to Annex 1 and 2 are taken into account.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the screws of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, 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 |
|--|-------------|
| Dimensions | See Annex 5 |
| Characteristic yield moment | See Annex 2 |
| Characteristic withdrawal parameter | See Annex 2 |
| Characteristic head pull-through parameter | See Annex 2 |
| Characteristic tensile strength | See Annex 2 |
| Characteristic yield strength | See Annex 2 |
| Characteristic torsional strength | See Annex 2 |
| Insertion moment | See Annex 2 |
| Spacing, end and edge distances of the screws and minimum thickness of the wood based material | See Annex 2 |
| Slip modulus for mainly axially loaded screws | See Annex 2 |

3.2 Safety in case of fire (BWR 2)

| Essential characteristic | Performance |
|--------------------------|--|
| Reaction to fire | The screws are made of steel classified as Euroclass A1 in accordance with EC decision 96/603/EC, as amended by EC decision 2000/605/EC. |

3.3 Hygiene, health and the environment (BWR 3)

Not applicable

3.4 Safety and accessibility in use (BWR 4)

Same as BWR 1

3.5 Protection against noise (BWR 5)

Not applicable

3.6 Energy economy and heat retention (BWR 6)

Not applicable

3.7 Sustainable use of natural resources (BWR 7)

For the sustainable use of natural resources no performance was investigated for this product.

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

In accordance with EAD No. 130118-00-0603 the applicable European legal act is: 97/176/EC.
The system to be applied is: 3

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 15 November 2016 by Deutsches Institut für Bautechnik

Andreas Kummerow
p. p. Head of Department

beglaubigt:
Dewitt

Annex 1 Specifications of intended use

A.1.1 Use of the BM Quick Drill screws only for:

- Static and quasi-static loads

A.1.2 Base materials

The screws are used for connections in load bearing timber structures between wood-based members or between those members and steel members:

- Solid timber (softwood) according to EN 14081-1¹,
- Glued laminated timber (softwood) according to EN 14080²,
- Laminated veneer lumber LVL of softwood according to EN 14374³, arrangement of the screws only perpendicular to the plane of the veneers,
- Glued solid timber (softwood) according to EN 14080 or national provisions that apply at the installation site,
- Cross-laminated timber (softwood) according to European Technical Approvals/Assessments or national provisions that apply at the installation site.

The screws may be used for connecting the following wood-based panels to the timber members mentioned above:

- Plywood according to EN 636⁴ and EN 13986⁵,
- Oriented Strand Board, OSB according to EN 300⁶ and EN 13986,
- Particleboard according to EN 312⁷ and EN 13986,
- Fibreboards according to EN 622-2⁸, EN 622-3⁹ and EN 13986,
- Cement-bonded particle boards according to EN 634-2¹⁰ and EN 13986,
- Solid-wood panels according to EN 13353¹¹ and EN 13986.

Wood-based panels shall only be arranged on the side of the screw head.

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws may be used for the fixing of thermal insulation material on top of rafters or on wood-based members in vertical façades.

BM FT Quick Drill screws may be used for reinforcing of timber structures perpendicular to the grain.

| | | |
|----|-------------------------|--|
| 1 | EN 14081-1:2005+A1:2011 | Timber structures – Strength graded structural timber with rectangular cross section – Part 1: General requirements |
| 2 | EN 14080:2013 | Timber structures - Glued laminated timber and glued solid timber - Requirements |
| 3 | EN 14374:2004 | Timber structures - Structural laminated veneer lumber - Requirements |
| 4 | EN 636:2012+A1:2015 | Plywood - Specifications |
| 5 | EN 13986:2004+A1:2015 | Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking |
| 6 | EN 300:2006 | Oriented strand boards (OSB) – Definition, classification and specifications |
| 7 | EN 312:2010 | Particleboards - Specifications |
| 8 | EN 622-2:2004 | Fibreboards – Specifications – Part 2: Requirements for hardboards |
| 9 | EN 622-3:2004 | Fibreboards - Specifications - Part 3: Requirements for medium boards |
| 10 | EN 634-2:2007 | Cement-bonded particleboards – Specifications – Part 2: Requirements for OPC bonded particleboards for use in dry, humid and external conditions |
| 11 | EN 13353:2008+A1:2011 | Solid wood panels (SWP) – Requirements |

| | |
|---|---------|
| BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws | Annex 1 |
| Specifications of intended use | |

A.1.3 Use Conditions (environmental conditions)

The corrosion protection of the BM Quick Drill screws is specified in Annex A.2.6. With regards to the use and the environmental conditions, the national provisions of the place of installation apply.

A.1.4 Installation provisions

EN 1995-1-1¹² in conjunction with the respective national annex applies for the installation.

A minimum of two screws shall be used for connections in load bearing timber structures. This does not apply for special situations specified in National Annexes to EN 1995-1-1.

The screws are driven into the wood-based member made of softwood without pre-drilling. The screw holes in steel members shall be pre-drilled with an adequate diameter greater than the outer thread diameter.

BM FT Quick Drill screws with an outer thread diameter of 13 mm and 14 mm and a length greater or equal than 800 mm shall be only driven in a guiding hole with a diameter of 7 mm and a minimum length of 80 mm.

If screws with an outer thread diameter $d \geq 8$ mm are driven into the wood-based member without pre-drilling, the structural solid or glued laminated timber, laminated veneer lumber and similar glued members shall be from spruce, pine or fir.

In the case of fastening battens on thermal insulation material on top of rafters the screws shall be driven in the rafter through the battens and the thermal insulation material without pre-drilling in one sequence.

Countersunk head screws may be used with washers according to Annex 5. After inserting the screw the washers shall touch the surface of the wood-based member completely.

By fastening screws in wood-based members the head of the screws shall be flush with the surface of the wood-based member. For cylinder head screws the head part remains unconsidered.

¹² EN 1995-1-1: 2004+AC:2006+A1:2008+A2:2014 Eurocode 5: Design of timber structures – Part 1-1: General - Common rules and rules for buildings

| | |
|---|---------|
| BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws | Annex 1 |
| Installation provisions | |

ANNEX 2 – Characteristic values of the load-carrying capacities

Table A.2.1 Characteristic load-carrying capacities of BM Quick Drill screws

| Outer thread diameter [mm] | 6.0 | 8.0 | 10.0 | 12.0 | 13.0 | 14.0 |
|---|------|------|------|------|------|-------|
| Characteristic yield moment $M_{y,k}$ [Nm] | 10.0 | 20.0 | 30.0 | 42.0 | 60.0 | 68.0 |
| Characteristic tensile strength $f_{tens,k}$ [kN] | 12.0 | 21.0 | 27.0 | 36.0 | 55.0 | 55.0 |
| Characteristic torsional strength $f_{tor,k}$ [Nm] | 10.0 | 24.0 | 39.0 | 58.0 | 95.0 | 102.0 |

A.2.1 General

The minimum penetration length of the threaded part of the screw in the wood-based members l_{ef} shall be

$$l_{ef} = \min \begin{cases} \frac{4 \cdot d}{\sin \alpha} \\ 20 \cdot d \end{cases} \quad (2.1)$$

where

α angle between screw axis and grain direction

d outer thread diameter of the screw.

The outer thread diameter of screws inserted in cross-laminated timber shall be at least 6 mm. The inner thread diameter d_i of the screws shall be greater than the maximal width of the gaps in the layer of cross laminated timber.

A.2.2 Laterally loaded screws

The outer thread diameter d shall be used as effective diameter of the screw according to EN 1995-1-1.

The embedding strength for the screws in wood-based members or in wood-based panels shall be taken from EN 1995-1-1 or from national provisions that apply at the installation site unless otherwise specified in the following.

A.2.3 Axially loaded screws

The axial slip modulus K_{ser} of the threaded part of a screw for the serviceability limit state shall be taken independent of angle α to the grain as:

$$K_{ser} = 780 \cdot d^{0.2} \cdot l_{ef}^{0.4} \quad [\text{N/mm}] \quad (2.2)$$

Where

d outer thread diameter of the screw [mm]

l_{ef} penetration length of the of the threaded part of the screw in the wood-based member [mm].

| | |
|---|---------|
| BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws | Annex 2 |
| Characteristic values of the load-carrying capacities | |

A.2.3.1 Axial withdrawal capacity

The characteristic withdrawal parameter at an angle $\alpha = 90^\circ$ to the grain based on a characteristic density of the wood-based member of 350 kg/m^3 is

$f_{ax,k} = 11 \text{ N/mm}^2$ for screws with $6 \text{ mm} \leq d \leq 8 \text{ mm}$ and

$f_{ax,k} = 10 \text{ N/mm}^2$ for screws with $d \geq 10 \text{ mm}$.

For LVL a maximum characteristic density of 500 kg/m^3 shall be used in equation (8.40a) of EN 1995-1-1.

A.2.3.2 Head pull-through capacity

The characteristic value of the head pull-through parameter for BM Quick Drill screws for a characteristic density of 350 kg/m^3 of the timber and for wood-based panels like

- Plywood according to EN 636 and EN 13986
- Oriented Strand Board, OSB according to EN 300 and EN 13986
- Particleboard according to EN 312 and EN 13986
- Fibreboards according to EN 622-2, EN 622-3 and EN 13986
- Cement-bonded particle boards according to EN 634-2 and EN 13986,
- Solid-wood panels according to EN 13353 and EN 13986

with a thickness of more than 20 mm is

$f_{head,k} = 9.4 \text{ N/mm}^2$ for screws with countersunk or wafer head.

For wood-based panels a maximum characteristic density of 380 kg/m^3 and for LVL a maximum characteristic density of 500 kg/m^3 shall be used in equation (8.40b) of EN 1995-1-1.

The head diameter shall be equal to or greater than $1.8 \cdot d_s$, where d_s is the smooth shank or the inner thread diameter. Otherwise the characteristic head pull-through capacity in equation (8.40b) of EN 1995-1-1 is for all wood-based materials: $F_{ax,\alpha,RK} = 0$.

For wood based panels with a thickness $12 \text{ mm} \leq t \leq 20 \text{ mm}$ the characteristic value of the head pull-through parameter for the screws is:

$f_{head,k} = 8 \text{ N/mm}^2$

For wood based panels with a thickness of less than 12 mm the characteristic head pull-through capacity for screws shall be based on a characteristic value of the head pull-through parameter of 8 N/mm^2 , and limited to 400 N complying with the minimum thickness of the wood based panels of $1.2 \cdot d$, with d as outer thread diameter and the values in Table A.2.2.

Table A.2.2 Minimum thickness of wood based panels

| Wood based panel | Minimum thickness [mm] |
|--|------------------------|
| Plywood | 6 |
| Fibreboards (hardboards and medium boards) | 6 |
| Oriented Strand Boards, OSB | 8 |
| Particleboards | 8 |
| Cement-bonded particle board | 8 |
| Solid wood Panels | 12 |

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|---|---------|
| BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws | Annex 2 |
| Characteristic values of the load-carrying capacities | |

For BM FT Quick Drill and BM DT Quick Drill screws with countersunk or wafer head the withdrawal capacity of the thread in the wood-based member with the screw head may be taken into account instead of the head pull-through capacity:

$$F_{ax,\alpha,Rk} = \max \left\{ \begin{array}{l} f_{head,k} \cdot d_h^2 \cdot \left(\frac{\rho_k}{350} \right)^{0,8} \\ \frac{f_{ax,k} \cdot d \cdot l_{ef,k}}{1,2 \cdot \cos^2 \alpha + \sin^2 \alpha} \cdot \left(\frac{\rho_k}{350} \right)^{0,8} \end{array} \right. \quad (2.3)$$

For BM FT Quick Drill and BM DT Quick Drill screws with cylinder head the withdrawal capacity of the thread in the wood-based member with the screw head may be taken into account:

$$F_{ax,\alpha,Rk} = \frac{f_{ax,k} \cdot d \cdot l_{ef,k}}{1,2 \cdot \cos^2 \alpha + \sin^2 \alpha} \cdot \left(\frac{\rho_k}{350} \right)^{0,8} \quad (2.4)$$

where

- $f_{head,k}$ characteristic value of the head pull-through capacity of the screw [N/mm²]
- $f_{ax,k}$ characteristic value of the axial withdrawal capacity of the threaded part of the screw, $f_{ax,k}$ does not apply for wood-based panels [N/mm²],
- d_h diameter of the screw head [mm],
- ρ_k characteristic density of the wood-based member with the screw head [kg/m³],
- $l_{ef,k}$ penetration length of the threaded part of the screw in the wood-based member with the screw head [mm],
 $l_{ef,k} \geq 4 \cdot d$
- α angle α between screw axis and grain direction, $30^\circ \leq \alpha \leq 90^\circ$.

Outer diameter of washer $d_k > 32$ mm shall not be considered.

In steel-to-timber connections the head pull-through capacity is not governing.

| | |
|---|---------|
| BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws | Annex 2 |
| Characteristic values of the load-carrying capacities | |

A.2.3.3 Compressive capacity of BM FT Quick Drill screws

The design axial capacity $F_{ax,Rd}$ of BM FT Quick Drill screws embedded in solid timber, glued solid timber or glued laminated timber made from softwood with an angle between screw axis and grain direction of $30^\circ \leq \alpha \leq 90^\circ$ is the minimum of the axial resistance against pushing-in and the buckling resistance of the screw.

$$F_{ax,Rd} = \min \{ f_{ax,d} \cdot d \cdot l_{ef}; \kappa_c \cdot N_{pl,d} \} \quad (2.5)$$

$f_{ax,d}$ design value of the axial withdrawal capacity of the threaded part of the screw [N/mm²]

d outer thread diameter of the screw [mm]

l_{ef} penetration length of the threaded part of the screw in the timber member [mm]

$$\kappa_c = 1 \quad \text{für } \bar{\lambda}_k \leq 0,2 \quad (2.6)$$

$$\kappa_c = \frac{1}{k + \sqrt{k^2 - \bar{\lambda}_k^2}} \quad \text{für } \bar{\lambda}_k > 0,2 \quad (2.7)$$

$$k = 0,5 \cdot \left[1 + 0,49 \cdot (\bar{\lambda}_k - 0,2) + \bar{\lambda}_k^2 \right] \quad (2.8)$$

$$\text{and a relative slenderness ratio } \bar{\lambda}_k = \sqrt{\frac{N_{pl,k}}{N_{ki,k}}} \quad (2.9)$$

where:

$N_{pl,k}$ characteristic plastic normal force related to the net cross-section

$$\text{of the inner thread diameter: } N_{pl,k} = \pi \cdot \frac{d_1^2}{4} \cdot f_{y,k} \quad (2.10)$$

$f_{y,k}$ characteristic yield strength,

$f_{y,k} = 900 \text{ N/mm}^2$ for BM FT Quick Drill screws with $d \geq 12 \text{ mm}$ and

$f_{y,k} = 1000 \text{ N/mm}^2$ for BM FT Quick Drill screws with $6 \text{ mm} \leq d \leq 10 \text{ mm}$

d_1 inner thread diameter of the screw [mm]

$$N_{pl,d} = \frac{N_{pl,k}}{\gamma_{M1}} \quad (2.11)$$

γ_{M1} partial factor according to EN 1993-1-1 in conjunction with the particular national annex

Characteristic ideal elastic buckling load:

$$N_{ki,k} = \sqrt{c_h \cdot E_s \cdot I_s} \quad [\text{N}] \quad (2.12)$$

Elastic foundation of the screw:

$$c_h = (0,19 + 0,012 \cdot d) \cdot \rho_k \cdot \left(\frac{90^\circ + \alpha}{180^\circ} \right) [\text{N/mm}^2] \quad (2.13)$$

ρ_k characteristic density of the wood-based member [kg/m³],

α angle between screw axis and grain direction, $30^\circ \leq \alpha \leq 90^\circ$

Modulus of elasticity:

$E_s = 210000 \text{ N/mm}^2$

Second moment of area:

$$I_s = \frac{\pi \cdot d_1^4}{64} \quad [\text{mm}^4] \quad (2.14)$$

| | |
|---|---------|
| BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws | Annex 2 |
| Compressive capacity | |

A.2.4 Spacing, end and edge distances of the screws and minimum thickness of the wood based material

Minimum thickness for structural members made from solid timber, glued laminated timber, glued solid timber, laminated veneer lumber and cross laminated timber is $t = 30$ mm for screws with $d \leq 8$ mm, $t = 40$ mm for screws with $d = 10$ mm and $t = 100$ mm for screws with $d \geq 12$ mm.

A.2.4.1 Laterally and/or axially loaded screws

Screws in non pre-drilled holes

For BM Quick Drill screws minimum spacing and distances are given in EN 1995-1-1:2004+AC:2006+A1:2008+A2:2014, clause 8.3.1.2 and Table 8.2 as for nails in non-predrilled holes. Here, the outer thread diameter d shall be considered.

For Douglas fir members minimum spacing and distances parallel to the grain shall be increased by 50%.

Minimum distances from loaded or unloaded ends shall be at least $15 \cdot d$ for screws with outer thread diameter $d \geq 8$ mm and timber thickness $t < 5 \cdot d$.

Minimum distances from the unloaded edge perpendicular to the grain may be reduced to $3 \cdot d$ also for timber thickness $t < 5 \cdot d$, if the spacing parallel to the grain and the end distance is at least $25 \cdot d$.

A.2.4.2 Only axially loaded screws

For BM Quick Drill screws the minimum spacings, end and edge distances are given in EN 1995-1-1:2004+AC:2006+A1:2008+A2:2014, clause 8.3.1.2 and Table 8.2 as for nails in non-predrilled holes and clause 8.7.2, Table 8.6.

A.2.5 Insertion moment

The ratio between the characteristic torsional strength $f_{tor,k}$ and the mean value of insertion moment $R_{tor,mean}$ fulfills the requirement for all screws.

A.2.6 Durability against corrosion

Screws and washers made from carbon steel may have the coatings according to Table A.2.3

Table A.2.3 Coatings of the BM Quick Drill screws

| Coating | Mean thickness of the coating [μm] |
|-------------------|---|
| electrogalvanised | 8 |

| | |
|---|---------|
| BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws | Annex 2 |
| Spacing, end and edge distances and durability against corrosion | |

ANNEX 3 - Compression reinforcement perpendicular to the grain

A.3.1 General

Only BM FT Quick Drill screws shall be used for compression reinforcement perpendicular to the grain. The provisions are valid for reinforcing timber members made from solid timber, glued solid timber or glued laminated timber made from softwood.

The compression force shall evenly be distributed to the screws used as compression reinforcement.

The screws are driven into the timber member perpendicular to the contact surface under an angle between the screw axis and the grain direction of 45° to 90°. The screw heads shall be flush with the timber surface.

A.3.2 Design

For the design of reinforced contact areas the following conditions shall be met independently of the angle between the screw axis and the grain direction.

The design resistance of a reinforced contact area is:

$$R_{90,d} = \min \left\{ k_{c,90} \cdot B \cdot \ell_{ef,1} \cdot f_{c,90,d} + n \cdot \min \{ R_{ax,d}; \kappa_c \cdot N_{pl,d} \} \right\} \quad (3.1)$$

where:

$k_{c,90}$ parameter according to EN 1995-1-1:2004 + AC:2006 + A1:2008 + A2:2014, 6.1.5

B bearing width [mm]

$\ell_{ef,1}$ effective contact length according to EN 1995-1-1:2004 + AC:2006 + A1:2008 + A2:2014, 6.1.5 [mm]

$f_{c,90,d}$ design compressive strength perpendicular to the grain [N/mm²]

n number of reinforcing screws, $n = n_0 \cdot n_{90}$

n_0 number of reinforcing screws arranged in a row parallel to the grain

n_{90} number of reinforcing screws arranged in a row perpendicular to the grain

$$R_{ax,d} = f_{ax,d} \cdot d \cdot \ell_{ef} \quad [N] \quad (3.2)$$

$f_{ax,d}$ design value of the axial withdrawal capacity of the threaded part of the screw [N/mm²]

d outer thread diameter of the screw [mm]

κ_c according to Annex A.2.3.3

$N_{pl,d}$ according to Annex A.2.3.3 [N]

$\ell_{ef,2}$ effective contact length in the plane of the screw tips (see Figure 3.1) [mm]

$\ell_{ef,2} = \{ \ell_{ef} + (n_0 - 1) \cdot a_1 + \min(\ell_{ef}; a_{1,c}) \}$ for end supports (see Figure 3.1 left)

$\ell_{ef,2} = \{ 2 \cdot \ell_{ef} + (n_0 - 1) \cdot a_1 \}$ for intermediate supports (see Figure 3.1 right)

ℓ_{ef} threaded length of the screw in the timber member [mm]

a_1 Spacing a_1 in a plane parallel to grain, see chapter A.2.4.2 [mm]

$a_{1,CG}$ End distance of the centre of gravity of the threaded part in the timber member, see chapter A.2.4.2 [mm]

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill
and BM FT Quick Drill screws

Compression reinforcement perpendicular to the grain

Annex 3

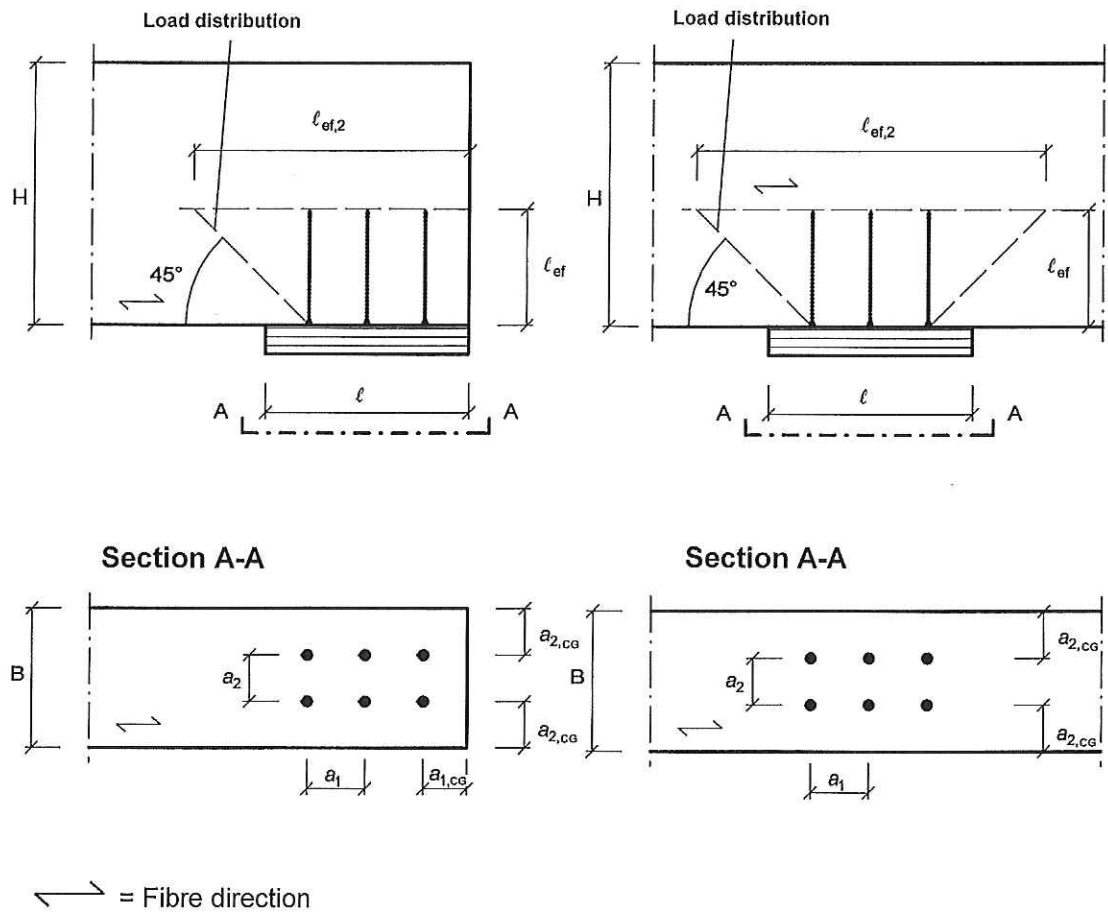


Figure A.3.1: Reinforced end support (left) and reinforced intermediate support (right)

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill
and BM FT Quick Drill screws

Compression reinforcement perpendicular to the grain

Annex 3

ANNEX 4 - Fastening of thermal insulation material on top of rafters

A.4.1 General

BM Quick Drill screws may be used for the fixing of thermal insulation material on top of rafters or on wood-based members in vertical façades. In the following, the meaning of the word rafter includes wood-based members with inclinations between 0° and 90°.

The thickness of the thermal insulation material may be up to 300 mm. The thermal insulation material shall be applicable as insulation on top of rafters or for façades according to national provisions that apply at the installation site.

The battens have to be from solid timber according to EN 338/ EN 14081-1. The minimum thickness t and the minimum width b of the battens are given in table A.4.1:

Table A.4.1 Minimum thickness and minimum width of the battens

| Outer thread diameter [mm] | Minimum thickness t [mm] | Minimum width b [mm] |
|-------------------------------|-------------------------------|---------------------------|
| 6 and 8 | 30 | 50 |
| 10 | 40 | 60 |
| 12, 13 and 14 | 80 | 100 |

Instead of battens the wood-based panels specified in chapter A.4.2.1 may be used. Only screws with countersunk head shall be used for fixing wood-based panels on rafters with thermal insulation material as interlayer.

The minimum width of the rafters shall be 60 mm.

The spacing between screws shall be not more than 1.75 m.

Friction forces shall not be considered for the design of the characteristic axial load of the screws.

The anchorage of wind suction forces as well as the bending stresses of the battens shall be considered for design. Screws perpendicular to the grain of the rafter (angle $\alpha = 90^\circ$) may be arranged where required considering the design of the battens.

A.4.2 Parallel inclined screws and thermal insulation material in compression

A.4.2.1 Mechanical model

The system of rafter, thermal insulation material on top of rafter and counter battens parallel to the rafter may be considered as a beam on elastic foundation. The counter batten represents the beam, and the thermal insulation material on top of the rafter the elastic foundation. The minimum compressive stress of the thermal insulation material at 10 % deformation, measured according to EN 826¹³, shall be $\sigma_{(10\%)} = 0.05 \text{ N/mm}^2$. The counter batten is loaded perpendicular to the axis by point loads F_b transferred by regularly spaced battens. Further point loads F_s are caused by the shear load of the roof due to dead and snow load, which are transferred from the screw heads into the counter battens.

Instead of battens the following wood-based panels may be used to cover the thermal insulation material if they are suitable for that use:

- Plywood according to EN 636 and EN 13986,
- Oriented Strand Board, OSB according to EN 300 and EN 13986,
- Particleboard according to EN 312 and EN 13986
- Fibreboards according to EN 622-2, EN 622-3 and EN 13986.

The minimum thickness of the wood-based panels shall be 22 mm.

The word batten includes the meaning of wood-based panels in the following.

¹³ EN 826:2013 Thermal insulating products for building applications - Determination of compression behaviour

| | |
|---|---------|
| BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws | Annex 4 |
| Fastening of thermal insulation material on top of rafters | |

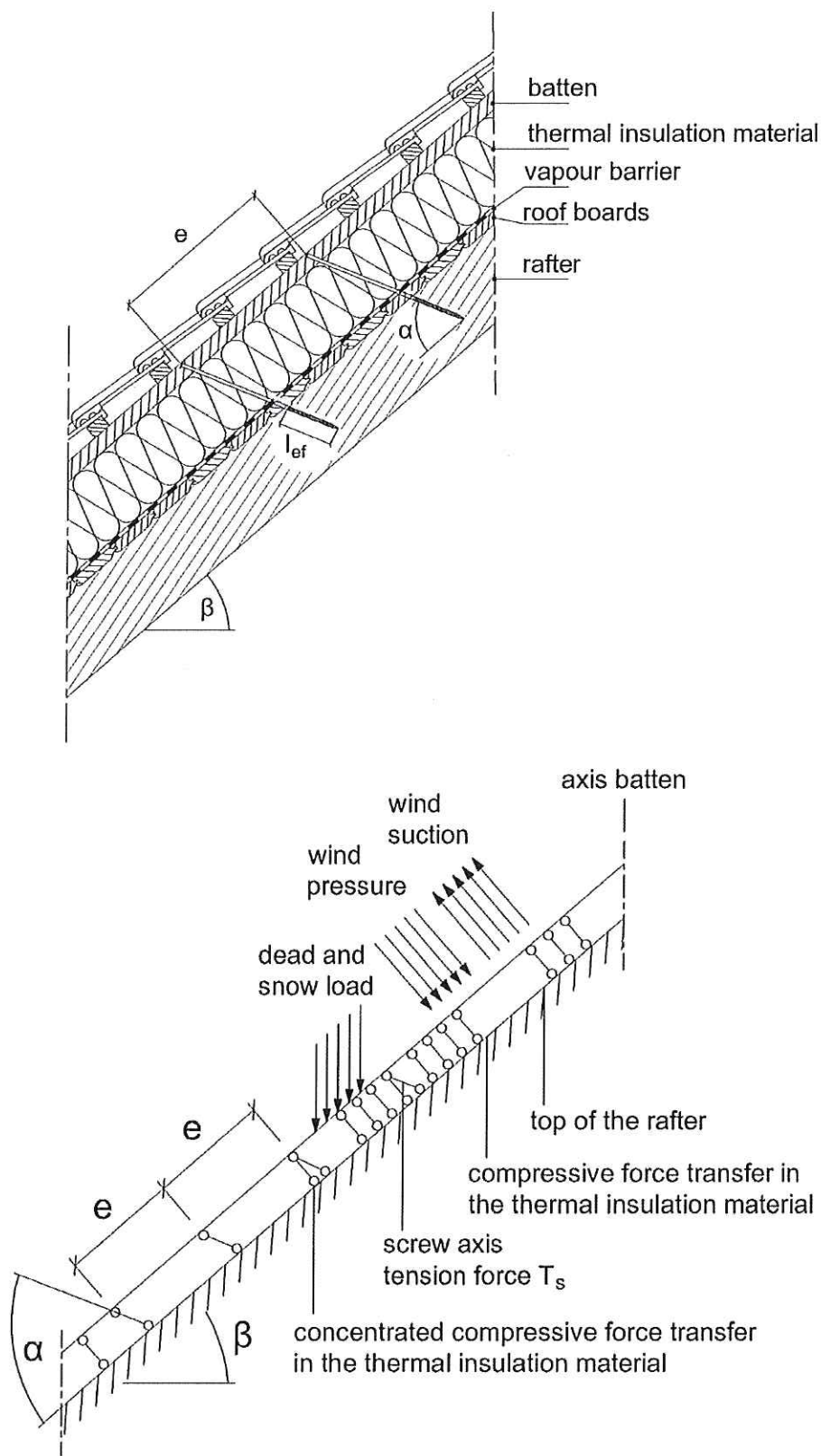


Figure A.4.1 Fastening of the thermal insulation material on top of rafters - structural system

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill
and BM FT Quick Drill screws

Fastening of thermal insulation material on top of rafters

Annex 4

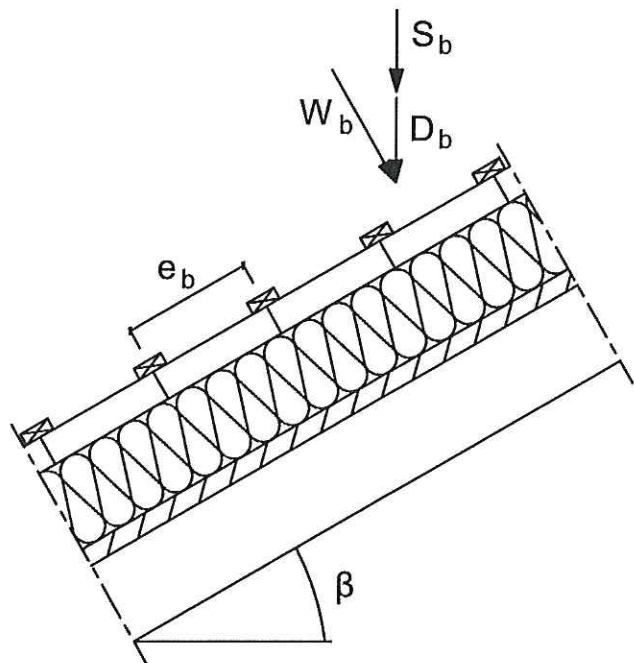


Figure A.4.2 Point loads F_b perpendicular to the battens

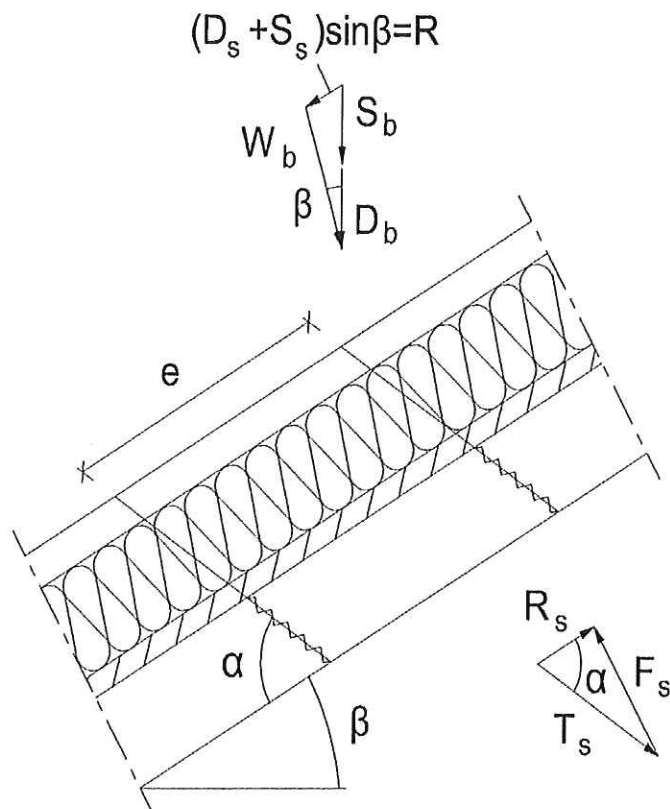


Figure A.4.3 Point loads F_s perpendicular to the battens, load application in the area of the screw heads

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill
and BM FT Quick Drill screws

Fastening of thermal insulation material on top of rafters

Annex 4

A.4.2.2 Design of the battens

It's assumed that the spacing between the counter battens exceeds the characteristic length l_{char} .

The characteristic values of the bending stresses are calculated as:

$$M_k = \frac{(F_b + F_s) \cdot l_{char}}{4} \quad (4.1)$$

where

$$l_{char} = \text{characteristic length } l_{char} = \sqrt[4]{\frac{4 \cdot EI}{w_{ef} \cdot K}} \quad (4.2)$$

EI = bending stiffness of the batten

K = coefficient of subgrade

w_{ef} = effective width of the thermal insulation material

$F_{b,k}$ = point loads perpendicular to the battens

$F_{s,k}$ = point loads perpendicular to the battens, load application in the area of the screw heads

The coefficient of subgrade K may be calculated from the modulus of elasticity E_{HI} and the thickness t_{HI} of the thermal insulation material if the effective width w_{ef} of the thermal insulation material under compression is known. Due to the load extension in the thermal insulation material the effective width w_{ef} is greater than the width of the batten or rafter, respectively. For further calculations, the effective width w_{ef} of the thermal insulation material may be determined according to:

$$w_{ef} = w + t_{HI} / 2 \quad (4.3)$$

where

w = minimum from width of the batten or rafter, respectively

t_{HI} = thickness of the thermal insulation material

$$K = \frac{E_{HI}}{t_{HI}} \quad (4.4)$$

The following condition shall be satisfied:

$$\frac{\sigma_{m,d}}{f_{m,d}} = \frac{M_d}{W \cdot f_{m,d}} \leq 1 \quad (4.5)$$

For the calculation of the section modulus W the net cross section shall be considered.

The characteristic values of the shear stresses shall be calculated according to:

$$V_k = \frac{(F_b + F_s)}{2} \quad (4.6)$$

The following condition need to be satisfied:

$$\frac{\tau_d}{f_{v,d}} = \frac{1.5 \cdot V_d}{A \cdot f_{v,d}} \leq 1 \quad (4.7)$$

For the calculation of the cross section area the net cross section shall be considered.

| | |
|---|---------|
| BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws | Annex 4 |
| Fastening of thermal insulation material on top of rafters | |

A.4.2.3 Design of the thermal insulation material

The characteristic value of the compressive stresses in the thermal insulation material shall be calculated according to:

$$\sigma_k = \frac{1.5 \cdot F_{b,k} + F_{s,k}}{2 \cdot l_{char} \cdot w} \quad (4.8)$$

The design value of the compressive stress shall not be greater than 110 % of the compressive strength at 10 % deformation calculated according to EN 826.

A.4.2.4 Design of the screws

The screws are loaded predominantly axial. The characteristic value of the axial tension force in the screw may be calculated from the shear loads of the roof R_s :

$$T_{S,k} = \frac{R_{S,k}}{\cos \alpha} \quad (4.9)$$

The load-carrying capacity of axially loaded screws is the minimum design value of the axial withdrawal capacity of the threaded part of the screw, the head pull-through capacity of the screw and the tensile capacity of the screw according to Annex 2.

In order to limit the deformation of the screw head for thermal insulation material with thickness over 220 mm or with compressive strength below 0.12 N/mm², respectively, the axial withdrawal capacity of the screws shall be reduced by the factors k_1 and k_2 :

$$F_{ax,\alpha,Rd} = \min \left\{ \frac{f_{ax,d} \cdot d \cdot l_{ef} \cdot k_1 \cdot k_2}{1.2 \cdot \cos^2 \alpha + \sin^2 \alpha} \cdot \left(\frac{\rho_k}{350} \right)^{0.8}; f_{head,d} \cdot d_h^2 \cdot \left(\frac{\rho_k}{350} \right)^{0.8}; \frac{f_{tens,k}}{\gamma_{M2}} \right\} \quad (4.10)$$

where:

| | |
|-----------------|---|
| $f_{ax,d}$ | design value of the axial withdrawal parameter of the threaded part of the screw [N/mm ²] |
| d | outer thread diameter of the screw [mm] |
| l_{ef} | penetration length of the threaded part of the screw in the rafter [mm], 40 mm $\geq l_{ef} \geq$ 100 mm |
| ρ_k | characteristic density of the wood-based member [kg/m ³], for LVL the assumed characteristic density shall not exceed 500 kg/m ³ |
| α | angle α between screw axis and grain direction, 30° $\leq \alpha \leq$ 90° |
| $f_{head,d}$ | design value of the head pull-through parameter of the screw [N/mm ²] |
| d_h | head diameter of the screw [mm] |
| $f_{tens,k}$ | characteristic tensile capacity of the screw according to Annex 2 [N] |
| γ_{M2} | partial factor according to EN 1993-1-1 in conjunction with the particular national annex |
| k_1 | $\min \{1; 220/t_{HI}\}$ |
| k_2 | $\min \{1; \sigma_{10\%}/0.12\}$ |
| t_{HI} | thickness of the thermal insulation material [mm] |
| $\sigma_{10\%}$ | compressive stress of the thermal insulation material under 10 % deformation [N/mm ²] |

If equation (4.10) is fulfilled, the deflection of the battens does not need to be considered when designing the load-carrying capacity of the screws.

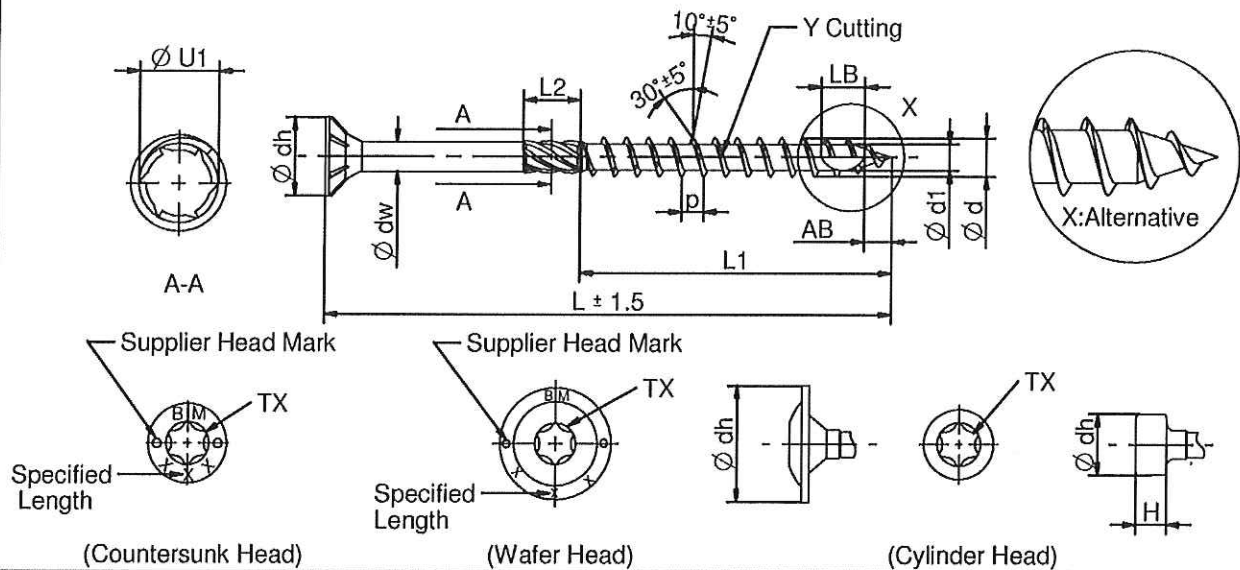
| | |
|---|---------|
| BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws | Annex 4 |
| Fastening of thermal insulation material on top of rafters | |

| | | | | | | | | | |
|--|------------|--------|--------|--------|--------|--------|---------|--------|-------|
| | | | | | | | | | |
| <p>(Countersunk Head) (Wafer Head) (Cylinder Head)</p> | | | | | | | | | |
| Nominal Diameter | Ø 6.0 | | Ø 8.0 | | Ø 10.0 | | Ø 12.0 | | |
| Ødh (Countersunk Head) | Upper Tol. | 12.0 | +0 | 15.0 | +0 | 18.5 | +0 | 21.5 | +0 |
| | Lower Tol. | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| Ødh (Wafer Head) | Upper Tol. | 15.0 | +1.0 | 22.0 | +1.0 | 25.0 | +1.0 | 29.0 | +1.0 |
| | Lower Tol. | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| Ødh (Cylinder Head) | Upper Tol. | 8.0 | +0 | 11.0 | +0 | 13.0 | +0 | 15.0 | +0 |
| | Lower Tol. | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| H (Cylinder Head) | Upper Tol. | 5.0 | +0.5 | 6.0 | +0.5 | 7.0 | +0.5 | 8.0 | +0.5 |
| | Lower Tol. | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| Ødw | Upper Tol. | 4.25 | +0.05 | 5.8 | +0.05 | 7.0 | +0.05 | 8.0 | +0.05 |
| | Lower Tol. | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 |
| Ød | Upper Tol. | 6.0 | +0.2 | 8.0 | +0.2 | 10.0 | +0.3 | 12.0 | +0.3 |
| | Lower Tol. | -0.2 | -0.2 | -0.2 | -0.2 | -0.3 | -0.3 | -0.3 | -0.3 |
| Ød1 | Upper Tol. | 4.0 | +0.2 | 5.2 | +0.25 | 6.2 | +0.3 | 7.0 | +0.3 |
| | Lower Tol. | -0.2 | -0.2 | -0.25 | -0.25 | -0.3 | -0.3 | -0.3 | -0.3 |
| ØU1 | Upper Tol. | 5.1 | +0.3 | 7.0 | +0.3 | 8.5 | +0.3 | 8.8 | +0.3 |
| | Lower Tol. | -0.3 | -0.3 | -0.3 | -0.3 | -0.3 | -0.3 | -0.3 | -0.3 |
| LB | Upper Tol. | 17.0 | +3.0 | 18.0 | +3.0 | 19.0 | +3.0 | 20.0 | +3.0 |
| | Lower Tol. | -3.0 | -3.0 | -3.0 | -3.0 | -3.0 | -3.0 | -3.0 | -3.0 |
| AB | Upper Tol. | 4.0 | +2.0 | 6.0 | +2.0 | 7.0 | +2.0 | 8.0 | +2.0 |
| | Lower Tol. | -2.0 | -2.0 | -2.0 | -2.0 | -2.0 | -2.0 | -2.0 | -2.0 |
| p ±10% | L1 < 180 | 3.3 | 5.2 | | 5.6 | | 6.0 | | |
| | L1 ≥ 180 | 4.5 | | | | | | | |
| TX | T30 | | T40 | | T50 | | T50 | | |
| L | L1 | L2 | L1 | L2 | L1 | L2 | L1 | L2 | |
| 40 mm | 32±1.5 | | 32±1.5 | | | | | | |
| 50 mm | 42±1.5 | | 42±1.5 | | | | | | |
| 60~70 mm | 52±1.5 | | 52±1.5 | | | | | | |
| 80~120 mm in 10 mm increments | 52±1.5 | 12±1.5 | 52±1.5 | 12±1.5 | 52±1.5 | 12±1.5 | | | |
| 130~200 mm in 10 mm increments | 75±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | |
| 220~300 mm in 20 mm increments | 75±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | |
| 320~440 mm in 20 mm increments | | | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | |
| 460~500 mm in 20 mm increments | | | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 120±1.5 | 12±1.5 | |
| 520~600 mm in 20 mm increments | | | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 120±1.5 | 12±1.5 | |

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill
and BM FT Quick Drill screws

BM Quick Drill screws

Annex 5.1

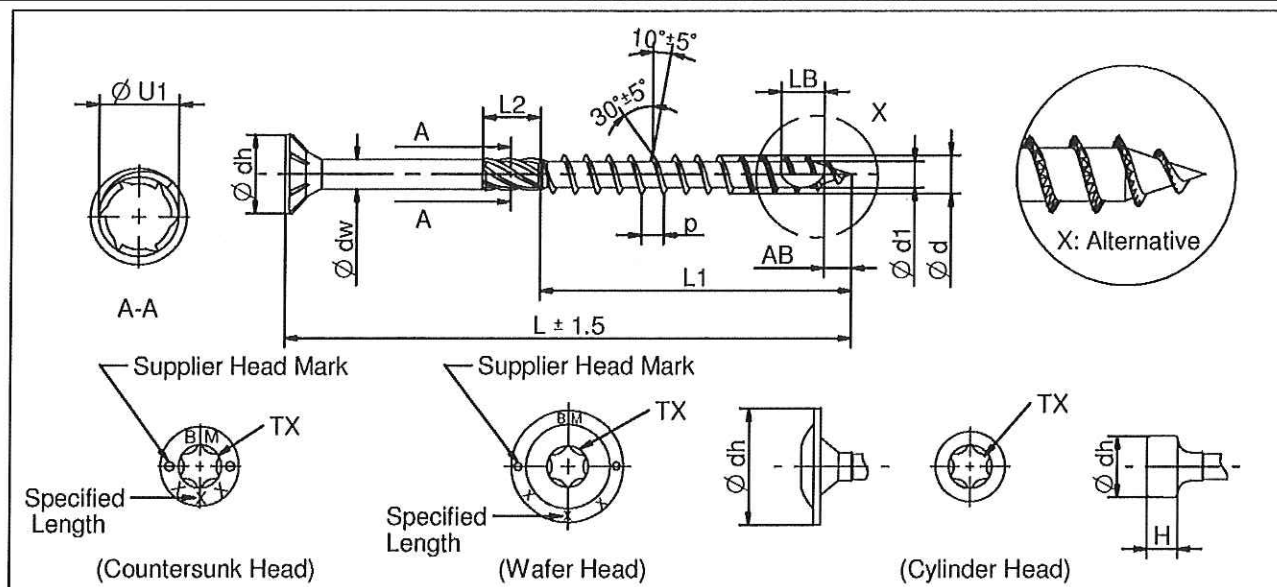


| Nominal Diameter | Ø 6.0 | | Ø 8.0 | | Ø 10.0 | | Ø 12.0 | |
|--------------------------------|------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Ødh (Countersunk Head) | Upper Tol. | 12.0 +0 | 15.0 +0 | 15.0 +0 | 18.5 +0 | 18.5 +0 | 21.5 +0 | 21.5 +0 |
| | Lower Tol. | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| Ødh (Wafer Head) | Upper Tol. | 15.0 +1.0 | 22.0 +1.0 | 22.0 +1.0 | 25.0 +1.0 | 25.0 +1.0 | 29.0 +1.0 | 29.0 +1.0 |
| | Lower Tol. | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| Ødh (Cylinder Head) | Upper Tol. | 8.0 +0 | 11.0 +0 | 11.0 +0 | 13.0 +0 | 13.0 +0 | 15.0 +0 | 15.0 +0 |
| | Lower Tol. | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| H (Cylinder Head) | Upper Tol. | 5.0 +0.5 | 6.0 +0.5 | 6.0 +0.5 | 7.0 +0.5 | 7.0 +0.5 | 8.0 +0.5 | 8.0 +0.5 |
| | Lower Tol. | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| Ødw | Upper Tol. | 4.25 +0.05 | 5.8 +0.05 | 5.8 +0.05 | 7.0 +0.05 | 7.0 +0.05 | 8.0 +0.05 | 8.0 +0.05 |
| | Lower Tol. | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 | -0.05 |
| Ød | Upper Tol. | 6.0 +0.2 | 8.0 +0.2 | 8.0 +0.2 | 10.0 +0.2 | 10.0 +0.2 | 12.0 +0.2 | 12.0 +0.2 |
| | Lower Tol. | -0.2 | -0.2 | -0.2 | -0.3 | -0.3 | -0.3 | -0.3 |
| Ød1 | Upper Tol. | 4.0 +0.2 | 5.2 +0.25 | 5.2 +0.25 | 6.2 +0.3 | 6.2 +0.3 | 7.0 +0.3 | 7.0 +0.3 |
| | Lower Tol. | -0.2 | -0.25 | -0.25 | -0.3 | -0.3 | -0.3 | -0.3 |
| ØU1 | Upper Tol. | 5.1 +0.3 | 7.0 +0.3 | 7.0 +0.3 | 8.5 +0.3 | 8.5 +0.3 | 8.8 +0.3 | 8.8 +0.3 |
| | Lower Tol. | -0.3 | -0.3 | -0.3 | -0.3 | -0.3 | -0.3 | -0.3 |
| LB | Upper Tol. | 17.0 +3.0 | 18.0 +3.0 | 18.0 +3.0 | 19.0 +3.0 | 19.0 +3.0 | 20.0 +3.0 | 20.0 +3.0 |
| | Lower Tol. | -3.0 | -3.0 | -3.0 | -3.0 | -3.0 | -3.0 | -3.0 |
| AB | Upper Tol. | 4.0 +2.0 | 6.0 +2.0 | 6.0 +2.0 | 7.0 +2.0 | 7.0 +2.0 | 8.0 +2.0 | 8.0 +2.0 |
| | Lower Tol. | -2.0 | -2.0 | -2.0 | -2.0 | -2.0 | -2.0 | -2.0 |
| p ±10% | L1 < 180 | 3.3 | 5.2 | | 5.6 | | 6.0 | |
| | L1 ≥ 180 | 4.5 | | | | | | |
| TX | T30 | | T40 | | T50 | | T50 | |
| L | L1 | L2 | L1 | L2 | L1 | L2 | L1 | L2 |
| 40 mm | 32±1.5 | | 32±1.5 | | | | | |
| 50 mm | 42±1.5 | | 42±1.5 | | | | | |
| 60~70 mm | 52±1.5 | | 52±1.5 | | | | | |
| 80~120 mm in 10 mm increments | 52±1.5 | 12±1.5 | 52±1.5 | 12±1.5 | 52±1.5 | 12±1.5 | | |
| 130~200 mm in 10 mm increments | 75±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 |
| 220~300 mm in 20 mm increments | 75±1.5 | 12±1.5 | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 |
| 320~400 mm in 20 mm increments | | | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 |
| 420~500 mm in 20 mm increments | | | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 | 120±1.5 | 12±1.5 |
| 520~600 mm in 20 mm increments | | | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 | 120±1.5 | 12±1.5 |

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill
and BM FT Quick Drill screws

BM Quick Drill + screws

Annex 5.2

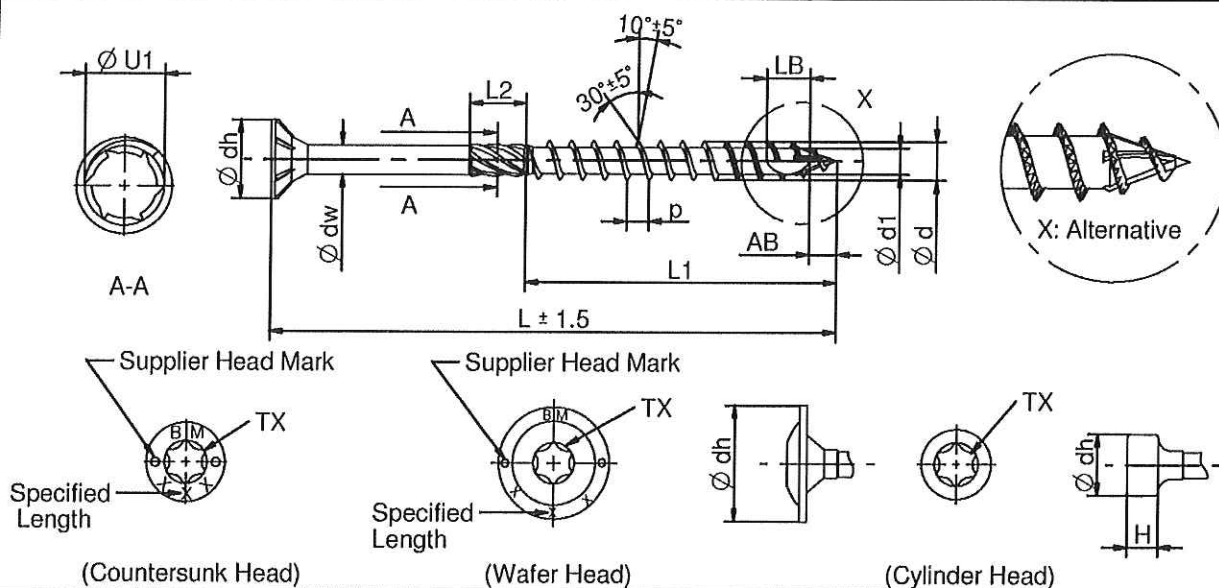


| Nominal Diameter | | Ø 6.0 | | Ø 8.0 | | Ø 10.0 | |
|------------------------|---------------------|--------|--------|--------|--------|--------|--------|
| Ødh (Countersunk Head) | Upper Tol. | 12.0 | +0 | 15.0 | +0 | 18.5 | +0 |
| | Lower Tol. | | -1.0 | | -1.0 | | -1.0 |
| Ødh (Wafer Head) | Upper Tol. | 15.0 | +1.0 | 22.0 | +1.0 | 25.0 | +1.0 |
| | Lower Tol. | | -1.0 | | -1.0 | | -1.0 |
| Ødh (Cylinder Head) | Upper Tol. | 8.0 | +0 | 11.0 | +0 | 13.0 | +0 |
| | Lower Tol. | | -1.0 | | -1.0 | | -1.0 |
| H (Cylinder Head) | Upper Tol. | 5.0 | +0.5 | 6.0 | +0.5 | 7.0 | +0.5 |
| | Lower Tol. | | -0.5 | | -0.5 | | -0.5 |
| Ødw | Upper Tol. | 4.25 | +0.05 | 5.8 | +0.05 | 7.0 | +0.05 |
| | Lower Tol. | | -0.05 | | -0.05 | | -0.05 |
| Ød | Upper Tol. | 6.0 | +0.2 | 8.0 | +0.2 | 10.0 | +0.3 |
| | Lower Tol. | | -0.2 | | -0.2 | | -0.3 |
| Ød1 | Upper Tol. | 4.0 | +0.2 | 5.2 | +0.25 | 6.2 | +0.3 |
| | Lower Tol. | | -0.2 | | -0.25 | | -0.3 |
| ØU1 | Upper Tol. | 5.1 | +0.3 | 7.0 | +0.3 | 8.5 | +0.3 |
| | Lower Tol. | | -0.3 | | -0.3 | | -0.3 |
| LB | Upper Tol. | 17.0 | +3.0 | 18.0 | +3.0 | 19.0 | +3.0 |
| | Lower Tol. | | -3.0 | | -3.0 | | -3.0 |
| AB | Upper Tol. | 4.0 | +2.0 | 6.0 | +2.0 | 7.0 | +2.0 |
| | Lower Tol. | | -2.0 | | -2.0 | | -2.0 |
| p ±10% | | L1<180 | 3.3 | 5.2 | | 5.6 | |
| | | L1≥180 | 4.5 | | | | |
| TX | | T30 | | T40 | | T50 | |
| L | | L1 | L2 | L1 | L2 | L1 | L2 |
| 40 mm | | 32±1.5 | | 32±1.5 | | | |
| 50 mm | | 42±1.5 | | 42±1.5 | | | |
| 60~70 mm | | 52±1.5 | | 52±1.5 | | | |
| 80~120 mm | in 10 mm increments | 52±1.5 | 12±1.5 | 52±1.5 | 12±1.5 | 52±1.5 | 12±1.5 |
| 130~200 mm | in 10 mm increments | 75±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 |
| 220~300 mm | in 20 mm increments | 75±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 |
| 320~400 mm | in 20 mm increments | | | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 |
| 420~500 mm | in 20 mm increments | | | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 |
| 520~600 mm | in 20 mm increments | | | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 |

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws

BM Quick Drill II screws

Annex 5.3

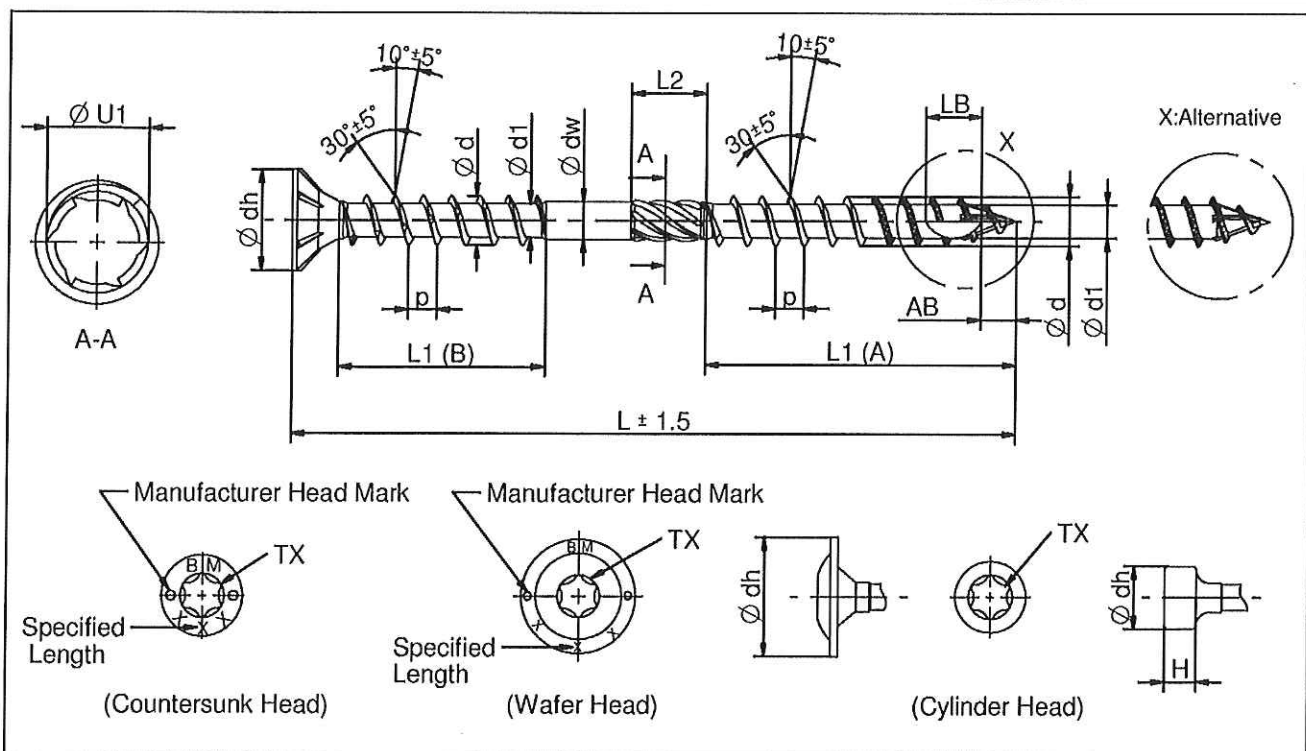


| Nominal Diameter | | Ø 6.0 | | Ø 8.0 | | Ø 10.0 | | Ø 12.0 | |
|------------------------|--------------------------|--------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| Ødh (Countersunk Head) | Upper Tol. Lower Tol. | 12.0 | +0 - 1.0 | 15.0 | +0 - 1.0 | 18.5 | +0 - 1.0 | 21.5 | +0 - 1.0 |
| Ødh (Wafer Head) | Upper Tol. Lower Tol. | 15.0 | +1.0 - 1.0 | 22.0 | +1.0 - 1.0 | 25.0 | +1.0 - 1.0 | 29.0 | +1.0 - 1.0 |
| Ødh (Cylinder Head) | Upper Tol. Lower Tol. | 8.0 | +0 - 1.0 | 11.0 | +0 - 1.0 | 13.0 | +0 - 1.0 | 15.0 | +0 - 1.0 |
| H (Cylinder Head) | Upper Tol. Lower Tol. | 5.0 | +0.5 - 0.5 | 6.0 | +0.5 - 0.5 | 7.0 | +0.5 - 0.5 | 8.0 | +0.5 - 0.5 |
| Ødw | Upper Tol. Lower Tol. | 4.25 | +0.05 - 0.05 | 5.8 | +0.05 - 0.05 | 7.0 | +0.05 - 0.05 | 8.0 | +0.05 - 0.05 |
| Ød | Upper Tol. Lower Tol. | 6.0 | +0.2 - 0.2 | 8.0 | +0.2 - 0.2 | 10.0 | +0.3 - 0.3 | 12.0 | +0.3 - 0.3 |
| Ød1 | Upper Tol. Lower Tol. | 4.0 | +0.2 - 0.2 | 5.2 | +0.25 - 0.25 | 6.2 | +0.3 - 0.3 | 7.0 | +0.3 - 0.3 |
| ØU1 | Upper Tol. Lower Tol. | 5.1 | +0.3 - 0.3 | 7.0 | +0.3 - 0.3 | 8.5 | +0.3 - 0.3 | 8.8 | +0.3 - 0.3 |
| LB | Upper Tol. Lower Tol. | 17.0 | +3.0 - 3.0 | 18.0 | +3.0 - 3.0 | 19.0 | +3.0 - 3.0 | 20.0 | +3.0 - 3.0 |
| AB | Upper Tol. Lower Tol. | 4.0 | +2.0 - 2.0 | 6.0 | +2.0 - 2.0 | 7.0 | +2.0 - 2.0 | 8.0 | +2.0 - 2.0 |
| p ±10% | | L1<180 | 3.3 | 5.2 | | 5.6 | | 6.0 | |
| | | L1≥180 | 4.5 | | | | | | |
| TX | | T30 | | T40 | | T50 | | T50 | |
| L | | L1 | L2 | L1 | L2 | L1 | L2 | L1 | L2 |
| 40 mm | | 32±1.5 | | 32±1.5 | | | | | |
| 50 mm | | 42±1.5 | | 42±1.5 | | | | | |
| 60 ~ 70 mm | | 52±1.5 | | 52±1.5 | | | | | |
| 80~120 mm | in 10 mm increments | 52±1.5 | 12±1.5 | 52±1.5 | 12±1.5 | 52±1.5 | 12±1.5 | | |
| 130~200 mm | in 10 mm increments | 75±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 | 80±1.5 | 12±1.5 |
| 220~300 mm | in 20 mm increments | 75±1.5 | 12±1.5 | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 |
| 320~400 mm | in 20 mm increments | | | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 |
| 420~500 mm | in 20 mm increments | | | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 | 120±1.5 | 12±1.5 |
| 520~600 mm | in 20 mm increments | | | 100±1.5 | 12±1.5 | 100±1.5 | 12±1.5 | 120±1.5 | 12±1.5 |

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws

BM Quick Drill III screws

Annex 5.4

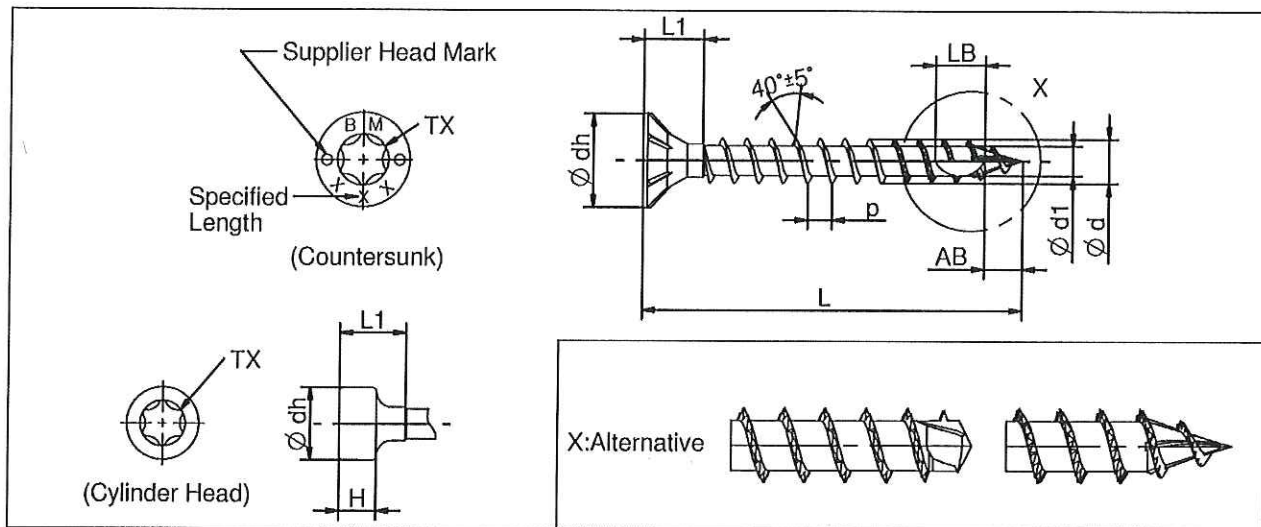


| Nominal Diameter | $\varnothing 6.0$ | | | $\varnothing 8.0$ | | | $\varnothing 10.0$ | | |
|-------------------------------------|-------------------|----------|----------|-------------------|----------|----------|--------------------|----------|----------|
| $\varnothing dh$ (Countersunk Head) | Upper Tol. | 12.0 | +0 | 15.0 | +0 | 18.5 | +0 | | |
| | Lower Tol. | | -1.0 | | -1.0 | | -1.0 | | |
| $\varnothing dh$ (Wafer Head) | Upper Tol. | 15.0 | +1.0 | 22.0 | +1.0 | 25.0 | +1.0 | | |
| | Lower Tol. | | -1.0 | | -1.0 | | -1.0 | | |
| $\varnothing dh$ (Cylinder Head) | Upper Tol. | 8.0 | +0 | 11.0 | +0 | 13.0 | +0 | | |
| | Lower Tol. | | -1.0 | | -1.0 | | -1.0 | | |
| H (Cylinder Head) | Upper Tol. | 5.0 | +0.5 | 6.0 | +0.5 | 7.0 | +0.5 | | |
| | Lower Tol. | | -0.5 | | -0.5 | | -0.5 | | |
| $\varnothing dw$ | Upper Tol. | 4.25 | +0.05 | 5.8 | +0.05 | 7.0 | +0.05 | | |
| | Lower Tol. | | -0.05 | | -0.05 | | -0.05 | | |
| $\varnothing d$ | Upper Tol. | 6.0 | +0.2 | 8.0 | +0.2 | 10.0 | +0.3 | | |
| | Lower Tol. | | -0.2 | | -0.2 | | -0.3 | | |
| $\varnothing d1$ | Upper Tol. | 4.0 | +0.2 | 5.2 | +0.25 | 6.2 | +0.3 | | |
| | Lower Tol. | | -0.2 | | -0.25 | | -0.3 | | |
| $\varnothing U1$ | Upper Tol. | 5.1 | +0.3 | 7.0 | +0.3 | 8.5 | +0.3 | | |
| | Lower Tol. | | -0.3 | | -0.3 | | -0.3 | | |
| LB | Upper Tol. | 17.0 | +3.0 | 18.0 | +3.0 | 19.0 | +3.0 | | |
| | Lower Tol. | | -3.0 | | -3.0 | | -3.0 | | |
| AB | Upper Tol. | 4.0 | +0.2 | 6.0 | +0.2 | 7.0 | +0.2 | | |
| | Lower Tol. | | -0.2 | | -0.2 | | -0.2 | | |
| $p \pm 10\%$ | $L1 < 180$ | | | 5.2 | | | 5.6 | | |
| | $L1 \geq 180$ | | | | | | | | |
| TX | T30 | | | T40 | | | T50 | | |
| L | L1 (A) | L1 (B) | L2 | L1 (A) | L1 (B) | L2 | L1 (A) | L1 (B) | L2 |
| 165~200 mm | 75 ± 1.5 | 60 ± 1.5 | 12 ± 1.5 | 80 ± 1.5 | 60 ± 1.5 | 12 ± 1.5 | 80 ± 1.5 | 60 ± 1.5 | 12 ± 1.5 |
| 201~300 mm | 75 ± 1.5 | 60 ± 1.5 | 12 ± 1.5 | 100 ± 1.5 | 60 ± 1.5 | 12 ± 1.5 | 100 ± 1.5 | 60 ± 1.5 | 12 ± 1.5 |
| 301~400 mm | | | | 100 ± 1.5 | 60 ± 1.5 | 12 ± 1.5 | 100 ± 1.5 | 60 ± 1.5 | 12 ± 1.5 |
| 401~500 mm | | | | 100 ± 1.5 | 60 ± 1.5 | 12 ± 1.5 | 100 ± 1.5 | 60 ± 1.5 | 12 ± 1.5 |
| 501~600 mm | | | | | | | 100 ± 1.5 | 60 ± 1.5 | 12 ± 1.5 |

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill and BM FT Quick Drill screws

BM DT Quick Drill screws

Annex 5.5

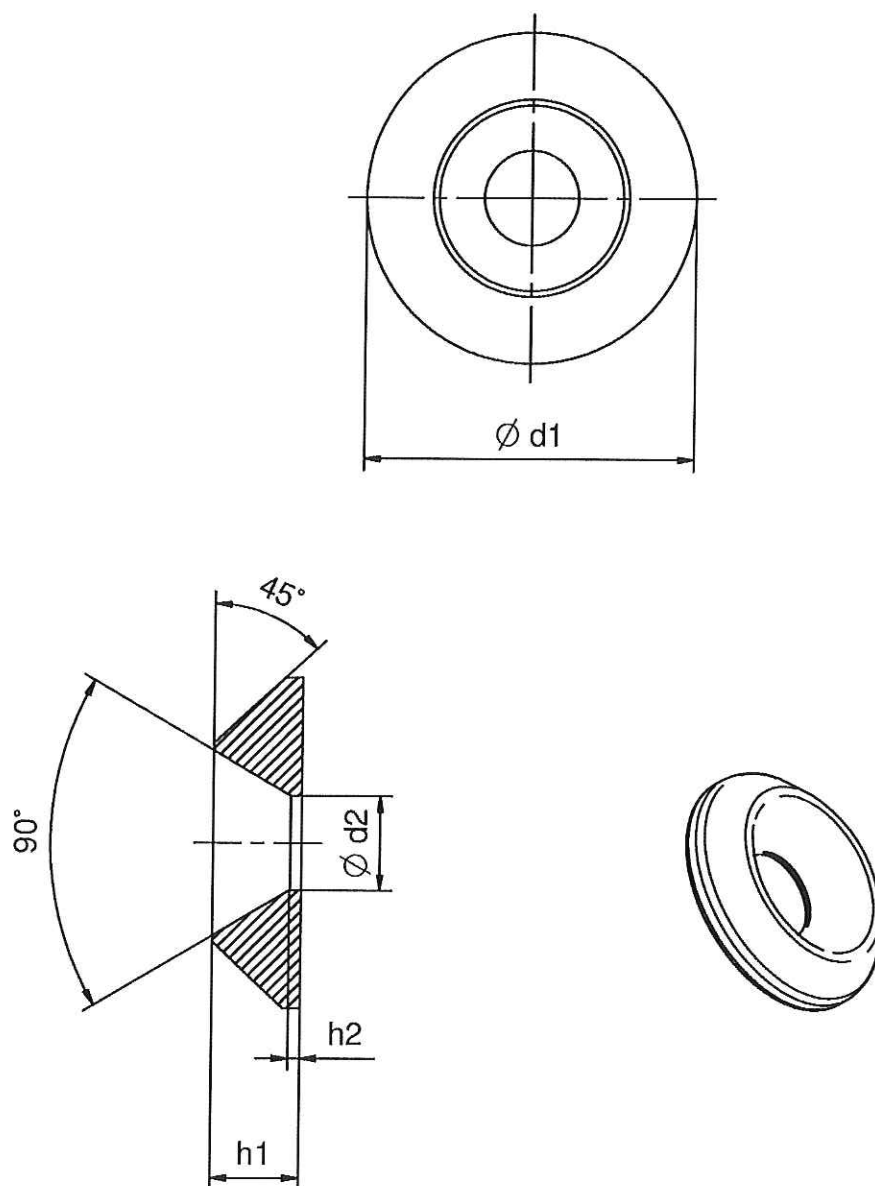


| Nominal Diameter | Ø 6.0 | Ø 8.0 | Ø 10.0 | Ø 12.0 | Ø 13.0 | Ø 14.0 |
|--|---|--|---|---|---|---|
| Ødh (Countersunk Head) | Upper Tol. 12.0 +0 Lower Tol. -1.0 | Upper Tol. 15.0 +0 Lower Tol. -1.0 | Upper Tol. 18.5 +0 Lower Tol. -1.0 | Upper Tol. 21.5 +0 Lower Tol. -1.0 | Upper Tol. 22.0 +0 Lower Tol. -1.0 | Upper Tol. 22.5 +0 Lower Tol. -1.0 |
| Ødh (Cylinder Head) | Upper Tol. 8.0 +0 Lower Tol. -1.0 | Upper Tol. 11.0 +0 Lower Tol. -1.0 | Upper Tol. 13.0 +0 Lower Tol. -1.0 | Upper Tol. 15.0 +0 Lower Tol. -1.0 | Upper Tol. 15.0 +0 Lower Tol. -1.0 | Upper Tol. 15.0 +0 Lower Tol. -1.0 |
| H (Cylinder Head) | Upper Tol. 5.0 +0.5 Lower Tol. -0.5 | Upper Tol. 6.0 +0.5 Lower Tol. -0.5 | Upper Tol. 7.0 +0.5 Lower Tol. -0.5 | Upper Tol. 8.0 +0.5 Lower Tol. -0.5 | Upper Tol. 9.0 +0.5 Lower Tol. -0.5 | Upper Tol. 10.0 +0.5 Lower Tol. -0.5 |
| Ød | Upper Tol. 6.0 +0.2 Lower Tol. -0.2 | Upper Tol. 8.0 +0.2 Lower Tol. -0.2 | Upper Tol. 10.0 +0.2 Lower Tol. -0.2 | Upper Tol. 12.0 +0.2 Lower Tol. -0.2 | Upper Tol. 13.0 +0.2 Lower Tol. -0.2 | Upper Tol. 14.0 +0.2 Lower Tol. -0.2 |
| Ød1 | Upper Tol. 4.0 +0.2 Lower Tol. -0.2 | Upper Tol. 5.2 +0.25 Lower Tol. -0.25 | Upper Tol. 6.2 +0.3 Lower Tol. -0.3 | Upper Tol. 7.0 +0.3 Lower Tol. -0.3 | Upper Tol. 8.0 +0.3 Lower Tol. -0.3 | Upper Tol. 8.5 +0.3 Lower Tol. -0.3 |
| LB | Upper Tol. 17.0 +3.0 Lower Tol. -3.0 | Upper Tol. 18.0 +3.0 Lower Tol. -3.0 | Upper Tol. 19.0 +3.0 Lower Tol. -3.0 | Upper Tol. 20.0 +3.0 Lower Tol. -3.0 | Upper Tol. 21.0 +3.0 Lower Tol. -3.0 | Upper Tol. 22.0 +3.0 Lower Tol. -3.0 |
| AB | Upper Tol. 4.0 +2.0 Lower Tol. -2.0 | Upper Tol. 6.0 +2.0 Lower Tol. -2.0 | Upper Tol. 7.0 +2.0 Lower Tol. -2.0 | Upper Tol. 8.0 +2.0 Lower Tol. -2.0 | Upper Tol. 8.5 +2.0 Lower Tol. -2.0 | Upper Tol. 9.0 +2.0 Lower Tol. -2.0 |
| p ±10% | 3.8 | 4.8 | 5.6 | 6.0 | 6.0 | 6.8 |
| TX | T30 | T40 | T50 | T50 | T50 | T50 |
| L | L1 | L1 | L1 | L1 | L1 | L1 |
| 100~200 mm(±1.5) in 10 mm increments | max.12mm | max.19mm | max.20mm | max.20.5mm | | |
| 210~300 mm(±1.5) in 10 mm increments | max.12mm | max.19mm | max.20mm | max.20.5mm | max.21mm | max.22mm |
| 310~400 mm(±1.5) in 10 mm increments | | max.19mm | max.20mm | max.20.5mm | max.21mm | max.22mm |
| 410~500 mm(±1.5) in 10 mm increments | | max.19mm | max.20mm | max.20.5mm | max.21mm | max.22mm |
| 510~600 mm(±1.5) in 10 mm increments | | | max.20mm | max.20.5mm | max.21mm | max.22mm |
| 610~800 mm(±1.5) in 10 mm increments | | | | max.20.5mm | max.21mm | max.22mm |
| 810~1000 mm(±1.5) in 10 mm increments | | | | max.20.5mm | max.21mm | max.22mm |
| 1010~1200 mm(±1.5) in 10 mm increments | | | | | max.21mm | max.22mm |
| 1210~1500 mm(±1.5) in 10 mm increments | | | | | | max.22mm |

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill
and BM FT Quick Drill screws

BM FT Quick Drill screws

Annex 5.6



| SIZE | M 6 | M 8 | M 10 | M 12 |
|------|--------------|--------------|--------------|--------------|
| Ø d1 | 19.50 ± 0.30 | 24.50 ± 0.30 | 30.00 ± 0.30 | 37.50 ± 0.30 |
| Ø d2 | 7.50 ± 0.30 | 8.50 ± 0.30 | 10.80 ± 0.30 | 14.00 ± 0.30 |
| h1 | 4.60 ± 0.30 | 5.40 ± 0.30 | 6.40 ± 0.30 | 8.50 ± 0.30 |
| h2 | 1.50 ± 0.10 | 2.50 ± 0.10 | 2.70 ± 0.10 | 3.50 ± 0.10 |

BM Quick Drill, BM Quick Drill +, BM Quick Drill II, BM Quick Drill III, BM DT Quick Drill
and BM FT Quick Drill screws

Washer

Annex 5.7