Part 1:

Fastener selection guide

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Selecting the right fastener

There are six fastener selection charts corresponding to six trade groups:

- Steel metal (e.g. siding and decking, cladding, grating)
- Petrochemical and industrial (e.g. installations, off-shore)
- Interior finishing (e.g. drywall, suspended ceilings)
- General construction (e.g. concrete forming, insulation)
- HVAC, plumbing and electrical
- Wood framing

To find a DX- or GX fastener for an application, enter the appropriate trade group chart with the application:

Detailed technical information for the selected fastener family is found on its product information sheet.

For some applications, two or more fastener families are listed as suitable. The final selection is influenced by technical data found on the product sheets.

Regional differences in building methods, materials, trade preferences, available tools, etc. also influence fastener selection. Therefore, designers and specifiers are advised to consult the current Hilti catalogue and make use of the local Hilti technical advisory service.

Corrosion

Corrosion has a major influence on the suitability of a fastener and therefore also on fastener selection. In order to provide a basis for judging the suitability of fasteners, it is useful to categorise applications in three classes:

- Safety relevant, permanent applications: (e.g. profiled metal sheet fastenings in roofs and walls)
- Non-safety relevant, permanent fastenings (e.g. metal track fastenings for drywall)
- Non-safety relevant, temporary fastenings (e.g. fastenings of wooden sills, kickers, etc. in concrete forming).

For **non-safety-relevant applications**, zinc-plated fasteners made of normal carbon steel can be used without restriction.

For **safety-relevant, permanent fastenings** the restrictions described below apply:

- In any case there is a restriction to the use of galvanized carbon steel fasteners if they are exposed to weather or if they are inside and subject to repeated wetting as from condensation. The galvanization (typically in a range from 5 to 20 microns of Zn) provides corrosion protection during transport and construction, during which exposure to weather can never be completely prevented. If the fastenings are exposed to repeated wetting or weather during their service life, the use of galvanized carbon steel fasteners is prohibited and stainless steel fasteners must be used. This safety measure must be observed without exception because the corrosion of galvanized steel fasteners leads not just to material loss but also to hydrogen embrittlement. Hydrogen embrittlement can easily result in fracture of the fastener at very low load.
- Referring to the above-mentioned example of profiled metal sheet fastening for roofs and walls, the use of galvanized steel fasteners is allowable only where wetting of the fastener is not to be expected. This applies in general to inside skins of two skin, insulated roofs and walls enclosing dry and closed rooms. This is the classic application area for X-ENP 19 galvanized fasteners.

Contact corrosion is taken into consideration by observing common rules concerning acceptable material combinations. Parts made of less noble metals are subject to increased corrosion if they are in electrochemical contact with a larger part made of a more noble metal, provided of course that an electrolyte is present. Fasteners that are used in wet areas must be at least as noble or better, nobler than the fastened part. The effect of contact corrosion is shown in the table below. This information is especially applicable to stainless steel X-CR fasteners because only the X-CR is suitable for safety-relevant, permanent application in outdoor areas or areas otherwise exposed to corrosion.

	Powder- and gas-actuated fastener:	
Fastened part	Zinc-plated carbon steel	X-CR stainless steel
Construction steel (uncoated)	○	○
Galvanized steel sheet	○	○
Aluminum alloy	●	○
Stainless steel sheet	●	○

○ Negligible or no corrosion of fastener
● Heavy corrosion of fastener

The accelerated corrosion of a fastener due to contact corrosion can take place only in the presence of an electrolyte (moisture from precipitation or condensation). Without this electrolyte – e.g. in dry inside rooms – zinc-plated fasteners can be used in connection with more noble metals.

Design concepts

The recommended working loads (N_{rec} and V_{rec}) are suitable for use in typical working load designs. If a partial safety factor design method is to be used, the N_{rec} and V_{rec} values are conservative when used as N_{Rd} and V_{Rd}. Exact values for N_{Rd} and V_{Rd} can be determined by using the safety factors where given and/or by reviewing test data. Design loads (characteristic strength, design resistance and working loads) for the **X-HVB** shear connector are listed and ordered as per design guideline.

Worldwide the designer may encounter two main fastening design concepts:

Working load concept

$$N_S \leq N_{rec} = \frac{N_{Rk}}{\gamma_{GLOB}}$$

where γ_{GLOB} is an overall factor of safety including allowance for:

- errors in estimation of load
- deviations in material and workmanship

and N_S is, in general a characteristic acting load.

$N_S \cong N_{Sk}$

Partial factors of safety

$$N_{Sk} \times \gamma_F = N_{Sd} \leq \frac{N_{Rk}}{\gamma_M} = N_{Rd}$$

where:

γ_F is a partial factor of safety to allow for errors in estimation on the acting load.

γ_M is a partial factor of safety to allow for deviations in material and workmanship.

Structural analysis of the fastened part (e.g. roof deck panel or pipe hung from a number of fastenings) leads to calculation of the load acting on a single fastening, which is then compared to the recommended load (or design value of the resistance) for the fastener.
In spite of this single point design concept, it is necessary to ensure that there is sufficient redundancy that the failure of a single fastening will not lead to collapse of the entire system. The old saying “one bolt is no bolt” applies also to DX and GX fastening.

Nomenclature / symbols

Following is a table of symbols and nomenclature used in the technical data.

Fastener test data and performance	
N and **V**	Tensile and shear forces in a general sense
F	Combined force (resulting from **N** and **V**) in a general sense
$\mathbf{N_s}$ and $\mathbf{V_s}$	Tensile and shear forces acting on a fastening in a design calculation
$\mathbf{F_s}$	Combined force (resulting from $\mathbf{N_s}$ and $\mathbf{V_s}$) in a design calculation
$\mathbf{N_u}$ and $\mathbf{V_u}$	Ultimate tensile and shear forces that cause failure of the fastening; statistically, the reading for one specimen
$\mathbf{N_{u,m}}$ and $\mathbf{V_{u,m}}$	Average ultimate tensile and shear forces that cause failure of the fastening, statistically, the average for a sample of several specimens
S	The standard deviation of the sample
$\mathbf{N_{test,k}}$ and $\mathbf{V_{test,k}}$	Characteristic tensile and shear resistance of test data, statistically, the 5 % fractile.
$\mathbf{N_{Rk}}$ and $\mathbf{V_{Rk}}$	Characteristic tensile and shear resistance of the fastening used for fastening design; statistically, the 5 % fractile. For example the characteristic strength of a fastening whose ultimate strength can be described by a standard Gauss type distribution is calculated by: $\mathbf{N_{Rk} = N_{u,m} - k \times S}$ where **k** is a function of the sample size, **n** and the desired confidence interval.
$\mathbf{N_{Rd}}$ and $\mathbf{V_{Rd}}$	Tensile and shear design force on the fastener shank $\mathbf{N_{Rd}} = \frac{\mathbf{N_{Rk}}}{\gamma_\mathbf{M}}$ and $\mathbf{V_{Rd}} = \frac{\mathbf{V_{Rk}}}{\gamma_\mathbf{M}}$ where $\gamma_\mathbf{M}$ is a partial safety factor for the resistance of the fastening
$\mathbf{N_{rec}}$ and $\mathbf{V_{rec}}$	Recommended tensile and shear force on the fastener shank $\mathbf{N_{rec}} = \frac{\mathbf{N_{Rk}}}{\gamma_\mathbf{GLOB}}$ and $\mathbf{V_{rec}} = \frac{\mathbf{V_{Rk}}}{\gamma_\mathbf{GLOB}}$ where $\gamma_\mathbf{GLOB}$ is an overall factor of safety
$\mathbf{M_{rec}}$	Recommended working moment on the fastener shank $\mathbf{M_{rec}} = \frac{\mathbf{M_{Rk}}}{\gamma_\mathbf{GLOB}}$ where $\mathbf{M_{RK}}$ is the characteristic moment resistance of the fastener shank and $\gamma_\mathbf{GLOB}$ is an overall factor of safety. Unless otherwise stated on the product data sheets, the $\mathbf{M_{rec}}$ values in this manual include a safety factor of “2” for static loading.

Fastening details	
h_{ET}	Penetration of the fastener point below the surface of the base material
h_{NVS}	Nail head standoff above the surface fastened into (with nails, this is the surface of the fastened material, with threaded studs, the surface of the base material).
t_{II}	Thickness of the base material
t_I	Thickness of the fastened material
Σt_I	Total thickness of the fastened material (where more than one layer is fastened)

Characteristics of steel and other metals	
f_y and f_u	Yield strength and ultimate tensile strength of metals (in N/mm² or MPa)

Characteristics of concrete and masonry	
f_c	Compressive strength of cylinder (150 mm diameter, 300 mm height)
f_{cc}	Compressive strength of cube (150 mm edge length)
$f_{c,100}$ / $f_{cc,200}$	Compressive strength of 100 mm diameter cylinder / cube with 200 mm edge length

In some cases building material grades are used to describe the suitable range of application. Examples of European concrete grades are C20/25, C30/35, C50/55.

Approvals, technical assessments and design guidelines are given on the product information sheets as abbreviations of the names of the issuing institutes or agencies. Following is a list of abbreviations:

Abbreviation	Name of institute or agency / description	Country
FM	Factory Mutual (insurers' technical service)	USA
UL	Underwriters Laboratories (insurers' technical service)	USA
ICC	International Code Council	USA
SDI	Steel Deck Institute (technical trade association)	USA
CSTB	Centre Scientifique et Technique du Bâtiment (approval agency)	France
DIBt	Deutsche Institute für Bautechnik (approval agency)	Germany
SOCOTEC	SOCOTEC (insurers' technical service)	France
ÖNORM	Österreichische Norm / Austrian National Standard	Austria
SCI	Steel Construction Institute	Great Britain

ABS	American Bureau of Shipping (international classification society for ship and marine structures)
LR	Lloyd's Register (international classification society for ship and marine structures)
GL	Germanischer Lloyd (international classification society for ship and marine structures)
DNV	Det Norske Veritas (international classification society for the marine and energy industry)