X-HVB shear connectors

General information

Material specifications

X-HVB
Carbon steel: \( R_m = 295\text{–}350 \text{ N/mm}^2 \)
Zinc coating: \( \geq 3 \mu\text{m} \)
X-ENP-21 HVB
Carbon steel shank: HRC58
Zinc coating: 8–16 \( \mu\text{m} \)

Recommended fastening tools

Tool
DX 76  DX 76 PTR

Fastener guide
X-76-F-HVB  X-76-F-HVB-PTR

Piston
X-76-P-HVB  X-76-P-HVB-PTR

Cartridges
6.8/18 M black, red
(for details see application limit X-ENP-21 HVB)

See Tools and equipment for more details.

Approvals and design guidelines

ETA-15/0876, design according to
Eurocode 4 (EN 1994-1-1, EN 1994-1-2)
and Eurocode 8 (EN 1998-1)

MLIT / BCJ (Japan)

With regard to composite design according to AISC
(American Institute of Steel Construction), please refer
to the technical literature of Hilti North America (Product Technical Guide)
Applications

Examples

Typical application of X-HVB shear connector with steel deck, e.g. new construction.

Typical application of X-HVB shear connector with jack arch system (without steel deck), e.g. rehabilitation project. “Duckwalk”

Characteristic and design resistance (ETA-15/0876) in composite beams with solid slabs

<table>
<thead>
<tr>
<th>Shear Connector</th>
<th>Characteristic Resistance $P_{Rk}$ [kN]</th>
<th>Design Resistance $P_{Rd}$ [kN]</th>
<th>Minimum base material thickness [mm]</th>
<th>X-HVB positioning</th>
<th>Ductility assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-HVB 40</td>
<td>29</td>
<td>23</td>
<td>6</td>
<td></td>
<td>“duckwalk”</td>
</tr>
<tr>
<td>X-HVB 50</td>
<td>29</td>
<td>23</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-HVB 80</td>
<td>32.5</td>
<td>26</td>
<td></td>
<td>“duckwalk”</td>
<td></td>
</tr>
<tr>
<td>X-HVB 95</td>
<td>35</td>
<td>28</td>
<td>8)</td>
<td>parallel with beam</td>
<td>Ductile according to EN 1994-1-1</td>
</tr>
<tr>
<td>X-HVB 110</td>
<td>35</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-HVB 125</td>
<td>37.5</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-HVB 140</td>
<td>37.5</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*) Reduction to 6 mm possible, with regards to required reduction of design resistance see annex C3 of ETA-15/0876.

Conditions:
- Normal weight concrete C20/25 to C50/60
- Light weight concrete LC20/22 to LC50/55 with a minimum density $\rho = 1750$ kg/m$^3$
Design resistance in composite beams with decking ribs transverse to beam axis

<table>
<thead>
<tr>
<th>X-HVB positioning</th>
<th>Design Resistance $P_{Rd,t}$ [kN]</th>
<th>Ductility assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Diagram" /></td>
<td>$P_{Rd,t,l} = k_{t,l} \cdot P_{Rd}$</td>
<td>Ductile according to EN 1994-1-1</td>
</tr>
<tr>
<td><img src="image2" alt="Diagram" /></td>
<td>$k_{t,l} = \frac{0.66 \cdot b_o}{\sqrt{n_r} \cdot h_p} \left(\frac{h_{SC}}{h_p} - 1\right) \leq 1.0$</td>
<td></td>
</tr>
</tbody>
</table>

Conditions:
- Applicable for X-HVB 80, X-HVB 95, X-HVB 110, X-HVB 125, X-HVB 140
- $n_r$ corresponds to the number of X-HVBs per rib ($n_r \leq 3$)

Design resistance in composite beams with decking ribs parallel to beam axis

<table>
<thead>
<tr>
<th>X-HVB positioning</th>
<th>Design Resistance $P_{Rd,t}$ [kN]</th>
<th>Ductility assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Diagram" /></td>
<td>$P_{Rd,t,l} = k_{t,l} \cdot P_{Rd}$</td>
<td>Ductile according to EN 1994-1-1</td>
</tr>
<tr>
<td><img src="image4" alt="Diagram" /></td>
<td>$k_{t,l} = \frac{0.6 \cdot b_o}{h_p} \left(\frac{h_{SC}}{h_p} - 1\right) \leq 1.0$</td>
<td></td>
</tr>
</tbody>
</table>

Conditions:
- Applicable for X-HVB 80, X-HVB 95, X-HVB 110, X-HVB 125, X-HVB 140
- X-HVB are to be positioned parallel with beam

Decking geometric parameters
**Design information**

**Connector placement along the beam**
The X-HVB is a ductile shear connector according to EN 1994-1-1, section 6.6, and may be uniformly distributed between critical sections. These critical sections, where large changes in shear flow occur, may be at supporting points, points of application of point loads or areas with extreme bending moments.

**Partial shear connection**
Strength:
The minimum connection depends on the design code used:
- In **EN 1994-1-1** design, \( \frac{N}{N_r} \) must be at least 0.4. This increases depending on span length and decking geometry.

**Deflection control only**
If the shear connection is needed for deflection control only, there is no minimum degree of connection. However, minimum allowable connector spacing applies and the steel beam must have enough strength to carry the self-weight and all imposed loads.

**Further specific design topics covered in the ETA-15/0876**
- Coverage of seismic loading according to Eurocode 8 (EN 1998-1-1)
- Design resistance in case of use of old steel with an ultimate strength greater than 300 N/mm² and less than 360 N/mm²
- Effect of reduced base material thickness less than 8 mm for X-HVB 80 to X-HVB 140
- Design of end anchorage of composite slabs
- Design in case of a fire

**Application requirements**

**Thickness of base material**

For beams with composite decking:
minimum thickness \( t_{II} = 8 \text{ mm} \).

For beams with solid concrete slabs:
minimum thickness \( t_{II} = 6 \text{ mm} \), especially relevant in renovation projects in order to take the thin flange thickness of small I-sections (e.g. IAO 100, I 100, IPE 100) into account.

**Thickness of fastened material**

Maximum total thickness of fixed sheeting \( t_{fix} \):
- 2.0 mm for X-HVB 80, X-HVB 95 and X-HVB 110
- 1.5 mm for X-HVB 125 and X-HVB 140
Positioning of X-HVB connectors in solid concrete slabs

X-HVB are to be positioned parallel with beam

1 row of connectors

2 row of connectors

Maximum 3 row of connectors

Positioning of X-HVB connectors with composite deck (deck positioned transverse to; and X-HVB positioned parallel with beam axis)

Spacing and positioning

- \( a_t \geq 50 \text{ mm} \) for compact profiled decking with \( b_y/h_p \geq 1.8 \)
- \( a_t \geq 100 \text{ mm} \) for other decking

1 row of connector - Minimum rib width and spacing to decking

Multiple rows of connector - Minimum rib width
Positioning of X-HVB connectors with composite deck (deck and X-HVB positioned transverse to beam axis)

Spacing

1 row  2 rows  3 rows

- 2 rows:
  - \(a_r \geq 100\) mm for all types decking

- 3 rows:
  - \(a_r \geq 50\) mm for compact profiled decking with \(b_0/h_p \geq 1.8\)
  - \(a_r \geq 100\) mm for other decking

Positioning - 1 row of connectors

Without rib stiffener

Center in rib

With rib stiffener (X-HVB in contact with rib stiffener)

Preferred position in compression zone of concrete rib

Positioning - 2 and 3 rows of connectors

Minimum width of deck rib

Contact with rib stiffener

OR equi-spacing

Positioning of X-HVB connectors with composite deck (deck parallel with beam axis)

X-HVB are to be positioned parallel with beam

Spacing and positioning

- If a centric positioning within the concrete rib is not possible due to the shape of the composite decking, the decking needs to be split.
**“Duckwalk” positioning of X-HVB 40 and 50 in combination with thin solid slabs for renovation construction**

- Minimum section width = 40 mm (e.g. old section IAO 100)
- Minimum center distance of steel sections = 400 mm

**Application limits**

Application limits are valid only if correct cartridge and power setting are used!

**Application limits X-ENP-21 HVB**

In thermo-mechanically rolled construction steel, e.g. S 355M per EN 10025-4 the application limit is reduced by 50 N/mm²

- Minimum section covered: IPE 100
- Minimum base material thickness for beams with composite decking: 8 mm

Fine adjustment by carrying out installation tests on site
### Fastener selection

**Minimum slab thickness**

<table>
<thead>
<tr>
<th>X-HVB</th>
<th>Minimum slab thickness h [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without effect of corrosion</td>
</tr>
<tr>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>80</td>
<td>80</td>
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<tr>
<td>95</td>
<td>95</td>
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<tr>
<td>110</td>
<td>110</td>
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<tr>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>140</td>
<td>140</td>
</tr>
</tbody>
</table>

**Maximum decking height $h_p$, dependent on decking geometry**

<table>
<thead>
<tr>
<th>X-HVB</th>
<th>Maximum height of composite decking $h_p$ [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\frac{b_{0}}{h_p} \geq 1.8$</td>
</tr>
<tr>
<td>80</td>
<td>45</td>
</tr>
<tr>
<td>95</td>
<td>60</td>
</tr>
<tr>
<td>110</td>
<td>75</td>
</tr>
<tr>
<td>125</td>
<td>80</td>
</tr>
<tr>
<td>140</td>
<td>80</td>
</tr>
</tbody>
</table>

$x) \ b_{0} / h_p \geq 1.0 \text{ for composite decking perpendicular to beam combined with X-HVB orientation parallel with beam}$

### Fastening quality assurance

### Fastening inspection

- **8.2 mm ≤ $h_{NVS}$ ≤ 9.8 mm**
- Clearly visible piston mark on top washer