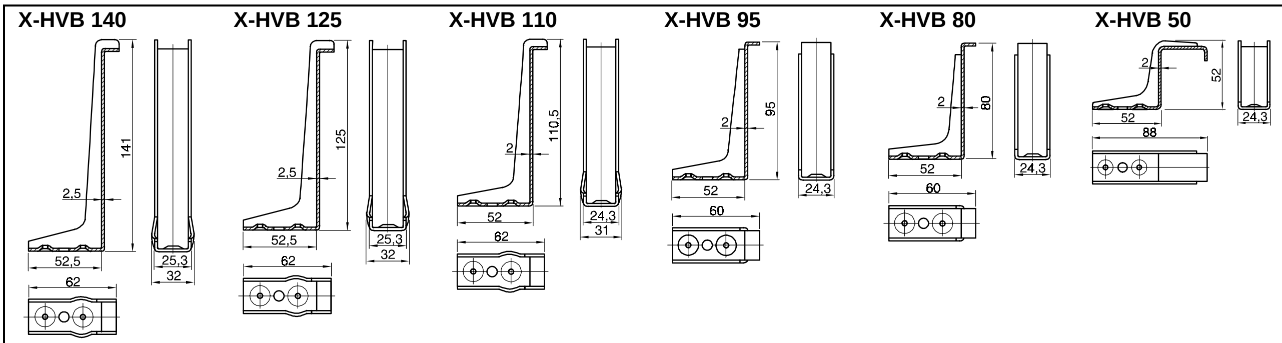
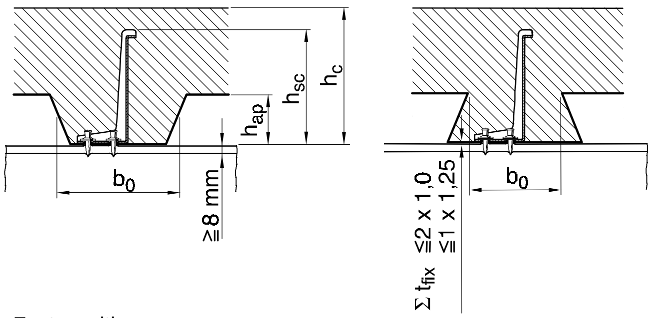
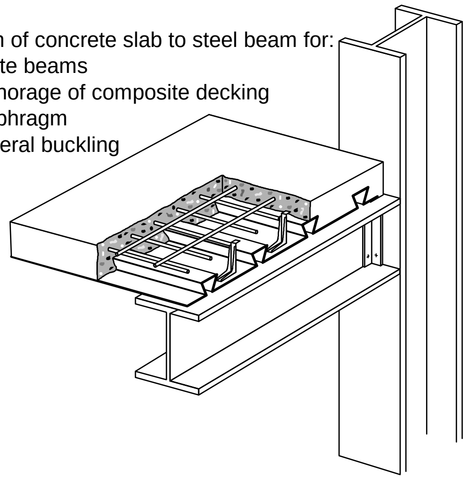
2.4 X-HVB Shear Connectors



carbon steel: f_u = 270 - 350 N/mm^2
coating: 8 - 16 mm zinc



Connection of concrete slab to steel beam for:
- composite beams
- end anchorage of composite decking
- floor diaphragm
- resist lateral buckling



Fasten with:
- **ENP2-21-L15** or **ENPH2-21-L15** nails (see Chapter 2.1 for details)
- **DX 750** or **DX 650** tools using **HVB** equipment

Application Approvals and Governing Design Guidelines

SOCOTEC, ÖNORM, SCI, SZS
Technical data (design loads, application restrictions, etc.) presented in these approvals and design guidelines reflect specific local conditions and may differ from those published in this handbook. If the project is in a jurisdiction where the fastening is subject to the approval process or where a design guideline must be used, technical data in the approval or design guideline has precedence over data presented here. Approval copies are available from your Hilti technical advisory service.

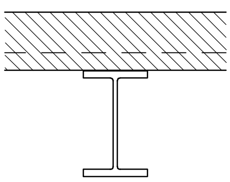
Product Selection and Performance in Solid Slabs

	Maximum decking height h_{ap} (mm)		Characteristic shear resistance P_{Rk} 1)	Design shear resistance P_{Rd} 2)	Allowable horizontal shear q 3)	Elastic resistance R_D 4)
	b_o / h_{ap} ≥ 1.8	b_o / h_{ap} < 1.8	(kN)	(kN)	(kN)	(kN)
X-HVB 50	Not for use with profiled decking		23	18	N.A.	13
X-HVB 80	45	45	28	23	14	16
X-HVB 95	60	57	35	28	17.5	22
X-HVB 110	75	66				
X-HVB 125	80	75				
X-HVB 140	80	80				

1) Per Austrian ENV 1994-1-1. Also nominal strength for AISC-LRFD and unfactored shear resistance for CISC design formulas.
2) Per Austrian ENV 1994-1-1 and SZS.
3) Allowable shear in designs per AISC-ASD.
4) Design resistance in elastic designs for Eurocode 4, SIA 161, and most other European codes.

Strength Reduction Factors for Profiled Metal Decking

Ribs transverse to beams



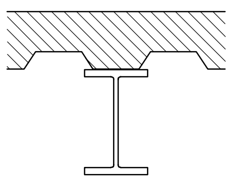
$$k_t = \frac{K}{\sqrt{N_r}} \times \frac{b_o}{h_{ap}} \times \frac{h_{sc} - h_{ap}}{h_{ap}}$$

EC 4 designs:
K = 0.70
N_r = HVB's / rib (≤ 2 in the calculation even if 3 are placed in a rib)

AISC, CISC, BS, other design codes:
K = 0.85
N_r = HVB's / rib (1, 2 or 3)

Note: $k_t \le 1.0$ *!!!*

Ribs parallel to beam



for: $\frac{b_o}{h_{ap}} \ge 18 \Rightarrow k_p = 1.0$

for: $\frac{b_o}{h_{ap}} < 18$

$$\Rightarrow k_p = 0.6 \times \frac{b_o}{h_{ap}} \times \frac{h_{sc} - h_{ap}}{h_{ap}}$$

Note: $k_p \le 1.0$ *!!!*

2.4 X-HVB Shear Connectors

Connector placement along the beam

The HVB is a flexible connector and may be uniformly distributed between points where large changes in shear flow occur (e.g. between the points of application of point loads).

Partial shear connection

Deflection control only: No minimum degree of connection, however, minimum allowable connector spacing applies and steel beam must have enough strength to carry the self-weight and all imposed loads.
Strength: If the shear connection is needed for strength, the minimum connection depends on the design code used:

In **EC4** and **BS 5950** designs, **N/N_f** must be at least 0.4. This is increased depending on span length and decking geometry	In **AISC**, **N/N_f** must be at least 0.25.	In **CISC**, **N/N_f** must be at least 0.50.

Deflections

EC4 designs: The deflection δ is calculated by:

$$\frac{\delta}{\delta_c} = 1 + k_\delta \times \left(1 - \frac{N}{N_f}\right) \times \left(\frac{\delta_a}{\delta_c} - 1\right)$$

δ_c = Deflection of composite beam with full connection
δ_a = Deflection of the steel beam alone
k_δ = 0.5 for propped construction; 0.3 for unpropped construction
N = Number of HVB's in the beam
N_f = Number of HVB's required for full connection

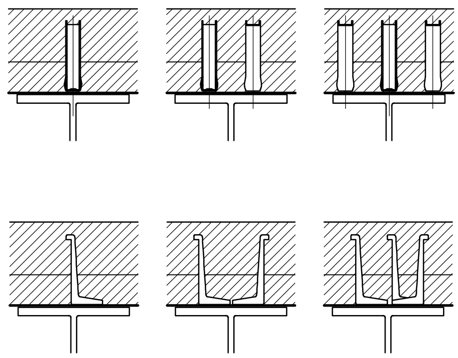
AISC, CISC, (or similar) designs: The deflection is calculated by conventional elastic formulae. For beams with partial shear connection, deflections may be estimated by using the following formula for the effective moment of inertia:

$$I_{eff} = I_a + \sqrt{N/N_f} \times (I_f - I_a)$$

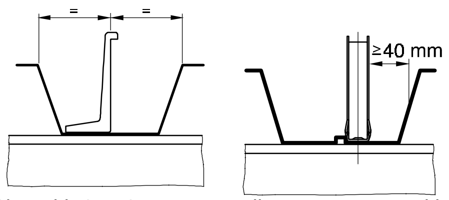
I_a = moment of inertia of steel selection
I_f = moment of inertia with 100 % connection

Connector Positioning (metal decking ribs transverse to beam)

1. One, two or three HVB's per rib; ⊥ or // to beam.

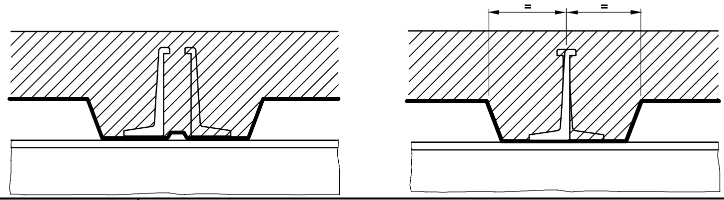


2a. Position in the rib: 1 HVB per rib – leg centered in the rib or 40 mm clearance

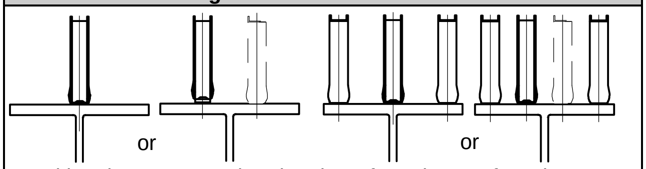


If centering / 40 mm clearance not possible, use minimum of 2 HVB's per rib

2b. With 2 or 3 HVB's per rib – Legs centered in the rib or alternated about the center.



General Positioning

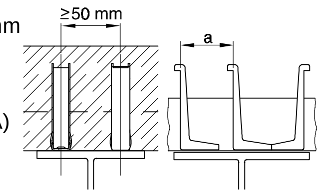


Position the HVB's so that the shear force is transferred symmetrically to the beam.

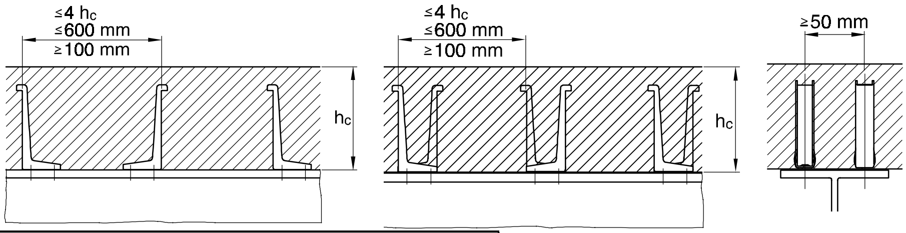
3. Spacing along the ribs

- Basic minim. spacing, **a** ≥ 50 mm
- **a** ≥ 100 mm for:
  - **b_o/m** < 0.7 and **b_o / h_{ap}** < 1.8
  - SDI 3'' composite decking (USA)

m = rib spacing

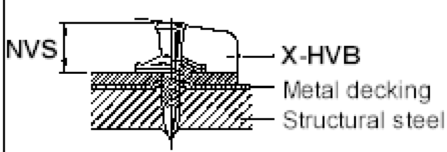


Connector Positioning (ribs parallel to beam and solid stabs)



- 1, 2 connectors per row or rib.
- With 1 connector per row, alternate direction of connectors from row to row.
- With 2 or 3 connectors per row, alternate direction of connectors inside of each row and from row to row.

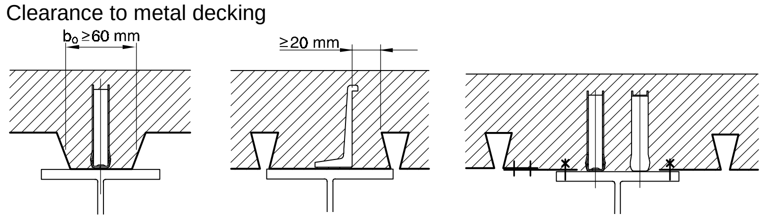
Construction Inspection



ENP2-21-L15/ENPH2-21-L15 ⇒ NVS = 8 - 11 mm

ENP3-21-L15/ENPH3-21-L15 ⇒ NVS = 6 - 9 mm

Clearance to metal decking



Split decking if necessary for spacing / clearance.