HALFEN Universal Connection System

The HALFEN HUC Universal Connection System is a family of components that together provides a very effective solutions for the transfer of high structural loads into concrete. The components of the HUC family comprise of the HSC-B Concrete Steel Connection System and the HSCC Steel Corbel System. The load range and adaptability of these components enables the HUC system to offer a huge range of connection applications. These include connections for steel beams, steel corbels, and anchor points for both DETAN Tension Rods, and cable bracing systems.

HALFEN HSC-B Concrete Steel Connection

Cast-in bars (female connections) with a positioning plate for accurate installation → page 3.

HSC-B Concrete Steel Connection

The external face plate of the system is supplied pre-drilled to match the required connection pattern of the cast-in bars. It is used as a welded end plate for structural steel beams or as part of the connection hardware for bracing systems.

Preview HALFEN HSCC Standard Steel Corbels

HALFEN HSCC Steel Corbels

To optimise the planning process HALFEN offers 34 pre-engineered sizes of steel Corbels to connect to concrete.

In comparison to concrete corbels, HSCC Steel Corbels have up to double the load capacity as well as a significantly reduced construction height → page 15.

Load range $F_{Ed}$ 115 kN to 2600 kN.
HALFEN HSC-B Concrete Steel Connection

The advantages at a glance

**Flexible planning**
- Secure transfer of tension loads, shear loads and bending moments
- Suitable for non-predominantly static loads
- Single, double-sided and bent anchor bars possible
- Freely selectable number of HSC-B bars; single or multi-layer
- Versatile connections: Numerous types of structural component can be attached e.g. steel corbels, beams, DETAN Tension Rods and bracing cables

**Easy design**
- Simple verification of load bearing capacity using tension-shear diagrams
- The system features extremely short anchorage lengths allowing secure connections even in small dimension concrete elements

**Time and cost saving**
- Accurate and simple installation to the formwork using a positioning plate and bolts - no formwork penetration required
- No on-site welding. Preparation and installation of connections thanks to 100% accurate, laser-cut HSC-B steel face plates
- Easy bolted connections; no special tools required

**Environmentally focused**
- Longevity due to optional corrosion protection of components; components are available in hot dip galvanized (fv), electro-zinc plated (gv) or in stainless steel (A4) material
- Bolted connections simplifies building demolition and construction material recycling

**Suitable for dynamic loads**
Application examples HALFEN HSC-B Concrete Steel Connector

The laser cut HSC-B face plate enables the accurate factory manufacture of structural steel components especially steel beams. The prefabricated steel components are then connected to the structure on site using simple bolted connections to accurately positioned cast-in female bars.

Fig.: single- and double-sided steel beam connections to reinforced concrete columns or concrete walls

HALFEN HSC-B Concrete Steel Connector with HSCC Steel Corbels

Reinforced concrete beam supported on a HALFEN HSCC Steel Corbel → page 15

Crane girder with HALFEN HSCC Steel Corbel

Further application examples with HSC-B

HSC-B face plate with welded connection flange for DETAN Tension Rod
HSC-B System with special connection for timber beam
Tension cable connection using HSC-B Concrete Connection System
HALFEN HSC-B Concrete Steel Connection

Installation example

HALFEN HSC-B Concrete Steel Connector using HSC-B SH female bars in 2 groups of 4 to form a connection for a steel beam to a reinforced concrete column.

1. Remove the thread protector immediately prior to installation

2. Connection of the HSC-B SH female bars to the positioning plate using flat headed bolts.

3. Cutting and fitting of adhesive foam sheet to form a recess in the concrete at the connection location. When used with steel formwork a magnet is located in the middle of the positioning plate. Accessories → page 7

4. The positioning plate with its attached female bars is attached either with a magnet to a steel formwork, or by nailing to timber formwork.

5. The column and additional reinforcement is positioned according to the requirement of the structural engineer → see also page 13

6. The female bars should be securely tied to the column reinforcement

7. After the concrete has been poured and the formwork removed the thread protector is replaced until final installation of components to prevent corrosion.

8. Structural steel beam with HSC-B face plate is bolted into position.

Alternatively: The positioning plate can be mounted flush if drilling the formwork is preferred

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HALFEN HUC UNIVERSAL CONNECTION
HALFEN HSC-B Concrete Steel Connection

Product overview

To order please provide a drawing with the following information.

**Positioning plate:** Dimensions $b_p$ and $h_p$, plus position and diameters of bolt, and nailing holes.

**Type of corrosion-protection.**

**Face plate:** Dimensions $b_c$, $h_c$, $t_c$, plus position and diameters of the bolt holes.

**Required material.**

Different edge distances for the bolt holes in the positioning and in the face plate.

- Recommendation: For easy installation use a positioning plate with a slightly larger footprint than the face plate.
  - i.e. $b_p = b_c + 10 \text{ mm, } h_p = h_c + 10 \text{ mm (to give 5 mm clearance all around)}$

<table>
<thead>
<tr>
<th>HSC-B Positioning- and face plates P /FP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td><strong>Positioning plates</strong></td>
</tr>
<tr>
<td>HSC-B P</td>
</tr>
<tr>
<td>HSC-B FP</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HSC-B SH female bar with anchor head</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>HSC-B SH- 16 ...</td>
</tr>
<tr>
<td>HSC-B SH- 20 ...</td>
</tr>
<tr>
<td>HSC-B SH- 25 ...</td>
</tr>
</tbody>
</table>

- Finish applies to exposed female threaded connection sleeve. Bars are mill finish carbon steel

<table>
<thead>
<tr>
<th>HSC-B SD double sided female bar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>HSC-B SD- 16 ...</td>
</tr>
<tr>
<td>HSC-B SD- 20 ...</td>
</tr>
<tr>
<td>HSC-B SD- 25 ...</td>
</tr>
</tbody>
</table>

- Finish applies to exposed female threaded connection sleeve. Bars are mill finish carbon steel

HSC-B SH with forged head. Especially suitable for short anchoring lengths.

HSC-B SD especially suited for double-sided connections of components to columns and walls.
HALFEN HUC UNIVERSAL CONNECTION
HALFEN HSC-B Concrete Steel Connection

**Product overview**

![Diagram of HSC-B S and HSC-B SB connections]

**HSC-B S** especially suited for connections to slabs with sufficient anchor depth.

**HSC-B SB** especially suited for load transfer in columns or walls of adequate dimension.

**Accessories**

**HSC-B FI Flat-headed assembly bolt for positioning plate – 3 mm head**

<table>
<thead>
<tr>
<th>Article name type</th>
<th>Article no.</th>
<th>Nominal size</th>
<th>Length L</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSC-B FI M 16</td>
<td>1060.410-00001</td>
<td>M 16</td>
<td>25</td>
</tr>
<tr>
<td>HSC-B FI M 20</td>
<td>1060.410-00002</td>
<td>M 20</td>
<td>25</td>
</tr>
<tr>
<td>HSC-B FI M 27</td>
<td>1060.410-00003</td>
<td>M 27</td>
<td>30</td>
</tr>
</tbody>
</table>

**HSC-B SE Sealing accessories for concreting**

<table>
<thead>
<tr>
<th>Article name</th>
<th>Article no.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSC-B SE</td>
<td>1060.420-00001</td>
<td>Foam sheet one-sided self adhesive 15 x 15 mm, length 1000mm</td>
</tr>
</tbody>
</table>

**Installation Variations**

**Application with sliding formwork:**
Positioning plate is installed recessed with flat headed bolts.

**Application with drilled formwork:**
Positioning plate is flush to formwork.

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The German approval regulates the alignment of HSC-B connectors in structural concrete elements, including dimension and constructional requirements. The regulations below apply to single- and double-sided connections. Furthermore, the connected steel and concrete structural components, plus the connecting bolts have to be verified. The transmission of forces in the reinforced concrete must be verified.

Materials
- Standard weight concrete, class C20/25 up to C70/85
- HSC-B-bar: BSt 500 S
- Diameters 16–20–25 mm

Corrosion protection of the sleeves
- Hot dip galvanized (fv)
- Stainless steel (A4)
- Electro-Zinc plated (gv)

Stress and resistance
- Predominantly and non-predominantly static loads
- Yield strength of reinforcement steel
  \[ f_{yd} = f_{yk} \left( \frac{500 \text{ N/mm}^2}{1.15} \right) = 435 \text{ N/mm}^2 \]

Fatigue resistance values of HSC-B female bars:
- Stress ranges for \( N = 2 \cdot 10^6 \):
  \[ \Delta \sigma_{RSK} = 80 \text{ N/mm}^2 \] for \( d_{HSC-B} = 16 \text{mm} \) and \( d_{HSC-B} = 20 \text{mm} \)
  \[ \Delta \sigma_{RSK} = 70 \text{ N/mm}^2 \] for \( d_{HSC-B} = 25 \text{mm} \)
- Stress exponents acc. Wöhlerline:
  \( k_1 = 3.5 \) for \( N \leq 2 \cdot 10^6 \)
  \( k_1 = 3 \) for \( 2 \cdot 10^6 \leq N \leq 10^7 \)
  \( k_2 = 5 \)

Hole pattern
The number of HSC-B bars selected depends on connection requirements. Single and multilayer anchorage patterns are possible, the minimum spacings in the table below should be observed. The maximum hole diameters in the table below for the HSC-B face plate, should also not be exceeded.

### Dimensions, geometric regulations

<table>
<thead>
<tr>
<th>HSC-B</th>
<th>Bolt</th>
<th>Minimum distances</th>
<th>hole diam.</th>
</tr>
</thead>
<tbody>
<tr>
<td>d_s</td>
<td>[mm]</td>
<td>( a_{ij,edge} ) [mm]</td>
<td>( a_{ij} ) [mm]</td>
</tr>
<tr>
<td>16</td>
<td>M16</td>
<td>50</td>
<td>38</td>
</tr>
<tr>
<td>20</td>
<td>M20</td>
<td>63</td>
<td>48</td>
</tr>
<tr>
<td>25</td>
<td>M27</td>
<td>86</td>
<td>66</td>
</tr>
</tbody>
</table>

Bolt lengths
The bolts length selected to connect the structural steel component should have a minimum thread depth of \( 1 \ d_s \) and maximum thread depth of \( L_1 \) in the female bar.

Maximum bolt screw depth

<table>
<thead>
<tr>
<th>HSC-B</th>
<th>( d_s ) [mm]</th>
<th>( L_1 ) [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>22.5</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>28.5</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>37.5</td>
<td></td>
</tr>
</tbody>
</table>

Detailed dimensioning example available at www.halfen.com
Positioning plate: The positioning plate is not taken into consideration in the calculation. Standard thickness is 3 mm. If the concrete pour requires a vent-hole a provision for a hole (≥ 4 mm) should be made.

Components must have a durable galvanized corrosion protection according to DIN EN ISO 1461.

Friction
The load bearing proportion of friction $V_{fr,Ed,inf}$ may be assumed providing that the surfaces of the positioning plate and face plate are suitable for friction transfer. If not suitable, the load bearing proportion of friction may not be assumed (see table).

$$V_{fr,Ed,inf} = D_{Ed} \cdot \mu_{inf}$$

for verification of bolts, threaded sleeves, and local concrete failure

$$V_{fr,Ed,sup} = D_{Ed} \cdot \mu_{sup}$$

for verification of concrete edge failure

<table>
<thead>
<tr>
<th>Friction coefficients</th>
<th>$\mu_{inf}$</th>
<th>$\mu_{sup}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>friction transfer</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>no friction transfer</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

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Design values permissible according to the German approval for the HSC-B anchors threaded sleeves

<table>
<thead>
<tr>
<th>Bolt Diameter</th>
<th>Crosssectional Area $A_{Sp}$ [mm$^2$]</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 16</td>
<td>1.57</td>
</tr>
<tr>
<td>M 20</td>
<td>2.45</td>
</tr>
<tr>
<td>M 27</td>
<td>4.59</td>
</tr>
</tbody>
</table>

### Designations

- $N_{ij,Ed}$: Tension load per threaded sleeve from the bolt
- $V_{ij,Ed}$: Shear load per threaded sleeve from the bolt
- $n_{tie}$: Number of bolts in tension
- $n_{tot}$: Total number of bolts
- $A_{Sp}$: Cross sectional area per bolt
- $f_y,b,k$: Yielding stress of the bolt
- $f_{u,b,k}$: Ultimate stress of the bolt
- $\alpha_a$: Material parameter

### Static actions

$$
N_{ij,Ed} = \frac{Z_{Ed}}{n_{tie}} \quad V_{ij,Ed} = \frac{(V_{Ed} - V_{fr,Ed,int})}{n_{tot}}
$$

### Dimensioning of the bolts

$(N-V)$ interaction according to DIN 18800-1,

- Resistances:
  $$
  N_{ij,Rd} = \min \left( \frac{f_y,b,k}{A_{Sp} \cdot 1.1 \cdot \gamma_M} , \frac{f_{u,b,k}}{A_{Sp} \cdot 1.25 \cdot \gamma_M} \right)
  \quad V_{ij,Rd} = \alpha_a \cdot \frac{f_{u,b,k}}{\gamma_M}
  $$

- Interaction verification:
  $$
  \left( \frac{N_{ij,Ed}}{N_{ij,Rd}} \right)^2 + \left( \frac{V_{ij,Ed}}{V_{ij,Rd}} \right)^2 \leq 1.0
  $$

According to DIN 18800 interaction verification may be omitted, if $N_{ij,Ed}/N_{ij,Rd} \leq 0.25$ or $V_{ij,Ed}/V_{ij,Rd} \leq 0.25$

### Recommendation

Determine the number of bolts in the pre-selection graphs as shown on pages 11 and 12.

### Threaded sleeve dimensioning

(Elastic - plastic method according to DIN 18800-1)

Each size of threaded sleeves can be checked using the limitation curves in the graph below. The capacity of the threaded sleeve is confirmed if the acting variables $V_{ij,Ed}$, $N_{ij,Ed}$ stay below the confines of the curve.

The load bearing capacity of the reinforcement bar attached to the threaded sleeves also has to be checked.
Pre-selection

The capacity of each HSC-B anchor is determined by:
- The threaded sleeve.
- Its headed/reinforcing bar
- The bolts used to connect the structural components to the threaded sleeve.

The load capacity of the sleeve and the yield value (F\text{yd}) of the attached anchor/reinforcement must be analysed and compared to the load capacity of the selected bolts. The load capacity of the bolts will vary according to the chosen strength grade.

To simplify pre-selection, the range of these components are combined in the following graphs. The yield force of the headed/reinforcing bar anchor is determined on the basis of F\text{yd} = 435 N/mm², while the load bearing capacities of the different bolt grades bolts are according to DIN 18800 (see page 10).

HSC-B 16 Load range graph
Indicates the upper limits of one sleeve with the headed/reinforcing bar and varying grades of M16 connecting bolts.

HSC-B 20 Load range graph
Indicates the upper limits of one sleeve with the headed/reinforcing bar and varying grades of M20 connecting bolts.
Pre-selection

HSC-B 25 Load range graph
limit curves including reinforcement creep and bolt load bearing capacities.

Concrete design and dimensioning according to German approval Z-15.6-284

HSC-B threaded sleeve dimensions

<table>
<thead>
<tr>
<th>ds [mm]</th>
<th>Sw [mm]</th>
<th>LM [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>24</td>
<td>48</td>
</tr>
<tr>
<td>20</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>25</td>
<td>41</td>
<td>75</td>
</tr>
</tbody>
</table>

The maximum shear force capacity of the steel connection max $V_{Ed}$ is determined by the load capacity of the concrete edge.

Local concrete failure

Action: shear force per sleeve $V_{ij,Ed}$ (→ page 10)
Resistance per sleeve:

$$V_{ij,c,loc,Rd} = \frac{1.3}{\gamma_c} \cdot S_w^2 \cdot (f_c \cdot R_{p,0.2})^{0.5}$$

$\gamma_c = 1.5$
$S_w =$ wrench size (→ table)
$f_c = f_{ck,cube} \leq 60 \text{ N/mm}^2$
$R_{p,0.2} = 440 \text{ N/mm}^2$
(Characteristic tensile yield strength of the sleeve material)

Verification:

$$\frac{V_{ij,Ed}}{V_{ij,c,loc,Rd}} \leq 1.0$$

Concrete edge failure

Action: $V_{con,Ed} = \frac{(V_{Ed} + V_{fr,Ed,\text{sup}})}{2}$
Friction proportion $V_{fr,Ed,\text{sup}}$ (→ page 9)

Resistance:

$$V_{con,Rd} = 15 \cdot \frac{\alpha}{\gamma_c} \cdot b_c \cdot L_M \cdot f_{ck}^{0.25} \text{ in [N]}$$
$\alpha = 0.85$
$\gamma_c = 1.5$
$f_{ck} \leq 50 \text{ N/mm}^2$
$b_c =$ face plate width of the attachment member [mm]
$L_M =$ sleeve length [mm] → table

Verification:

$$\frac{V_{con,Ed}}{V_{con,Rd}} \leq 1.0$$
1. Primary reinforcement preventing tensile splitting

The primary reinforcement preventing tensile splitting is provided by the first stirrup directly below each row of threaded sleeve anchors in both the tensile and in the compression zone.

\[ A_{sw,1} = 0.25 \cdot \frac{V_{Ed}}{n_{tot}} \left( 1 - \frac{S_w}{a_{ij,\text{max}}} \right) \cdot \frac{1.15}{f_{yk}} \]

- \( n_{tot} \) = total number of bolts
- \( S_w \) = wrench size, → table page 10
- \( a_{ij,\text{max}} \) = maximum distance between two sleeves in one row

2. Secondary reinforcement preventing tensile splitting

Secondary reinforcement preventing tensile splitting is provided by the stirrups positioned in both the tension and compression zones. The stirrups are spaced according to the minimum distances in the area \( x_{sw} \) shown in the figure. Minimum stirrup diameters \( d_{sw,2} \) are provided in the table above.

\[ A_{sw,2,tie} = 0.25 \cdot \frac{V_{Ed}}{2} \left( 1 - \frac{\sum a_{ij}}{b_{col}} \right) \cdot \frac{1.15}{f_{yk}} \]

\[ A_{sw,2,strut} = 0.25 \cdot \frac{V_{con,Ed}}{2} \left( 1 - \frac{\sum a_{ij}}{b_{col}} \right) \cdot \frac{1.15}{f_{yk}} \]

- \( a_{ij} \) = distance between two sleeves in one row
- \( b_{col} \) = width of the reinforced concrete member
- \( V_{con,Ed} \) = → page 12

Longitudinal reinforcement

A minimum number of longitudinal reinforcement \( A_{sl,\text{edge}} \) and \( A_{sl,\text{bet}} \) has to be placed in the concrete between the threaded sleeve bars. Minimum bar diameters are shown in the table above. This reinforcement has to be anchored above and below the steel member.

<table>
<thead>
<tr>
<th>HSC-B [mm]</th>
<th>( d_{sw,2} ) [mm]</th>
<th>( d_{sl,\text{edge}} ) [mm]</th>
<th>( d_{sl,\text{bet}} ) [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>6</td>
<td>≥ 12</td>
<td>≥ 10</td>
</tr>
<tr>
<td>20</td>
<td>8</td>
<td>≥ 12</td>
<td>≥ 12</td>
</tr>
<tr>
<td>25</td>
<td>12</td>
<td>≥ 20</td>
<td>≥ 20</td>
</tr>
</tbody>
</table>
Concrete reinforcement design and dimensioning following German approval Z-15.6-284

Anchorage of tension connection
The position of the tension anchor relative to the rear longitudinal column reinforcement is critical. Recommendation: Use headed female anchors.

Text for invitation to tender

HALFEN HSC-B
Concrete Steel Connection

with cast-in female bars for connecting steel structural members; positioning plate for accurate placement of the female bars; and face plate connection for accurate placement on supporting structural component,

Suitable for predominantly static and dynamic loads,

Suitable as connection to structural concrete for any structural steel component subject to bending moments, tension loads, and shear loads. Available with rectangular anchor heads for minimum anchorage lengths,

bar material BST 500 S
type of bar ...
corrosion protection ...
diameter ...
length ...
positioning plate and face plate according to provided drawing,

or similar, deliver and assemble according to manufacturer’s installation instructions.

Example: HALFEN HSC-B Concrete Steel Connection with Steel beam.
HALFEN Steel Corbel Connection

The advantages at a glance

HALFEN HSCC Steel Corbel Connections are a range of standard type tested corbels based on the HSC-B Concrete Steel Connection. The securely transfer tension and shear loads between attached structural components. HSCC Steel corbels have up to twice the load capacity of reinforced concrete corbels. The smaller beam recesses enable higher load bearing capacities for the supported beams. As a result the connection dimensions and building height can be significantly reduced.

Optimised construction sequence

- Easy to handle low-weight components
- Easily assembled bolted connections
- Immediately loadable connection
- No complicated and time consuming formwork needed
- Simplifies shape of precast structural components - less damage and less space required in transport

Multiple use

- Range to support loads from 115 kN up to 2600 kN – substantially reducing design time.
- Suitable to support components from walls, columns, and other concrete structural elements.
- Accurate installation using HSC-B positioning plate

Environmentally focused

- Components are available in hot dip galvanized (fv), electro-zinc plated (gv) or in stainless steel (A4) material to match corrosion protection with environmental conditions.
- The bolted connection allows an easy recycling of the material
### CONTACT HALFEN WORLDWIDE

HALFEN has a global network of Subsidiary Companies to assist you. The main contact information for North America, Europe and Asia is provided below. For a full list of offices please visit [www.halfen.com](http://www.halfen.com)

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