Construction specialists consider the HALFEN handrail connections type HGB to be particularly well suited for securing banisters on the front faces of thin deck and balcony slabs.

**Fast and cost-effective**
- adjustable anchoring
- can be used even on thin front faces of d ≥ 100 mm
- bolts instead of welds or dowels
- pre-engineered to reduce construction time
- permits later adjustment and even simple replacement of all attached structures

**Safe and dependable**
- statically verified mounting
- no damage to the concrete on the visible front faces of the slab
- while construction is in progress, it can also serve to secure safety rails (note DIN EN 795 „Fall protection“)
- The associated extra-strong HALFEN bolts ensure secure and statically solid attachment of the banister structure
### Regulatory requirements

Balconies are a part of the structural system. They must be designed, constructed, modified and maintained in such fashion that public safety or order and especially life, health or the natural fundamentals of life are not jeopardized. (MBO 07 and implementation directives)

In this context, the technical rules established by public announcement as regulatory building codes must be observed.

Technical rules specify load parameters, the calculation, dimensioning of structural products, construction types, structural layouts etc.

A regulatory requirement as part of regional building codes refers to structural stability: "Every structure as a whole and in its individual components must be stably self-supporting". This stability must be statically verifiable on the basis of technical standards (here DIN 1055 Part 3+4).

Another regulatory requirement addresses traffic safety, for example: Balconies and loggias must have fall-preventing safety banisters when they border on an area that lies more than 1 meter below. Up to a drop height of 12m the minimum banister height is 0.90m from the top surface of the finished floor or accessible ledge. For drop heights greater than 12m (except as per German LBO’s) the banister must be 1.10m high.

Other regulations, not covered here, address the design, dimensioning, banister spacing, fire protection, thermal/sound insulation, and rainwater drainage.

### Regulations, standards and directives to be observed when constructing banisters:

#### Regional Building Codes

The individual federal states have established different building codes and regulations. In all cases the technical regulations require verification of structural safety and functional fitness. The dimensioning of the banister mount must be backed up by a static calculation or a regulatory certification.

#### VOB – Part B, § 4, execution:

§ 4.2 (1) The contractor is required to perform the installation, at his own responsibility, in accordance with the contract. He has to abide by the accepted standards of the art as well as the provisions of the law and regulatory directives. VOB Part B, § 4.3, requires the contractor to report to the customer, in writing, any obvious design flaws, which he, as the expert, must be able to recognize. He alone is responsible for any resulting defect and consequential expenses. If he has satisfied his reporting obligation, the responsibility for the defect (such as a frontal banister attachment into too thin a concrete slab) passes to the customer.

#### BVM Directive

Directive on metal banisters / balustrades, version 98, publisher: BVM

#### Other applicable regulations and Standards (excerpted):

Accident Prevention Regulation “General Provisions” (VGB 1)

Industrial Safety Regulations

ETB – Directive “Fall Prevention Components”, version 06/85

Stainless Steels, certification No. Z-30.3-3, version 04/96

DIN 1045-1: Support structures of concrete, reinforced concrete and prestressed concrete; design and construction

DIN 1055-3: Action on support structures; intrinsic load and superimposed loads for above-ground structures

DIN 1055-4: Action on support structures; wind loads

DIN 18800-1: Steel structures; design and construction

DIN 18800-7: Steel structures; verification of weldability
HALFEN HANDRAIL CONNECTIONS HGB

Application Examples

Mounting of grandstand banister, O₂ World Berlin (under construction)

HALFEN handrail connections combine cost-effectiveness with aesthetic appearance

Fall protection during the construction phase

Finished, HGB cast-in channel, residential construction
HALFEN HANDRAIL CONNECTIONS HGB
Materials / Corrosion Protection

**Stainless Steel A4:**
Chromium is the most important alloying element in stainless steel. A specific chromium concentration ensures the generation of a passive layer on the surface of the steel that protects the base material against corrosion. This explains the high corrosion resistance of stainless steel.

"Anchor channels of stainless steel may be employed outdoors – even in an industrial environment and near the ocean but may not be exposed to saltwater".
→ refer to BVM directive “Metal banisters and balustrades”.

### HALFEN cast-in channels, stainless steel

<table>
<thead>
<tr>
<th>Designation</th>
<th>Stainless steel</th>
<th>Corrosion resistance class per Z-30.3-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel profile</td>
<td>1.4401, 1.4404 or 1.4571</td>
<td>DIN EN 10 088</td>
</tr>
<tr>
<td>Ribbed-head anchor</td>
<td>Betonstahl BST 500S</td>
<td>DIN 488</td>
</tr>
</tbody>
</table>

### HALFEN bolts, stainless steel

<table>
<thead>
<tr>
<th>Designation</th>
<th>Stainless steel</th>
<th>Corrosion resistance class per Z-30.3-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolt</td>
<td>1.4401, 1.4404, 1.4571 or 1.4578</td>
<td>DIN EN 3506-1 and DIN EN 10 088</td>
</tr>
<tr>
<td>Hexagonal nut</td>
<td>1.4401, 1.4404 or 1.4571, A4-50, A4-70</td>
<td>DIN EN 3506-2 and DIN EN 10 088</td>
</tr>
<tr>
<td>Washer</td>
<td>1.4401, 1.4404, 1.4571 or 1.4578</td>
<td>DIN EN 10 088</td>
</tr>
</tbody>
</table>

**Galvanised:**
Dipped in a galvanizing bath at a temperature of approx. 460°C, a method used primarily for open-profile channels.

Galvanised material for closed, dry rooms, for instance when mounting staircase banisters in residential buildings, schools or retail stores.
→ Available on request

### Identifying the HALFEN HGB cast-in channels

**Product identification**

1. on the anchor
2. additionally inside the profile
**HALFEN HANDRAIL CONNECTIONS HGB**

**Installation / Assembly**

1. **Nail the HALFEN cast-in channel to the formwork**

   Where possible, use stainless steel nails to avoid extraneous corrosion.

   After the formwork is removed, extract the foam filler from the HALFEN cast-in channels.

2. **Installation and adjustment of the balusters**

   Turn HGB-M banister bolts 90° (up to the stop in the HALFEN cast-in channel).

   Remember to also order the washers.

3. **Tighten the nut - done**

   Use torque wrench for tightening the nuts. Apply torque as shown in the table on the right.

---

**Banister bolts**

<table>
<thead>
<tr>
<th>Stainless steel</th>
<th>Material grade A4-70</th>
<th>Torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>HGB - M 50/30</td>
<td>M 16</td>
<td>60</td>
</tr>
<tr>
<td>for profiles 49/30 and 54/33</td>
<td>M 12</td>
<td>25</td>
</tr>
<tr>
<td>HGB - M 40/22</td>
<td>M 16</td>
<td>60</td>
</tr>
<tr>
<td>for profiles 40/25</td>
<td>M 12</td>
<td>25</td>
</tr>
<tr>
<td>HGB - M 38/17</td>
<td>M 16</td>
<td>60</td>
</tr>
<tr>
<td>for profiles 38/17</td>
<td>M 12</td>
<td>25</td>
</tr>
</tbody>
</table>
HALFEN HANDRAIL CONNECTIONS HGB
Product Range

HALFEN HGB cast-in channels and bolts

<table>
<thead>
<tr>
<th>Nomenclature</th>
<th>Dimensions HGB-E [mm]</th>
<th>Dimensions HGB-EE [mm]</th>
<th>HALFEN HGB bolts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>l  dA hA G l1 / l2 dA hA G l1 / l2 dA hA G l1 / l2</td>
<td>Weight kg / ea</td>
<td>Weight kg / ea</td>
</tr>
<tr>
<td>HGB E - 54/33-A4</td>
<td>100</td>
<td>14</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>14</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>14</td>
<td>200</td>
</tr>
<tr>
<td>HGB E - 49/30-A4</td>
<td>100</td>
<td>12</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>12</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>12</td>
<td>110</td>
</tr>
<tr>
<td>HGB E - 40/25-A4</td>
<td>100</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>HGB E - 38/17-A4</td>
<td>100</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>10</td>
<td>90</td>
</tr>
</tbody>
</table>

Ordering example HGB channel:
HGB-E-49/30 - 200 - A4

Ordering example banister bolt:
HGB-M-50/30-M12x40-A4-70

Materials:
- A4 = Stainless steel 1.4571/1.4404/1.4401
- FV = Steel S235JR, hot-dip galvanised (for interiors)

Available on request

Bolt placement:

Short element

Dimensions [mm]:
l1 = 170, l2 = 170, α = 90°

Available on request
**HALFEN HANDRAIL CONNECTIONS HGB**

Dimensioning Fundamentals

---

**Banister height**

The minimum height $h_b$ of a banister is 0.90 m from the top edge of the finished floor or accessible ledge to the upper edge of the banister/balustrade. In the case of drop heights of more than 12.0 m (except as specified in the applicable regional building code (LBO)), the banister must be 1.10 m high.

It would be desirable to have one uniform minimum height of 1.00 m as has already been mandated in the commercial sector and in some other European countries.

**Balcony slab**

An attachment with anchor channels or dowel systems requires concrete at least of grade C 20/25. If the concrete is of less than a grade C 20/25 or it is unknown, a case-by-case decision must be made.

The thickness of the balcony slab must be at least $h = (120)$ mm when the HGB is mounted on the front face. Other mounting types and systems require a thicker slab.

All concrete-embedded mounts installed outdoors (e.g. on balconies) must consist of stainless steel.

**Clearances**

The structural design of the banister must take all fundamental requirements into account. As a general rule, all banisters must be built in a way that a person cannot fall through them, for instance between rods, lattice bars or solid infill.

They should also be designed so as not to entice but instead to discourage anyone from climbing over them.

The specific requirements for a banister are determined by the intended use (private, public, commercial) and the drop height involved.

Also to be observed are the building codes of the individual federal states, the ETB Directive “Fall Protection Components” and DIN 18065 (Stairs in Buildings – definition, rules, key measurements).

**Dimensions**

The forces bearing on the banister must be conducted into the structural base. It will be necessary to verify that the forces

- a) are absorbed by the banister itself and
- b) can be transferred by the mounting elements into the deck slab.
### Banister heights

<table>
<thead>
<tr>
<th>Drop height</th>
<th>Minimum height of banister</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 12 m</td>
<td>100 cm</td>
<td>Relevant local building regulations LBO and if necessary other provisions e.g., ZTV-ING for civil constructions should be observed.</td>
</tr>
<tr>
<td>Greater than 12 m</td>
<td>110 cm</td>
<td></td>
</tr>
</tbody>
</table>

### Load assumptions

1. **Rail load H according to DIN 1055-3, Table 7**
   
   "The actual horizontal loads per table 7 are to be assessed at full height in the drop height and at 50% in the opposite direction (but not less than 0.5 kN/m)."

2. **Vertical loads V according to BVM directive**
   
   For mounting, the following assumptions as per the BVM directive: 1998 for metal banisters / balustrades are made.

3. **Wind loads FW according to DIN 1055-4**

   7.1 (3) "Wind and actual horizontal loads need not be added together."

   Except balcony parapets and pergolas, which serve as escape routes. As per ETB Directive “Fall Prevention Components”, wind and horizontal loads are to be added together.

### Size determination

\[
N = \max\left(\frac{M}{d} + H \text{ or } F_W\right)
\]

\[
F = \sqrt{N^2 + V^2}
\]

\(DF\) = Pressure area under connecting plate

\(F_c^o\) = Compressive force above

\(F_c^b\) = Compressive force below

\(d\) = inner lever arm, \(\text{h}_p/2 - 10\) mm, depends on the size of the connecting plate

\(V, M, H, F_W\) = Loads and stress factors per pillar
HALFEN HANDRAIL CONNECTIONS HGB

Dimensioning

Calculation example:

Size determination:

Pillar spacing: 1.625 m
Pillar height over OKFF: 1.00 m
Structure height: 9.0 m < 25.0 m
Railload: 0.5 kN/m (residential building)

Wind effect:
Structure height 9.0 m < 25.0 m → not susceptible to vibrations
q = 0.65 kN/m² → Wind zone 2, inland, h ≤ 10 m

Load bearing area:
A = 1.24 ∙ 1.625 = 2.02 m² = 2.0 m² ; h/d = 0.75

External pressure coefficient:
cpe,1 = -1.4
cpe,10 = -1.2
cpe = cpe,1 + (cpe,10 - cpe,1) ∙ lg A = -1.4 + (-1.2 + 1.4) ∙ lg2 = -1.34

Wind effect:
Fw = cpe ∙ q ∙ A = -1.34 ∙ 0.65 ∙ 2.0 = -1.74 kN

Impact per pillar:

Wind load*: 
Fw,Ed = 1.74 ∙ 1.5 = 2.61 kN
Rail load*: 
HEd = 0.5 ∙ 1.625 ∙ 1.5 = 1.22 kN

Vertical load:
VEd = 0.4 ∙ 1.625 ∙ 1.5 = 0.4 kN → from support load
+ 0.35 ∙ 1.625 ∙ 1.35 = 0.9 kN → from dead load

Size determination:

MEd = 2.61 ∙ 0.56 + (0.4 + 0.9) ∙ 0.10 + 0.8 ∙ (0.10 + 0.10)
= 1.75 kNm

Nd = \frac{Me}{d} + Fw,Ed = \frac{1.75}{0.05} + 2.61 = 37.61 kN

Ve = 0.4 + 0.9 + 0.8 = 2.1 kN

\[ F_{Ed} = \sqrt{N_{Ed}^2 + V_{Ed}^2} = \sqrt{37.61^2 + 2.1^2} = 37.67 kN = 2 \cdot 18.8 kN \]

Selected:

HALFEN cast-in channel: HGB-E-54/33-200, Mounting type B
with \( M_{Ed} = 2.44 kNm > M_{Ed} = 1.75 kNm \) at
\( F_{Rd} = 2.22.8 kN > F_{Ed} = 2.18.8 kN \)
\( V_{Rd} = 11.2 kN > V_{Ed} = 2.1 kN \)

Banister bolt: HGB-M-50/30, M16x50
with \( F_{Rd} = 33.0 kN > F_{Ed} = 18.8 kN \)
\( M_{Rd}, F_{Rd}, V_{Rd} \rightarrow page 42 \)

*) the higher value of wind and rail load is the determining factor.
HALFEN HANDRAIL CONNECTIONS HGB

Dimensioning

Fastening with 1 bolt

Banister bolt HGB-M cast-in channel HGB-E

≥25 ≥25

Fastening with 2 bolts

Banister bolt HGB-M cast-in channel HGB-E

≥25 ≥25

The maximum acceptable force is comprised of a horizontal component N and a vertical component V. Thus the vertical load V, which acts as a transverse load for the channels, is limited for all the profiles as per the table presented below left.

Design ratings of acceptable connection moments MRd [kNm] and load capacity FRd [kN] per HGB - screw

<table>
<thead>
<tr>
<th>e</th>
<th>h</th>
<th>Mounting type</th>
<th>FEd</th>
<th>NEd</th>
<th>VEd</th>
</tr>
</thead>
<tbody>
<tr>
<td>[mm]</td>
<td>[mm]</td>
<td>A (1)</td>
<td>[kN]</td>
<td>[kN]</td>
<td>[kN]</td>
</tr>
<tr>
<td>38/17</td>
<td>40/25</td>
<td>49/30</td>
<td>54/33</td>
<td>38/17</td>
<td>40/25</td>
</tr>
<tr>
<td>40</td>
<td>120</td>
<td>0.36</td>
<td>0.61</td>
<td>1.28</td>
<td>0.61</td>
</tr>
<tr>
<td>60</td>
<td>160</td>
<td>0.52</td>
<td>0.90</td>
<td>1.87</td>
<td>0.90</td>
</tr>
<tr>
<td>80</td>
<td>200</td>
<td>0.68</td>
<td>1.17</td>
<td>2.44</td>
<td>1.17</td>
</tr>
<tr>
<td>100</td>
<td>240</td>
<td>0.83</td>
<td>1.42</td>
<td>2.97</td>
<td>1.42</td>
</tr>
<tr>
<td>120</td>
<td>280</td>
<td>0.97</td>
<td>1.67</td>
<td>3.48</td>
<td>1.67</td>
</tr>
<tr>
<td>140</td>
<td>320</td>
<td>1.10</td>
<td>1.90</td>
<td>3.97</td>
<td>1.90</td>
</tr>
<tr>
<td>FRd</td>
<td>kN</td>
<td>9.8</td>
<td>11.2</td>
<td>16.8</td>
<td>35.0</td>
</tr>
</tbody>
</table>

Design ratings of acceptable transverse forces VEd [kN] and edge clearances ae, ae

<table>
<thead>
<tr>
<th>Profile</th>
<th>VEd per channel [kN]</th>
<th>ae [mm]</th>
<th>ae [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>38/17</td>
<td>4.9</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>40/25</td>
<td>7.4</td>
<td>60</td>
<td>45</td>
</tr>
<tr>
<td>49/30</td>
<td>9.9</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>54/33</td>
<td>11.2</td>
<td>75</td>
<td>50</td>
</tr>
</tbody>
</table>

Design ratings of the load capacity FRd and MRd

<table>
<thead>
<tr>
<th>Bolts Type HGB-M</th>
<th>Stainless steel A4-70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thread</td>
<td>FEd [kN]</td>
</tr>
<tr>
<td>M12</td>
<td>17.6</td>
</tr>
<tr>
<td>M16</td>
<td>33.0</td>
</tr>
</tbody>
</table>

Concrete ≥ C20/25