Handrail Connections HGB

The Advantages at a glance

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.

HALFEN handrail connections HGB
Profile HGB E-54/33-A4

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

HALFEN handrail connections HGB
Profile HGB E-49/30-A4

HALFEN handrail connections HGB
Profile HGB E-40/25-A4

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

HALFEN handrail connections HGB
Profile HGB E-38/17-A4

HALFEN HANDRAIL CONNECTIONS HGB

General

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 heigh.

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

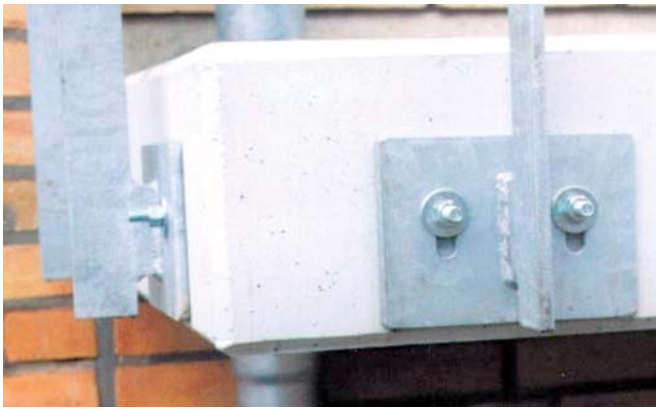
DIN 1045-1:	Support structures of concrete, reinforced concrete and prestressed concrete; design and construction
DIN 1055-3:	Action on support structures; intrinsic load and superimposed loads for above-ground structures
DIN 1055-4:	Action on support structures; wind loads
DIN 18800-1:	Steel structures; design and construction
DIN 18800-7:	Steel structures; verification of weldability

HALFEN HANDRAIL CONNECTIONS HGB

Application Examples

Mounting of grandstand banister, O_2 World Berlin (under construction)

HALFEN handrail connections combine cost-effectiveness with aesthetic appearance



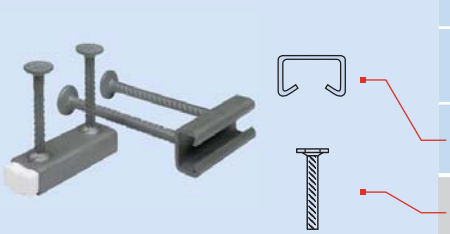
Fall protection during the construction phase

Finished, HGB cast-in channel, residential construction

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.

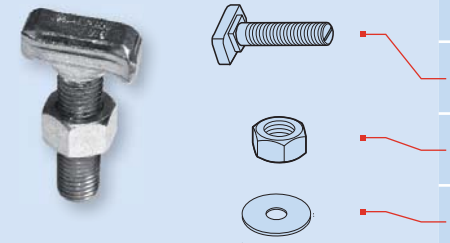
"Anchor channels of stainless steel may be employed outdoors – even in an industrial environment and near the ocean but may not be exposed to saltwater".
→ refer to BVM directive "Metal banisters and balustrades".

HALFEN cast-in channels, stainless steel



Designation	Stainless steel		
	Materials	Standard	Corrosion resistance class per Z-30.3-6
Channel profile	1.4401, 1.4404 or 1.4571 ■	DIN EN 10 088	III
Ribbed-head anchor	Betonstahl BSt 500S □	DIN 488	

HALFEN bolts, stainless steel



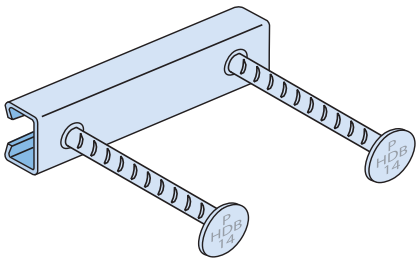
Designation	Stainless steel		
	Materials	Standard	Corrosion resistance class per Z-30.3-6
Bolt	1.4401, 1.4404, 1.4571 or 1.4578, A4-50 or A4-70 ■	DIN EN 3506-1 and DIN EN 10 088	III
Hexagonal nut	1.4401, 1.4404 or 1.4571, A4-50, A4-70 ■	DIN EN 3506-2 and DIN EN 10 088	III
Washer	1.4401, 1.4404, 1.4571 or 1.4578 ■	DIN EN 10 088	III

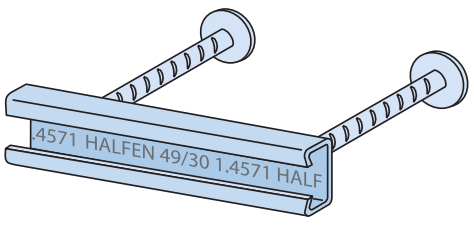
■ **A4** = Stainless steel 1.4571/1.4404/1.4401

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

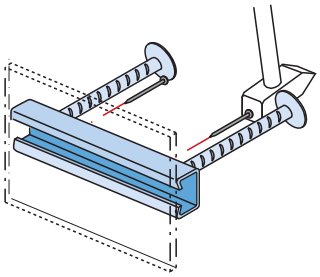




Product identification

① on the anchor
② additionally inside the profile

1 Nail the HALFEN cast-in channel to the formwork

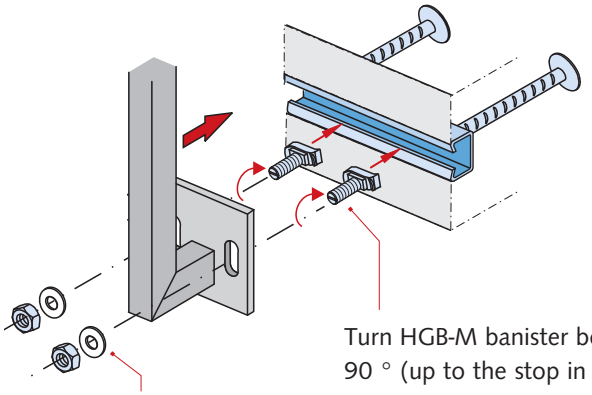


Where possible, use stainless steel nails to avoid extraneous corrosion.

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

Nail the HALFEN cast-in channel to the formwork

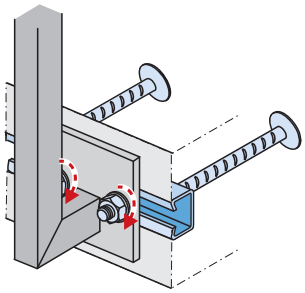
2 Installation and adjustment of the balusters

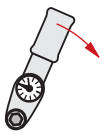


Turn HGB-M banister bolts 90 ° (up to the stop in the HALFEN cast-in channel).

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.

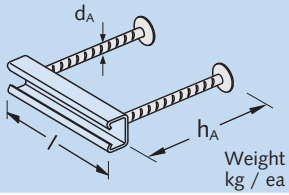
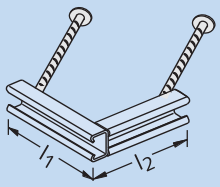
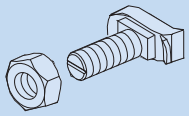
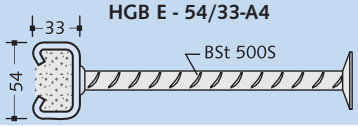
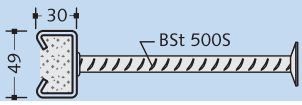
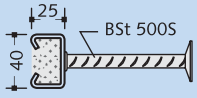
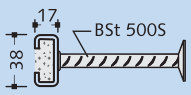
Banister bolts

Stainless steel Material grade A4-70		Torque [Nm]	
HGB - M 50/30		M 16	60
for profiles 49/30 and 54/33		M 12	25
HGB - M 40/22		M 16	60
for profiles 40/25		M 12	25
HGB - M 38/17		M 16	60
for profiles 38/17		M 12	25

HALFEN HANDRAIL CONNECTIONS HGB

Product Range

HALFEN HGB cast-in channels and bolts

Nomenclature	Dimensions HGB-E [mm]				Dimensions HGB-EE [mm]				HALFEN HGB bolts	
				Weight kg / ea				Weight kg / ea		
	l	dA	hA	G	l1 / l2	dA	hA	G	Type / FK	Size
HGB E - 54/33-A4 	100	14	200	1.105	170/170	14	250	2.363	HGB M-50/30 A4-70	M12x40 M16x50
	150			1.348						
	200			1.591						
HGB E - 49/30-A4 	100	12	110	0.589	170/170	14	150	1.457	HGB M-50/30 A4-70	M12x40 M16x50
	150			0.743						
	200			0.897						
HGB E - 40/25-A4 	100	10	90	0.213	170/170	14	90	1.031	HGB M-40/22 A4-70	M12x40 M16x40
	150			0.320						
	200			0.427						
HGB E - 38/17-A4 	100	10	90	0.176	170/170	12	90	0.817	HGB M-38/17 A4-70	M12x40 M16x40
	150			0.265						
	200			0.353						

Ordering example HGB channel:

HGB-E-49/30 - 200 - A4
- A4 → Material
- 200 → Length [mm]
- HGB-E-49/30 → Nomenclature

Ordering example banister bolt:

HGB-M-50/30-M12x40-A4-70
- A4-70 → Material
- M12x40 → Thread-Ø x Length
- HGB-M-50/30 → Nomenclature

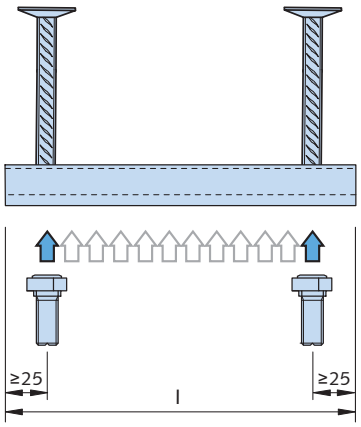
Materials:

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

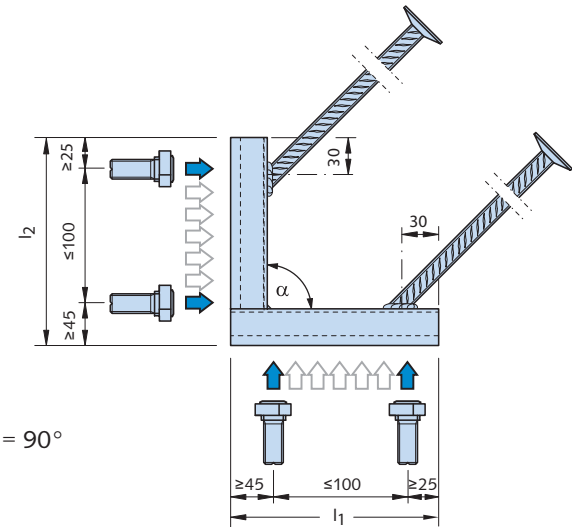
Available on request

Bolt placement:

Short element



Corner piece



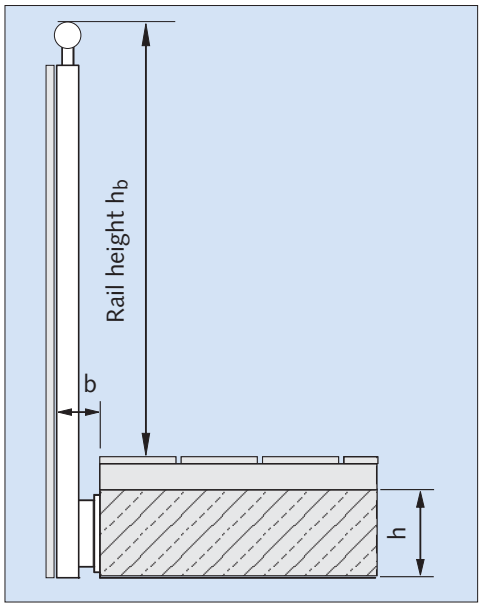
Dimensions [mm]:
l_1 = 170, l_2 = 170, α = 90°

Available on request

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 1.00m as has already been mandated in the commercial sector and in some other European countries..

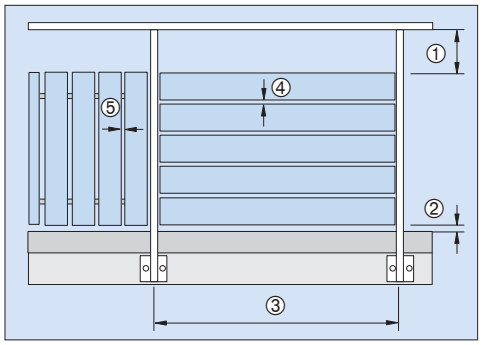


b = clear distance between back of the veneer and the front face of the balcony slab or gutter / kick plate

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.



① clear distance between bottom edge of hand rail and top edge of facing / lower structure
② clear distance between the top edge of the finished floor and the bottom edge of the facing / lower structure
③ distance between posts (inter-axis)
④ clear distance between horizontal facings
⑤ clear distance between vertical facings

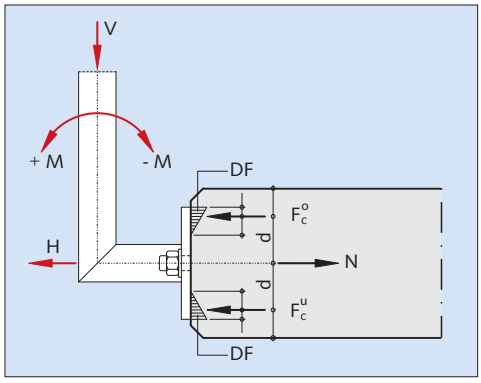
Clearances

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.



Dimensioning

Banister heights

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

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)."

Residential buildings and common rooms with little traffic	H= 0,5 KN/m
General	H= 1,0 KN/m
Areas with considerable gatherings, factories, workshops	H= 2,0 KN/m

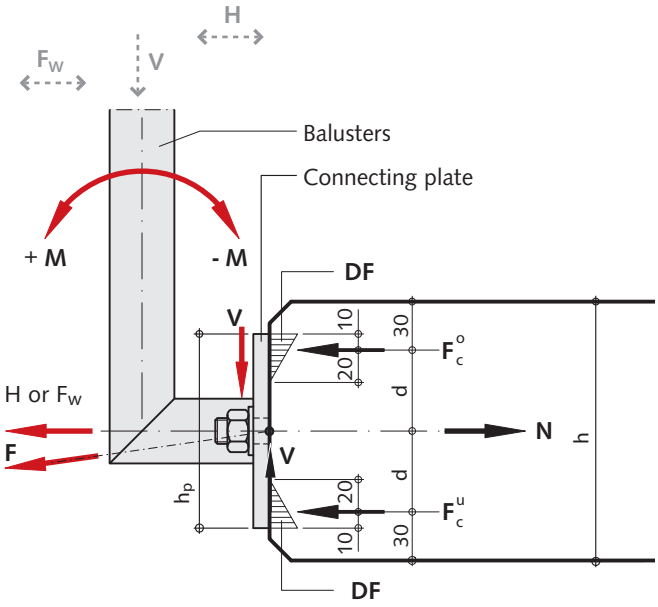
2. Vertical loads V according to BVM directive
For mounting, the following assumptions as per the BVM directive: 1998 for metal banisters / balustrades are made.

From support capacity	V_1 = 0,15 KN/m
Dead weight of structure including lining	V_2 = 0,40 KN/m
From window planter	V_3 = 0,35 KN/m

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.

Velocity pressure q in kN/m² and total wind power F_W are calculated as per DIN 1055-4 (not applicable to interior banisters).

Size determination



DF = Pressure area under connecting plate
F_c^o = Compressive force above
F_c^u = Compressive force below
d = inner lever arm, $h_p/2$ - 10 mm, depends on the size of the connecting plate
V, M, H, F_W = Loads and stress factors per pillar

$$N = \frac{\text{max. } M}{d} + H \text{ or } F_w$$

$$F = \sqrt{N_2 + V^2}$$

Calculation example:

Size determination:

Pillar spacing: 1.625 m
Pillar height over OKFF: 1.00 m
Structure heigth: 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:

$A = 1.24 \cdot 1.625 = 2.02\ m^2 \approx 2.0\ m^2$; h/d = 0.75

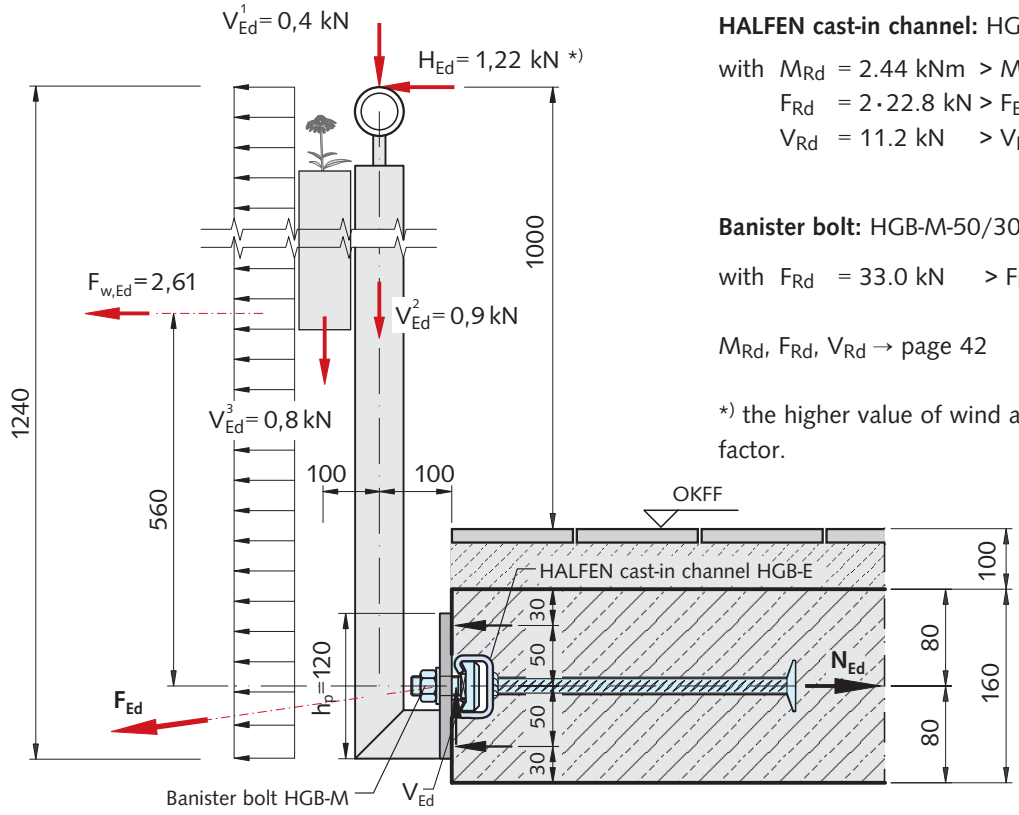
External pressure coefficient:

$c_{pe,1} = -1.4$
$c_{pe,10} = -1.2$
$c_{pe} = c_{pe,1} + (c_{pe,10} - c_{pe,1}) \cdot \lg A = -1.4 + (-1.2 + 1.4) \cdot \lg 2 = -1.34$

Wind effect:

$F_w = c_{pe} \cdot q \cdot A = -1.34 \cdot 0.65 \cdot 2.0 = -1.74$ kN

Example:



Impact per pillar:

Wind load*): $F_{w,Ed} = 1.74 \cdot 1.5 = 2.61$ kN

Rail load*): $H_{Ed} = 0.5 \cdot 1.625 \cdot 1.5 = 1.22$ kN

Vertical load:

$V_{Ed} = 0.15 \cdot 1.625 \cdot 1.5 = 0.4$ kN → from support load
$+ 0.40 \cdot 1.625 \cdot 1.35 = 0.9$ kN → from dead load
$+ 0.35 \cdot 1.625 \cdot 1.35 = 0.8$ kN → from window planter

Size determination:

$M_{Ed} = 2.61 \cdot 0.56 + (0.4 + 0.9) \cdot 0.10 + 0.8 \cdot (0.10 + 0.10) = 1.75$ kNm

$N_{Ed} = \frac{M_{Ed}}{d} + F_{w,Ed} = \frac{1,75}{0,05} + 2,61 = 37,61$ kN

$V_{Ed} = 0.4 + 0.9 + 0.8 = 2.1$ kN

$F_{Ed} = \sqrt{N_{Ed}^2 + V_{Ed}^2} = \sqrt{37,61^2 + 2,1^2} = 37,67$ kN = $\underline{\underline{2 \cdot 18,8}}$ kN

Selected:

HALFEN cast-in channel: HGB-E-54/33-200, Mounting type B

with $M_{Rd} = 2.44$ kNm > $M_{Ed} = 1.75$ kNm
$F_{Rd} = 2 \cdot 22.8$ kN > $F_{Ed} = 2 \cdot 18.8$ kN
$V_{Rd} = 11.2$ kN > $V_{Ed} = 2.1$ kN
} at h_p = 120 mm

Banister bolt: HGB-M-50/30, M16x50

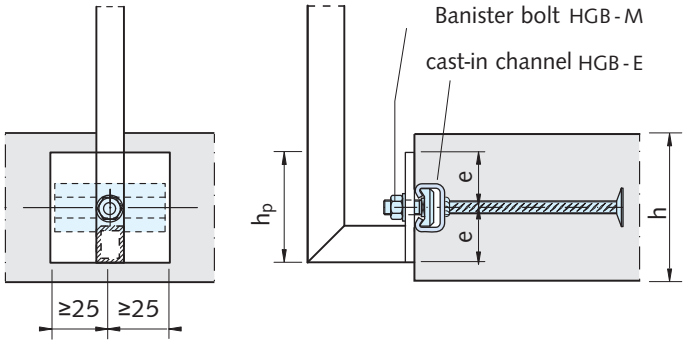
with $F_{Rd} = 33.0$ kN > $F_{Ed} = 18.8$ kN

M_{Rd}, F_{Rd}, V_{Rd} → page 42

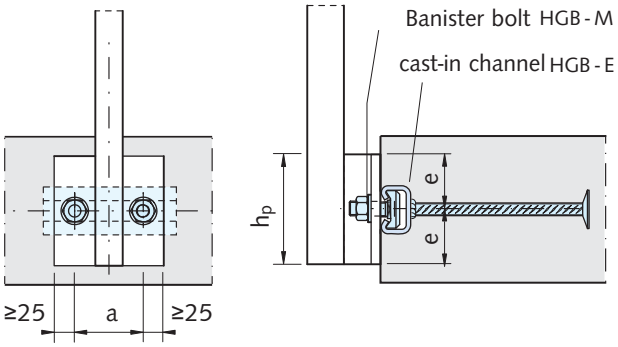
*) the higher value of wind and rail load is the determining factor.

Dimensioning

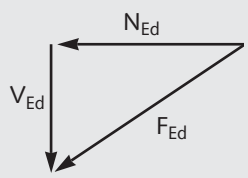
Fastening with 1 bolt



Fastening with 2 bolts



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.



Concrete ≥ C20/25

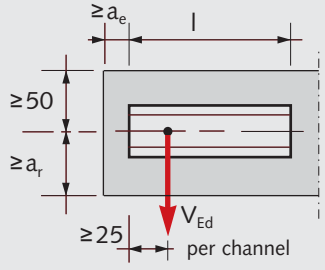
$F_{Ed} = \sqrt{N_{Ed}^2 + V_{Ed}^2} \leq F_{Rd}$

$V_{Ed} \leq V_{Rd}$

Design ratings of acceptable connection moments $M_{R,d}$ [kNm] and load capacity F_{Rd} [kN] per HGB - screw

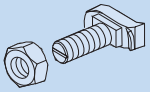
e	h	100-200 F_{Ed} < 80 Mounting type A ①				150-200 F_{Ed} F_{Ed} ≥ 80 Mounting type B				150-200 F_{Ed} F_{Ed} ≥ 100 Mounting type C			
		HGB-E				HGB-E				HGB-E			
[mm]	[mm]	38/17	40/25	49/30	54/33	38/17	40/25	49/30	54/33	38/17	40/25	49/30	54/33
40	120	0.36	0.41	0.61	1.28	0.46	0.61	0.92	1.67	0.51	0.66	1.02	1.79
60	160	0.52	0.60	0.90	1.87	0.67	0.90	1.35	2.44	0.75	0.97	1.50	2.62
80	200	0.68	0.78	1.17	2.44	0.87	1.17	1.75	3.18	0.97	1.26	1.95	3.41
100	240	0.83	0.95	1.42	2.97	1.07	1.42	2.14	3.87	1.19	1.54	2.37	4.16
120	280	0.97	1.11	1.67	3.48	1.25	1.67	2.50	4.54	1.39	1.81	2.78	4.88
140	320	1.10	1.26	1.90	3.97	1.42	1.90	2.85	5.18	1.58	2.06	3.17	5.56
F_{Rd} [kN]		9.8	11.2	16.8	35.0	2x 6.3	2x 8.4	2x 12.6	2x 22.8	2x 7.0	2x 9.1	2x 14.0	2x 24.5

Design ratings of acceptable transverse forces V_{Rd} and edge clearances a_r, a_e



Profile	V_{Rd} per channel [kN]	a_r [mm]	a_e [mm]
38/17	4.9	50	40
40/25	7.4	60	45
49/30	9.9	70	50
54/33	11.2	75	50

Design ratings of the load capacity F_{Rd} and M_{Rd}

Bolts Type HGB-M 	Stainless steel A4-70	
		Bending moment per screw
Thread	F_{Rd} [kN]	M_{Rd} [Nm]
M12	17,6	45,9
M16	33,0	116,6