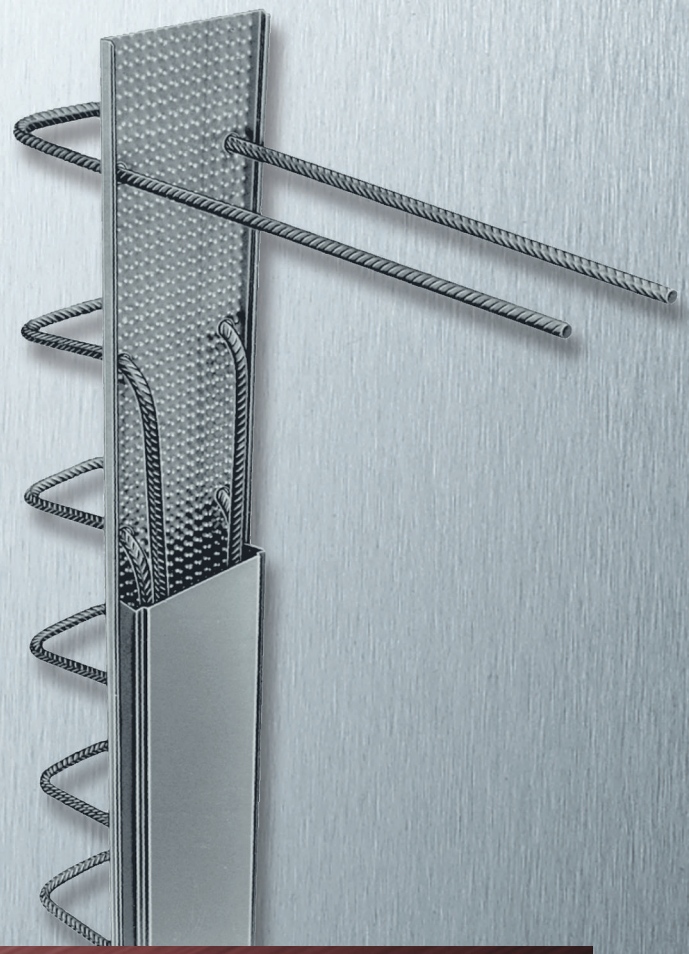
HALFEN HBT REBEND CONNECTION

TECHNICAL PRODUCT INFORMATION



HALFEN HBT REBEND CONNECTION

HBT 16.1-E

CONCRETE

- DIBt Approval Z-21.8-2035
- Type tested acc. to approval and EUROCODE 2

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HALFEN HBT REBEND CONNECTION

Contents

CAD drawings for HBT-Elements can be found in the HALFEN CAD library under reinforcement technology. All drawing can be downloaded free at www.halfen.com. Following file formats are available:

- CAD - DWG and DXF

A free DVD is also available if preferred. Our contact details, addresses, telephone and fax numbers can be found on the back cover of this catalogue

Following approval and type test apply in this document:

- German National Technical Approval (DIBt Deutsches Institut für Bautechnik) No. Z-21.8-2035 for HALFEN HBT Rebend Connection
- Type test report no. 4117-6131/14 for HALFEN HBT Rebend Connection according to approval no. Z-21.8-2035

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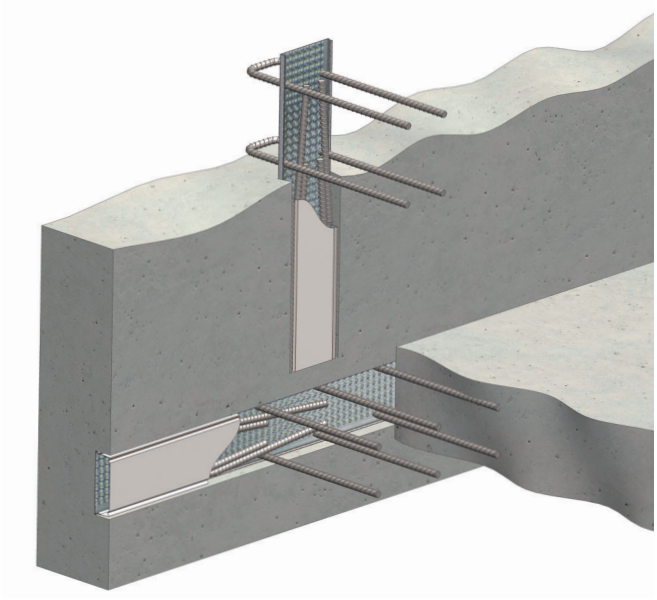
HBT – the connection solution

The HALFEN HBT is the first rebend connection with general building approval. The simplified calculation method according to the approval requires verification of only two basic load cases, this results in higher shear load capacity than previously.



HALFEN HBT Rebend connections allow a simple and effective connection of reinforced concrete elements, which are cast in different phases. All types of slabs, from floor slabs, walls and stairs can be subsequently cast with sufficient bond.

The rebar are bent and secured in a case with a back and a removable cover. The HALFEN profile cases are available in different widths. The case is cast into the concrete element; after striking the formwork, the case cover is removed and the rebar is straightened.

The customer can select either a single-row or double-row profile. The single-row profile has a regular spacing of holes in a single row penetrated by reinforcement bars designed for the required application; the double-row profile is similar but has two rows.

Safety

- improved planning-reliability through general building authority approval based on real-world load capacity tests
- type tested load capacity tables
- more safety in planning and execution due to factory production and third party control

- rebar (8, 10, 12 mm) B500B steel (stainless steel B500 NR on request)
- the back is galvanised sheet metal with a specially profiled surface
- dimensionally stable, galvanised, sheet metal cover with a pre-punched hole to facilitate removal

Simple

- simplified calculation concept with only two basic load cases
  - shear load longitudinal to joint
  - shear load transverse to joint
- both shear and longitudinal load transfer using standard type profiles
- if required a verification of combined shear and longitudinal load in the concrete joint is possible
- standard type is suitable for constructive connections as well as for static critical connections – no risk of mix ups on-site or in the precast plant
- reduced case height – ideal for thin elements or precast concrete elements with minimal concrete cover

Versatile

Optimal connections for a multitude of applications with 57 possible combinations of rebar and profile widths.
A standardized range of product with element lengths of 0.8 m and 1.25 m are available for the most common applications.

Lots of reasons, one conclusion: safety, quality and protection – for you and your company.

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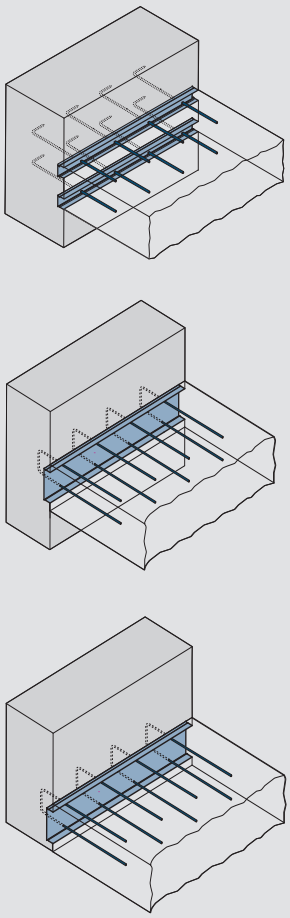
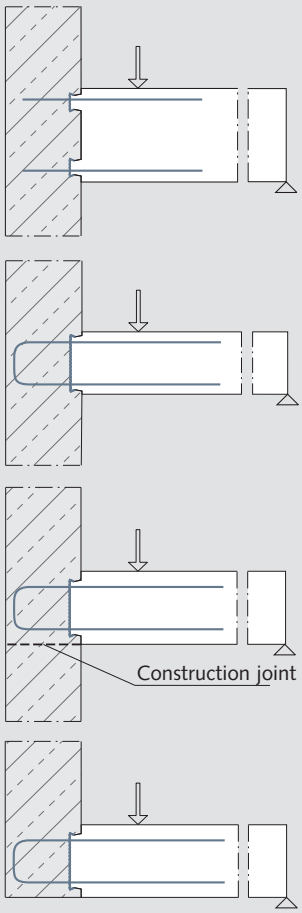
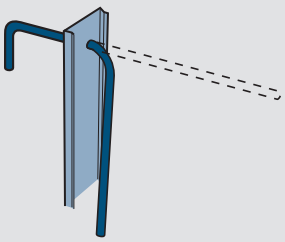
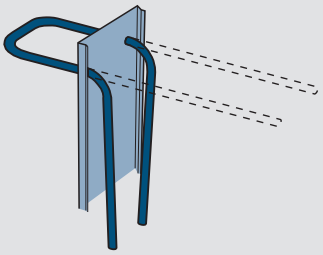
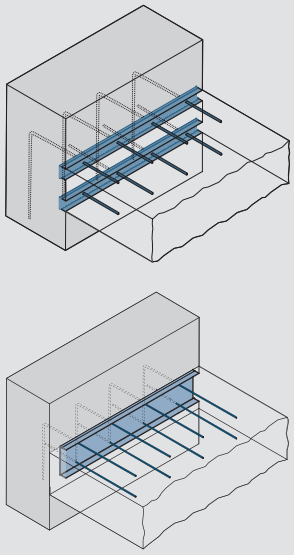
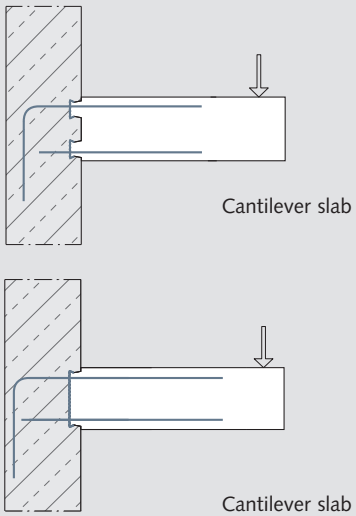
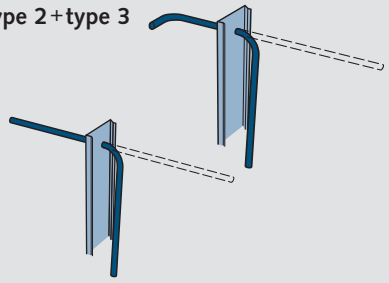
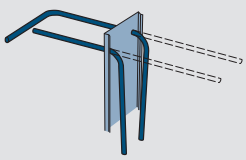
HALFEN HBT REBEND CONNECTION

Type Overview/Application Examples

Shear load transverse to the case, for example; floor-slab – wall

Application	Vertical section	Rebar type
		2 × Type 1  Type 5 

Shear load transverse to the case, for example; landing-slab – wall

Application	Vertical section	Rebar type
		Type 2 + type 3  Type 23 

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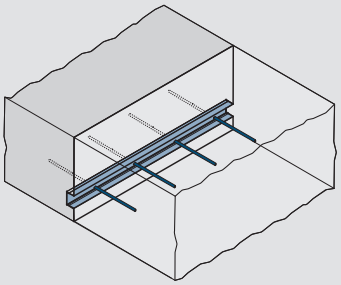
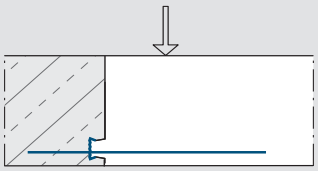
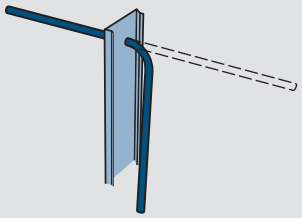
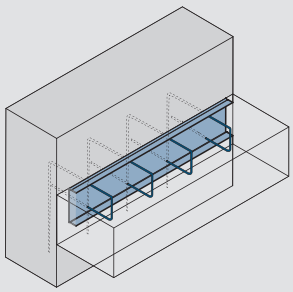
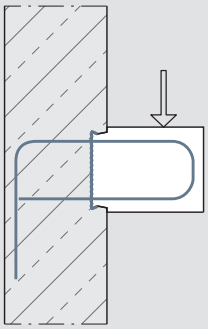
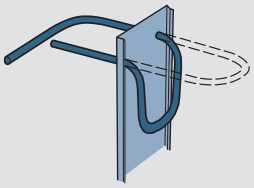
HALFEN HBT REBEND CONNECTION

Type Overview/Application Examples

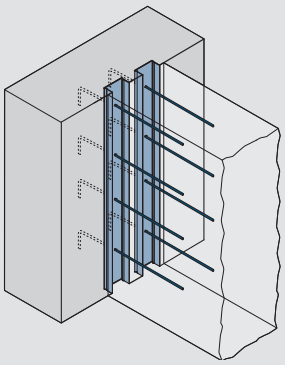
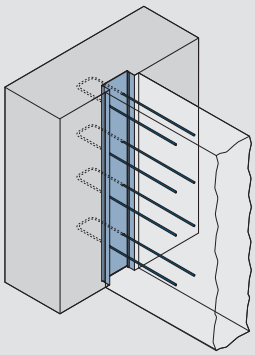
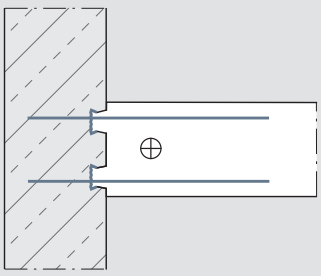
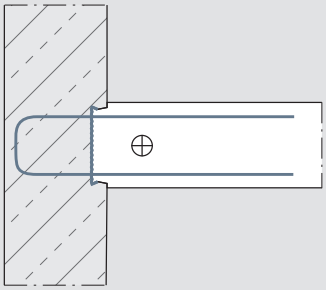
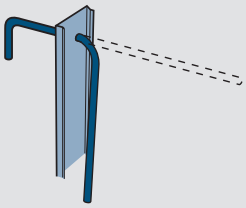
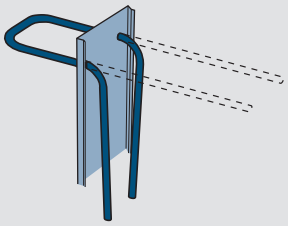
Shear load tranverse to the case, for example floor-slab – floor-slab

Application	Vertical section	Rebar type
		Type 3 

Shear load transverse to the case, for example corbel – wall

Application	Vertical section	Rebar type
		Type 7 

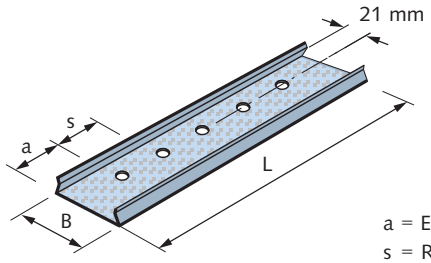
Shear load longitudinal to the case, for example wall – wall and floor-slab – wall

Application	Horizontal section	Rebar type
 	 	2 × Type 1  Type 5 

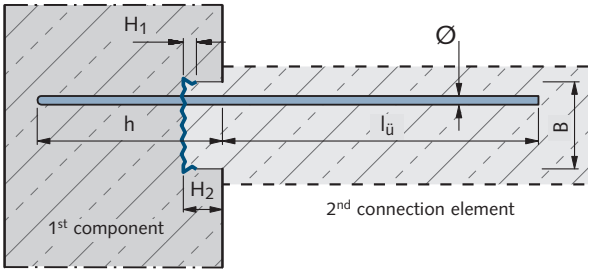
HALFEN HBT REBEND CONNECTION

Single-Row Profiles

Profile dimensions



a = End spacing
s = Rebar spacing
B = Casing width
L = Element length

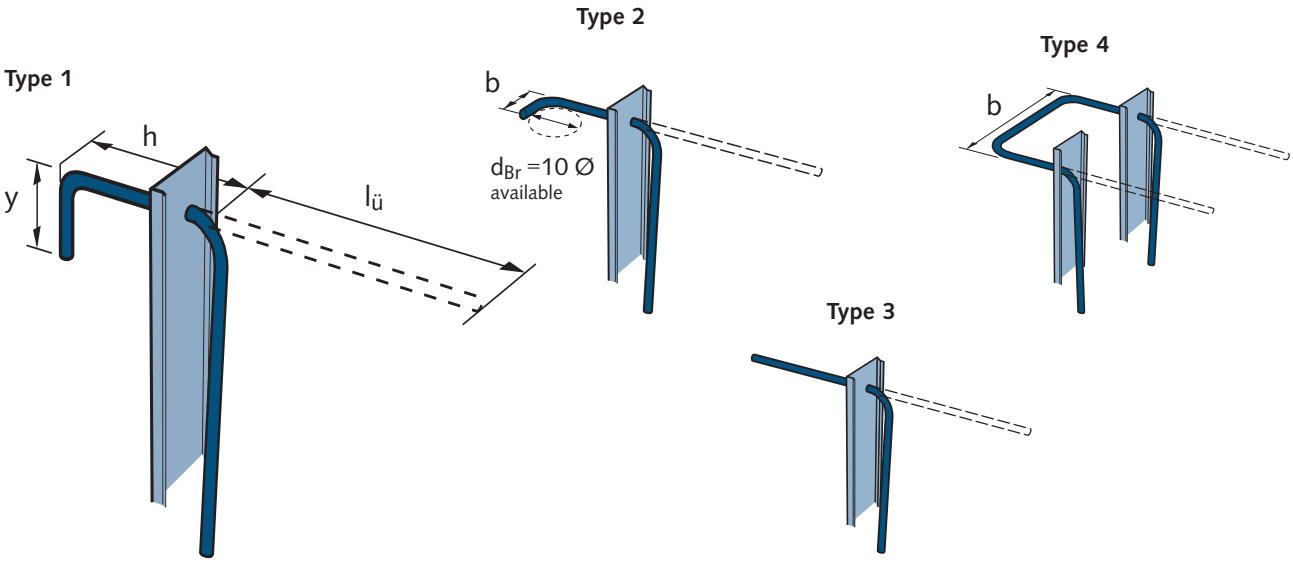


Case dimensions [mm]				
profile	rebar Ø [mm]	width B	height H_1	height H_2
HBT 55	8	58	12	24
	10			30
HBT 85	10	86		30
	12			36
HBT 120	10	122		30
	12			36

Rebar layout			
element length L	rebar spacing s [cm]	number of rebar	end spacing a [cm]
standard element L = 1250 mm	10	12	7.5
	15	8	10.0
	20	6	12.5
	25	5	12.5
short element L = 800 mm	10	8	5.0
	15	6	2.5
	20	4	10.0
	25	4	2.5

Other element lengths on request

Rebar types



See table on page 7 for rebar dimensions

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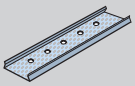
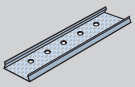
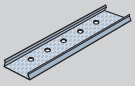
HALFEN HBT REBEND CONNECTION

Single-Row Profiles

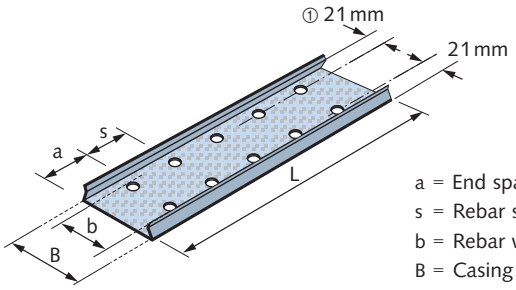
Rebar dimensions [mm]

profile	rebar Ø	rebar spacing	standard type 1			types 1, 2, 3, 4			only for type 4
			L = 1250 mm			h_{min}	L = 1250 mm	L ≥ 800 mm	
	[mm]	[cm]	h	$l_ü$	y		$l_{ü,max}$	$l_{ü,max}$	b [mm]
HBT 55 	8	10	170	210	75	120	210	210	200...500
		15		320			510	430	
		20					600	455	
		25						480	
	10	10	170	200	95	120	200	200	
		15		390			390	390	
		20					510	450	
		25						475	
HBT 85 	10	10	170	390	95	120	430	400	250...500
		15					510	425	
		20					600	450	
		25						475	
	12	10	170	430	110	120	430	395	
		15		460			510	420	
		20					600	445	
		25						470	
HBT 120 	10	10	170	390	95	120	600	400	on request
		15						425	
		20						450	
		25						475	
	12	10	170	460	110	120	600	395	
		15						420	
		20						445	
		25						470	

HALFEN HBT REBEND CONNECTION

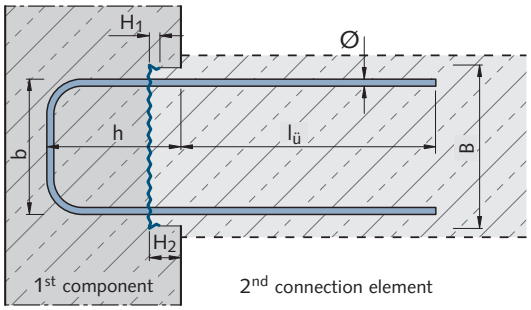
Double-Row Profiles

Profile dimensions



① for HBT 80: 18 mm

a = End spacing
s = Rebar spacing
b = Rebar width
B = Casing width
L = Element length



Case dimensions [mm]

profile	rebar Ø [mm]	width B	height H_1	height H_2	b
HBT 80	8	86	12	24	58
	10			30	60
HBT 120	8	122		24	88
	10			30	90
	12			36	92
HBT 150	8	150		24	116
	10			30	118
	12			36	120
HBT 190	8	186		24	152
	10			30	154
	12			36	156
HBT 220	8	222		24	188
	10			30	190
	12			36	192

Rebar layout

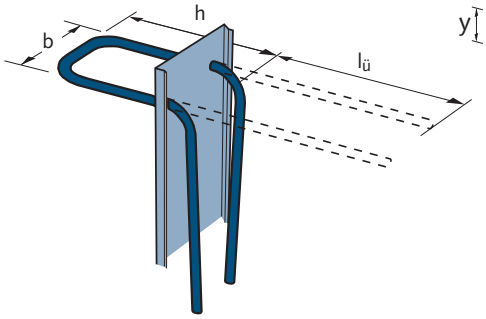
element length L	rebar spacing s [cm]	number of rebar	end spacing a [cm]
standard element L = 1250 mm	10	12	7.5
	15	8	10.0
	20	6	12.5
	25	5	12.5
short element L = 800 mm	10	8	5.0
	15	6	2.5
	20	4	10.0
	25	4	2.5

Other element lengths on request

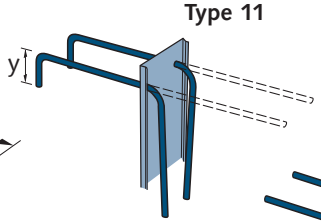
Rebar types

Straight rebar

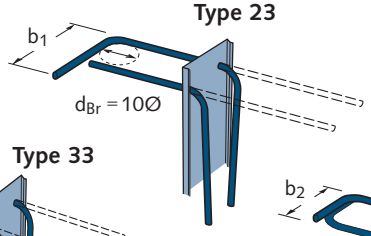
Type 5



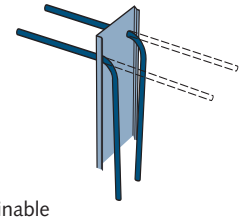
Type 11



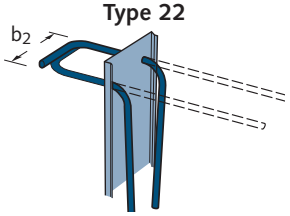
Type 23



Type 33



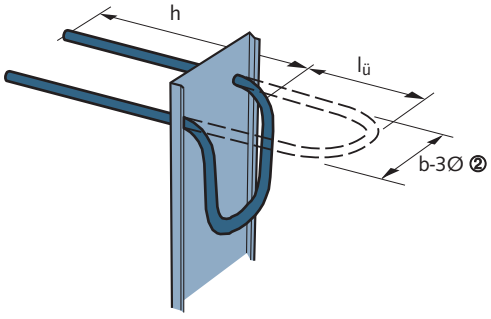
Type 22



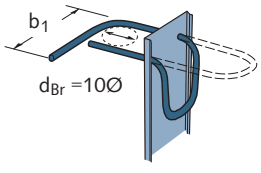
y, b_1, b_2; are freely definable

Stirrups

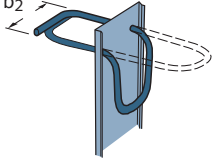
Type 6



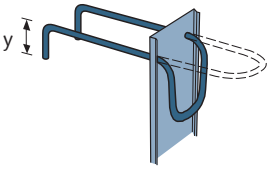
Type 7 from HBT 120



Type 8



Type 9



② Reduced rebar width at stirrup end due to minimal space in the case (see page 16)

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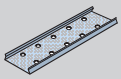
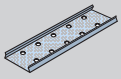
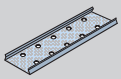
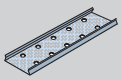
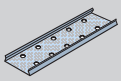
HALFEN HBT REBEND CONNECTION

Double-Row Profiles

Rebar dimensions [mm]

profile	rebarØ	rebar spacing	standard type 5		types 5, 11, 22, 23 ④, 33			types 6, 7, 8, 9			
			L = 1250 mm			L = 1250 mm	L ≥ 800 mm	type 6	type 7 ③, 8	type 9	L ≥ 600 mm
	[mm]	[cm]	h	$l_ü$	h_{min}	$l_{ü,max}$	$l_{ü,max}$	h_{min}	h_{min}	h_{min}	$60 \le l_ü \le l_{ü,max}$
HBT 80 ③ 	8	10	170	170	120	170	170	120	135	140	70
		15		320		360	360				125
		20				450	450				175
		25				500	480				225
	10	10	170	160	120	160	160	120	155	140	60
		15		320		320	320				120
		20		390		400	400				170
		25				450	450				220
HBT 120 	8	10	170	290	120	290	290	120	135	140	115
		15		320		510	430				175
		20				600	455				235
		25					480				290
	10	10	170	240	120	240	240	120	155	140	80
		15		390		510	425				130
		20				600	450				180
		25					475				230
	12	10	170	215	120	215	215	120	170	140	70
		15		390		390	390				120
		20		440		440	440				170
		25		460		490	470				220
HBT 150 	8	10	170	320	120	360	360	120	135	140	100
		15				510	430				150
		20				600	455				210
		25					480				260
	10	10	170	360	120	360	360	120	155	140	85
		15		390		510	425				135
		20				600	450				185
		25					475				235
	12	10	170	310	120	310	310	120	170	140	90
		15		460		480	420				150
		20				530	445				200
		25				580	470				250
HBT 190 	8	10	170	320	120	500	405	120	135	140	100
		15				510	430				150
		20				600	455				210
		25					480				260
	10	10	170	390	120	500	400	120	155	140	110
		15				510	425				170
		20				600	450				220
		25					475				280
	12	10	170	430	120	430	395	120	170	140	90
		15		460		510	420				140
		20				600	445				190
		25					470				240
HBT 220 	8	10	170	320	120	600	405	120	135	140	100
		15					430				150
		20					455				210
		25					480				260
	10	10	170	390	120	600	400	120	155	140	110
		15					425				170
		20					450				220
		25					475				280
	12	10	170	460	120	600	395	120	170	140	90
		15					420				140
		20					445				190
		25					470				240

③ rebar type 7 for HBT 80 not available
④ Due to the required bending roll diameter (d_{Br} = 10x bar diam.); h_{min} for type 23 is equal to h_{min} of type 7

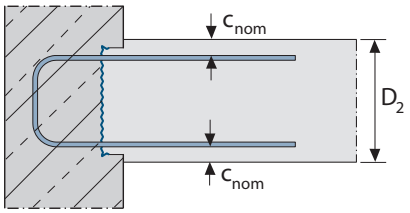
HALFEN HBT REBEND CONNECTION

Product Selection/Calculation Basis according to Approval no. Z-21.8-2035

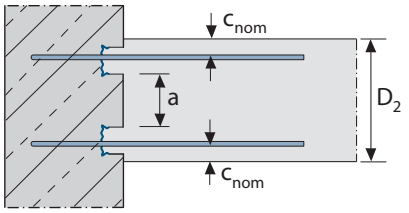
Product selection allowing for required concrete cover of the rebend reinforcement

profile	Thickness of component D_2 [mm]										
	100	120	140	160	180	200	220	240	260	280	300
	concrete cover c_{nom} [mm]										
2×HBT 55 ①	-	-	≤ 25	≤ 35	≤ 45	≤ 55	≤ 65	≤ 75	≤ 85	≤ 95	≤ 105
2×HBT 85 ①	-	-	-	-	≤ 20	≤ 30	≤ 40	≤ 50	≤ 60	≤ 70	≤ 80
HBT 80	20	30	40	50	60	70	80	90	100	110	120
HBT 120	-	-	25	35	45	55	65	75	85	95	105
HBT 150	-	-	-	20	30	40	50	60	70	80	90
HBT 190	-	-	-	-	-	23	33	43	53	63	73
HBT 220	-	-	-	-	-	-	-	25	35	45	55

① depends on spacing a between the cases



Product selection for 1-part element



Product selection for multi-part elements

Basis for calculation according to approval number Z-21.8-2035

General information

The concept for the approval is based on the calculation and the structural application as applied in the following standards and guidelines: DIN EN 1992-1-1 with DIN EN 1992-1-1/NA (National Annex) and the DBV-guidelines "Rebending of reinforcing steel and requirements of protective boxes according to Eurocode 2". Generally two different cases of shear load are examined: shear load transverse and longitudinal to the concrete joint.

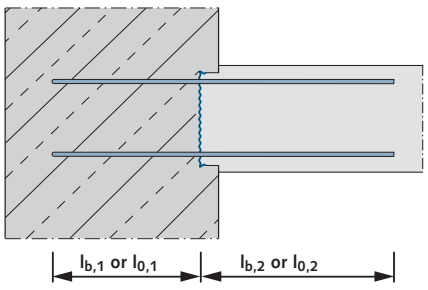
According to the approval, due to the product characteristics the shear loads transverse to the joint in the HBT Rebend connections can be classed as "indented" and shear loads longitudinal to the joint can be classified as "rough".

Material: Rebend reinforcement B500B, stainless steel B500 NR with bar diameters of 8, 10 and 12 mm
Normal concrete ≥ C20/25

The maximum load bearing capacity of the rebend connection must be limited to 80 % of the ultimate limit state; the following applies for tensile strength:

$$f_{yd,red} = 0.8 \cdot \frac{f_{yk}}{\gamma_s}$$

Existing anchorage lengths and overlap lengths must be taken into consideration for the calculation. These can be calculated from the back surface of the case. Verification of the anchorage lengths and overlap lengths is according to Eurocode 2, taking the bonding characteristics into account.



Anchorage and overlap length requirements for the reinforcement

Calculating the HALFEN HBT Rebend connections as in the DBV-guidelines "Rebending of reinforcing steel and requirements of protective boxes according to Eurocode 2" with roughness classification "smooth", is conservative while still being acceptable.

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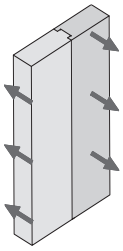
HALFEN HBT REBEND CONNECTION

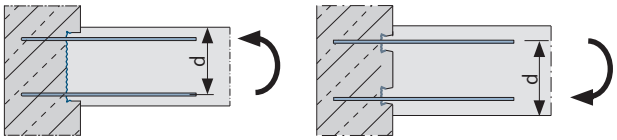
Calculation Basis according to Approval no. Z-21.8-2035

Shear load, transverse to the concrete joint

Calculation is according to DIN EN 1992-1-1, section 6.2 and DIN EN 1992-1-1/NA, as for monolithic produced building components; whereby the following additional provisions must be observed.



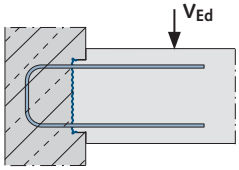
Effective static height:



Tension zones: upper and lower component edges

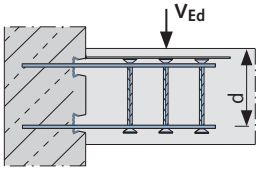
Shear resistance with no shear reinforcement

The decisive resistance $V_{Rd,c}$ for the calculation is according to DIN EN 1992-1-1, section 6.2.2; whereby a reduction in the reinforcement ratio ρ_l is not required (caused by the reduced yield strength of the rebend reinforcement).



Shear resistance with shear reinforcement

The decisive resistance for verification results from 30% of the shear load resistance $V_{Rd,max}$ according to DIN EN 1992-1-1, section 6.2.3:



$$V_{Ed} \leq V_{Rd} \leq 0.3 \cdot V_{Rd,max}$$

An additional load in the longitudinal reinforcement caused by shear forces must be verified assuming a compression strut angle of 45° (cot θ = 1.0). The required shear reinforcement is calculated using cot θ = 1.0

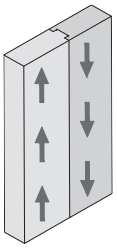
To calculate the shear load reinforcement for HALFEN HDB-S Shear rails see HDB technical product information and the approvals Z-15.1-249 and Z-15.1-270.

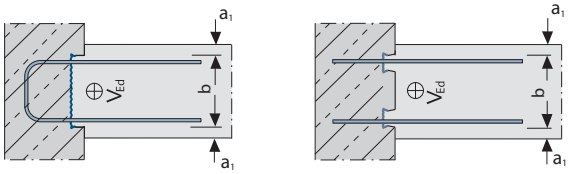
Shear load, longitudinal to the concrete joint

Static verification is according to DIN EN 1992-1-1, section 6.2.5 and DIN EN 1992-1-1/NA (National Annex), whereby the following additional provisions are to be observed.

Factors to used to calculate the shear load resistance:

c = 0.4
μ = 0.7
v = 0.5





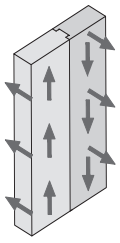
If the spaces between the HBT Cases are additionally subjected to shear load, then these must be designed as rough or suitably indented in accordance with DIN EN 1992-1-1. The edge areas can also be assumed as load bearing if $a_1 \geq 50$ mm.

The concrete cover c_{nom} is according to DIN to EN 1992-1-1. In addition for the rebend reinforcement the following must be observed.

c_{nom} ≥ max. {3 Ø, 30 mm, max. aggregate diameter d_g}

Combined shear load, transverse and longitudinal to the concrete joint

If the connection is subjected to combined shear load (longitudinal and transverse to the concrete joint), each load direction can be verified separately.



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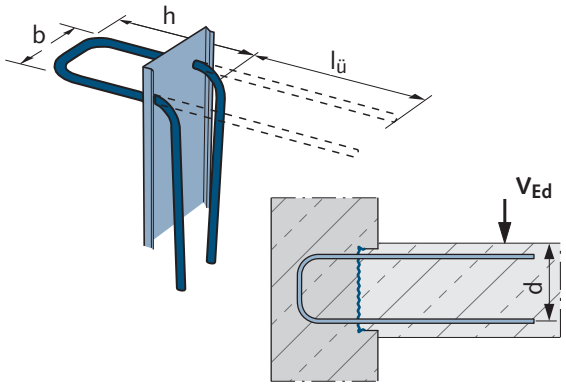
HALFEN Technical services
See back of catalogue for technical advice for your individual projects and contact information for all products.

HALFEN HBT REBEND CONNECTION

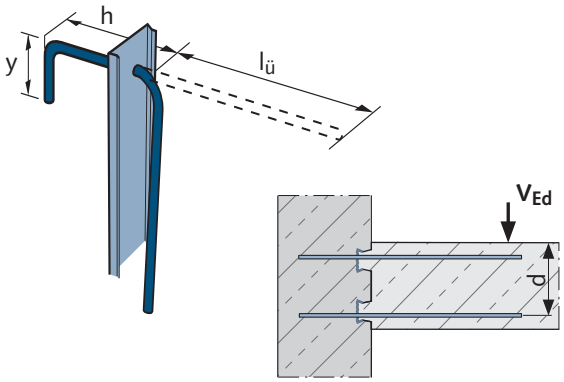
Selected Load Capacity Values according to Type Test and Approval no. Z-21.8-2035

Shear load capacity transverse to the case — no shear reinforcement

Single connection example; 1× **Type 5**



Multipart connection example; 2× **Type 1**



Shear load resistance V_{Rd} [kN/m] ($\leq 0.3 \cdot V_{Rd,max}$)									Always refer to the information in the type test	
rebar Ø/ spacing s [mm/cm]	d = 100 mm	d = 120 mm	d = 140 mm	d = 160 mm	d = 180 mm	d = 200 mm	d = 220 mm	d = 240 mm	d = 260 mm	d = 280 mm
	HBT 80	HBT 120	HBT 150	HBT 150	HBT 190	HBT 190	HBT 220	HBT 220	2×55 (Ø 8) 2×85 (Ø 10,12)	2×55 (Ø 8) 2×85 (Ø 10,12)
concrete strength class C20/25										
8/20	44.3	53.1	62.0	70.8	78.7	78.7	78.7	78.7	78.7	78.7
8/15	44.3	53.1	62.0	70.8	79.7	88.5	94.0	99.4	104.7	104.9
8/10	-	53.1	62.0	70.8	79.7	88.5	94.0	99.4	104.7	109.8
10/20	44.3	53.1	62.0	70.8	79.7	88.5	94.0	98.4	98.4	98.4
10/15	44.3	53.1	62.0	70.8	79.7	88.5	94.0	99.4	104.7	109.8
10/10	-	56.6	62.7	70.8	79.7	88.5	94.0	99.4	104.7	109.8
12/20	-	53.1	62.0	70.8	79.7	88.5	94.0	99.4	104.7	109.8
12/15	-	55.8	62.0	70.8	79.7	88.5	94.0	99.4	104.7	109.8
12/10	-	63.9	70.8	77.4	83.7	89.8	94.0	99.4	104.7	109.8
concrete strength class C25/30										
8/20	49.5	59.4	69.3	78.7	78.7	78.7	78.7	78.7	78.7	78.7
8/15	49.5	59.4	69.3	79.2	89.1	99.0	104.9	104.9	104.9	104.9
8/10	-	59.4	69.3	79.2	89.1	99.0	105.1	111.1	117.0	122.8
10/20	49.5	59.4	69.3	79.2	89.1	99.0	105.1	111.1	114.2	114.2
10/15	49.5	59.4	69.3	79.2	89.1	99.0	105.1	111.1	117.0	122.8
10/10	-	60.9	69.3	79.2	89.1	99.0	105.1	111.1	117.0	122.8
12/20	-	59.4	69.3	79.2	89.1	99.0	105.1	111.1	117.0	122.8
12/15	-	60.1	69.3	79.2	89.1	99.0	105.1	111.1	117.0	122.8
12/10	-	68.8	76.3	83.4	90.2	99.0	105.1	111.1	117.0	122.8
concrete strength class C30/37										
8/20	54.2	65.1	75.9	78.7	78.7	78.7	78.7	78.7	78.7	78.7
8/15	54.2	65.1	75.9	86.8	97.6	104.9	104.9	104.9	104.9	104.9
8/10	-	65.1	75.9	86.8	97.6	108.4	115.1	121.7	128.2	134.5
10/20	54.2	65.1	75.9	86.8	97.6	108.4	115.1	121.7	122.9	122.9
10/15	54.2	65.1	75.9	86.8	97.6	108.4	115.1	121.7	128.2	134.5
10/10	-	65.1	75.9	86.8	97.6	108.4	115.1	121.7	128.2	134.5
12/20	-	65.1	75.9	86.8	97.6	108.4	115.1	121.7	128.2	134.5
12/15	-	65.1	75.9	86.8	97.6	108.4	115.1	121.7	128.2	134.5
12/10	-	73.1	81.0	88.6	97.6	108.4	115.1	121.7	128.2	134.5

Note: Standard dimension according to page 7 and 9.
Load capacities for further rebar dimensions and for rebar spacings of 25 cm, see type test.

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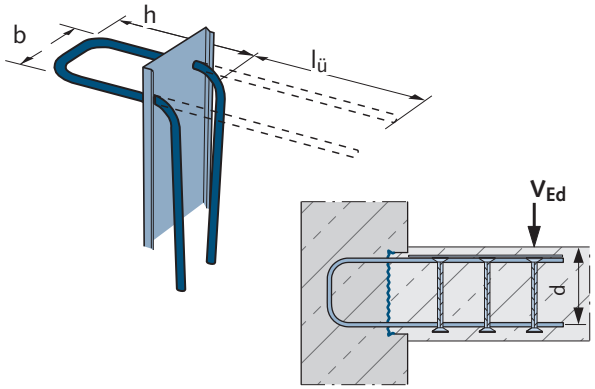
HALFEN HBT REBEND CONNECTION

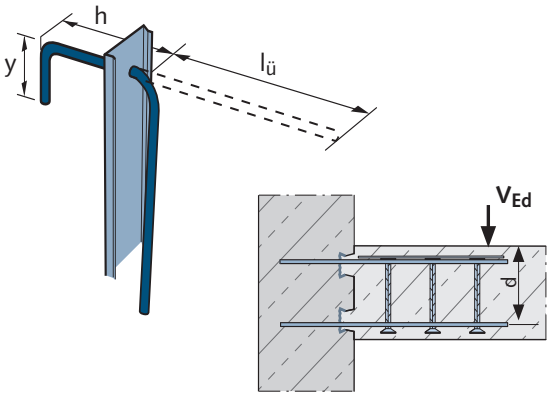
Selected Load Capacity Values according to Type Test and Approval no. Z-21.8-2035

Shear load capacity transverse to the case — with shear reinforcement

Single connection example; 1× **Type 5**



Multipart connection example; 2× **Type 1**



Please refer to the HDB Product information and approvals no. Z-15.1-249 and Z-15.1-270 when determining the shear reinforcement using HALFEN HDB-S Shear reinforcement.

Shear load resistance V_{Rd} [kN/m] ($\leq 0.3 \cdot V_{Rd,max}$)									Always refer to the information in the type test	
rebar Ø/ spacing s [mm/cm]	d = 100 mm	d = 120 mm	d = 140 mm	d = 160 mm	d = 180 mm	d = 200 mm	d = 220 mm	d = 240 mm	d = 260 mm	d = 280 mm
	HBT 80	HBT 120	HBT 150	HBT 150	HBT 190	HBT 190	HBT 220	HBT 220	2×55 (Ø 8) 2×85 (Ø 10,12)	2×55 (Ø 8) 2×85 (Ø 10,12)
concrete strength class C20/25										
8/20	76.5	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4
8/15	76.5	102.0	116.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6
8/10	-	102.0	127.5	153.0	174.8	174.8	174.8	174.8	136.5	136.5
10/20	76.5	102.0	109.4	109.4	109.4	109.4	109.4	109.4	109.4	109.4
10/15	76.5	102.0	127.5	145.8	145.8	145.8	145.8	145.8	145.8	145.8
10/10	-	102.0	127.5	153.0	178.5	204.0	218.7	218.7	218.7	218.7
12/20	-	102.0	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6
12/15	-	102.0	127.5	153.0	167.5	167.5	167.5	167.5	167.5	167.5
12/10	-	102.0	127.5	153.0	178.5	204.0	229.5	251.2	251.2	251.2
concrete strength class C25/30										
8/20	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4
8/15	95.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6
8/10	-	127.5	159.4	174.8	174.8	174.8	174.8	174.8	158.4	158.4
10/20	95.6	126.9	126.9	126.9	126.9	126.9	126.9	126.9	126.9	126.9
10/15	95.6	127.5	159.4	169.2	169.2	169.2	169.2	169.2	169.2	169.2
10/10	-	127.5	159.4	191.3	223.1	253.8	253.8	253.8	253.8	253.8
12/20	-	127.5	145.8	145.8	145.8	145.8	145.8	145.8	145.8	145.8
12/15	-	127.5	159.4	191.3	194.4	194.4	194.4	194.4	194.4	194.4
12/10	-	127.5	159.4	191.3	223.1	255.0	286.9	291.5	291.5	291.5
concrete strength class C30/37										
8/20	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4
8/15	114.8	116.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6
8/10	-	153.0	174.8	174.8	174.8	174.8	174.8	174.8	174.8	174.8
10/20	114.8	136.6	136.6	136.6	136.6	136.6	136.6	136.6	136.6	136.6
10/15	114.8	153.0	182.1	182.1	182.1	182.1	182.1	182.1	182.1	182.1
10/10	-	153.0	191.3	229.5	267.8	273.2	273.2	273.2	273.2	273.2
12/20	-	153.0	164.6	164.6	164.6	164.6	164.6	164.6	164.6	164.6
12/15	-	153.0	191.3	219.5	219.5	219.5	219.5	219.5	219.5	219.5
12/10	-	153.0	191.3	229.5	267.8	306.0	329.2	329.2	329.2	329.2

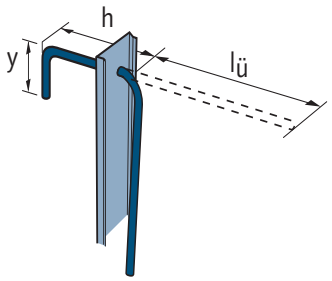
Note: Standard dimension according to page 7 and 9.
Load capacities for further rebar dimensions and for rebar spacings of 25 cm, see type test.

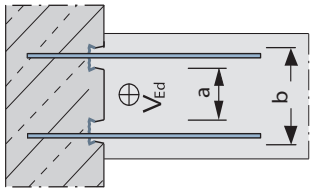
HALFEN HBT REBEND CONNECTION

Basis of Calculation According to Type Test and Approval no. Z-21.8-2035

Shear load capacity, longitudinal to the case – single row profile

Multipart connection example; 2× **Type 1**
Standard type according to page 7





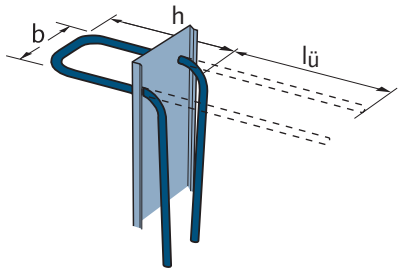
Shear load resistance V_{Rdi} [kN/m] (≤ $V_{Rdi,max}$) — Always refer to the information in the type test

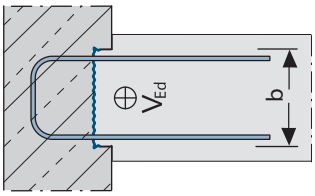
profile	b = 260 mm			**2×HBT 55** (Ø8) b = 300 mm			**2×HBT 85** (Ø10, 12) b = 360 mm			b = 400 mm		
rebar Ø [mm]/ spacing **s** [cm]	**concrete strength class**											
	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37
8/20	193.4	224.4	253.4	207.4	240.7	271.8	228.5	265.1	299.4	242.5	281.4	317.7
8/15	227.4	263.9	298.0	241.5	280.2	316.4	262.5	304.6	344.0	276.6	320.9	362.4
8/10	295.6	343.0	387.3	309.6	359.3	405.7	330.7	383.7	433.3	344.7	400.0	451.7
10/20	213.7	248.0	280.0	227.7	264.2	298.4	248.8	288.7	326.0	262.8	304.9	344.3
10/15	254.5	295.3	333.5	268.5	311.6	351.9	289.6	336.0	379.5	303.6	352.3	397.8
10/10	336.2	390.1	440.5	350.2	406.4	458.9	371.3	430.8	486.5	385.3	447.1	504.9
12/20	231.9	269.1	303.9	245.9	285.4	322.2	267.0	309.8	349.8	281.0	326.1	368.2
12/15	278.8	323.5	365.3	292.8	339.8	383.7	313.9	364.2	411.3	327.9	380.5	429.6
12/10	372.6	432.3	488.2	386.6	448.6	506.6	407.7	473.0	534.2	421.7	489.3	552.6

Note: Load capacities for further joint widths, for further rebar dimensions and for rebar spacings of 25 cm, see type test.
The joint areas a between the HBT Cases must be designed as rough or suitably indented as defined in DIN EN 1992-1-1; 6.2.5.

Shear load capacity, longitudinal to the case – double-row profile

Single connection example; 1× **Type 5**
Standard type according to page 9





Shear load resistance V_{Rdi} [kN/m] (≤ $V_{Rdi,max}$) for HBT 120, 150, 190 and 220 — Always refer to the information in the type test

profile	**HBT 120**			**HBT 150**			**HBT 190**			**HBT 220**		
rebar Ø [mm]/ spacing **s** [cm]	**concrete strength class**											
	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37
8/20	145.0	168.2	190.0	154.8	179.6	202.9	167.4	194.3	219.4	180.1	208.9	235.9
8/15	179.1	207.8	234.6	188.9	219.2	247.5	201.5	233.8	264.0	214.1	248.5	280.6
8/10	247.2	286.8	323.9	257.0	298.2	336.8	269.6	312.9	353.3	282.3	327.5	369.9
10/20	165.3	191.8	216.6	175.1	203.2	229.5	187.7	217.8	246.0	200.4	232.5	262.5
10/15	206.1	239.2	270.1	215.9	250.6	283.0	228.6	265.2	299.5	241.2	279.9	316.0
10/10	279.0	323.8	365.6	297.6	345.3	390.0	310.2	360.0	406.5	322.9	374.6	423.1
12/20	183.5	212.9	240.4	193.3	224.3	253.3	205.9	239.0	269.8	218.6	253.6	286.4
12/15	230.4	267.3	301.9	240.2	278.7	314.8	252.8	293.4	331.3	265.5	308.0	347.8
12/10	306.3	355.5	401.4	334.0	387.6	437.7	346.6	402.2	454.2	359.3	416.9	470.8

Note: Load capacities for the HBT 80 profile; for further rebar dimensions and for rebar spacings of 25 cm, see type test

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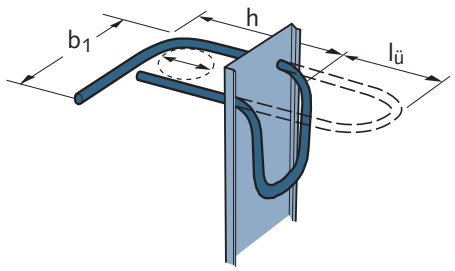
Calculating a reinforced concrete corbel for HBT Type 7

Type 7



Strutural boundary conditions

Geometric assumptions: $0.2 \le \frac{a_c}{h_c} \le 1.0$

Anchorage length in the corbel:

$$l_{bd,dir} = \frac{2}{3}\, l_{b,eq} \ge \max \begin{cases} 0.67 \cdot \alpha_1 \cdot \alpha_4 \cdot l_{b,rqd} \\ 6.7\,\varnothing \end{cases}$$

Shear load capacity in the corbel:

$$F_{Ed} \le V_{Rd,max} = 0.5 \cdot \nu \cdot b_c \cdot z \cdot \frac{f_{ck}}{\gamma_c}$$

where $\nu = 0.7 - \frac{f_{ck}}{200\ N/mm^2} \ge 0.5$

$z = 0.9 \cdot d$

Tensile load in the corbel:

$$Z_{Ed} = F_{Ed} \cdot \frac{a_c}{z_o} + H_{Ed} \cdot \frac{a_H + z_o}{z_o}$$

where $z_o = d \cdot \left(1 - 0.4 \cdot \frac{F_{Ed}}{V_{Rd,max}}\right)$; $H_{Ed} \ge 0.2 \cdot F_{Ed}$

and $\frac{a_c}{z_o} \ge 0.4$

Required reinforcement for tension

$$a_{s,rqd} = \min \begin{cases} \frac{Z_{Ed}}{0.8 \cdot f_{yd}} \\ \frac{F_{bd}}{0.8 \cdot f_{yd}} \end{cases}$$; where F_{bd} = anchored load

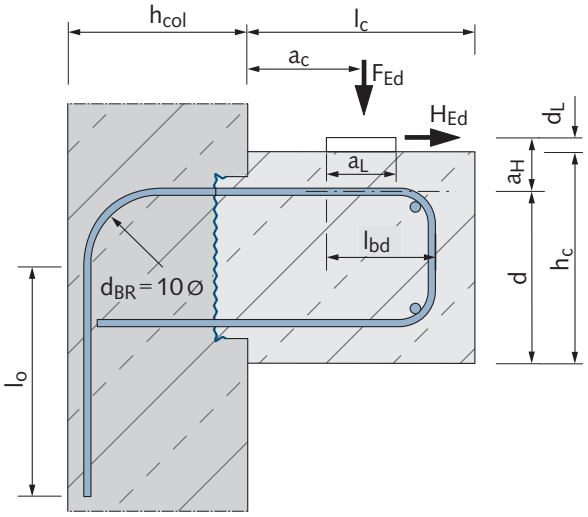
Verifying the reinforcement overlap length in the wall for:

$$l_{0,avail.} = b_1 - 6\varnothing$$

In addition to the corbel calculation above, the rebend connection has to be verified according to the specifications in approval no. Z-21.8-2035 (see page 10f).

The compressive stresses under the load application plate and the wall's joint load bearing capacity must be verified in accordance with DIN EN 1992-1-1 resp. publication no. 532 issued by the German Committee for Structural Concrete (DAfStb).

The spacing between the side-edge of the corbel and the outermost stirrups in the HBT Connection should not exceed 5 cm. The free side-edge of the corbel must be strengthened using stirrups.



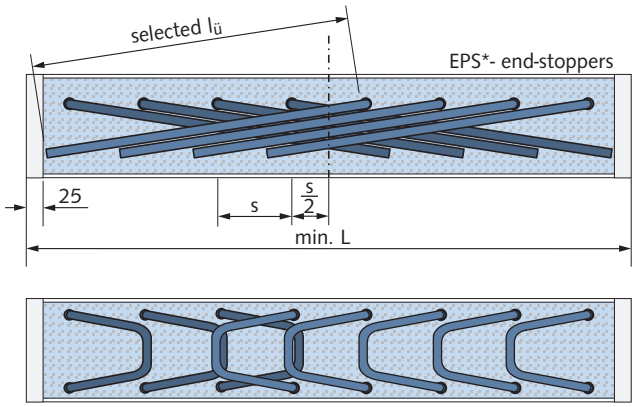
Concrete strength class C30/37 c_{nom}=35 mm

	reinforcement Ø/s	h_c= 160 mm	190 mm	230 mm	250 mm
		max F_{Ed} for profile type [kN/m]			
		HBT 120	HBT 150	HBT 190	HBT 220
L_c = 200 mm	8/25	51.7	61.7	61.4	61.3
$l_ü$ = 165 mm	8/20	64.2	76.9	77.1	77.0
a_c = 100 mm	8/15	64.5	-	-	-
	10/25	63.7	76.4	91.8	96.7
	10/20	64.0	80.1	101.5	110.1
	10/15	-	-	101.5	110.1
L_c = 220 mm	8/25	53.4	61.5	61.2	61.1
$l_ü$ = 185 mm	8/20	64.4	77.3	77.0	76.8
a_c = 110 mm	10/25	63.9	79.1	95.4	96.5
	10/20	-	79.9	101.3	110.0
	12/25	63.3	79.4	100.8	109.6
	12/20	-	79.4	100.8	109.6
L_c = 240 mm	8/25	53.3	61.4	61.1	60.9
$l_ü$ = 205 mm	8/20	64.3	77.1	76.8	76.7
a_c = 120 mm	10/25	63.8	79.8	96.5	96.3
	10/20	-	-	101.2	109.8
	12/25	63.2	79.3	100.6	109.5
L_c = 260 mm	8/25	50.1	60.5	60.9	60.7
$l_ü$ = 225 mm	8/20	62.2	-	-	-
a_c = 130 mm	10/25	63.7	79.7	96.3	96.2
	12/25	-	79.1	100.5	109.3
L_c = 280 mm	8/25	47.3	57.2	60.8	60.6
$l_ü$ = 245 mm	10/25	-	-	96.2	96.0
a_c = 140 mm	12/25	-	79.0	-	-

H_{Ed} = 0,2 · F_{Ed}; h = 170 mm, b_1 = 400 mm load-plate a_L = 50 mm, d_L = 10 mm

These values are for pre-dimensioning; final values must be verified. Further dimensions and resistance values are available on request. Generally, significantly better resistance values are possible when using the HALFEN HSC Stud connector.

Minimal element lengths for the rebend connections – layout of the reinforcement bars in the case



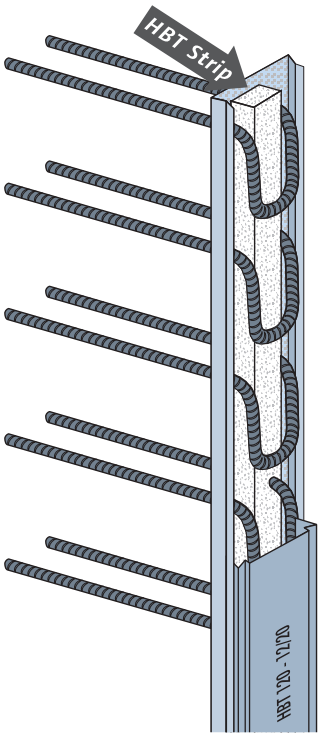
* Expanded polystyrene

Minimal element lengths for $l_ü$ standard

Ø [mm]	rebar spacing s [cm]	① $l_ü$ [mm]	minimal case length L [mm]	number of rebar
8	10	320	650	6
8	15	320	600	4
8	20	320	650	4
10	10	390	800	8
10	15	390	750	4
10	20	390	700	4
12	10	460	950	8
12	15	460	900	6
12	20	460	850	4

① Max. $l_ü$ - observe dimensions for selected profile (see page 7 and 9)

HBT Strip — the perfect solution for precast elements



Due to inherent low concrete cover and restriction in element size in precast elements, demands on precise measurement and manufacturing of rebend connections are generally higher.

The HBT-Connection with 'HBT Strip' (HBT-S) fulfils these requirements perfectly. Available for all double-row HBT connections with rebar types 6, 7, 8 and 9, in profile widths HBT - S 80, 120, 150, 190, 220.

- rebars are secured during transport
- compliance with required over-lap and anchorage lengths
- recommended for loops and corbel connections
- HBT Strip is easily removed after striking the formwork

Order example:

HBT - S - 80 - 10/15 - 6 - 1250

- element length L [mm]
- rebar type (see page 8)
- rebar diameter Ø [mm]/rebar spacing s [cm]
- profile indentifier - S for 'HBT-Strip'

Installation is as described on page 18; the HBT Strip must be removed after all connecting rebar have been rebent.

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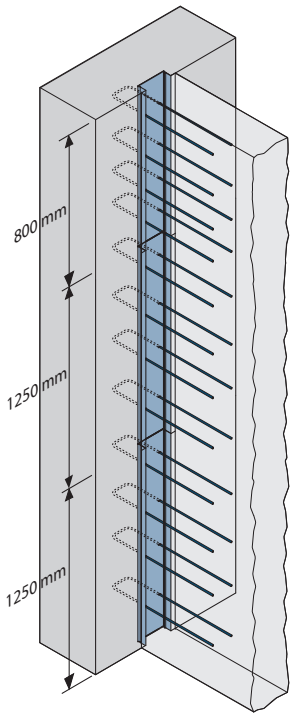
Application of short elements

Various lengths — efficient installation times

Combining 1250 mm standard elements and 800 mm elements helps to avoid unnecessary modification of HBT Elements.

Standard combinations					
HBT Element	clear floor height [m]				
	2.40	2.50	2.85	3.30	3.75
	combinations				
short element L = 800 mm	3	-	2	1	-
standard element L = 1250 mm	-	2	1	2	3

In numerous applications, further on-site modification of the HBT cases is therefore not required. The risk of damaging the rebar in the casing is avoided. The planner can plan more efficiently and on-site preparation time for installation of the HBT Elements is reduced.

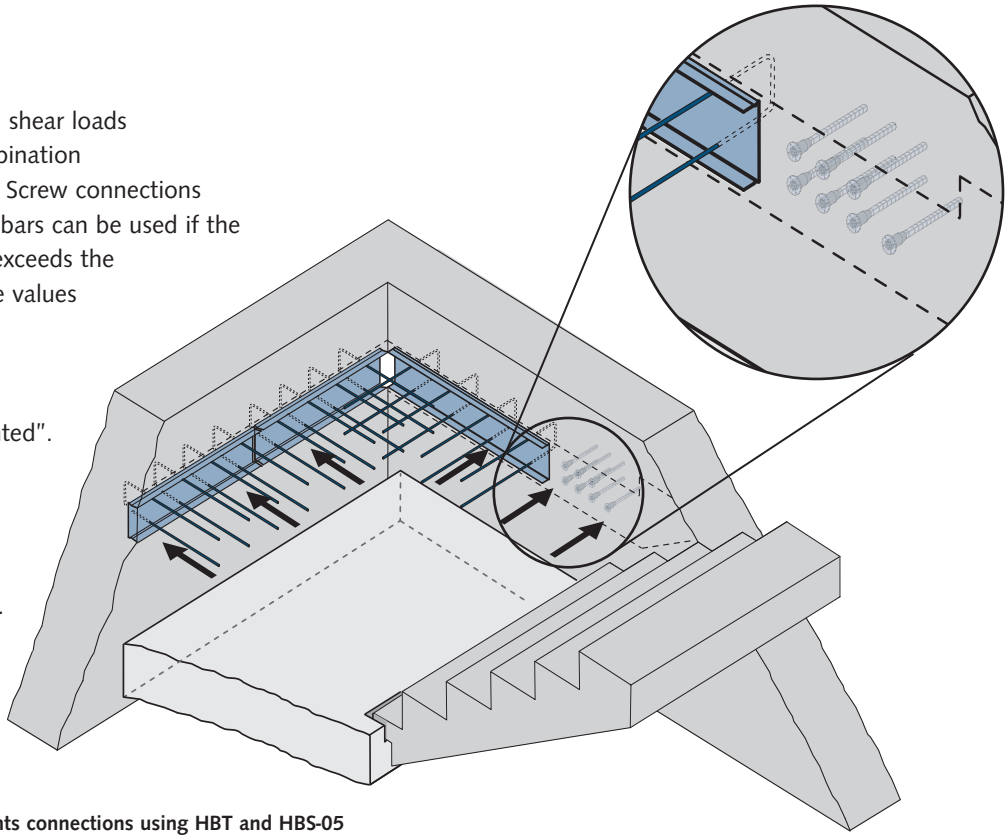


Wall connection using two 1250 mm HBT Elements and a 800 mm HBT Element to obtain 3.30 m floor height

In combination with HBS-05

Combined strength!

In applications with concentrated shear loads HBT Rebend connections in combination with the proven HALFEN HBS-05 Screw connections is feasible. HBS-05 Connection rebars can be used if the calculated shear load in an area exceeds the allowable characteristic resistance values for the HBT Profiles. The surface characteristics in the area of the HBS-05 Screw connections must be designed as “rough” or “indented”. Verification of the shear load transfer is according to DIN EN 1992-1-1, 6.2.5. The result is a **cost effective** solution and **efficient** installation.

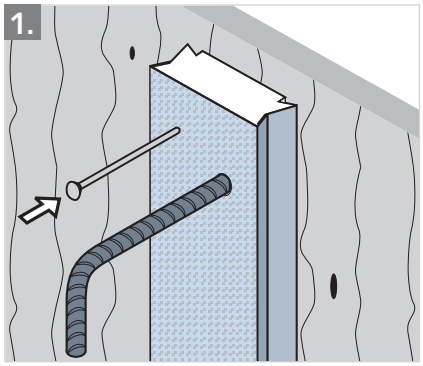


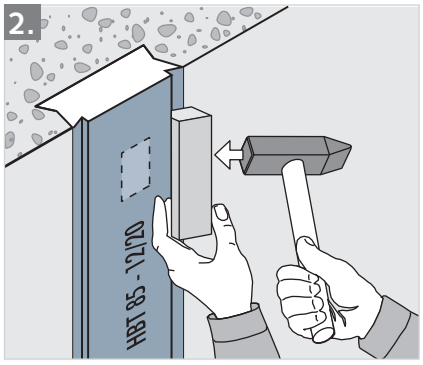
Stair-elements connections using HBT and HBS-05

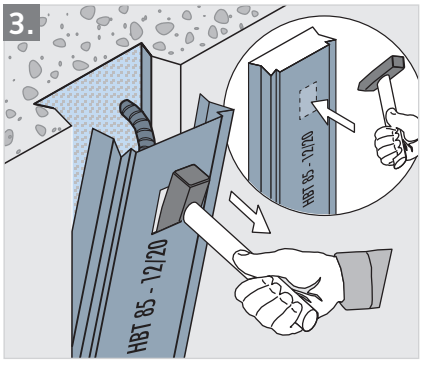
HALFEN HBT REBEND CONNECTION

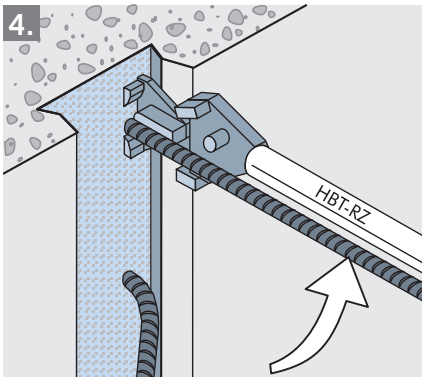
Assembly Instructions

Assembly instructions





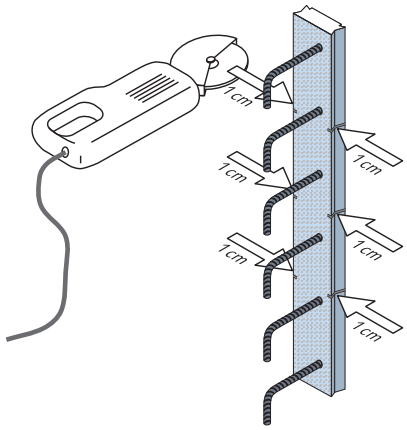




1. Nail the HBT Element to the timber formwork in the specified position. Use suitable methods for fixing elements to metal formwork, for example magnets. Check stirrup lengths protruding from the case after installation.
2. After the concrete has cured, strike the formwork; hitting a wood block placed in the long groove in the cover with a hammer, loosen the cover.
3. Use a hammer with a claw to punch-in the perforated hole in the cover; hook the hammer in the hole and pull the lid out.
4. Place the HALFEN Rebending tool under the rebar and pull down on the handle evenly with both hands until the rebar is in the correct position. The bar must be rebent straight without any kinks. Proceed in a similar manner to rebend all bars in the HBT Element one-by-one. The profiled back of the HBT Element case remains in the concrete.

Note: A more detailed installation instruction can be found at www.halfen.com.

HBT Element adapted to curved formwork

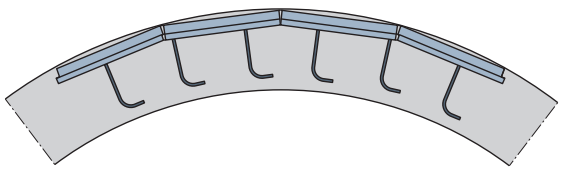


Adapting the HBT Case

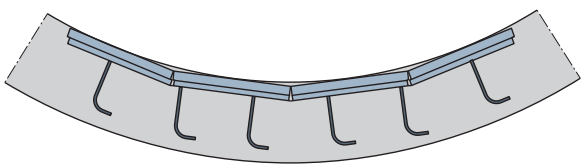
Using an angle-grinder cut approximately 1 cm deep incisions symmetrically into both sides of the case at regular intervals; the HBT housing loses its rigidity, easing fixing to the formwork. To achieve a better fit to smaller curvature (< 3.00 m), up to seven incisions per side are possible.

After fixing the HBT Case to the formwork cover the incisions with adhesive tape to prevent concrete seeping into the form.

Caution when working with an angle-grinder!
The reinforcing steel bars in the HBT Case must not be damaged.



HBT Element fitted to an convex curvature
Outer radius ≥ ca. 3.00 m; smaller radius is achieved with more incisions.



HBT Element fitted to an concave curvature
Inner radius ≥ ca. 3.00 m; smaller radius is achieved with more incisions.

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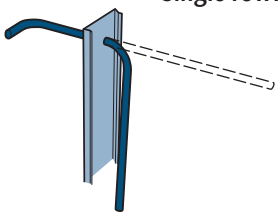
Order Examples

Order examples

HALFEN offers a wide range of standard HBT Rebend connections for the most common applications (see page 6ff.).

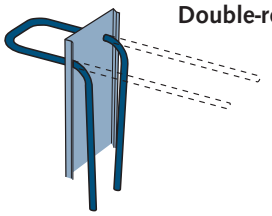
There is also a wide product range with corresponding profile widths and rebar shapes to choose from.

Rebar dimensions and element lengths are freely definable, limited only by geometric specifications and limits in production (see also page 16).



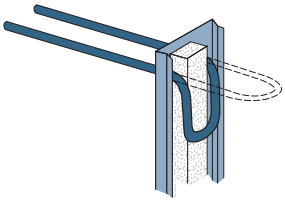
Single-row: HBT 85 - 10/10 - 2 - 1250, h = 120, $l_{ü}$ = 430, b= 95, 10Ø

- bend diameter
- rebar dimensions in [mm] (see page 7)
- element length L [mm]
- rebar type (see page 6)
- bar diameter Ø [mm] / bar spacing s [cm]
- profile indentifier



Double-row: HBT 120 - 10/15 - 5 - 1250, h = 170, $l_{ü}$ = 390

- rebar dimensions in [mm] (see page 9)
- element length L [mm]
- rebar type (see page 8)
- bar diameter Ø [mm] / bar spacing s [cm]
- profile indentifier



Double-row: HBT- S 220 - 12/20 - 6 - 750, h = 300, $l_{ü}$ = 190, 4 stirrups

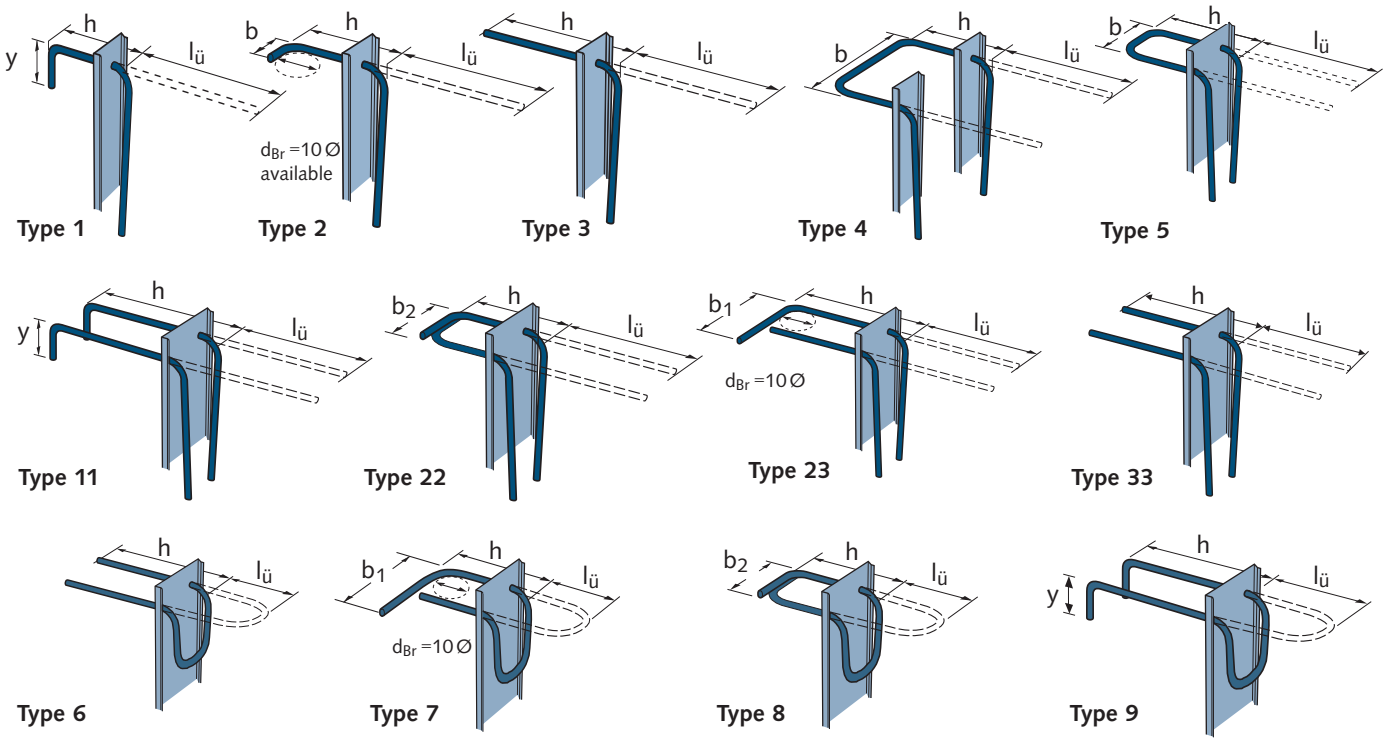
- rebar dimensions in [mm] (see page 9)
- element length L [mm]
- rebar type (see page 8)
- bar diameter Ø [mm] / bar spacing s [cm]
- profile indentifier
- S for „HBT Strip" (see page 16)

HBT Connection with foam strip filler „HBT Strip" (see page 16).

HALFEN HBT REBEND CONNECTION

Order form

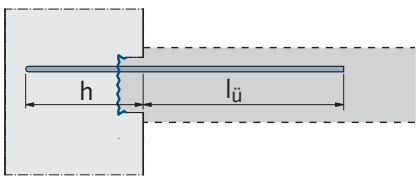
Single and double-row connections



Pos.	profile **HBT...**	rebar Ø [mm]	rebar spacing **s** [cm]	stirrup type	element length **L** [mm]	**h** [mm]	$l_{ü}$ [mm]	1 × value in [mm] if present **y**	**b**	b_1	b_2	d_{Br}	total length [m]	number of elements [items]

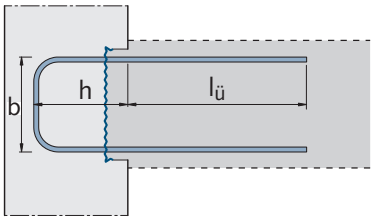
Note: do not exceed $l_{ü,max}$ see table on page 7 and 9; see page 6 to 9 for rebar and profile dimensions.

Single-row connection



Company	Fax or email
Address	this form to
City, Postcode/Zip.	HALFEN.
Tel. no.	See back-cover
E-Mail	for addresses.
Fax	

Double-row connection



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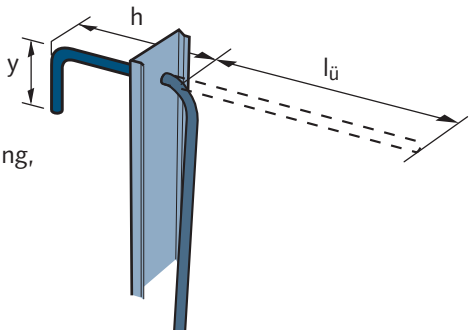
HALFEN HBT REBEND CONNECTION

Tender Texts

HALFEN Rebend connection, type HBT 85-10/20-1-1250

HALFEN HBT Rebend connection with single-row rebend reinforcement in a galvanised sheet-metal case to form a reinforced connection, with general building authority approval no. Z-21.8-2035,

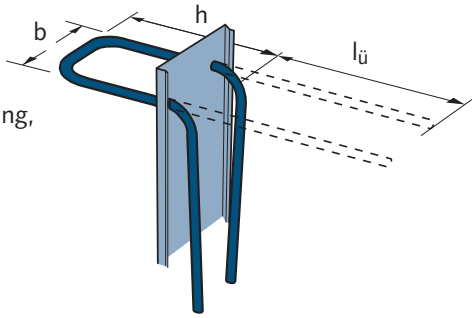


Type HBT 85 – 10/20 – 1 – 1250
with
85 = type identifier for a case width of 85 mm with a single-row of rebar,
10/20 = reinforcement steel B500B with 10 mm bar diameter and 200 mm bar spacing,
1 = standard rebar type 1,
1250 = element length [mm],
in standard rebar dimensions
rebar length 1 h = 170 mm,
rebar length 2 $l_ü$ = 390 mm,
bend length y = 95 mm,

or equivalent; deliver and install according to the manufacturer's instructions.

HALFEN Rebend connection, type HBT 150-12/15-5-1250

HALFEN HBT Rebend connection with double-row rebend reinforcement in a galvanised sheet-metal case to form a reinforced connection, with general building authority approval no. Z-21.8-2035,



Type HBT 150 – 12/15 – 5 – 1250
with
150 = type identifier for a case width of 150 mm with a double-row of rebar,
12/15 = reinforcement steel B500B with 12 mm bar diameter and 150 mm bar spacing,
5 = standard rebar type 5,
1250 = element length [mm],
in standard rebar dimensions
rebar length 1 h = 170 mm,
rebar length 2 $l_ü$ = 460 mm,

or equivalent; deliver and install according to the manufacturer's instructions.

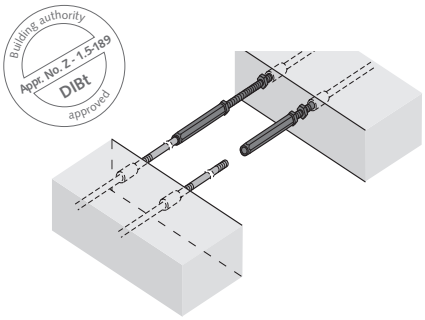
HALFEN Rebend connection, with stainless steel reinforcement bars

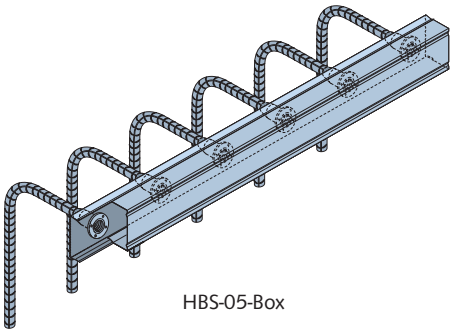
Use the text as above, but replace "B500B" with "stainless steel B500 NR according to building authority approval".

Further tender texts can be found at www.halfen.com.

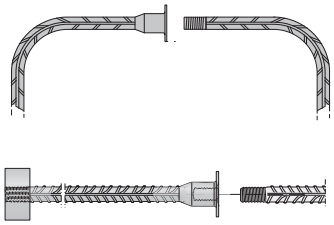
HALFEN HBS-05 Screw connections

The HALFEN HBS-05 Screw connections allow rebar continuity joints possible with simple screw and socket rebar. Their versatility allows nearly every type of reinforcement joint. HALFEN HBS-05 fulfils German and international certification criterion. Extensive certification and test reports prove their suitability also under extreme conditions.





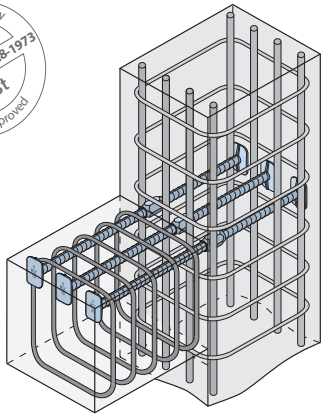
HBS-05-Box



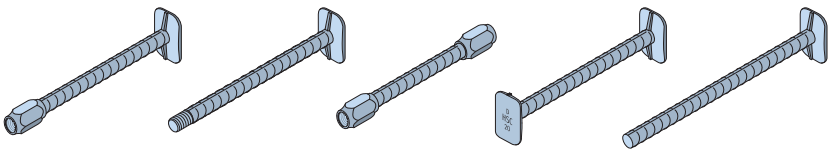
No torque wrench or special tools required – visual check is sufficient

HALFEN HSC Stud Connector

The HALFEN HSC Stud connector is a building authority approved reinforcement optimized for anchorage in concrete. Maximum exploitation of the reinforcement is possible with extremely short anchoring lengths.
HALFEN HSC Anchor is especially advantageous for use in high-density reinforced areas, for example; corbels and frame corner nodes.

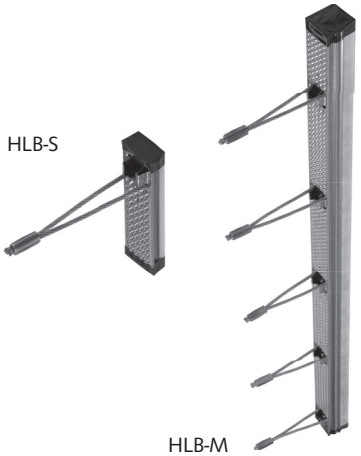


HSC-S Single head female bar
HSC-A Single head male bar
HSC-SD Double female bar
HSC-HD Double head bar
HSC-H Single head bar



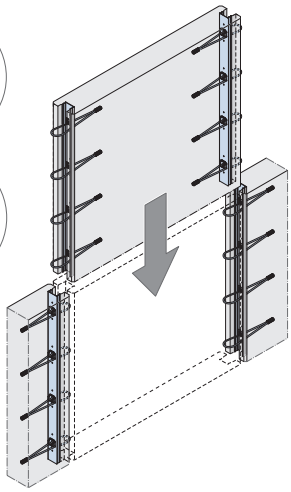
HALFEN HLB Loop Box

The HALFEN HLB Loop Box is an efficient and time saving method for connecting concrete elements. HLB Loop boxes are cast into concrete elements (e.g. wall elements) in the precast plant. The prepared concrete elements are transported to site, lifted and correctly placed with a crane; the joint between the elements is then cement-grouted.



HLB-S

HLB-M



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References

Kö-Bogen, Düsseldorf, Germany

The Kö-Bogen complex designed by Daniel Libeskind offers commercial space for business as well as a shopping centre with restaurants etc. The Kö-Bogen (curve) is located at the end of the Königsallee in Düsseldorf, Germany.

HALFEN supplied HALFEN HBT Rebend connections for the Kö-Bogen. Other HALFEN products also used in this project include;

- HALFEN HTA Channels
- HALFEN Masonry connection channels
- HALFEN HDB Shear rails
- HALFEN HBS-05 Screw connections


Kopernikus Science centre, Warsaw, Poland

The Science centre in Warsaw, Poland, named after Nikolaus Kopernikus, is a collection of buildings with six exhibition areas.

HALFEN supplied HALFEN HBT Rebend connections for this project.

DATEV IT-Campus, Nuremberg, Germany

The DATEV IT-Campus on Fürther Strasse in Nuremberg offers 1800 workspaces including 200 individual offices and conference rooms of various sizes.
The building was inaugurated in 2015.

HALFEN supplied HDB Shear rails and HBT Rebend connections for this project.

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