

HALFEN HBT REBEND CONNECTION

TECHNICAL PRODUCT INFORMATION



HALFEN HBT REBEND CONNECTION

HBT 13-E

CONCRETE

NEW!

Type tested to EUROCODE 2

and quality marked



HALFEN
YOUR BEST CONNECTIONS

HALFEN HBT REBEND CONNECTION

System Description

HBT - solution for reinforcement starter bars



HBT technical specifications

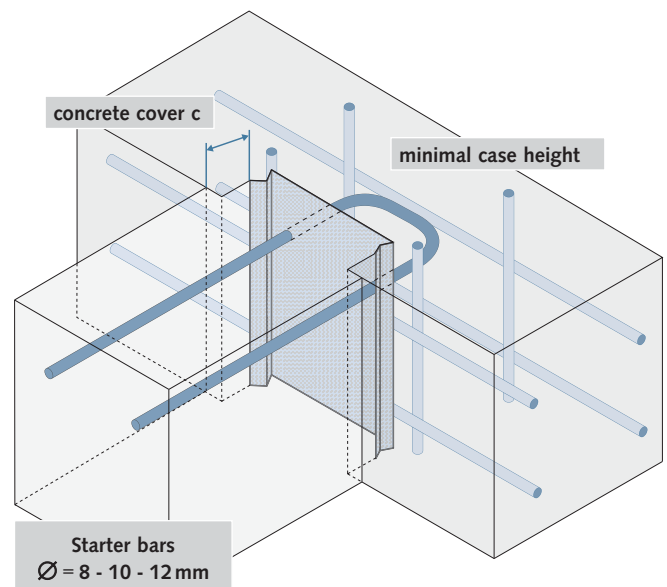
- standard element lengths: 1.25 m and 0.80 m, further lengths on request
- 7 case sizes starting from 6 cm width for connecting various building components
- 13 different stirrup types available for one- and two-row connections
- rebar diameter $\varnothing$: 8 - 10 - 12 mm
- stirrups
 - a) B500B
 - b) B500B NR available (on request)
- bending roll diameter at rebend location
$$d_{BR} = 6 \times \varnothing$$

Product advantages

HALFEN HBT Rebend connections are type tested. They comply with the requirements stipulated by the German Concrete Association (DBV Deutscher Beton Verein) in its publication on rebending reinforcement bars and recess cases from January 2011. The over-lap lengths are calculated according to Eurocode 2.

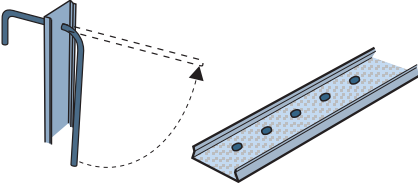
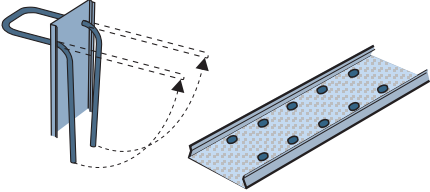
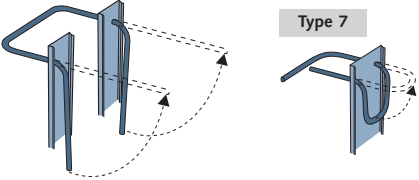
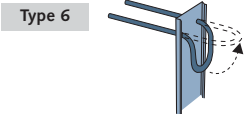
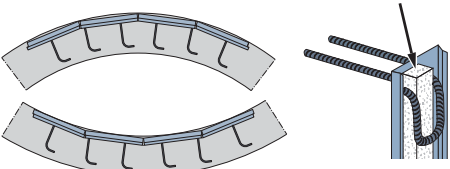
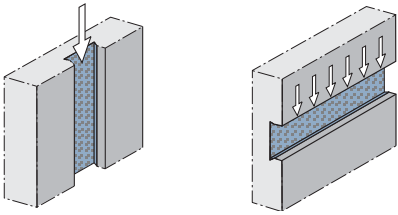
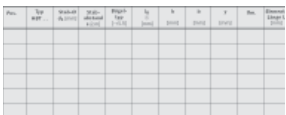
An approval certificate is therefore not required for the rebend connection.

- case and cover are made of pre-galvanized steel to prevent corrosion
- no plastic components remain in the concrete
- the specially shaped profile prevents fresh concrete entering the case
- case is simply nailed or glued to the formwork
- strong steel case and cover retain their shape during concrete pour
- the pre-punched cover is simple and quick to remove after the concrete has cured
- the steel casing has a profiled back providing optimal bond and shear transfer to the concrete
- minimal required concrete cover is ensured with minimal height case sides (see "c" in drawing below)



HALFEN HBT REBEND CONNECTION

Contents

	Application examples / Type overview	4-5
	Standard element single row: HBT 55 and 85	6
	Standard element double row: HBT 120 and 150	7
	Standard element double row: HBT 190 and 220	8
	Minimal element lengths for HBT	8
	Standard short element for single or double row, L=800 mm	9
	Product Range: Profile variants, stirrup types	10
	Maximal over-lap length $l_{ü,max}$	11
	Standard element HBT 80 as precast connection (structural connection)	12
	Adapting the HBT to curved formwork, 'HBT-Strip' securing strip	13
	Static values, notes on calculations	14
	Applications according to 'Rebending reinforcement' guidelines	15
	Table values according to type tests; Basics according to 'Rebend' guidelines	16-19
	Assembly instructions	19
	Corbel calculations/calculation basics	20-21
	Order forms	22
	Specifications for tender	23
	Addresses, technical assistance	back of catalogue



Digital technical drawings for HBT-Elements can be found in the HALFEN reinforcement systems CAD-library. Free download available under www.halfen.de. Available in the following file formats:

- CAD - DWG
- CAD - DXF

A free DVD is also available. Call us or send an e-mail. Addresses, telephone- and fax numbers can be found on the back cover of this catalogue.

HALFEN HBT REBEND CONNECTION

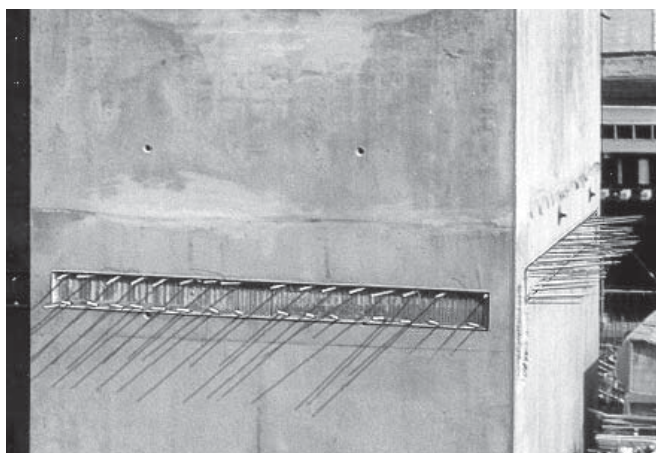
Application examples



The RAL Quality Mark guarantees compliance with the technical product requirements and the related services regarding:

- specification, quality management, logistics, competent technical advice, high-quality technical documentation and software, fulfilment of the guaranteed benefits and guaranteeing the neutrality of tender documents

Biannual monitoring provided by HDB-S guarantees that the recommended requirements of the quality control association for Anchor and reinforcement technology (Gütegemeinschaft Verankerungs und Bewehrungstechnik e.V) are maintained.



Connection; wall — floor/ceiling slab



Connection; grandstand in stadium — supporting element



Connection; wall — Stair landing



Connection; column — wall

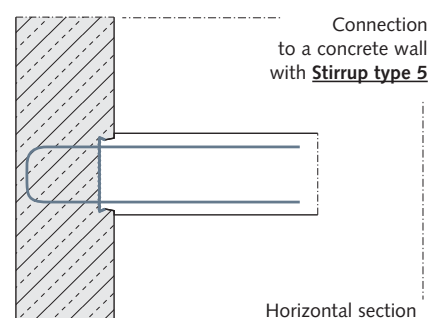
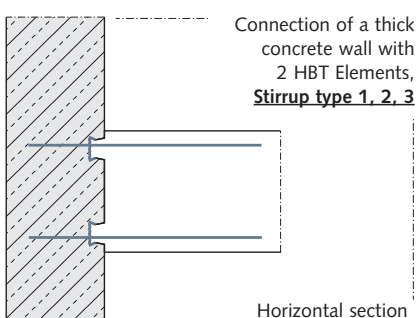
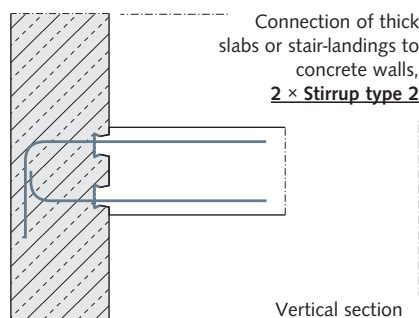
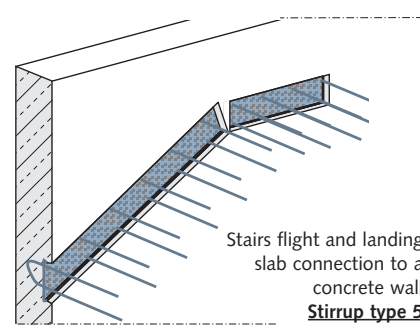
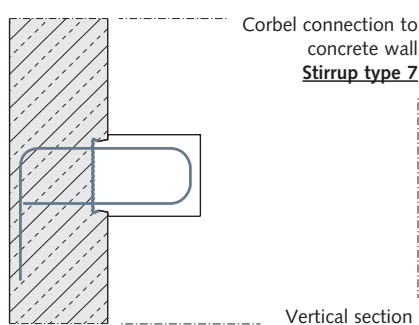
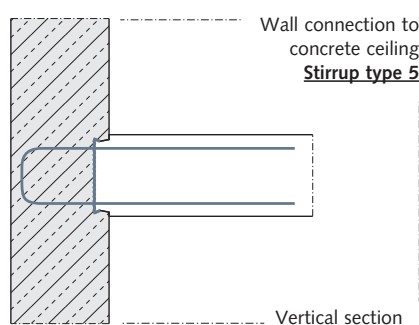
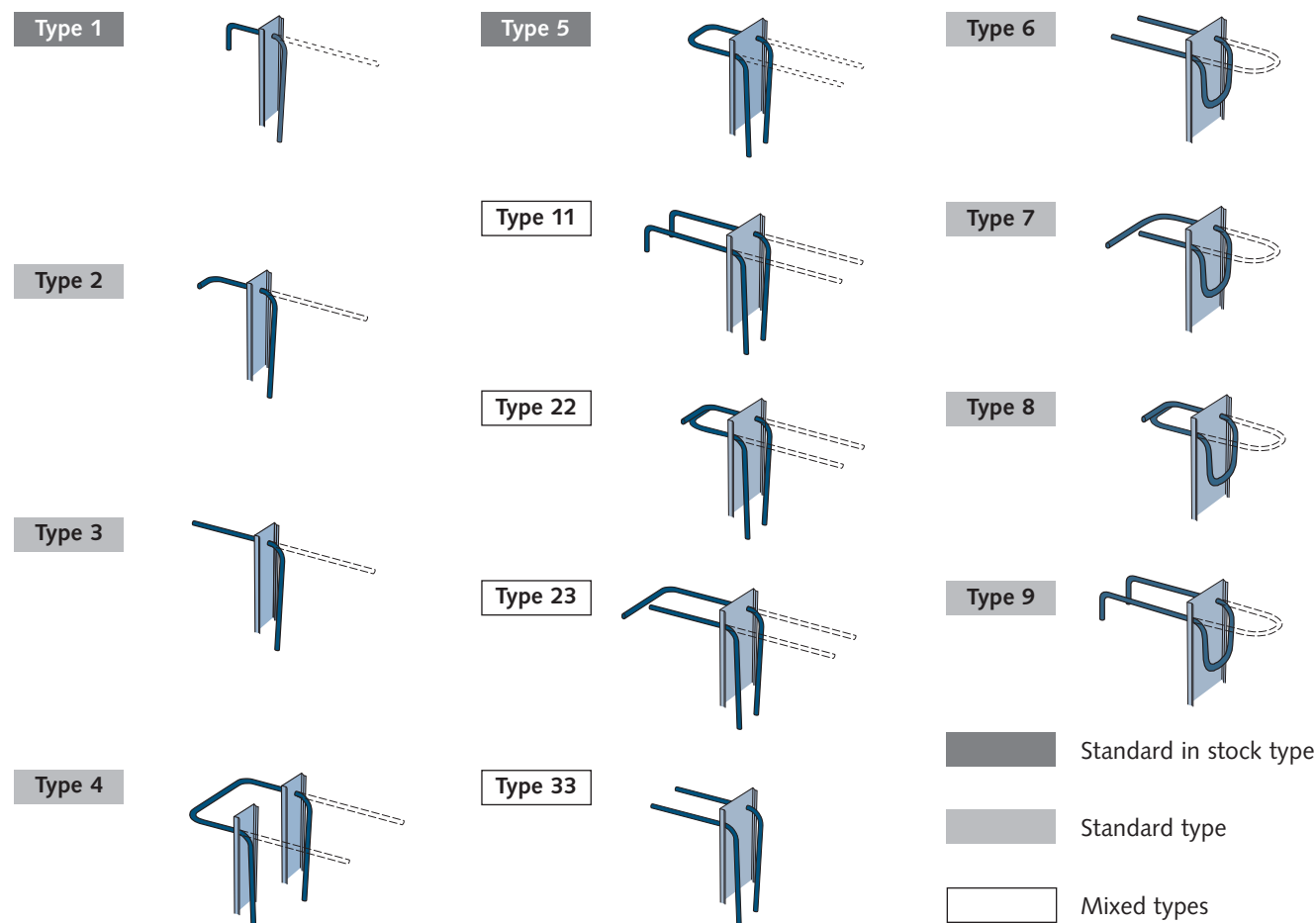
The HALFEN HBT Rebend connection allows easy and efficient connection of concrete components at different phases of construction. Walls ceilings and stairs can be subsequently cast and securely fixed using HALFEN HBT Rebend connections.

Perfect connections for numerous applications with 57 possible combinations of rebar types and profile widths. HALFEN HBT Rebend connection elements are available with reinforcement bars in diameters of 8, 10 and 12 mm.

Available as a standard product for the most common installation situations with single- and double-row connections in element lengths of 0.8 m and 1.25 m.

HALFEN HBT REBEND CONNECTION

Type Overview/Application examples

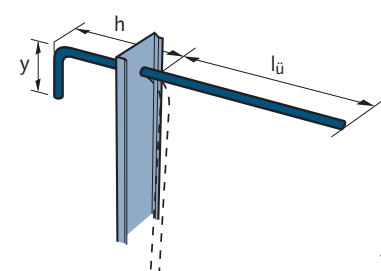


HALFEN HBT REBEND CONNECTION

Standard Elements Single-row

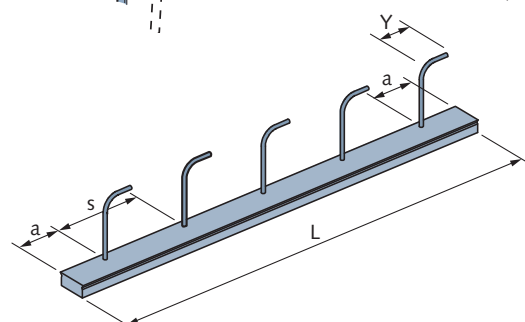
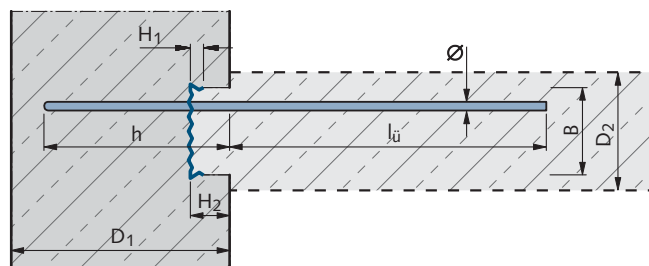
HBT 55 and HBT 85

Type 1



- bending roll diameter in bend location
 $d_{BR} = 6 \times \emptyset$

- material:
Steel rebar
B500B, B500B NR



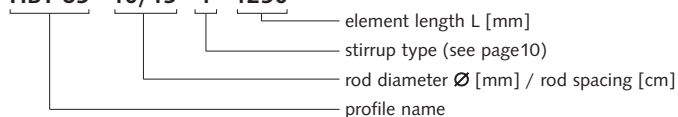
HBT Type 1 — System layout			
element length L	rebar spacing s [cm]	number of rebars	end distance a [cm]
standard element L = 1250 mm	10	12	7.5
	15	8	10.0
	20	6	12.5
	25	5	12.5

HBT Type 1 — Standard element with element length 1250 mm

item		order no.	dimension of starter bars			for element thickness		case dimensions			
profile	rod Ø/ spacing s [mm/cm]	0054.010-	l _ü * [mm]	h* [mm]	y* [mm]	D ₁ [cm]	D ₂ [cm]	width B [mm]	height H ₁ [mm]	height with cover H ₂ [mm]	element- weight [kg]
HBT 55	8/15	00001	320	170	75	≥ 19	≥ 6	58	12	24	2.7
	8/20	00002									2.3
	8/25	00003									2.1
	10/15	00004	390		95					30	4.1
	10/20	00005									3.4
	10/25	00006									3.0
profile		0054.020-									
HBT 85	10/10	00007	390	170	95	≥ 19	≥ 9	86	12	30	6.0
	10/15	00001									4.4
	10/20	00002									3.7
	10/25	00003	430		110					36	3.3
	12/10	00008									9.0
	12/15	00004									6.4
	12/20	00005	460								5.2
	12/25	00006									4.5

* Other sizes are also available.

Order example: HBT 85 - 10/15 - 1 - 1250



Notes:

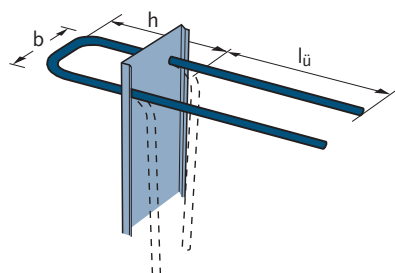
- other HBT 120 element lengths on request (compare tables on page 8 and page 11)
- according to DIN 1045-1:2008-08, section 12.6, the required anchorage and over-lap lengths for individual tensile forces in each reinforcing rod must be observed
- the anchorage and over-lap lengths required by DIN 1045-1:2008-08 may be reduced by 20%, otherwise, according to the data sheet 'Rebending rebar', the reinforcement may only be utilized to 80% of calculated values
- calculation notes for anchoring length → page 20

HALFEN HBT REBEND CONNECTION

Standard Elements Double-row

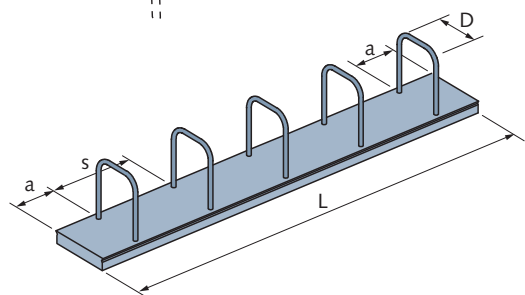
HBT 120 and HBT 150

Type 5 Double-row connection, standard rebar

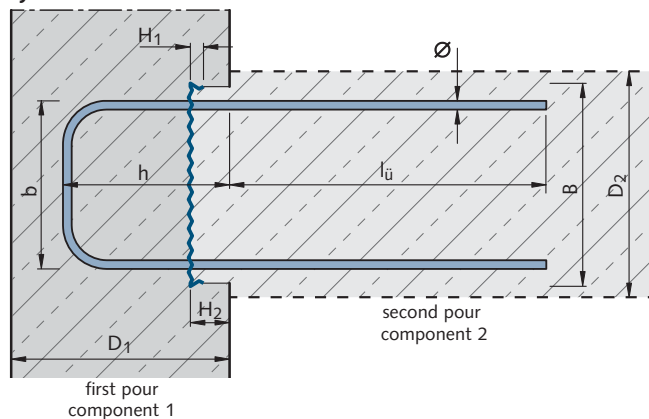


- bending roll diameter in bend location
 $d_{BR} = 6 \times \varnothing$

- material:
Steel rebar
B500B, B500B NR



System:



HBT Type 5 — Stirrup position

element length L	stirrup spacings [cm]	no. of stirrup	end distance a [cm]
standard element L = 1250 mm	10	12	7.5
	15	8	10.0
	20	6	12.5
	25	5	12.5

HBT Type 5 — Standard element with element length 1250 mm (table continues on page 8)

item		order no.	dimensions of starter bars			for element thickness		case dimensions				
profile	rod Ø/ spacings s [mm/cm]	0054.040-	l _ü * [mm]	h* [mm]	b [mm]	D ₁ [cm]	D ₂ [cm]	width B [mm]	height H ₁ [mm]	height with cover H ₂ [mm]	element- weight [kg]	
HBT 120	8/15	00001	320	170	88	≥ 19	≥ 13	122	12	24	4.9	
	8/20	00002			90						30	4.1
	8/25	00003										3.7
	10/15	00004	390		92					36		7.5
	10/20	00005									6.1	
	10/25	00006			5.4							
	12/15	00007	390		92					36	10.1	
	12/20	00008	440								8.5	
	12/25	00009	460								7.6	
profile		0054.050-										
HBT 150	8/15	00001	320	170	116	≥ 19	≥ 16	150	12	24	5.3	
	8/20	00002			118						30	4.4
	8/25	00003										4.0
	10/10	00010	360		120					36		10.8
	10/15	00004	390								7.9	
	10/20	00005									6.4	
	10/25	00006								5.6		
	12/10	00011	310		120					36	16.2	
	12/15	00007	460								11.5	
	12/20	00008									9.1	
	12/25	00009									7.9	

* Other sizes are also available.

Notes:

- other element lengths on request, further available rebar types → table on page 11
- according to DIN 1045-1:2008-08, section 12.6, the required anchorage and over-lap lengths for individual tensile forces in each reinforcing rod must be observed
- the anchorage and over-lap lengths required by DIN 1045-1:2008-08 may be reduced by 20%, otherwise, according to the data sheet 'Rebending rebar', the reinforcement may only be utilized to 80% of calculated values
- calculation notes for anchor lengths → page 20

HALFEN HBT REBEND CONNECTION

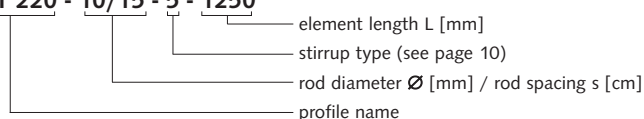
Standard Element Double Row; Minimal Element Lengths for HBT

HBT 190 and HBT 220

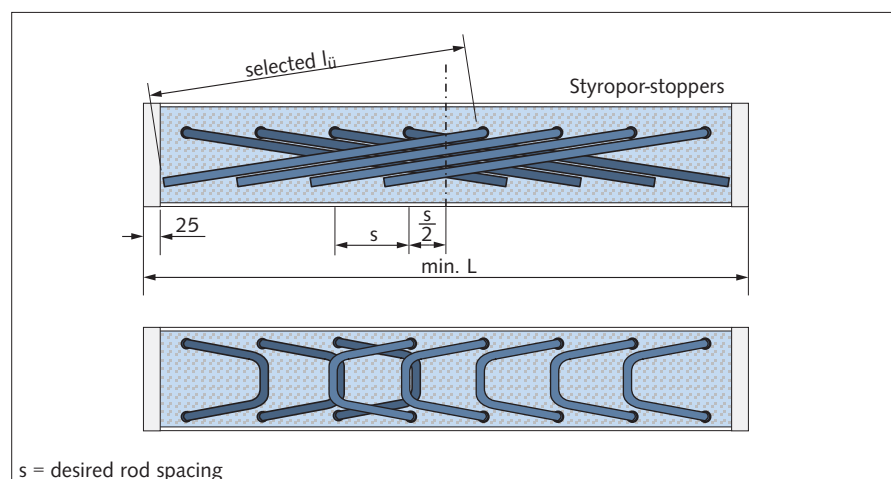
HBT Type 5 — Standard element with element length 1250 mm (table continued from page 7)											
item name		order no.	dimension of starter bars			for element thickness		case dimensions			
profile	rod Ø/ spacing s [mm/cm]	0054.060-	l _ü * [mm]	h* [mm]	b [mm]	D ₁ [cm]	D ₂ [cm]	width B [mm]	height H ₁ [mm]	height with cover H ₂ [mm]	element- weight [kg]
HBT 190	8/15	00001	320	170	152	≥ 19	≥ 19	186	12	24	5.8
	8/20	00002									4.9
	8/25	00003									4.5
	10/10	00010	390		154					30	11.5
	10/15	00004									8.5
	10/20	00005									6.9
	10/25	00006	430		156					36	6.2
	12/10	00011									17.0
	12/15	00007									12.1
	12/20	00008									9.7
12/25	00009	460	8.5								
profile		0054.070-									
HBT 220	8/15	00001	320	170	188	≥ 19	≥ 23	222	12	24	6.2
	8/20	00002									5.3
	8/25	00003									4.9
	10/10	00010	390		190					30	12.1
	10/15	00004									9.0
	10/20	00005									7.4
	10/25	00006	460		192					36	6.6
	12/10	00011									17.7
	12/15	00007									12.7
	12/20	00008									10.2
12/25	00009		9.0								

* Other sizes are also available. Please see notes on page 7

Order example: **HBT 220 - 10/15 - 5 - 1250**



Minimal element lengths for re-bend connection HBT, position of reinforcement in the metal case



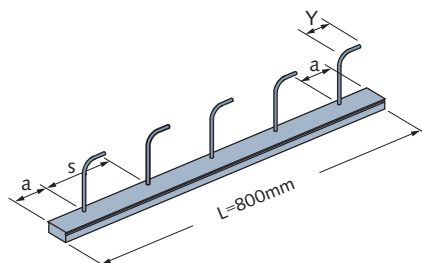
Minimal element lengths for $l_{ü}$ standard				
Ø [mm]	s [cm]	$l_{ü}$ ① [mm]	minimal length [mm]	no. of stirrups
8	10	320	650	6
8	15	320	600	4
8	20	320	650	4
10	10	390	800	8
10	15	390	750	4
10	20	390	700	4
12	10	460	950	8
12	15	460	900	6
12	20	460	850	4

① Max. $l_{ü}$ - observe dimension for each profile (see page 11)

HALFEN HBT REBEND CONNECTION

Standard Elements as Short Element, L = 800 mm

HBT 55 and 85

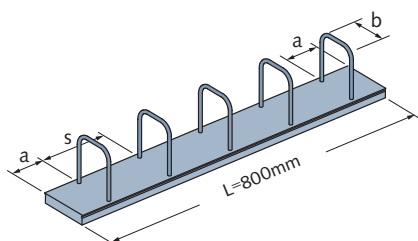


1-row

Type 1

system drawing see page 6

HBT 120, 150, 190 and 220



2-row

Type 5

system drawing see page 7

Stirrup position, short elements

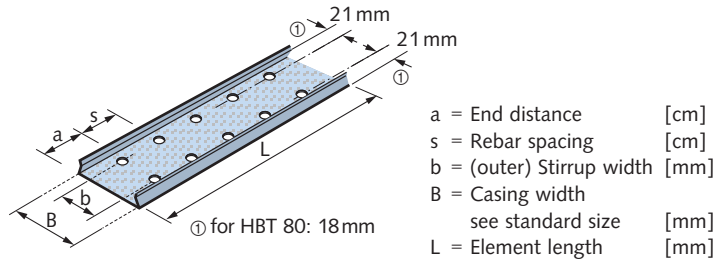
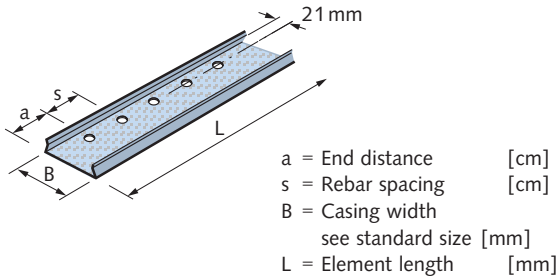
HBT Type 1 and 5 – stirrup position			
element length L	stirrup-spacing s [cm]	no. of stirrup	end distance a [cm]
short-element L = 800 mm	10	8	5.0
	15	6	2.5
	20	4	10.0
	25	4	2.5

Short element, element length 800 mm											
item name		order no.	dimension of starter bars			for element thickness		case dimensions			
profile	rod Ø/ spacing s [mm/cm]	0054. ...	l _ü [mm]	h [mm]	y, b [mm]	D ₁ [cm]	D ₂ [cm]	width B [mm]	height H ₁ [mm]	height with cover H ₂ [mm]	element- weight [kg]
HBT 55	8/15	010-00101	320	170	75	≥ 19	≥ 6	58	12	24	1.9
	8/20	010-00102									1.5
	8/25	010-00103									1.5
	10/15	010-00104	390		95					30	3.0
	10/20	010-00105									2.2
	10/25	010-00106									2.2
HBT 85	10/10	020-00101	390	170	95	≥ 19	≥ 9	86	12	30	3.9
	10/15	020-00102									3.1
	10/20	020-00103									2.3
	10/25	020-00104									2.3
profile											
HBT 120	8/15	040-00101	320	170	88	≥ 19	≥ 13	122	12	24	3.5
	8/20	040-00102									2.7
	8/25	040-00103									2.7
	10/15	040-00104	390		90					30	5.5
	10/20	040-00105									4.0
	10/25	040-00106									4.0
HBT 150	8/15	050-00101	320	170	116	≥ 19	≥ 16	150	12	24	3.7
	8/20	050-00102									2.9
	8/25	050-00103									2.9
	10/10	050-00104	360		118					30	6.8
	10/15	050-00105	5.6								
	10/20	050-00106	4.2								
	10/25	050-00107	4.2								
HBT 190	8/15	060-00101	320	170	152	≥ 19	≥ 19	186	12	24	4.1
	8/20	060-00102									3.2
	8/25	060-00103									3.2
	10/10	060-00104	390		154					30	7.5
	10/15	060-00105									5.9
	10/20	060-00106									4.4
	10/25	060-00107									4.4
HBT 220	8/15	070-00101	320	170	188	≥ 19	≥ 23	222	12	24	4.4
	8/20	070-00102									3.5
	8/25	070-00103									3.5
	10/10	070-00104	390		190					30	7.7
	10/15	070-00105									6.2
	10/20	070-00106									4.6
	10/25	070-00107									4.6

HALFEN HBT REBEND CONNECTION

Product Range: Profile Variants, Stirrup Types

Single- and double-row layouts



1-row

for profile **HBT 55, 85 and 120**

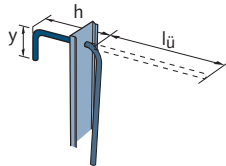
2-row

for profile **HBT 80, 120, 150, 190 and 220**

Stirrup types

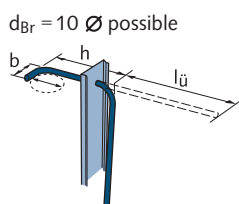
Type 1

min $h = 120$ mm

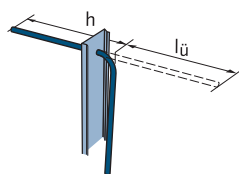


Type 2

min $h = 120$ mm

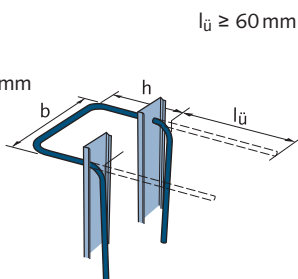


Type 3



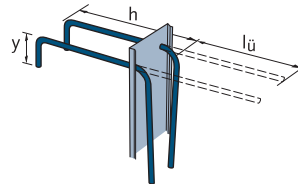
Type 4

min $h = 120$ mm

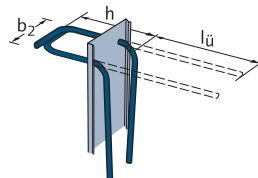


Type 4	b [mm]
HBT 55	200...500
HBT 85	250...500

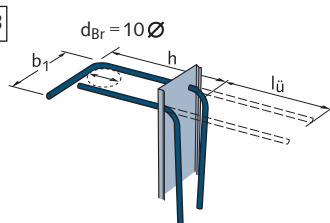
Type 11



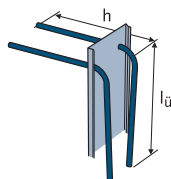
Type 22



Type 23

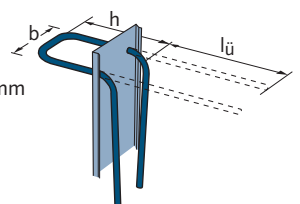


Type 33



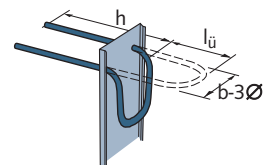
Type 5

min $h = 120$ mm



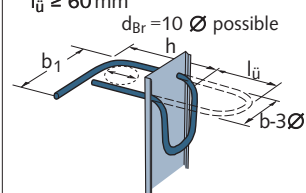
Type 6

$l_ü \geq 60$ mm



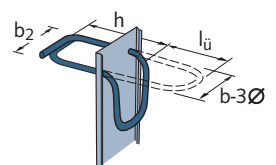
Type 7

$l_ü \geq 60$ mm



Type 8

$l_ü \geq 60$ mm

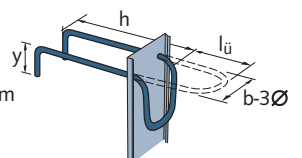


Type 7 and 8

rod $\varnothing$	min h [mm]
8	135
10	155
12	170

Type 9

$l_ü \geq 60$ mm
min $h = 140$ mm



It may be possible to use **HALFEN HBS-05** or a **HALFEN HLB Loop Box®** if a connection using HBT is not viable. Product information can be found at www.halfen.com. For technical support contact Halfen GmbH, Engineering Support, reinforcement technology. Addresses can be found at the back of this catalogue.

HALFEN HBT REBEND CONNECTION

Product Range: Maximum Possible Over-lap Lengths $l_{ü,max}$

HBT 55, 85, 80 and 120

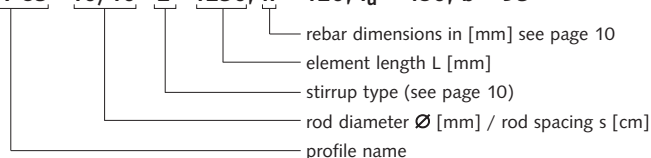
$l_{ü,max}$ [mm]					
item name			$l_{ü,max}$ [mm] for stirrup type (see page 10)		
profile	rod Ø [mm]	rod-spacing s [cm]	1, 2, 3, 4	5, 11, 22, 23, 33	6, 7, 8, 9
HBT 55	8	10	210	—	—
		15	510	—	—
		20	600	—	—
		25	600	—	—
	10	10	200	—	—
		15	390	—	—
		20	510	—	—
		25	510	—	—
HBT 85	10	10	430	—	—
		15	510	—	—
		20	600	—	—
		25	600	—	—
	12	10	430	—	—
		15	510	—	—
		20	600	—	—
		25	600	—	—
HBT 80	8	10	—	170	70
		15	—	360	125
		20	—	450	175
		25	—	500	225
	10	10	—	160	60
		15	—	320	120
		20	—	400	170
		25	—	450	220
HBT 120	8	10	—	290	115
		15	—	510	175
		20	—	600	235
		25	—	600	290
	10	10	600	240	80
		15	600	510	130
		20	—	600	180
		25	—	600	230
	12	10	600	215	70
		15	600	390	120
		20	—	440	170
		25	—	490	220

HBT 150, 190 and 220

$l_{ü,max}$ [mm]				
item name			$l_{ü,max}$ [mm] for stirrup type (see page 10)	
profile	rod Ø [mm]	rod-spacing s [cm]	5, 11, 22, 23, 33	6, 7, 8, 9
HBT 150	8	10	360	100
		15	510	150
		20	600	210
		25	600	260
	10	10	360	85
		15	510	135
		20	600	185
		25	600	235
	12	10	310	90
		15	480	150
		20	530	200
		25	580	250
HBT 190	8	10	500	100
		15	510	150
		20	600	210
		25	600	260
	10	10	500	110
		15	510	170
		20	600	220
		25	600	280
	12	10	430	90
		15	510	140
		20	600	190
		25	600	240
HBT 220	8	10	600	100
		15	600	150
		20	600	210
		25	600	260
	10	10	600	110
		15	600	170
		20	600	220
		25	600	280
	12	10	600	90
		15	600	140
		20	600	190
		25	600	240

Note: Maximal over-lap only applies to element length 1250mm. Maximum over-lap for other element lengths are supplied on request.

Order example: **HBT 85 - 10/10 - 2 - 1250, h = 120, $l_{ü}$ = 430, b = 95**

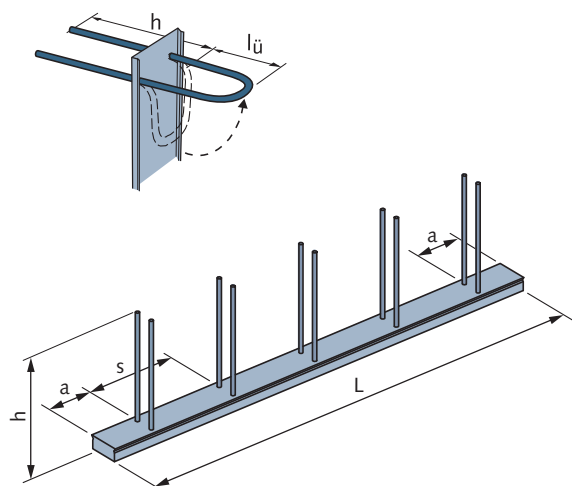


HALFEN HBT REBEND CONNECTION

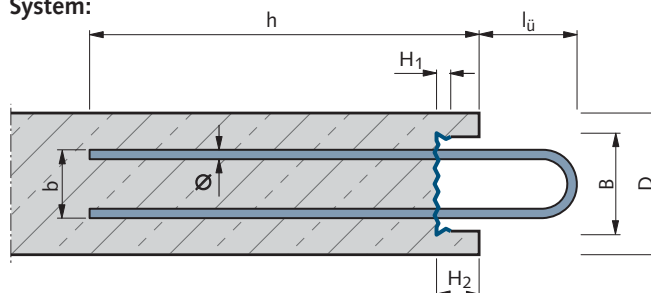
Standard Element as Precast Connection (Structural Connection)

HBT 80 as precast connection

Type 6 Double-row connection, standard stirrup



System:



HBT 80 Type 6 – System layout

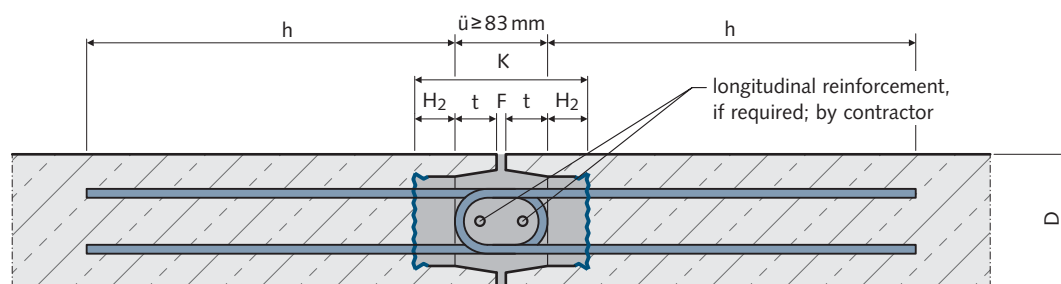
element length L	stirrup spacing s [cm]	number of stirrups	end distance a [cm]
standard element L = 1250 mm	10	12	7.5
	15	8	10.0
	20	6	12.5
	25	5	12.5

HBT 80 Type 6 – Precast connection with element length 1250 mm

item name		order no.	dimension of starter bars			spacing	for element thickness	case dimensions			
profile	rod Ø/ spacing s [mm/cm]	0054.030-	l _ü * [mm]	h* [mm]	b [mm]	K [cm]	D [cm]	width B [mm]	height H ₁ [mm]	height with cover H ₂ [mm]	element-weight [kg]
HBT 80	8/15	00001	≥ 90	330	58	12 - 16	≥ 12	86	12	24	4.0
	8/20	00002									3.3
	8/25	00003									3.0
	10/15	00004	≥ 90	400	60					30	6.2
	10/20	00005									5.0
	10/25	00006									4.4

* Other dimensions are also available

- Note:
- structural connection
 - other rebar types and element length on request
 - with D = 12 cm the casing has a concrete cover of 1.7 cm on both sides



Detail; connection between two precast wall slabs

F = Joint width
t = Recess

Order example:

HBT 80 - 10/15 - 6 - 1250 - 400 - 90

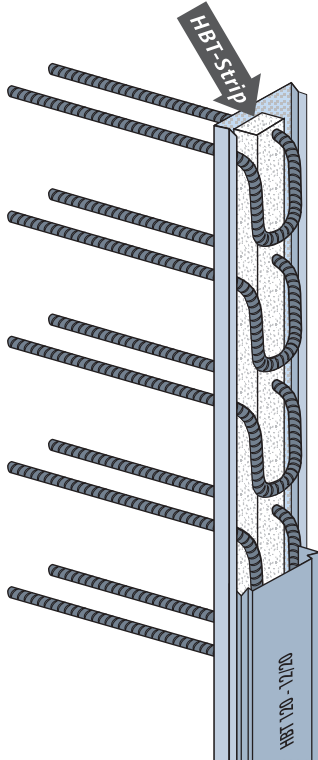
- over-lap length $l_{\bar{u}}$ [mm]
- stirrup dimension h [mm]
- element length L [mm]
- stirrup type (see page 10)
- rod diameter Ø [mm] / rod spacing s [cm]
- profile name

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HALFEN HBT REBEND CONNECTION

Securing strip 'HBT-Strip', Adapting the HBT to Curved Formwork

'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 than for other building products.

The HBT-Connection with 'HBT-Strip' (HBT-S) fulfils these requirements perfectly:

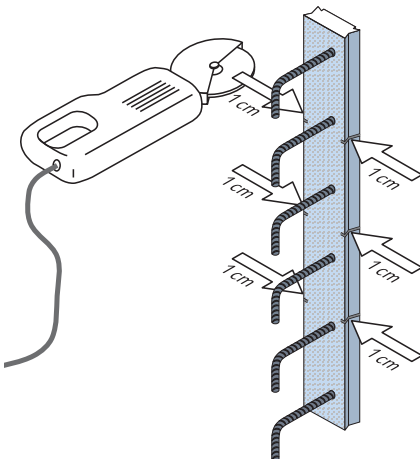
- rebars are secured during transport
- compliance with required over-lap and anchorage lengths
- recommended for loop and corbel connections
- HBT securing strip is easily removed after striking the formwork
- available for all double row HBT connections, rebar types 6, 7, 8 and 9 in casing size HBT 80, 120, 150, 190 and 220

Order example: **HBT - S - 80 - 10/15 - 6 - 1250**

element length L [mm]
stirrup type (→ S. 10)
rod diameter Ø [mm] / rod spacing s [cm]
profile name, - S for 'HBT-Strip'

Installation is as described on page 22: the HBT securing strip must be removed after rebending the rebars.

HBT-Element adapted to curved formwork



Making incisions in the HBT-Casing

Using an angle-grinder, cut approximately 1 cm deep incisions symmetrically into both sides of the casing at regular intervals. As a result the HBT housing loses its rigidity, easing fixing to the formwork.

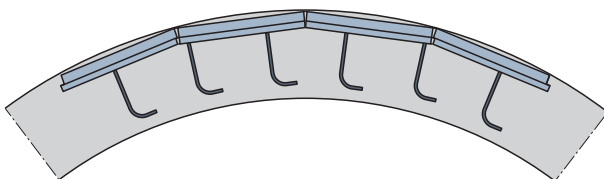
To achieve a better fit to smaller curvature (< 3.00 m), up to seven incisions per side are possible.

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



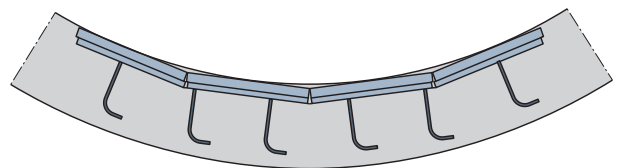
Caution when working with an angle-grinder!

The reinforcing steel bars in the HBT-Casing must not be damaged.



HBT-Element fitted to an convex curvature

RV radius $\geq$ ca. 3.00 m; Smaller radius is achieved with more incisions.



HBT-Element fitted to an concave curvature

RC radius $\geq$ ca. 3.00 m; Smaller radius is achieved with more incisions.

HALFEN HBT REBEND CONNECTION

Static Values, Calculation Values

Shear load, standard cases (in accordance with 'Rebending rebar' data sheet issued by the DBV)

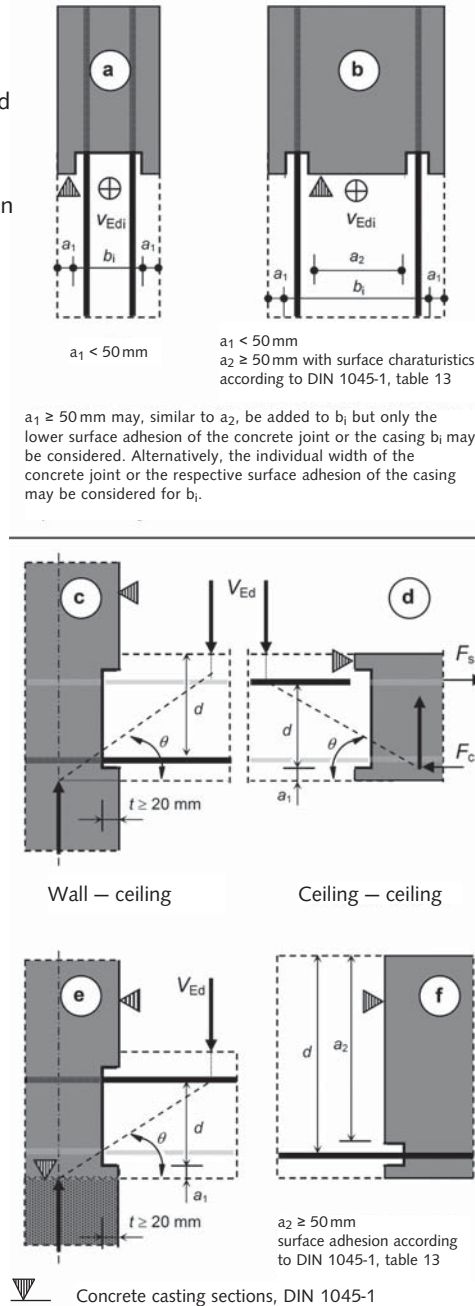
Source:

Data sheet 'Rebending of reinforcing steel and requirements on protective boxes according to Eurocode 2' issued by the (DBV) Deutschen Beton- und Bautechnik-Verein e.V. (German Society for Concrete and Construction Technology), January 2011

figure 8:

Calculating limits of load capacity – cross-section values

Explanations of the standard cases see page 15.



The type test for HALFEN HBT Rebend connectors can be found at www.halfen.de

According to DIN EN 1992-1-1, section 6.2.5 the HBT-Profile is classified as having a smooth surface. According to the type test, in its main application, case (C), the HBT-Profiles mostly achieve the same results for $V_{Rd,c}$ as is achieved by **serrated profiles**.

The type test for HBT Connections was based on the guide lines 'Rebending rebar' issued by the DBV and on **DIN EN 1992-1-1**.

Excerpts for shear load capacity as defined in the type test can be found in the tables on pages 16 through to page 19.

Load capacity values have not changed in comparison to the previous type test according to DIN 1045-1:2008-8

- Case (a) → page 19
- Case (b) → type test HBT
- Case (c) → page 16, 17
- Case (d) → type test HBT
- Case (e) → page 18
- Case (f) → type test HBT
- Corbel → page 19

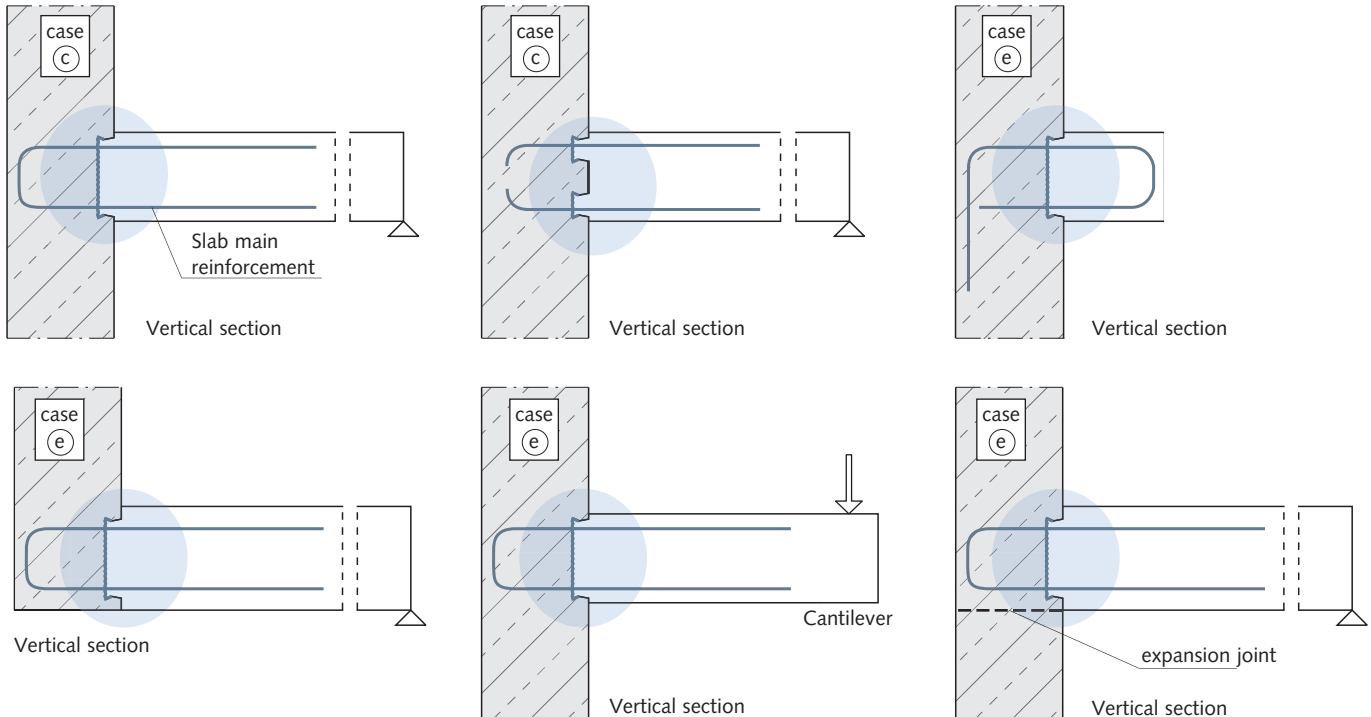
Calculation of the required anchoring and over-lap length is according to DIN 1045-1:2008-08, taking into account that the base value for anchoring length l_b can be calculated using the reduced calculation value for steel stress. This generally results in a reduction of about 20% in anchoring and over-lap lengths.

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

HALFEN HBT REBEND CONNECTION

Applications according to data sheet 'Rebending rebar'

Case classification in accordance with the 'Rebending rebar' data sheet



Case (a) (b)

The rebend rebar acts as connecting reinforcement in the joint. The shear force is transmitted parallel to the connection.

Case a is only for type HBT with double-row rebar. The side surfaces are only considered as supporting if these are > 5 cm, taking surfaces adhesion into account.

Case (c)

Case c is assumed with pin-jointed, linear-loads. The rebend rebar serves as longitudinal reinforcement for the connected building component, whereby, the lower row overlaps the bending reinforcement of the slab; the top row represents the structural reinforcement of the slab. If not placed in the connected component then shear force capacity in the connection is limited to $V_{Rd,c}$. By adding shear reinforcement, HALFEN HDB-S Shear rails for example (see HDB catalogue), the load capacity may be increased to $V_{Rd,s} \leq 0.3 V_{Rd,max}$. If the distance from the component edge to the lower edge of the profile is less than $a_1 < 5$ cm, then the connection as in case e must be selected.

Case (e)

If the upper row is assumed to be load bearing then a fixed end beam as in case e must be calculated. These cases generally include applications such as stair-landing slabs and corbels.

According to DIN EN 1992-1-1, 8.3 (NA.5) [R1] the reinforcement in rebend connections when subjected to predominantly static loads up to the load bearing limit may be subjected to maximum 80% of the allowable value of the calculated stress-strain factor for rebar as in DIN EN 1992-1-1, figure 3.8 [R1] (see also figure 6). According to DIN EN 1992-1-1, 8.4.3, Gl. (8.3) [R1] the reinforcement anchorage length may also be calculated with the reduced design value for steel stress, $\sigma_{s,d} \leq f_{yd,red} = 0.8 \times f_{yk}/\gamma_s$.

Data sheet 'rebending rebar'
Section 3.1 (3)

If subjected to a combination of shear forces along the joint and transverse forces at right-angles to the joint simultaneously, these verification may be carried out separately.

Data sheet 'rebending rebar'
Section 5.3 (7)

HALFEN HBT REBEND CONNECTION

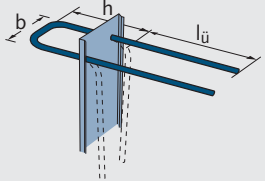
Tables According to the Type-test (Eurocode 2)

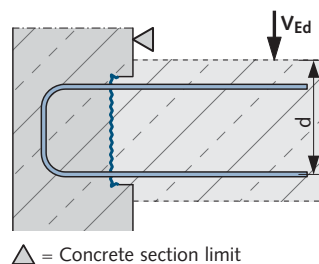
Shear load, standard case 'c' (according to 'Rebending rebar' data sheet issued by the DBV) without shear reinforcement

Example: 'Rebending rebar' data sheet figure 8, case (c)

$\sigma_{cp} = 0$

d: see illustration

Type 5 double-row connection, $h = 170 \text{ mm}$	$\varnothing [\text{mm}]$	$l_{\bar{u}}^* [\text{mm}]$
	8	320
	10	390
	12	460



Shear force stress max. $V_{Ed} [\text{kN/m}] (\leq 0.3 V_{Rd,max})$ for HBT 80, 120*, 150, 190 and 220										Observe the specifications in the type tests
rod $\varnothing$ / 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
concrete quality C20/25										
8/25	44.3	48.2	51.8	55.3	58.9	62.4	62.9	62.9	62.9	62.9
8/20	44.3	48.2	51.8	55.3	58.9	62.4	64.6	66.7	68.8	70.9
8/15	44.3	48.2	51.8	55.3	58.9	62.4	64.6	66.7	68.8	70.9
10/25	44.3	53.1	58.5	62.1	65.6	69.1	71.3	73.5	75.6	77.7
10/20	44.3	53.1	58.5	62.1	65.6	69.1	71.3	73.5	75.6	77.7
10/15	44.3	53.1	58.5	62.1	65.6	69.1	71.3	73.5	75.6	77.7
12/25	-	53.1	62.0	68.8	72.3	75.9	78.1	80.2	82.3	84.4
12/20	-	53.1	62.0	68.8	72.3	75.9	78.1	80.2	82.3	84.4
12/15	-	55.8	62.0	68.8	72.3	75.9	78.1	80.2	82.3	84.4
concrete quality C25/30										
8/25	49.5	55.1	59.0	62.9	62.9	62.9	62.9	62.9	62.9	62.9
8/20	49.5	55.1	59.0	63.0	66.9	70.9	73.3	75.7	78.1	78.7
8/15	49.5	55.1	59.0	63.0	66.9	70.9	73.3	75.7	78.1	80.4
10/25	49.5	59.4	66.8	70.8	74.8	78.7	81.2	83.6	85.9	88.3
10/20	49.5	59.4	66.8	70.8	74.8	78.7	81.2	83.6	85.9	88.3
10/15	49.5	59.4	66.8	70.8	74.8	78.7	81.2	83.6	85.9	88.3
12/25	-	59.4	69.3	78.6	82.6	86.6	89.0	91.4	93.8	96.1
12/20	-	59.4	69.3	78.6	82.6	86.6	89.0	91.4	93.8	96.1
12/15	-	60.1	69.3	78.6	82.6	86.6	89.0	91.4	93.8	96.1
concrete quality C30/37										
8/25	54.2	61.4	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9
8/20	54.2	61.4	65.7	70.1	74.4	78.7	78.7	78.7	78.7	78.7
8/15	54.2	61.4	65.7	70.1	74.4	78.7	81.4	84.0	86.6	89.2
10/25	54.2	65.1	74.6	78.9	83.2	87.6	90.2	92.9	95.5	98.0
10/20	54.2	65.1	74.6	78.9	83.2	87.6	90.2	92.9	95.5	98.0
10/15	54.2	65.1	74.6	78.9	83.2	87.6	90.2	92.9	95.5	98.0
12/25	-	65.1	75.9	86.8	92.1	96.4	99.1	101.7	104.3	106.8
12/20	-	65.1	75.9	86.8	92.1	96.4	99.1	101.7	104.3	106.8
12/15	-	65.1	75.9	86.8	92.1	96.4	99.1	101.7	104.3	106.8

Note:

- refer to type test for values for rebar spacing of 10 cm
- * because of its dense reinforcement sufficient over-lap is not always possible with the HBT 120 (page 7).
The values for load capacity should be adjusted accordingly

HALFEN HBT REBEND CONNECTION

Tables According to the Type-test (Eurocode 2)

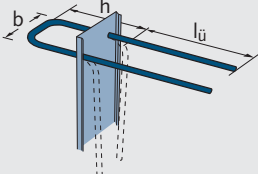
Shear load, standard case 'c' (according to 'Rebending rebar' data sheet issued by the DBV) with shear reinforcement

Example: 'Rebending rebar' data sheet figure 8, case (C)

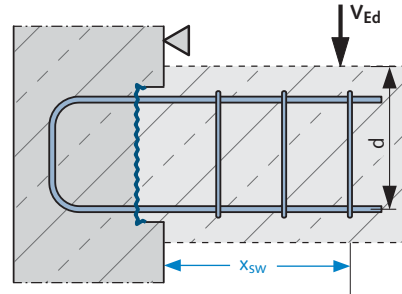
$\sigma_{cp} = 0$

d: see illustration

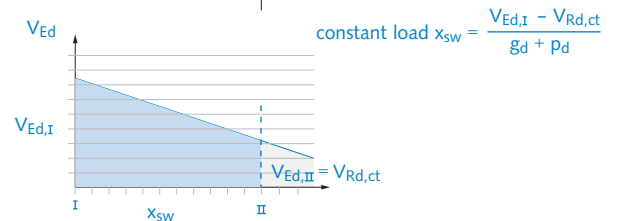
(HALFEN HDB-S or rebar)

Type 5 double row connection, h = 170 mm	Ø [mm]	$l_{\bar{u}}^*$ [mm]
	8	320
	10	390
	12	460

$$a_{sw} = \frac{V_{Ed}}{f_{yd} \cdot z} \quad z = \min \begin{cases} 0,9 \cdot d \\ d - c_{v,l} - 30 \text{ mm} \end{cases}$$



Δ = Concrete section limit



Shear force stress max. V_{Ed} [kN/m] ($\leq 0.3 \cdot V_{Rd,max}$) for HBT 80, 120*, 150, 190 and 220										Observe the specifications in the type tests.
rod 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
concrete quality C20/25										
8/25	63.8	69.9	69.9	69.9	69.9	69.9	69.9	69.9	69.9	69.9
8/20	63.8	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4
8/15	63.8	89.3	114.8	116.6	116.6	116.6	116.6	116.6	116.6	116.6
10/25	63.8	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5
10/20	63.8	89.3	109.4	109.4	109.4	109.4	109.4	109.4	109.4	109.4
10/15	63.8	89.3	114.8	140.3	145.8	145.8	145.8	145.8	145.8	145.8
12/25	-	89.3	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5
12/20	-	89.3	114.8	125.6	125.6	125.6	125.6	125.6	125.6	125.6
12/15	-	89.3	114.8	140.3	165.8	167.5	167.5	167.5	167.5	167.5
concrete quality C25/30										
8/25	69.9	69.9	69.9	69.9	69.9	69.9	69.9	69.9	69.9	69.9
8/20	79.7	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4
8/15	79.7	111.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6
10/25	79.7	101.5	101.5	101.5	101.5	101.5	101.5	101.5	101.5	101.5
10/20	79.7	111.6	126.9	126.9	126.9	126.9	126.9	126.9	126.9	126.9
10/15	79.7	111.6	143.4	169.2	169.2	169.2	169.2	169.2	169.2	169.2
12/25	-	111.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6
12/20	-	111.6	143.4	145.8	145.8	145.8	145.8	145.8	145.8	145.8
12/15	-	111.6	143.4	175.3	194.4	194.4	194.4	194.4	194.4	194.4
concrete quality C30/37										
8/25	69.9	69.9	69.9	69.9	69.9	69.9	69.9	69.9	69.9	69.9
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
10/25	95.6	109.3	109.3	109.3	109.3	109.3	109.3	109.3	109.3	109.3
10/20	95.6	133.9	136.6	136.6	136.6	136.6	136.6	136.6	136.6	136.6
10/15	95.6	133.9	172.1	182.1	182.1	182.1	182.1	182.1	182.1	182.1
12/25	-	131.7	131.7	131.7	131.7	131.7	131.7	131.7	131.7	131.7
12/20	-	133.9	164.6	164.6	164.6	164.6	164.6	164.6	164.6	164.6
12/15	-	133.9	172.1	210.4	219.5	219.5	219.5	219.5	219.5	219.5

Note:

- refer to type test for values for rebar spacing of 10 cm
- * because of its dense reinforcement sufficient over-lap is not always possible with the HBT 120 (page 7).
The values for load capacity should be adjusted accordingly

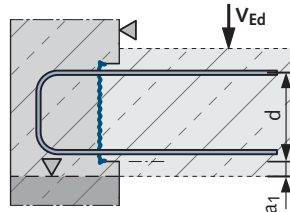
HALFEN HBT REBEND CONNECTION

Values in Tables are According to the Type-test (Eurocode 2)

Shear force, Standard case 'e' (in accordance with 'Rebending rebar' data sheet)

Example: 'Rebending rebar' data sheet
figure 8, case **e**
 $\sigma_{cp} = 0$

No shear force reinforcement



Δ = Concrete section limit

Type 5 double row connection, h = 170 mm	$\emptyset$ [mm]	$l_{\bar{u}}^*$ [mm]
	8	320
	10	390
	12	460

Shear force stress $V_{Rd,c}$ [kN/m] ($\leq 0.3 \cdot V_{Rd,max}$) for HBT 120*; 150; 190 and 220

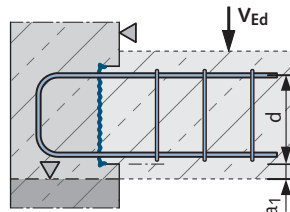
Observe the specifications in the type tests.

profile	HBT 120 ①			HBT 150			HBT 190			HBT 220		
concrete quality												
rod $\emptyset$ [mm]/ spacing s [cm]	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37
8/25	17.9	20.0	21.9	22.8	25.5	28.0	29.2	32.7	35.8	35.5	39.7	43.5
8/20	17.9	20.0	21.9	22.8	25.5	28.0	29.2	32.7	35.8	35.5	39.7	43.5
8/15	17.9	20.0	21.9	22.8	25.5	28.0	29.2	32.7	35.8	35.5	39.7	43.5
10/25	17.9	20.0	21.9	22.8	25.5	28.0	29.2	32.7	35.8	35.5	39.7	43.5
10/20	17.9	20.0	21.9	22.8	25.5	28.0	29.2	32.7	35.8	35.5	39.7	43.5
10/15	17.9	20.0	21.9	22.8	25.5	28.0	29.2	32.7	35.8	35.5	39.7	43.5
12/25	17.9	20.0	21.9	22.8	25.5	28.0	29.2	32.7	35.8	35.5	39.7	43.5
12/20	18.1	20.0	21.9	22.8	25.5	28.0	29.2	32.7	35.8	35.5	39.7	43.5
12/15	19.9	21.4	22.8	23.4	25.5	28.0	29.2	32.7	35.8	35.5	39.7	43.5

* Because of its dense reinforcement sufficient over-lap is not always possible with the HBT 120 (Page 7).
Refer to the type test for HBT 80 and values for rebar spacing of 10 cm.

Example: 'Rebending rebar' data sheet
figure 8, case **e**
 $\sigma_{cp} = 0$

With shear force reinforcement
(HALFEN HDB-S or rebar)



Δ = Concrete section limit

Type 5 double-row connection, h = 170 mm	$\emptyset$ [mm]	$l_{\bar{u}}^*$ [mm]
	8	320
	10	390
	12	460

$$a_{sw} = \frac{V_{Ed}}{f_{yd} \cdot z} \quad z = \min \begin{cases} 0.9 \cdot d \\ d - c_{v,l} - 30 \text{ mm} \end{cases}$$

Shear force stress $V_{Rd,s}$ [kN/m] ($\leq 0.3 \cdot V_{Rd,max}$) for HBT 120*; 150; 190 and 220

Observe the specifications in the type tests.

profile	HBT 120 ①			HBT 150			HBT 190			HBT 220		
concrete quality												
rod $\emptyset$ [mm]/ spacing s [cm]	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37
8/25	48.7	56.5	63.8	48.7	56.5	63.8	48.7	56.5	63.8	48.7	56.5	63.8
8/20	60.8	70.6	79.7	60.8	70.6	79.7	60.8	70.6	79.7	60.8	70.6	79.7
8/15	77.8	94.1	106.3	81.1	94.1	106.3	81.1	94.1	106.3	81.1	94.1	106.3
10/25	58.3	67.7	76.4	58.3	67.7	76.4	58.3	67.7	76.4	58.3	67.7	76.4
10/20	72.9	84.6	95.5	72.9	84.6	95.5	72.9	84.6	95.5	72.9	84.6	95.5
10/15	77.8	97.2	116.7	97.2	112.8	127.4	97.2	112.8	127.4	97.2	112.8	127.4
12/25	67.0	77.7	87.8	67.0	77.7	87.8	67.0	77.7	87.8	67.0	77.7	87.8
12/20	77.8	97.2	109.7	83.7	97.2	109.7	83.7	97.2	109.7	83.7	97.2	109.7
12/15	77.8	97.2	116.7	111.7	129.6	146.3	111.7	129.6	146.3	111.7	129.6	146.3

* Because of its dense reinforcement sufficient over-lap is not always possible with the HBT 120 (Page 7).
Refer to the type test for HBT 80 and values for rebar spacing of 10 cm.

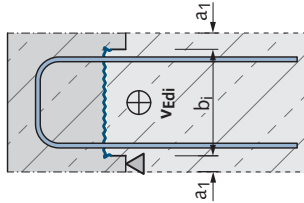
HALFEN HBT REBEND CONNECTION

Values in Tables are According to the Type-test (Eurocode 2) / Assembly instructions

Shear force, Case 'a' (in accordance with 'Rebending rebar' data sheet issued by the DBV)

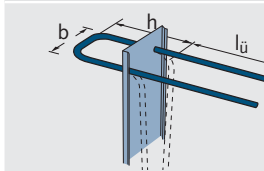
Example: Rebending rebar' data sheet
figure 8, case (a)

$$a_1 \leq 5 \text{ cm}, \sigma_n = 0$$



Δ = Concrete section limit

Type 5 double row connection, $h = 170 \text{ mm}$



$\emptyset$ [mm]	$l_{ü}^*$ [mm]
8	320
10	390
12	460

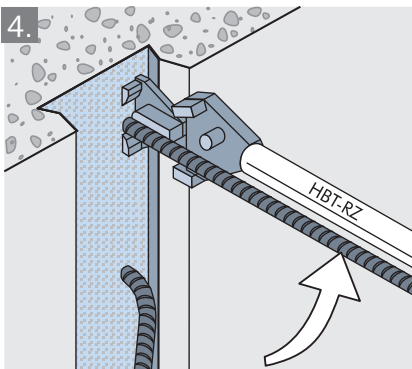
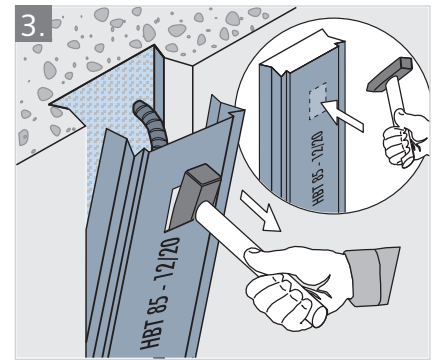
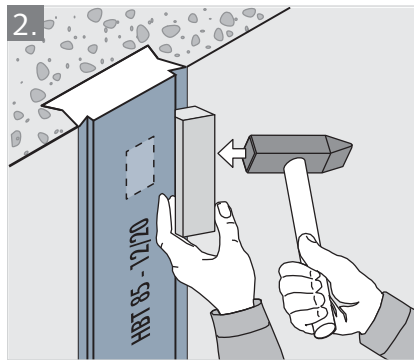
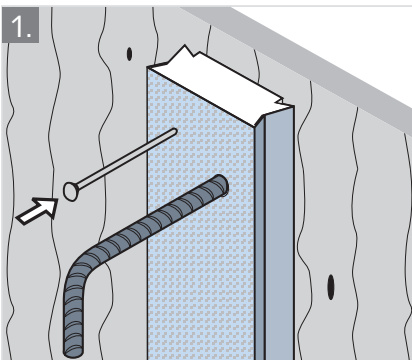
Shear force stress max. V_{Edi} [kN/m] ($\leq V_{Rdi,max}$) for HBT 120*, 150; 190 and 220

Observe the specifications in the type tests.

profile	HBT 120 ①			HBT 150			HBT 190			HBT 220		
concrete quality rod $\emptyset$ [mm]/ spacing s [cm]	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37	C20/25	C25/30	C30/37
8/25	91.1	105.7	119.3	95.9	111.2	125.6	102.1	118.4	133.7	108.2	125.6	141.8
8/20	108.6	126.0	142.3	113.4	131.6	148.6	119.6	138.8	156.7	125.8	145.9	164.8
8/15	137.8	159.9	180.5	142.6	165.5	186.8	148.8	172.6	194.9	155.0	179.8	203.1
10/25	105.0	121.8	137.6	109.8	127.4	143.9	116.0	134.6	152.0	122.2	141.8	160.1
10/20	126.0	146.2	165.1	130.8	151.8	171.4	137.0	158.9	179.5	143.2	166.1	187.6
10/15	138.3	172.8	207.4	165.8	192.4	217.2	172.0	199.6	225.3	178.2	206.7	233.5
12/25	117.5	136.3	153.9	122.3	141.9	160.2	128.5	149.1	168.3	134.6	156.2	176.4
12/20	138.3	164.3	185.5	146.4	169.9	191.8	152.6	177.0	199.9	158.8	184.2	208.0
12/15	138.3	172.8	207.4	170.0	212.5	244.5	192.8	223.7	252.6	199.0	230.9	260.7

* Because of its dense reinforcement sufficient over-lap is not always possible with the HBT 120 (Page 7).
Refer to the type test for HBT 80 and values for rebar spacing of 10 cm.

Assembly instructions



1. Nail the HBT-Element to the timber formwork in the specified position. When using steel formwork use suitable fixings, for example, magnetic fixing plates.
2. After the concrete has cured strike the formwork; place a wood block in the long groove in the cover and tap lightly with a hammer until the cover loosens.
3. Use a hammer 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-Rebend gripper under the rebar and pull handle evenly with both hands until the rebar is in the desired position. The bar must be rebent straight without any kinks. Proceed in a similar manner to rebend all rods of the HBT-Element one-by-one. The contoured back of the HBT-Element casing remains in the concrete

Note: Detailed assembly instructions can be found at www.halfen.de.

HALFEN HBT REBEND CONNECTION

Calculation Basics

Calculation basics, extracts from the DBV "rebending reinforcement" data sheet

DIN EN 1992-1-1. 6.2.5

Joint surface	c	μ	v
serrated	0.5	0.9	0.7
rough	0.4 ¹⁾	0.7	0.5
smooth	0.2 ¹⁾	0.6	0.2
very smooth	0	0.5	0

¹⁾ if $\sigma_n \leq 0$ then $c_j = 0$ applies

Further notes

Anchoring length:

$$l_{bd}(80\%) = 0.8 \cdot \frac{\sigma}{4} \cdot \frac{f_{yd}}{f_{bd}} \cdot \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \frac{A_{s,req}}{A_{s,actual}} \geq l_{b,min}$$

$$l_o(80\%) = l_{bd}(80\%) \cdot \alpha_6 \geq l_{o,min} \quad \text{according DIN EN 1992-1-1}$$

Shear force perpendicular to the concrete joint

Acceptable shear load with no shear reinforcement: DIN EN 1992-1-1, Gl. 6.2 reduction using roughness coefficient.

$$V_{Rd,c} = \frac{c}{0.5} \cdot \left(0.15 / \gamma_c \cdot k \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3} + 0.12 \cdot \sigma_{cp} \right) \cdot b_w \cdot d$$

c = factor according to DIN EN 1992-1-1, 6.2.5

$$k = 1 + \sqrt{\frac{200}{d[\text{mm}]}} \leq 2.0$$

In Gl. 6.2, the longitudinal reinforcement considered in tension in the static system, given sufficient anchorage, may be used in the calculation. Reducing the amount of reinforcement because the longitudinal reinforcement is not fully utilized with 80% of characteristic strength is not necessary.

Acceptable shear force **with** shear force reinforcement: DIN EN 1992-1-1, Gl. 6.8

$$V_{Rd,s} = \frac{A_{sw}}{s} \cdot f_{ywd} \cdot z \cdot \cot \theta$$

with $z \approx 0.9 \cdot d$ or $z \leq d - c_{v,l} - 30 \text{ mm}$

Maximal acceptable shear force **with** shear force reinforcement: DIN EN 1992-1-1, Gl. 6.9 for 90° - stirrup reinforcement, limited in rebend area to 30%

$$V_{Ed} \leq 0.30 \cdot b_w \cdot z \cdot v_1 \cdot f_{cd} \cdot \frac{1}{\cot \theta + \tan \theta}$$

$$\text{with } v_1 = 0.75 \cdot \left(1.1 - \frac{f_{ck}}{500} \right) \leq 0.75$$

Limits for compression struts:

DIN EN 1992-1-1, Gl. 6.7aDE but limited to $\theta \leq 45^\circ$ for $l_e = 0.5 \cdot \cot \theta \cdot d$ both sides of the joint

$$1.0 \leq \cot \theta \leq \frac{1.2 + 1.4 \cdot \sigma_{cd} / f_{cd}}{1 - V_{Rd,cc} / V_{Ed}} \leq 3.0$$

with Gl. 6.7bDE according to DIN EN 1992-1-1

$$V_{Rd,cc} = c \cdot 0.48 \cdot f_{ck}^{1/3} \cdot (1 - 1.2 \cdot \sigma_{cd} / f_{cd}) \cdot b_w \cdot z$$

c = factor according to DIN EN 1992-1-1, 6.2.5

Table below:

over-lap length l_o according to DIN EN 1992-1-1

for good bonding properties the following applies:

$f_{bd} = 2.3 \text{ N/mm}^2$ for C20/25

$f_{bd} = 2.7 \text{ N/mm}^2$ for C25/30

$f_{bd} = 3.0 \text{ N/mm}^2$ for C30/37

$\alpha_1 = 1.0$ for straight rebar ends

$\alpha_2 = 1.0$

$\alpha_3 = 1.0$

$\alpha_6 = 1.0$ according to table 8.3DE, DIN EN 1992-1-1

$\alpha_6 = 1.4$ for $\emptyset 12/10$

reinforcement density in cm ² /m				over-lap length for C20/25		
Ø [mm]	s [cm]	100%	80%	$l_o(100\%)$ [mm]	$l_o(80\%)$ [mm]	selected l_o as Standard size [mm]
8	10	5.03	4.02	375	300	320
	15	3.35	2.68			
	20	2.51	2.01			
	25	2.01	1.61			
10	10	7.85	6.28	468	375	390
	15	5.24	4.19			
	20	3.93	3.14			
	25	3.14	2.51			
12	10	11.31	9.05	787	629	460
	15	7.54	6.03			
	20	5.65	4.52			
	25	4.52	3.62			

Technical support

Engineering services and technical support for your individual projects. Contact information can be found at the back of this catalogue.

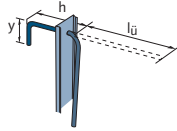
HALFEN HBT REBEND CONNECTION

Order Form

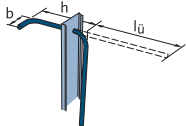
single-row connections

Type 1

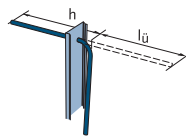
= Standard,
see page 6



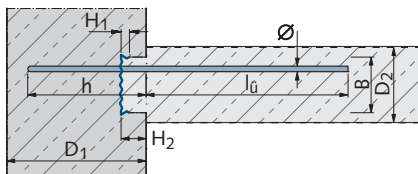
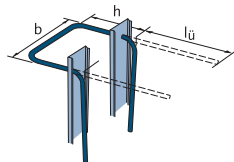
Type 2



Type 3



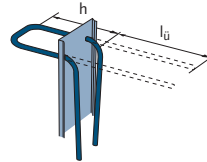
Type 4



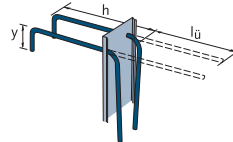
double-row connections

Type 5

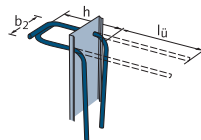
= Standard,
see page 7



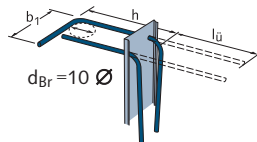
Type 11



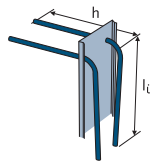
Type 22



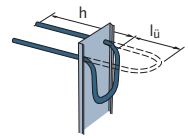
Type 23



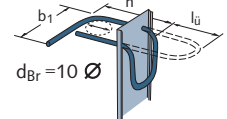
Type 33



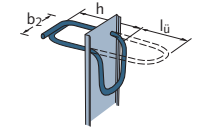
Type 6



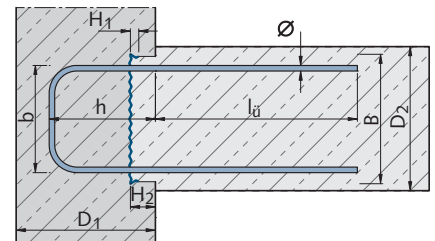
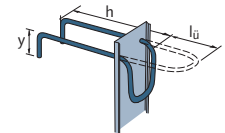
Type 7



Type 8



Type 9



pos.	profile HBT ...	rod-Ø [mm]	rod - spacing s [cm]	stirrup type	$l_{\bar{u}}$ [mm]	h [mm]	b [mm]	b_1 [mm]	b_2 [mm]	y [mm]	metres	element- length L [mm]	number of element [Units]

Note: do not exceed $l_{\bar{u}}$ max., see table on page 11.

HALFEN HBT REBEND CONNECTION

Tender Text Examples

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

HALFEN HBT Rebend connection with single-row rebend reinforcement in a galvanized steel case to form a reinforced connection, type-tested according to DIN 1045-1:2008-08 and DIN EN 1992-1; with approved surface properties for the case according to the DBV „rebending reinforcement“ data sheet; marked and RAL-GZ 658/2 approved by the Association of anchoring and reinforcement technology.

Type HBT 85 – 10/20 – 1 – 1250

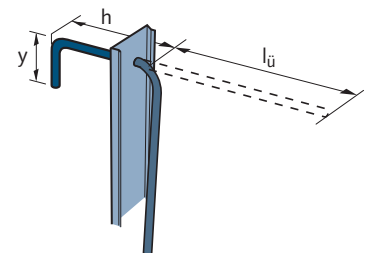
with

85 = type identifier for case width 86 mm, with single-row of rebar,
10/20 = rebar steel B500B, rod diameter 10 mm, rod spacing 200 mm,
1 = standard rebar type 1,
1250 = case length [mm],
in standard rod dimensions

rod length 1 $h = 170 \text{ mm}$,

rod length 2 $l_{\bar{u}} = 390 \text{ mm}$,

hook length $y = 95 \text{ mm}$,



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

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

HALFEN HBT Rebend connection with double-row rebend reinforcement in a galvanized steel case to form a reinforced connection, type-tested according to DIN 1045-1:2008-08 and DIN EN 1992-1; with approved surface properties for the case according to the DBV „rebending reinforcement“ data sheet; marked and RAL-GZ 658/2 approved by the Association of anchoring and reinforcement technology.

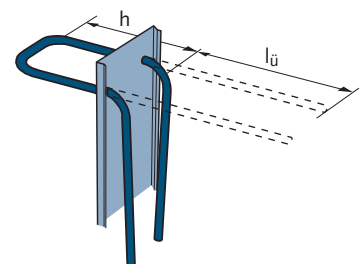
Type HBT 150 – 12/15 – 5 – 1250

with

150 = type identifier for case width of 150 mm, with double-row of rebar,
12/15 = rebar steel B500B, rod diameter 12 mm, rod spacing 150 mm,
5 = standard rebar type 5,
1250 = case length [mm],
in standard rod dimensions

rod length 1 $h = 170 \text{ mm}$,

rod length 2 $l_{\bar{u}} = 460 \text{ mm}$,



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

HALFEN Rebend connection, stainless steel A4

Apply the text as above but replace “B500B” with “stainless reinforcement steel B500B NR according to Building Authority Approval”.

Further tender text examples can be found at www.halfen.de

CONTACT HALFEN WORLDWIDE

HALFEN is represented by subsidiaries in the following 14 countries, please contact us:

Austria	HALFEN Gesellschaft m.b.H. Leonard-Bernstein-Str. 10 1220 Wien	Phone: +43-1-259 6770 E-Mail: office@halfen.at Internet: www.halfen.at	Fax: +43-1-259-677099
Belgium / Luxembourg	HALFEN N.V. Borkelstraat 131 2900 Schoten	Phone: +32-3-658 07 20 E-Mail: info@halfen.be Internet: www.halfen.be	Fax: +32-3-658 15 33
China	HALFEN Construction Accessories Distribution Co.Ltd. Room 601 Tower D, Vantone Centre No. A6 Chao Yang Men Wai Street Chaoyang District Beijing · P.R. China 100020	Phone: +86-10 5907 3200 E-Mail: info@halfen.cn Internet: www.halfen.cn	Fax: +86-10 5907 3218
Czech Republic	HALFEN-DEHA s.r.o. Business Center Šafránková Šafránková 1238/1 155 00 Praha 5	Phone: +420-311-690 060 E-Mail: info@halfen-deha.cz Internet: www.halfen-deha.cz	Fax: +420-235-314 308
France	HALFEN S.A.S. 18, rue Goubet 75019 Paris	Phone: +33-1-445231 00 E-Mail: halfen@halfen.fr Internet: www.halfen.fr	Fax: +33-1-445231 52
Germany	HALFEN Vertriebsgesellschaft mbH Katzbergstrasse 3 40764 Langenfeld	Phone: +49-2173-970-0 E-Mail: info@halfen.de Internet: www.halfen.de	Fax: +49-2173-970 225
Italy	HALFEN S.r.l. Soc. Unipersonale Via F.lli Bronzetti N° 28 24124 Bergamo	Phone: +39-035-0760711 E-Mail: info@halfen.it Internet: www.halfen.it	Fax: +39-035-0760799
Netherlands	HALFEN b.v. Oostermaat 3 7623 CS Borne	Phone: +31-742-6714 49 E-Mail: info@halfen.nl Internet: www.halfen.nl	Fax: +31-742 6726 59
Norway	HALFEN AS Postboks 2080 4095 Stavanger	Phone: +47-51 82 34 00 E-Mail: post@halfen.no Internet: www.halfen.no	Fax: +47-51 82 34 01
Poland	HALFEN Sp. z o.o. Ul. Obornicka 287 60-691 Poznan	Phone: +48-61-622 14 14 E-Mail: info@halfen.pl Internet: www.halfen.pl	Fax: +48-61-622 14 15
Sweden	Halfen AB Box 150 435 23 Mölnlycke	Phone: +46-31-98 58 00 E-Mail: info@halfen.se Internet: www.halfen.se	Fax: +46-31-98 58 01
Switzerland	HALFEN Swiss AG Hertistrasse 25 8304 Wallisellen	Phone: +41-44-849 78 78 E-Mail: mail@halfen.ch Internet: www.halfen.ch	Fax: +41-44-849 78 79
United Kingdom / Ireland	HALFEN Ltd. Humphrys Road · Woodside Estate Dunstable LU5 4TP	Phone: +44-1582-47 03 00 E-Mail: info@halfen.co.uk Internet: www.halfen.co.uk	Fax: +44-1582-47 03 04
United States of America	HALFEN USA Inc. 8521 FM 1976 P.O. Box 547 Converse, TX 78109	Phone: +1 800.423.91 40 E-Mail: info@halfenusa.com Internet: www.halfenusa.com	Fax: +1 877.683.4910
For countries not listed HALFEN International	HALFEN International GmbH Liebigstr. 14 40764 Langenfeld / Germany	Phone: +49-2173-970-0 E-Mail: info@halfen.com Internet: www.halfen.com	Fax: +49-2173-970-849

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