HALFEN HSD SHEAR DOWEL SYSTEM

TECHNICAL PRODUCT INFORMATION

HALFEN SHEAR DOWEL SYSTEM

CONCRETE

HSD EC 10-E

Acc. to EN 1992-1-1:2008

HALFEN

YOUR BEST CONNECTIONS

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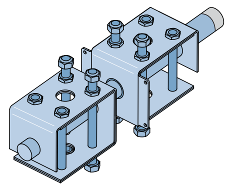

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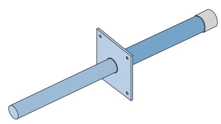
HALFEN HSD single shear dowels



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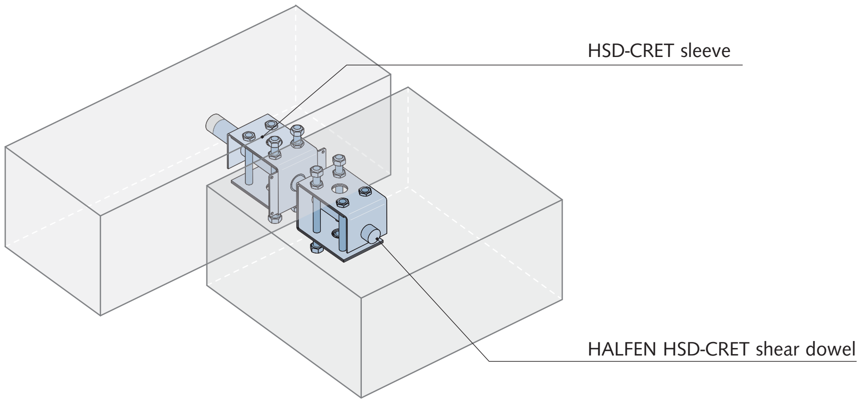
Introduction

Expansion joints to prevent constraint stresses



The effects of

- shrinkage
- temperature
- creep in case of post-tensioning
- subsidence

require constructive measures in large supporting frameworks.

Movement joints prevent the uncontrolled formation of cracks and the subsequent damage that arises from this as a result of leakage and corrosion.

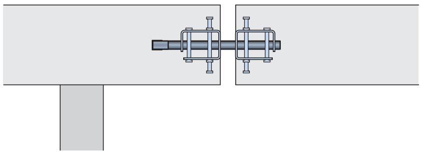
Advantages of the HALFEN shear dowel system:

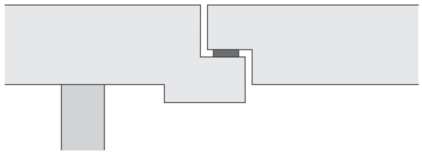
- simple geometry of the formation of the joint
- simple formwork and time saving installation
- simple reinforcement layout
- gain in space through avoidance of double supports
- cost saving and gain in space through staged erection of the construction elements
- approved in several European countries
- user-friendly HSD dimensioning software available in the Internet www.halfen.(→ country code)
- fire resistance classification F120 designable with fire protection pads (see page 15)

The solution: the HALFEN HSD Shear dowel system

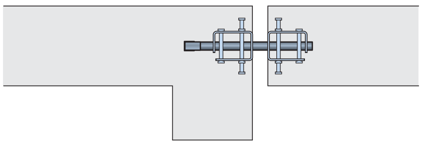
Conventional: problems with conventional design

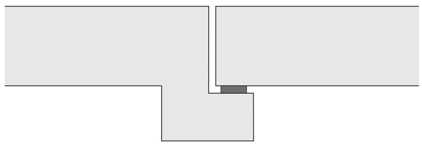
Flat slab (vertical section)



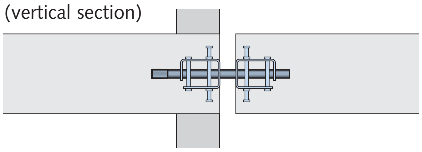


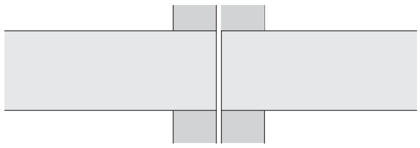
Slab connection with console (vertical section)



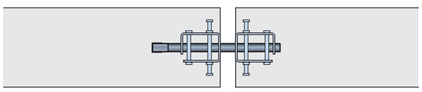


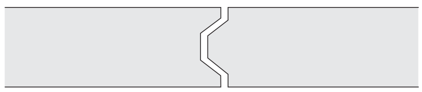
Double column replaced by a single column (vertical section)



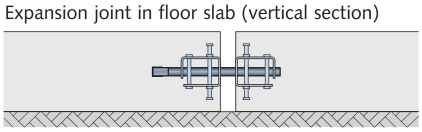


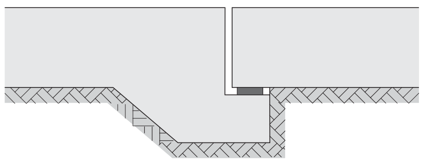
Connection of a supporting wall (horizontal section)



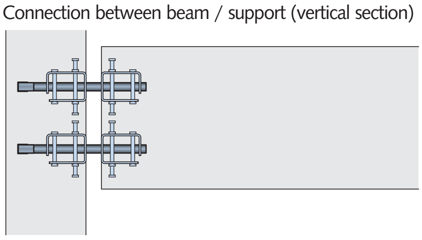


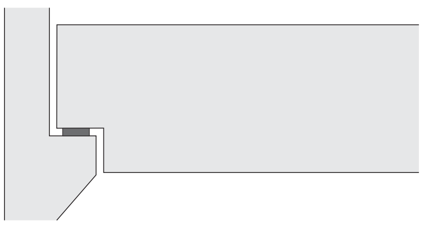
Expansion joint in floor slab (vertical section)





Connection between beam / support (vertical section)

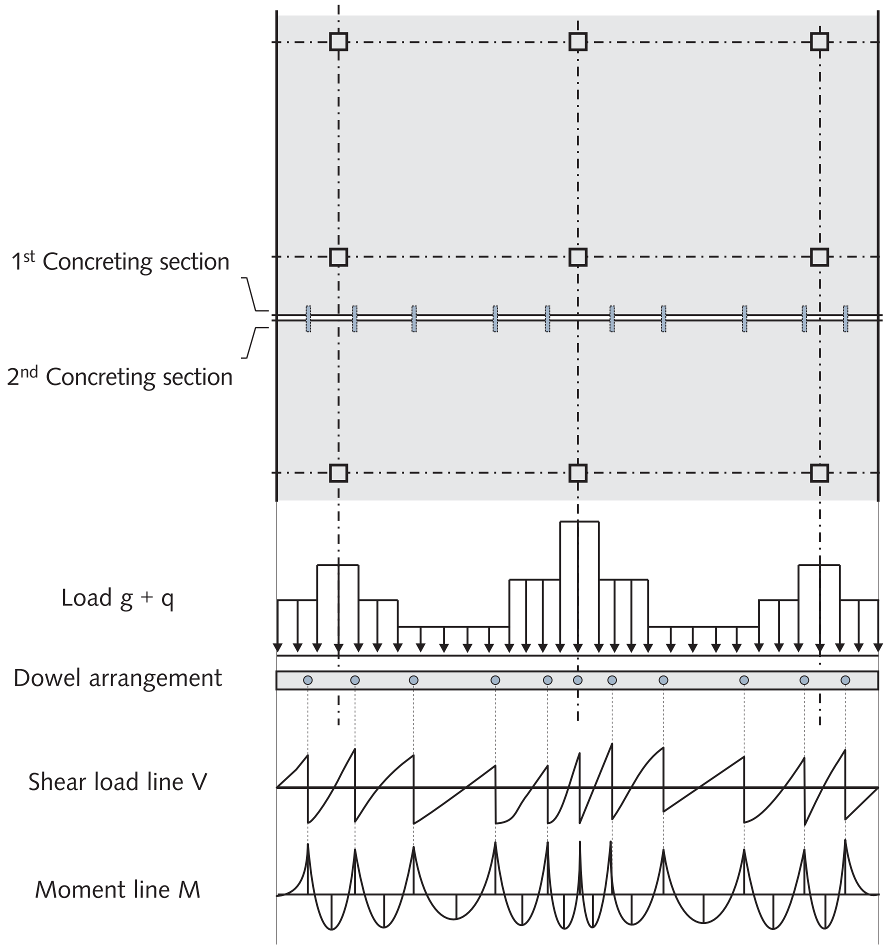




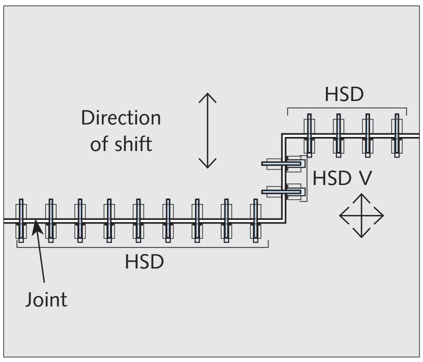
Expansion joints to prevent constraint stresses

For flat slabs, it is advisable to arrange the dowels at different spacings according to the different shear load concentrations. The value and the distribution of the shear load to be transmitted can be determined by a finite elements slab calculation.
The static model of a continuous beam is suitable for the dimensioning of the edge of the slab. Shear and bending moments will be used for the dimensioning of the reinforcement across and along the edge. It must thereby be noted that transverse and longitudinal reinforcement is also required in the load introduction area of the dowel, which could be decisive against those from the continuous beam calculation. With large dowel spacings, the continuous beam calculation is normally the decisive value for the longitudinal reinforcement.

Dimensioning of the joint width
f = calculated joint width + safety supplement (approx. 1cm)



Arrangement of the shear dowel - Examples

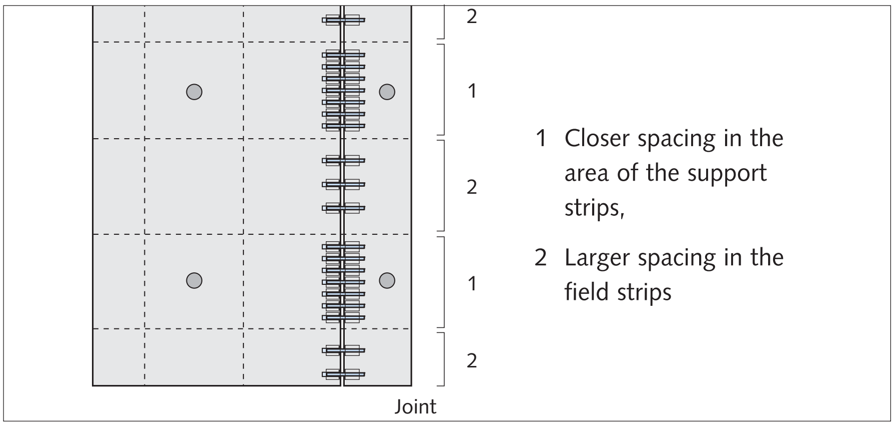


Angled joint run

Shifting direction of the shear dowels:

HSD = longitudinal movement

HSD V = longitudinal and transverse movement

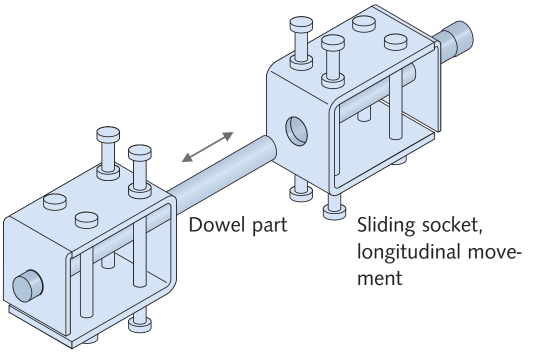


Flat slab joint; dowel arrangement corresponding to the support model for the slab

Heavy-duty shear dowels

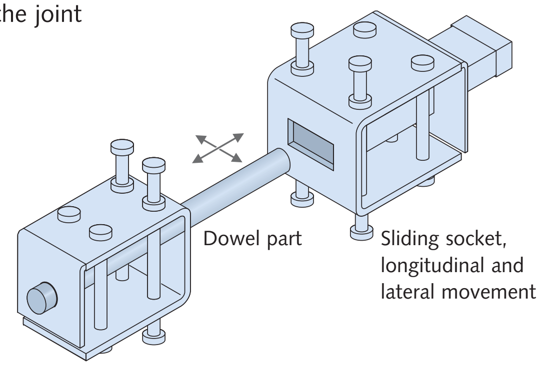
Product description

HSD-CRET heavy-duty shear dowel
consisting of dowel part and sliding socket,
single-axis movement - along the dowel axis



HALFEN HSD-CRET heavy-duty shear dowels allow a sliding movement in the direction of the dowel axis. The dowels are normally used to transfer shear loads in any direction. A high load capacity is effectuated by the load distribution body.

HSD-CRET V heavy-duty shear dowel
consisting of dowel part and sliding socket,
two-axis movement – along the dowel axis and parallel to the joint



If lateral movements must be considered, the HALFEN HSD-CRET V heavy-duty shear dowel is used, which allows also lateral movement. In this case, the shear load will only be transferred in one direction.

Technical data

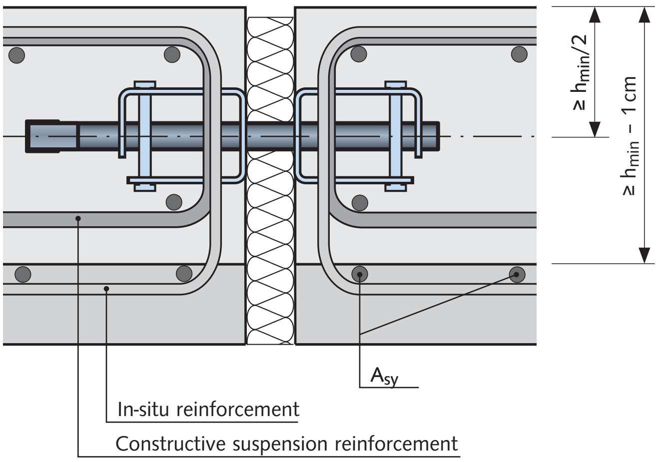
Dowel diameter and minimum component thickness			
HSD-	HSD-	Dowel diameter [mm]	Minimum component thickness h_{min} [cm]
CRET 122	CRET 122 V	22	18
CRET 124	CRET 124 V	24	20
CRET 128	CRET 128 V	28	24
CRET 134	CRET 134 V	34	30
CRET 140	CRET 140 V	40	35
CRET 145	CRET 145 V	45 · 45[1)]	42
CRET 150	CRET 150 V	50 · 50[1)]	60
CRET 155	CRET 155 V	55 · 55[1)]	65

[1)] Square shaped cross section

Materials:

- dowels HSD CRET 122-140: stainless steel S 690 (grade 1.4462)
- dowels HSD CRET 145-155: (grade 1.7225)
- load distribution body and sliding socket: Stainless steel S 275 (grade 1.4404)
- fixing rod: Stainless steel, strength class 70 (grade 1.4401)
- All materials correspond to at least the corrosion-resistance class III.

Installation in semi-prefabricated slabs

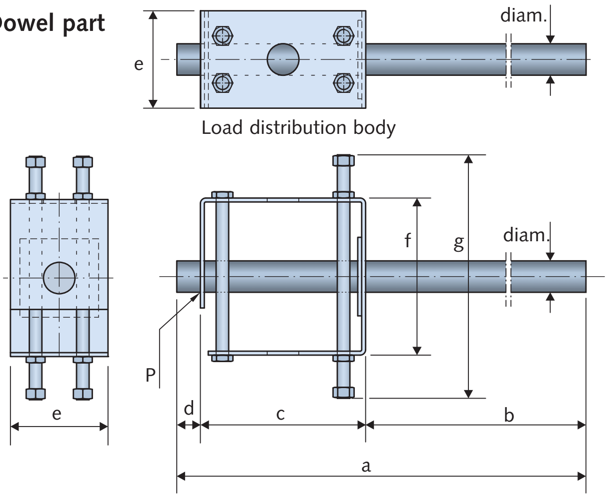


Recommendation:

- Insertion of constructive suspension reinforcement in the semi-prefabricated slab (dimensioning for $V_{Rd}/3$).
- Thickness of the in-situ cast concrete = h_{min} – 1 cm.
- Dimension between the shear dowel axis and upper edge of the in-situ concrete = $h_{min}/2$.
- With a sufficient thickness of the in-situ concrete, the reinforcement A_{sy} can also be placed outside the semi-prefabricated slab.
- In-situ reinforcement (A_{sx} and A_{sy} top) is to be arranged according to the tables on pages 9 to 10 and/or the approval.

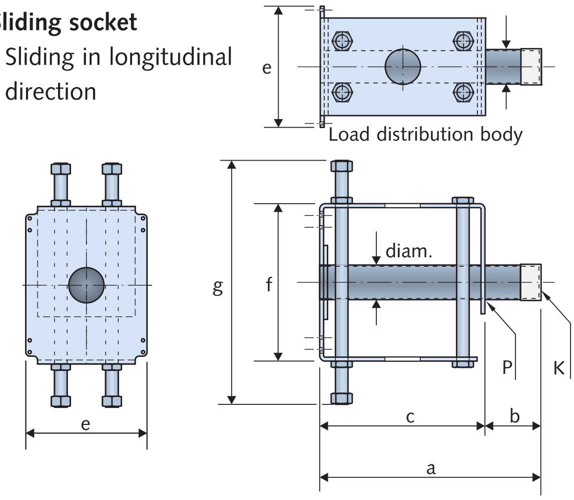
Type selection

Dowel part



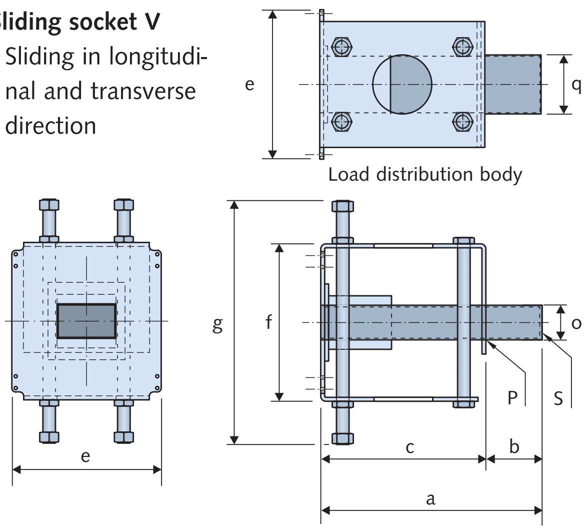
Sliding socket

- Sliding in longitudinal direction



Sliding socket V

- Sliding in longitudinal and transverse direction



Dimensions [mm]

HSD-CRET type		a	b	c	d	e	f	g	diam.	o	q
122 / 122 V	dowel part	302	180	108	14	70	80	140	22	–	–
	socket	180	72	108	–	100	80	140	25.4	–	–
	socket V	181.5	73.5	108	–	125	80	140	–	26	50
124 / 124 V	dowel part	341	192	133	16	76	90	160	24	–	–
	socket	192	59	133	–	106	90	160	28	–	–
	socket V	193.5	60.5	133	–	133	90	160	–	28	55
128 / 128 V	dowel part	388	215	155	18	88	110	200	28	–	–
	socket	215	60	155	–	118	110	200	32	–	–
	socket V	217	62	155	–	146	110	200	–	32	60
134 / 134 V	dowel part	450	246	180	24	106	160	260	34	–	–
	socket	246	66	180	–	136	160	260	38	–	–
	socket V	248	68	180	–	168	160	260	–	38	78
140 / 140 V	dowel part	520	280	210	30	124	200	310	40	–	–
	socket	280	70	210	–	154	200	310	44	–	–
	socket V	281.5	71.5	210	–	190	200	310	–	44	75
145 / 145 V	dowel part	546	302	210	34	124	250	380	45[1)]	–	–
	socket	309	99	210	–	154	250	380	–	–	–
	socket V	309	99	210	–	194	250	380	–	49	90
150 / 150 V	dowel part	609	335	210	64	160	300	560	50[1)]	–	–
	socket	337	127	210	–	190	300	560	–	–	–
	socket V	337	127	210	–	230	300	560	–	54	95
155 / 155V	dowel part	667	363	230	74	200	350	610	55[1)]	–	–
	socket	365	135	230	–	230	350	610	–	–	–
	socket V	365	135	230	–	270	350	610	–	59	100

Dowels 145/145 V, 150/150 V and 155/155 V have square shaped cross sections

1) edge length of cross section

Ordering example: **HSD-CRET 124 V**

HALFEN heavy-duty shear dowel
Load range
V = Transverse and longitudinal movement

P = Spot welding
K = PE pipe protection cap
S = Sheet metal cover

Dimensioning

Ultimate limit state:

$$V_{Rd} = \min (V_{Rd,1}; V_{Rd,2}; V_{Rd,max}) \leq V_{Rd,s}$$

$V_{Rd,1}$ Design resistance of the steel dowel

$V_{Rd,2}$ Design resistance of the steel box

$V_{Rd,max}$ Load capacity of the concrete compression struts

Dimensioning of the joint width f

f = calculated joint width + safety supplement (approx. 1cm)

$V_{Rd,s}$ Load capacity of the additional slab border reinforcement

$V_{Ed} \leq V_{Rd}$ (with consideration of friction factor f_{μ})

If a dowel will be selected from these tables, no further proofs are required.

The values quoted for the maximum dimensioning resistance V_{Rd} only apply for an arrangement of the suspension reinforcement according to the table on page 9.

V_{Ed} = design load on the shear dowel with partial safety factors acc. EN 1992-1-1:2008.

f_{μ} = Friction factor (1.0 for dowels with longitudinal movement)
(0.9 for dowels with longitudinal and transverse movement)

Relevant dimensioning resistances V_{Rd} [kN] HSD-CRET Shear dowels with longitudinal movement

Shear dowel	Component thickness [mm]	C20/25						C25/30					
		Joint width f [mm]						Joint width f [mm]					
		≤ 10	20	30	40	50	60	≤ 10	20	30	40	50	60
HSD-CRET-122	180	54.9	54.9	54.9	54.9	53.2	44.4	68.6	68.6	68.6	66.6	53.2	44.4
	200	61.3	61.3	61.3	61.3	53.2	44.4	76.6	76.6	76.6	66.6	53.2	44.4
	220	67.6	67.6	67.6	66.6	53.2	44.4	84.5	84.5	81.8	66.6	53.2	44.4
	240	74.0	74.0	74.0	66.6	53.2	44.4	92.5	92.5	81.8	66.6	53.2	44.4
	250	77.2	77.2	77.2	66.6	53.2	44.4	96.5	96.5	81.8	66.6	53.2	44.4
	260	80.4	80.4	80.4	66.6	53.2	44.4	100.5	98.2	81.8	66.6	53.2	44.4
	≥280	86.8	86.8	81.8	66.6	53.2	44.4	108.5	98.2	81.8	66.6	53.2	44.4
HSD-CRET-124	200	79.8	79.8	79.8	79.8	69.1	57.6	99.7	99.7	99.7	86.4	69.1	57.6
	220	87.7	87.7	87.7	86.4	69.1	57.6	109.7	109.7	108.8	86.4	69.1	57.6
	240	95.7	95.7	95.7	86.4	69.1	57.6	119.6	119.6	108.8	86.4	69.1	57.6
	250	99.7	99.7	99.7	86.4	69.1	57.6	124.6	124.6	108.8	86.4	69.1	57.6
	260	103.7	103.7	103.7	86.4	69.1	57.6	129.6	125.6	108.8	86.4	69.1	57.6
	≥280	111.7	111.7	108.8	86.4	69.1	57.6	139.6	125.6	108.8	86.4	69.1	57.6
HSD-CRET-128	240	121.0	121.0	121.0	121.0	109.8	91.5	151.2	151.2	147.9	130.2	109.8	91.5
	250	125.6	125.6	125.6	125.6	109.8	91.5	157.0	157.0	147.9	130.2	109.8	91.5
	260	130.3	130.3	130.3	130.2	109.8	91.5	162.8	162.8	147.9	130.2	109.8	91.5
	280	139.6	139.6	139.6	130.2	109.8	91.5	174.5	169.1	147.9	130.2	109.8	91.5
	300	148.9	148.9	147.5	130.2	109.8	91.5	186.1	169.1	147.9	130.2	109.8	91.5
	≥320	158.2	158.2	147.5	130.2	109.8	91.5	188.2	169.1	147.9	130.2	109.8	91.5
HSD-CRET-134	300	202.9	202.9	202.9	197.0	175.5	162.7	253.6	239.7	219.3	198.2	175.7	162.7
	≥320	213.8	213.8	213.8	197.0	175.5	162.7	259.5	239.7	219.3	198.2	175.7	162.7
HSD-CRET-140	350	290.4	290.4	290.4	290.4	263.0	250.2	363.0	347.0	320.8	293.2	263.1	250.2
	360	296.8	296.8	296.8	291.9	263.0	250.2	370.9	347.0	320.8	293.2	263.1	250.2
	380	309.4	309.4	309.4	291.9	263.0	250.2	372.1	347.0	320.8	293.2	263.1	250.2
	≥400	322.0	322.0	317.9	291.9	263.0	250.2	372.1	347.0	320.8	293.2	263.1	250.2

For concrete classes C30/37 and higher the values for C25/30 have to be used.

$V_{Rd,1}$ $V_{Rd,2}$ $V_{Rd,max}$

With partial safety factors: $\gamma_s = 1.15$ EN 1992-1-1:2008; $\gamma_c = 1.5$ EN 1992-1-1:2008; $\gamma_{M0} = 1.0$ EN 1993-1-1; $\gamma_{M2} = 1.25$ EN 1993-1-8

Dimensioning resistances for HSD-CRET 145, HSD-CRET 150 and HSD-CRET 155 available on request. Adresses → page 23

Dimensioning

$V_{Rd} = \min(V_{Rd,1}; V_{Rd,2}; V_{Rd,max}) \leq V_{Rd,s}$

$V_{Rd,1}$ Design resistance of the steel dowel

$V_{Rd,2}$ Design resistance of the steel box

$V_{Rd,max}$ load capacity of the concrete compression struts

Dimensioning of the joint width f

f = calculated joint width + safety supplement (approx. 1cm)

$V_{Rd,s}$ Load capacity of the additional slab border reinforcement

$V_{Ed} \leq V_{Rd}$ (with consideration of friction factor f_{μ})

If a dowel will be selected from these tables, no further proofs are required.

The values quoted for the maximum dimensioning resistance V_{Rd} only apply for an arrangement of the suspension reinforcement according to the table on page 9.

V_{Ed} = design load on the shear dowel with partial safety factors acc. EN 1992-1-1:2008.

f_{μ} = Friction factor (1.0 for dowels with longitudinal movement)
(0.9 for dowels with longitudinal and transverse movement)

Relevant dimensioning resistances V_{Rd} [kN] HSD-CRET V shear dowels with longitudinal and transverse movement

Shear dowel	Component thickness [mm]	C20/25						C25/30					
		Joint width f [mm]						Joint width f [mm]					
		≤ 10	20	30	40	50	60	≤ 10	20	30	40	50	60
HSD-CRET-122 V	180	54.9	54.9	54.9	54.9	47.9	39.9	68.6	68.6	68.6	59.9	47.9	39.9
	200	61.3	61.3	61.3	59.9	47.9	39.9	76.6	76.6	76.6	59.9	47.9	39.9
	220	67.6	67.6	67.6	59.9	47.9	39.9	84.5	84.5	79.4	59.9	47.9	39.9
	240	74.0	74.0	74.0	59.9	47.9	39.9	92.5	92.5	79.4	59.9	47.9	39.9
	250	77.2	77.2	77.2	59.9	47.9	39.9	96.5	93.1	79.4	59.9	47.9	39.9
	260	80.4	80.4	79.4	59.9	47.9	39.9	100.5	93.1	79.4	59.9	47.9	39.9
	≥280	86.8	86.8	79.4	59.9	47.9	39.9	108.5	93.1	79.4	59.9	47.9	39.9
HSD-CRET-124 V	200	79.8	79.8	79.8	77.8	62.2	51.8	99.7	99.7	99.7	77.8	62.2	51.8
	220	87.7	87.7	87.7	77.8	62.2	51.8	109.7	109.7	101.4	77.8	62.2	51.8
	240	95.7	95.7	95.7	77.8	62.2	51.8	119.6	119.6	101.4	77.8	62.2	51.8
	250	99.7	99.7	99.7	77.8	62.2	51.8	124.6	119.0	101.4	77.8	62.2	51.8
	260	103.7	103.7	101.4	77.8	62.2	51.8	129.6	119.0	101.4	77.8	62.2	51.8
	≥280	111.7	111.7	101.4	77.8	62.2	51.8	139.6	119.0	101.4	77.8	62.2	51.8
HSD-CRET-128 V	240	121.0	121.0	121.0	121.0	98.8	82.3	151.2	151.2	138.5	123.4	98.8	82.3
	250	125.6	125.6	125.6	123.4	98.8	82.3	157.0	157.0	138.5	123.4	98.8	82.3
	260	130.3	130.3	130.3	123.4	98.8	82.3	162.8	162.2	138.5	123.4	98.8	82.3
	280	139.6	139.6	138.4	123.4	98.8	82.3	174.5	162.2	138.5	123.4	98.8	82.3
	300	148.9	148.9	138.4	123.4	98.8	82.3	182.6	162.2	138.5	123.4	98.8	82.3
	≥320	158.2	158.2	138.4	123.4	98.8	82.3	182.6	162.2	138.5	123.4	98.8	82.3
HSD-CRET-134 V	300	202.9	202.9	202.9	185.6	162.7	147.4	251.8	231.1	209.5	186.5	162.7	147.4
	≥320	213.8	213.8	207.6	185.6	162.7	147.4	251.8	231.1	209.5	186.5	162.7	147.4
HSD-CRET-140 V	350	290.4	290.4	290.4	275.6	250.2	240.0	361.1	334.6	306.6	276.2	250.2	240.0
	360	296.8	296.8	296.8	275.6	250.2	240.0	361.1	334.6	306.6	276.2	250.2	240.0
	380	309.4	309.4	304.5	275.6	250.2	240.0	361.1	334.6	306.6	276.2	250.2	240.0
	≥400	322.0	322.0	304.5	275.6	250.2	240.0	361.1	334.6	306.6	276.2	250.2	240.0

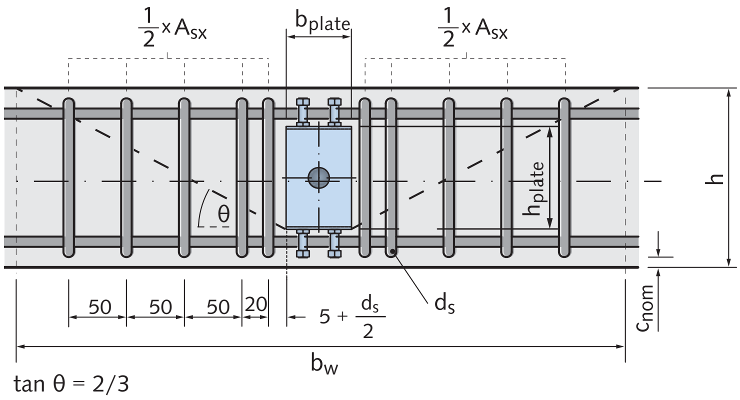
For concrete classes C30/37 and higher the values for C25/30 have to be used

$V_{Rd,1}$ $V_{Rd,2}$ $V_{Rd,max}$

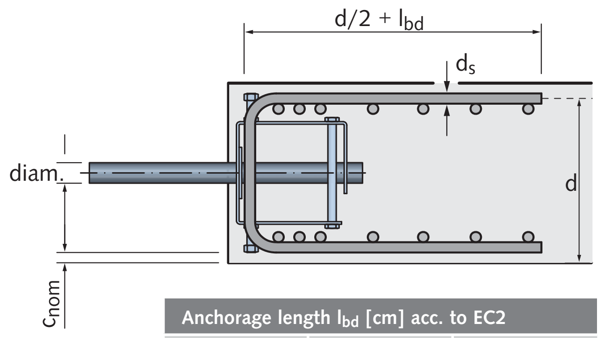
With partial safety factors: γ_s = 1.15 EN 1992-1-1:2008; γ_c = 1.5 EN 1992-1-1:2008; γ_{M0} = 1.0 EN 1993-1-1; γ_{M2} = 1.25 EN 1993-1-8

Dimensioning resistances for HSD-CRET 145 V, HSD-CRET 150 V and HSD-CRET 155 V available on request. Adresses → page 23

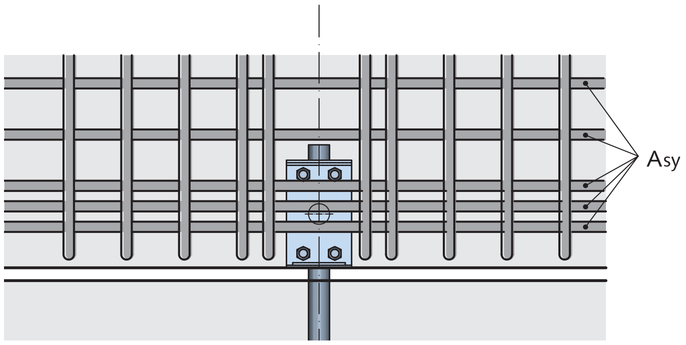
In-situ reinforcement

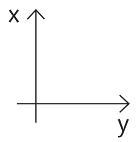


tan θ = 2/3



Anchorage length l_{bd} [cm] acc. to EC2		
d_s [mm]	C20/25	C25/30
10	47	40
12	56	48
14	66	57
16	75	65





A_{sx} Stirrups on both sides as a vertical suspension reinforcement

A_{sy} Longitudinal reinforcement parallel to the edge, placed above and below according to the bending design of the continous beam

Number of stirrups A_{sx} (f_{yk}= 500 MPa)

h [mm]	CRET-122(V)				CRET-124(V)				CRET-128(V)				CRET-134(V)				CRET-140(V)			
	stirrup diameter d_s [mm]																			
	10	12	14	16	10	12	14	16	10	12	14	16	10	12	14	16	10	12	14	16
180	6	4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
200	6	4	2	2	8	4	4	2	-	-	-	-	-	-	-	-	-	-	-	-
220	6	4	4	2	8	6	4	2	-	-	-	-	-	-	-	-	-	-	-	-
240	6	4	4	2	8	6	4	2	10	6	4	4	-	-	-	-	-	-	-	-
250	6	4	4	2	8	6	4	2	10	6	4	4	-	-	-	-	-	-	-	-
260	6	4	4	2	8	6	4	4	10	6	4	4	-	-	-	-	-	-	-	-
280	6	4	4	2	8	6	4	4	10	6	4	4	-	-	-	-	-	-	-	-
300	6	4	4	2	8	6	4	4	10	6	4	4	-	10	6	4	-	-	-	-
320	6	4	4	2	8	6	4	4	10	6	4	4	-	10	6	4	-	-	-	-
340	6	4	4	2	8	6	4	4	10	6	4	4	-	10	6	4	-	-	-	-
350	6	4	4	2	8	6	4	4	10	6	4	4	-	10	6	4	-	-	8	6
360	6	4	4	2	8	6	4	4	10	6	4	4	-	10	6	4	-	-	8	6
380	6	4	4	2	6	4	4	4	10	6	4	4	-	10	6	4	-	-	8	6
400					6	4	4	2	8	6	4	4	-	8	6	4	-	-	8	6
420									8	6	4	4	-	8	6	4	-	-	8	6
440									8	6	4	4	-	8	6	4	-	-	8	6
450													-	8	6	4	-	-	8	6
460													-	8	6	4	-	-	8	6
480													-	8	6	4	-	-	8	6
500													10	8	6	4	-	-	8	6
520																	-	10	8	6
540																	-	10	8	6

Advice: The reinforcement layout in the above table can be used for all cases in the load tables pages 7-8.
50% of the stirrups from the above table have to be placed on each side of the dowel.

HALFEN Dimensioning Software

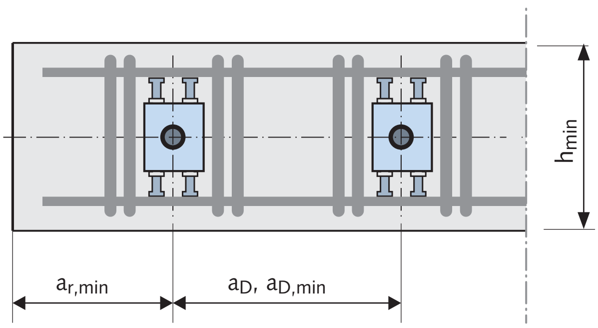
For an optimised suspension reinforcement, please use the HSD-CRET design program, downloadable from: www.halfen.(→ country code)
If required, a DVD with all design programs, catalogues and approvals is also available.

Installation dimensions

Minimum spacings

HSD-CRET-	HSD-CRET-	Minimum component thickness h_{min} [cm]	Minimum dowel spacing $a_{D,min}$	Minimum edge distance $a_{r,min}$
122	122 V	18	$\frac{V_{Ed,i}}{v_{Rd,c}}$	$\frac{1}{2} \cdot \frac{V_{Ed,i}}{v_{Rd,c}}$
124	124 V	20		
128	128 V	24		
134	134 V	30		
140	140 V	35		
145	145 V	42		
150	150 V	60		
155	155 V	65		

In order to obtain a linear support, it is recommended that the centre spacing of the dowels should not be above the limit of 10 · h. The optimum is 5 · h.



Calculation acc. to EN 1992-1-1:2008 (section 6)

V_{Rd} acc. page 7 - 8

$$v_{Rd,c} = (C_{Rd,c} \cdot k \cdot (100 \cdot \rho_L \cdot f_{ck})^{1/3} + k_1 \cdot \sigma_{cp}) \cdot d \quad [kN/m] \quad (6.2a)$$

with a minimum of:

$$v_{Rd,c} = (v_{min} + k_1 \cdot \sigma_{cp}) \cdot d \qquad (6.2b)$$

$$v_{min} = 0.035 \cdot k^{\frac{3}{2}} \cdot \sqrt{f_{ck}} \qquad (6.3)$$

h_{min} acc. adjacent table

where: $\rho_L = \frac{A_{sx}}{b_w \cdot d}$

b_w = width of the concrete cone
$= b_{plate} + \frac{3}{2}(h + h_{plate})$

A_{sx} acc. page 9 [mm²]

If $a_D < 2 \cdot h_{min}$, the design resistance V_{Rd} (acc. pages 7 and 8) has to be reduced by the quotient of : a_D / $a_{D,min}$, **only** if $V_{Rd,max}$ is the determinant resistance.

a_D = centre spacing between the dowels
$a_{D,min}$ = minimum dowel spacing
$a_{r,min}$ = minimum edge spacing

! If $a_D < a_{D,min}$, shear reinforcement has to be provided in the slab

coefficient: $C_{Rd,c} = 0{,}18/\gamma_c = 0{,}12$

size factor: $k = 1 + \sqrt{\frac{200}{d}} \leq 2$ mit d in mm

coefficient: $k_1 = 0{,}10$

compressive concrete stress from axial load or prestressing: σ_{cp}

Design example - slab

Input

Design shear force: v_{Ed} = 50 kN/m

Advice: All calculations of HSD-CRET dowels are done with partial safety factors according to EN 1992-1-1:2008.

Concrete: C25/30 → f_{ck} = 25 MPa, γ_c = 1.5 (EN 1992-1-1:2008)
Concrete cover: c_{nom} = 30 mm
Slab thickness: h = 280 mm → effective depth d = h – c_{nom} – diam./2 = 245 mm

Advice: Diameter of the bending reinforcement perpendicular to the joint (here 10 mm)

Joint length: L = 10 m
Designed joint width: f = 30 mm (20 mm + 10 mm)

Advice: The designed joint width should be the maximum value that can appear during building utilization. In case of lack of detailed information it is recommended to increase nominal joint width with additional 10 mm.

Number of dowels

Preliminary dowel choice HSD-CRET-124 with parameters:

Load capacity V_{Rd} = 108.8 kN (page 7)
Minimum slab thickness h_{min} = 200 mm ≤ h = 280 mm (page 9) → condition fulfilled

Sum of loading on the joint: $V_{Ed} = L \cdot v_{Ed} = 10 \cdot 50 = 500$ kN
Minimum number of dowels in the joint: $n_{min} = V_{Ed} / V_{Rd} = 500 / 108.8 = 4.59$ pcs. → chosen 5 dowels
Distance between dowels: $a_D = L / n_{min} = 10 / 5 = 2.0$ m

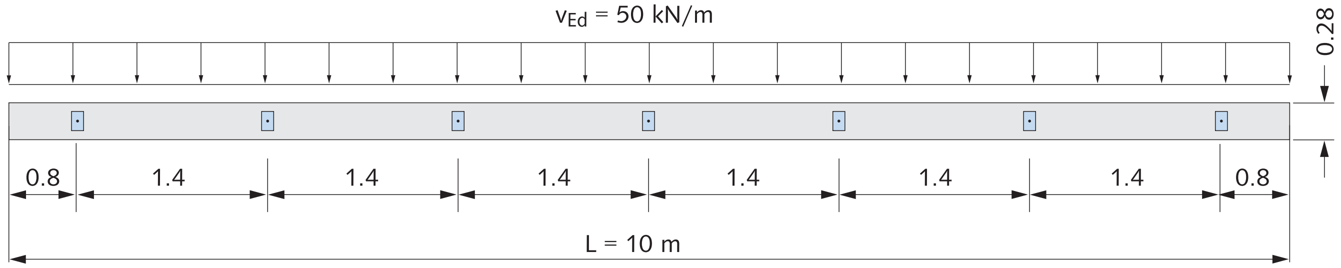
Proof of maximum distance between dowels

Advice: Basis of this proof is the condition that the maximum distance between the dowels should not exceed 5 · h. Although it is a recommended condition, the designer can also define larger maximum distances between the dowels, but should not exceed 10 · h.

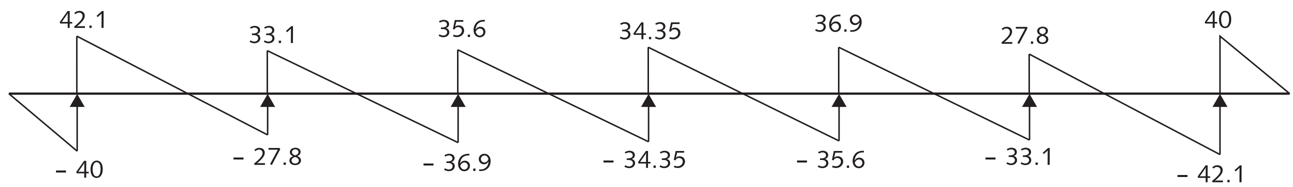
Maximum distance between dowels:

$a_{D,max} = 5 \cdot h = 5 \cdot 0.28 = 1.4$ m ≤ a_D = 2.0 m → it is necessary to increase the number of dowels, because of exceeding $a_{D,max}$

Number of dowels in the joint: $n = L / a_{D,max} = 10 / 1.4 = 7.14$ pcs. ; chosen 7 dowels with arrangement as on the drawing below



Shear force distribution for continuous beam V_{Ed} [kN]:



max $V_{Ed,i}$ = 82.1kN ≤ V_{Rd} = 108.8 kN → condition fulfilled

Design example - slab

Additional slab reinforcement
Suspension reinforcement

From the table on page 9 it is taken reinforcement 8 diam. 10 placed as on the drawing beside according to recommendations from page 10.

Advice: Optimal calculation of the reinforcement can be done with the HSD-CRET design program.

Longitudinal reinforcement

Longitudinal reinforcement should be calculated acc. to the bending design of a continous beam with support points according to dowel arrangement.

Proof of slab shear capacity and minimum distance between dowels

Slab shear capacity $v_{Rd,c}$ (EN 1992-1-1: 2008 sect. 6.2.2)

$$v_{Rd,c} = \left[C_{Rd,c} \cdot k\,(100 \cdot \rho_l \cdot f_{ck})^{\frac{1}{3}} + k_1 \cdot \sigma_{cp}\right] d$$

but not less than $v_{Rd,c} = v_{min} + k_1\,\sigma_{cp}$
(EN 1992-1-1:2008, 6.2a and 6.2b)

where: $k = 1 + \sqrt{200/d} = 1 + \sqrt{200/245} = 1.90 \leq 2.0$

$C_{Rd,c} = 0.18/\gamma_c = 0.18/1.5 = 0.12$

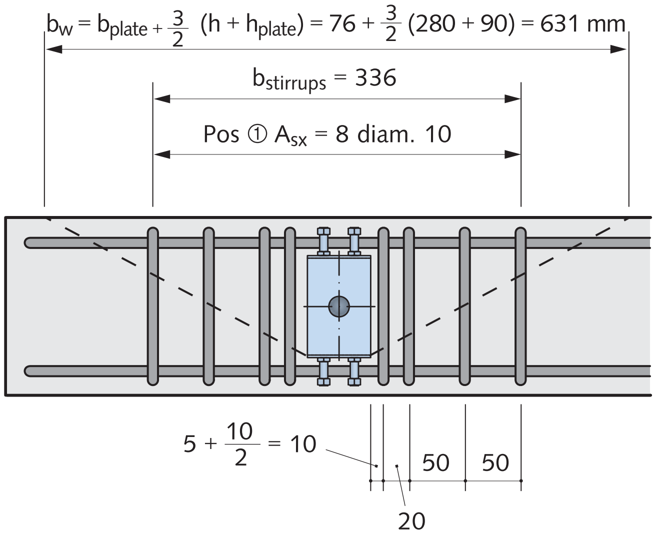
$$\rho_L = \frac{A_{sx}}{b_w \cdot d} = \frac{628}{631 \cdot 245} = 0.0041 \leq 0.02$$

$k_1 \cdot \sigma_{cp} = 0$; because slab is not pre-stressed

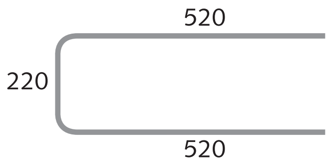
$$v_{min} = 0.035\,k^{\frac{3}{2}} \cdot f_{ck}^{\frac{1}{2}} = 0.035 \cdot 1.90^{\frac{3}{2}} \cdot 25^{\frac{1}{2}} = 0.46$$

$$v_{Rd,c} = (0.12 \cdot 1.90 \cdot (100 \cdot 0.0041 \cdot 25)^{\frac{1}{3}} + 0) \cdot 245$$
$$= 121.2 > (0.46 + 0) \cdot 245 = 112.6 \text{ kN/m}$$

Slab shear capacity $v_{Rd,c}$ = 121.1 kN/m



Pos ① 8 diam. 10 L = 1260



Proof of minimum distance between dowels

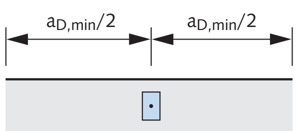
$a_{D,min} = V_{Ed,i}/v_{Rd,c}$
$V_{Ed,i}/v_{Rd,c} = 82.1/121.2 = 0.68$ m
$a_{D,min} = 0.68 \leq a_D = 1.40$ → condition fulfilled, no shear reinforcement required

$a_D = 1.4$ m $> 2 \cdot h_{min} = 2 \cdot 0.2 = 0.4$ m → condition fulfilled

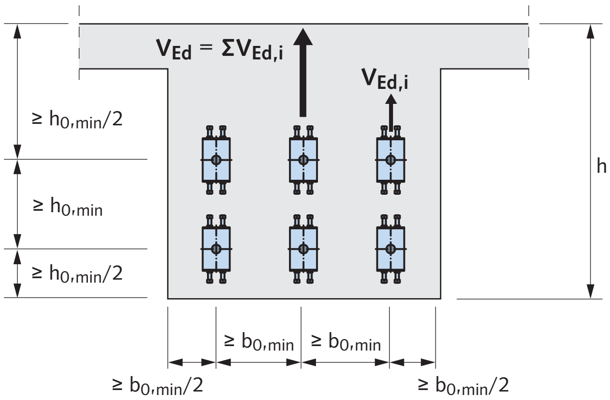
reinforcement ratio $\rho_L = 0.0041$ must be provided in area $a_{D,min}/2$, right and left-hand of the dowel

Proof of minimum edge distance
$a_{r,min} = a_{D,min}/2$
$= 0.68/2$
$= 0.34$ m $\leq a_r = 0.80$ m → condition fulfilled

$h_{min} = 0.2$ m $< a_r = 0.80$ m → condition fulfilled

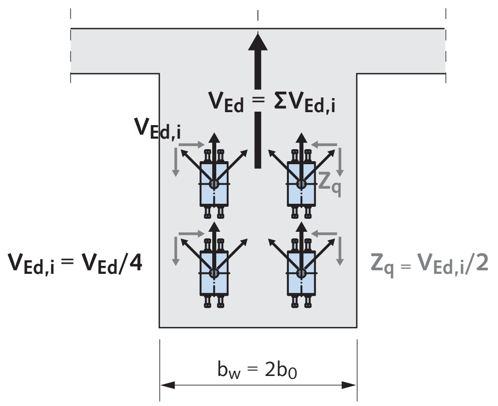


Minimum dimensions of beam-webs and minimum dowel distances

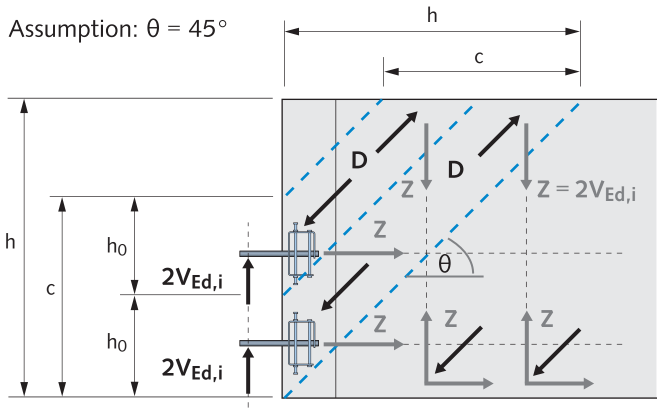


Minimum dowel distances		
CRET – 122	$b_{0,min}$ = 180 mm	$h_{0,min}$ = 180 mm
CRET – 124	$b_{0,min}$ = 200 mm	$h_{0,min}$ = 200 mm
CRET – 128	$b_{0,min}$ = 250 mm	$h_{0,min}$ = 240 mm
CRET – 134	$b_{0,min}$ = 300 mm	$h_{0,min}$ = 300 mm
CRET – 140	$b_{0,min}$ = 350 mm	$h_{0,min}$ = 350 mm
CRET – 145	$b_{0,min}$ = 400 mm	$h_{0,min}$ = 420 mm
CRET – 150	$b_{0,min}$ = 500 mm	$h_{0,min}$ = 600 mm
CRET – 155	$b_{0,min}$ = 600 mm	$h_{0,min}$ = 650 mm

Design of beam connections, strut and tie model (truss theory)



Assumption: $\theta = 45°$



Verification of the shear force load capacity acc. to (EN 1992-1-1: 2005)

$V_{Ed} \leq \min(V_{Rd,max}; V_{Rd,s})$

$V_{Rd,max} = \alpha_{cw} \cdot b_w \cdot z \cdot \nu_1 \cdot f_{cd}/(\cot\theta + \tan\theta)$

where: $\alpha_{cw} = 1.0$

$\nu_1 = 0.6 \cdot [1 - f_{ck}/250]$

$z = 0.9 \cdot d$

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

f_{ywd} design yield strength of the shear reinforcement

s spacing of the stirrups

z lever arm of internal forces

Reinforcement in the area of force introduction

• Vertical stirrups at the end of the girder, distributed in area c	$A_{sw} = V_{Ed} \cdot s/(z \cdot f_{ywd} \cdot \cot\theta)$	[Pos 1]
• Vertical reinforcement per dowel, U-shaped	$A_{sw} = V_{Ed,i}/f_{yd}$	[Pos 2]
• Vertical reinforcement, face of beam *	$A_{sw} = V_{Ed,i}/f_{yd}$	[Pos 3]
• Horizontal transverse reinforcement per dowel row, face of beam	$A_{sw} = 0.5 \cdot V_{Ed,i}/f_{yd}$	[Pos 4]

$V_{Ed,i} = V_{Ed}/n$ with n = number of dowels

* Advice: Bottom reinforcement has to be calculated for a tension force V_{Ed}. And it has to be totally anchored at beam end with hook or loop. Otherwise $A_{sw} = 2 \cdot V_{Ed,i}/f_{yd}$

Design example - beams

Input

Connection beam column, V_{Ed} = 750 kN
Choice: 4 × HSD-CRET 134, Concrete C25/30; γ_c = 1.5

b_w = 600 mm; h = 800 mm
d = 760 mm
Joint width f = 30 mm

Calculation

$V_{Rd,i}$ according table page 7 → $V_{Rd,i}$ = 219.3 kN
$4 \cdot V_{Rd,i} = 4 \cdot 219.3 =$ **877.2 kN > 750 kN = V_{Ed}**

Minimum dimensions

min b_w = 150+300+150 = 600 mm ≥ b_w = 600 mm
min h = 150+300+150 = 600 < h_{ef} = 800 mm

Proof of the resistance of the compression struts

$\alpha_{cw} = 1.0$
$\nu_1 = 0.6 \cdot [1 - f_{ck}/250] = 0.54$
$z = 0.9 \cdot d = 0.9 \cdot 760$ mm = 684 mm
$\cot\theta = 1.0$; $\tan\theta = 1.0$

$\mathbf{V_{Rd,max}} = 1.0 \cdot 600 \cdot 684 \cdot 0.54 \cdot 25/1.5/(1+1) =$

1847 kN > 750 kN = V_{Ed}

Reinforcement

Pos 1

Due to $V_{Rd,s} \geq V_{Ed}$ → req. A_{sw}
$= V_{Ed} \cdot s/(z \cdot f_{ywd} \cdot \cot\theta)$
$= 750 \cdot 10^3 \cdot 150/(684 \cdot 435 \cdot 1)$
= 378 mm² per row

Choice: diam.12, s = 150 mm, 4-cutting, distributed in area c
→ prov. A_{sw} = 452 mm² per row

Pos 2

$A_{sw} = V_{Ed,i}/f_{yd} = 187.5 \cdot 10^3 / 435 = 431$ mm²
Choice: 2 diam.12 per dowel, U-shaped
→ prov. A_{sw} = 452 mm²

Pos 3

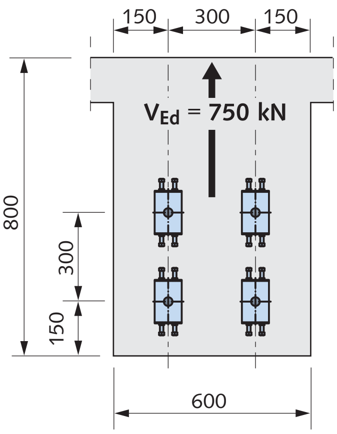
$A_{sw} = V_{Ed,i}/f_{yd} = 187.5 \cdot 10^3 / 435 = 431$ mm²
Choice: 4 diam.12 per vertical dowel row, U-shaped
→ prov. A_{sw} = 452 mm²

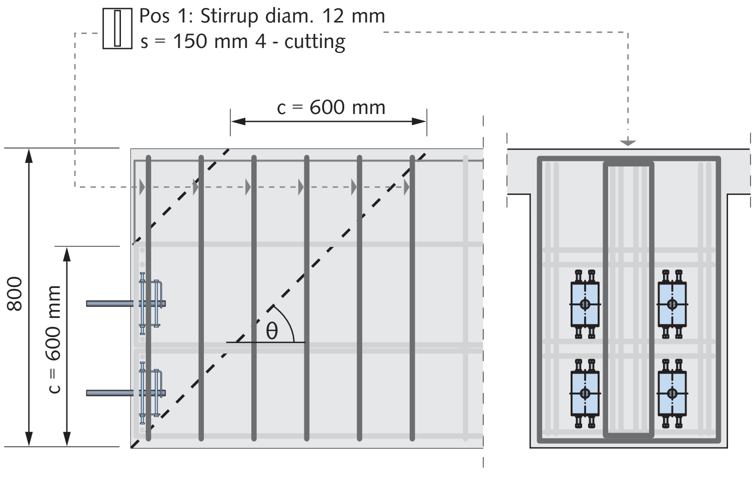
Pos 4

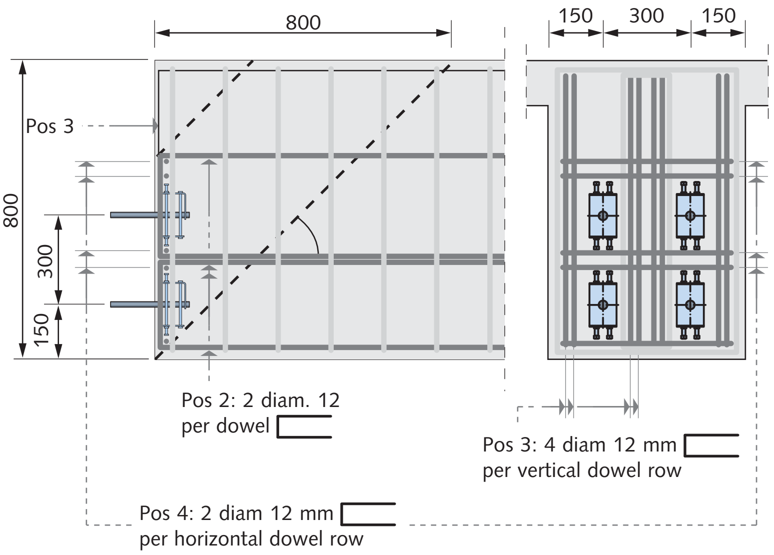
$A_{sw} = 0.5 \cdot V_{Ed,i}/f_{yd} = 93.8 \cdot 10^3 / 435 = 215$ mm²
Choice: 2 diam.12 per horizontal dowel row, U-shaped
→ prov. A_{sw} = 226 mm²

Pos 1: 4 - cutting
Pos 2: 2 - cutting
Pos 3: 1 - cutting
Pos 4: 1 - cutting

Positions 2 and 3 have to be anchored with l_{bd} outside the area of load introduction (area c)





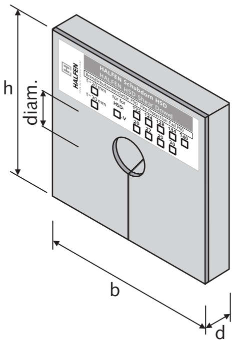


HSD-F Fire protection pad

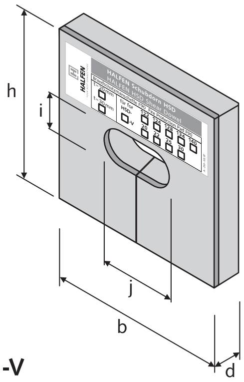
If fire protection is required for components according to DIN 4102 T.2, we recommend to install the HALFEN HSD Shear dowels with fire protection pads.

The fire protection pad can be supplied 20 mm (d = 20) and 30 mm (d = 30) thick. For larger joint widths, a combination of fire protection pads is possible.

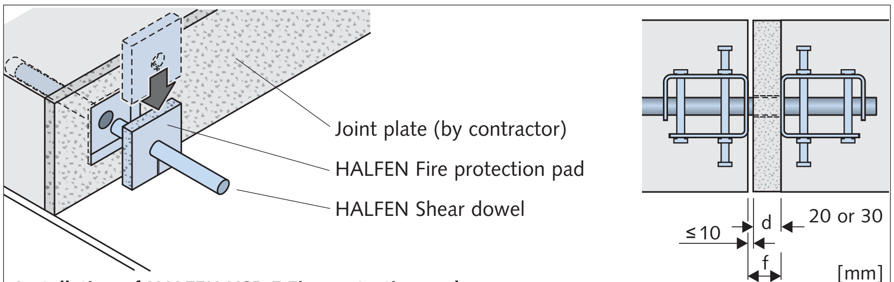
The fire-resistance classification F120 (longitudinal movement) or F90 (longitudinal and transverse movement) is confirmed by the MFPA Leipzig.



HSD-F
for shear dowels HSD, longitudinal movement



HSD-F -V
for shear dowels HSD, longitudinal and transverse movement



Installation of HALFEN HSD-F Fire protection pad

Note: The HSD-F Fire protection pad consists of a material that will produce foam in case of a fire and will tightly seal the joint.

Ordering example:

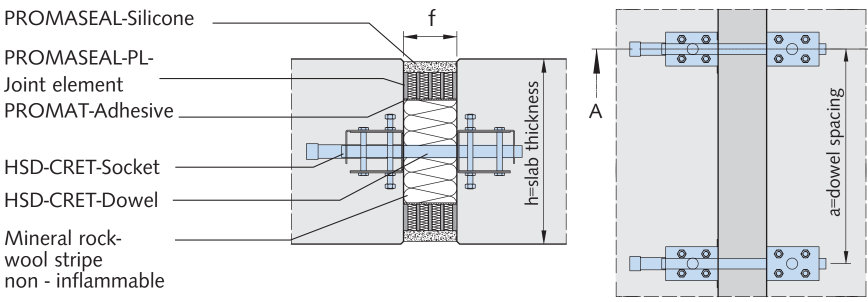
HSD-F - CRET 124 V - 30

Fire protection pad
Matching dowel type
Thickness d [mm]

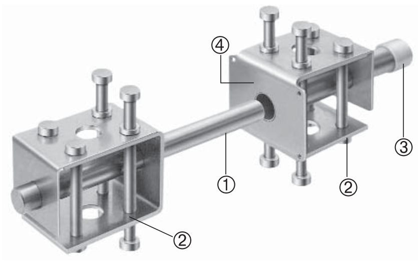
Fire protection pad selection

matching the HALFEN HSD Shear dowel -	Item name d = 20 ⇒ f ≤ 30 d = 30 ⇒ f ≤ 40	h / b	diam. or i	j
Heavy-duty dowel, longitudinal movement				
CRET 122	**HSD-F-CRET 122 -** d	120 / 120	23	
CRET 124	**HSD-F-CRET 124 -** d	130 / 130	25	
CRET 128	**HSD-F-CRET 128 -** d	140 / 140	29	
CRET 134	**HSD-F-CRET 134 -** d	180 /160	35	
CRET 140	**HSD-F-CRET 140 -** d	220 / 180	41	
Single dowel, longitudinal movement				
Set 20	**HSD-F 20 -** d	110 / 110	21	
Set 22	**HSD-F 22 -** d	110 / 110	23	
Set 25	**HSD-F 25 -** d	110 / 110	26	
Set 30	**HSD-F 30 -** d	110 / 110	31	
Heavy-duty dowel, longitudinal and transverse movement				
CRET 122 V	**HSD-F-CRET 122 V -** d	150 / 150	23	46
CRET 124 V	**HSD-F-CRET 124 V -** d	160 / 160	25	50
CRET 128 V	**HSD-F-CRET 128 V -** d	170 / 170	29	58
CRET 134 V	**HSD-F-CRET 134 V -** d	190 / 190	35	70
CRET 140 V	**HSD-F-CRET 140 V -** d	220 / 210	41	82
Single dowel, longitudinal and transverse movement				
Set 20 V	**HSD-F 20 V -** d	110 / 160	21	42
Set 22 V	**HSD-F 22 V -** d	110 / 160	23	50
Set 25 V	**HSD-F 25 V -** d	110 / 160	26	56
Set 30 V	**HSD-F 30 V -** d	110 / 160	31	62

For requirements - smoke tight "enclosure of space" - according DIN EN 1366-4 in combination with DIN EN 1363-1, we recommend to use the joint element **PROMASEAL-PL** (see fig.).
For the combination of HALFEN Shear dowel with PROMASEAL-PL the enclosing design function and the fire resistance classification F90 is confirmed by the MFPA Leipzig.



Assembly instructions for HALFEN HSD-CRET heavy-duty shear dowels



① Dowel
② Load distribution body
③ Sliding socket
④ Nail plate for the fixation of the socket to the formwork

HSD-CRET sliding sockets nailed onto the formwork

First concreting section

The sliding sockets are fixed to the formwork by nailing (illustrations 1 and 2); in doing this, it must be ensured that the sockets are exactly aligned in the sliding direction.

The label applied over the opening in the socket protects the socket against the entry of concrete, and must therefore not be removed.

The in-situ junction and suspension reinforcement is to be installed according to the information from the static calculations and the reinforcement plan.

Second concreting section

After removing the formwork from the first concreting section, the filling material is placed into the joint (illustration 3). The joint width specified in the plan must be complied with exactly.

A recess in the filling material has to be provided so that the dowels can be inserted into the sockets. The required joint reinforcement is to be installed according to the data from the static calculations and the reinforcement plans. The use of the shear dowels without additional measures for environmental conditions according to DIN 1045–1 is permissible.

In the case of environmental conditions with higher requirements on corrosion protection, the dowels and the sliding sockets are to be well coated with a corrosion protection compound, e.g. on a petroleum basis.

If a higher fire resistance duration is specified in the reinforcement plan, non-inflammable material must be used as filling material in the joints (e.g. mineral fibre with a relative density of approx. 110 kg/m^3 according to DIN 4102 T 4).

If there are fire protection requirements on the construction components according to DIN 4102 T.2, we recommend the installation of the HALFEN HSD Shear dowels with fire protection pad (see page 15).

Illustration 1

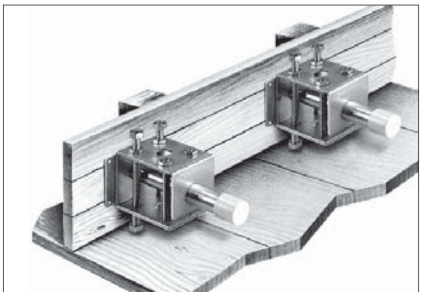


Illustration 2

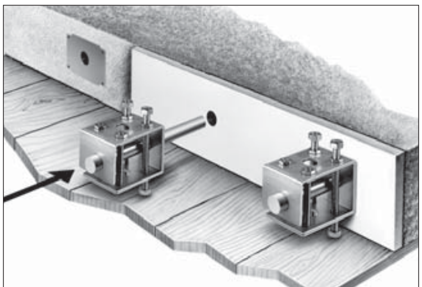
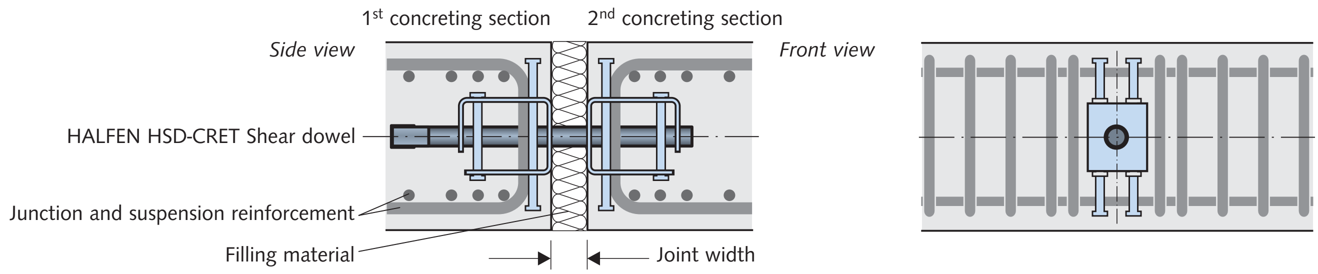


Illustration 3

Additional and suspension reinforcement (by contractor)



HALFEN HSD SHEAR DOWEL SYSTEM

Single shear dowels

Product description

HALFEN Single shear dowels HSD allow sliding in the direction of the member axis. The dowels are normally used to transmit shear loads in any direction.

If lateral movements have to be taken into account, the HSD-SV sockets are used, which permit a sideways movement, i.e. the shear load will only be transmitted in one direction.

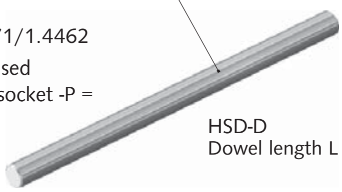
HALFEN Single shear dowels HSD-D require no official approval.

Single shear dowel HSD-D

Material / finish:

A4 = Stainless steel grade 1.4571/1.4462

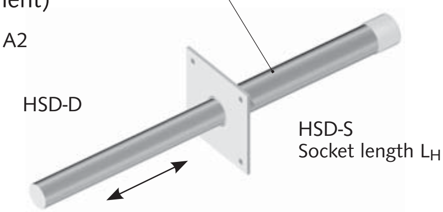
FV = Steel S355, hot-dip galvanised
(only in combination with socket -P = plastic)



Socket HSD-S

(longitudinal movement)

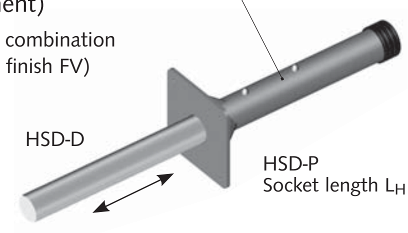
Material: Stainless steel A2



Socket HSD-P

(longitudinal movement)

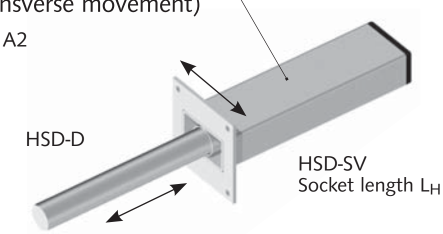
Material: Plastic (only in combination with dowel in material / finish FV)



Socket HSD-SV

(longitudinal and transverse movement)

Material: Stainless steel A2



Dimensions of single shear dowels and sockets

Dowel type	Single shear dowel		Sliding sockets HSD-P, -S		Sliding sockets HSD-SV	
	Dowel diam. [mm]	Dowel length L [mm]	Socket length L_H [mm]	Nail plate width/height [mm]	Socket length L_H [mm]	Nail plate width/height [mm]
HSD-D 20	20	300	160	70/70	180	80/80
HSD-D 22	22	300	160	70/70	180	80/80
HSD-D 25	25	300	160	70/70	180	80/80
HSD-D 30	30	350	185	80/80	205	100/80

Ordering examples:

- Dowel: **HSD-D 22 -A4**
  HALFEN Shear dowel
  Diameter [mm]
  A4 = Stainless steel A4 material

- Sliding socket: **HSD-SV 22**
  HALFEN Sliding socket
  - S = Stainless steel A2
  - SV = ditto, transverse and longitudinal movement
  - P = Plastic
  for dowel diameter [mm]

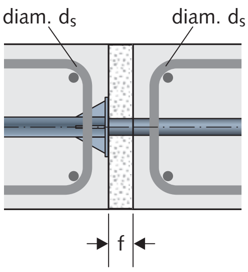
- Set (Dowel + sliding socket) **HSD-SET 22 V -A4**
  HALFEN Shear dowel set
  with dowel diameter [mm]
  V = Socket transverse and longitudinal movement
  A4 = Dowel stainless steel A4, Socket S/SV = stainless steel A2

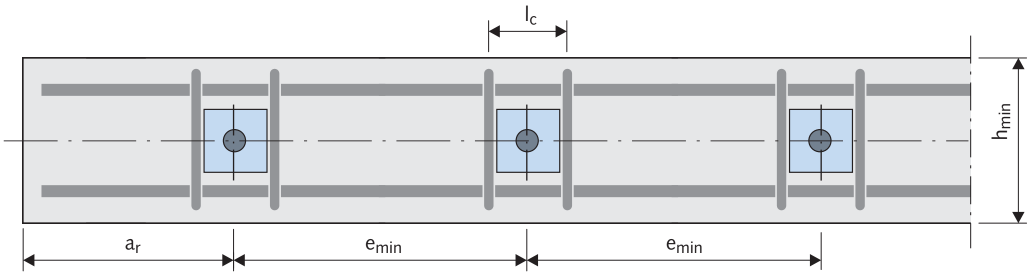
Single shear dowels

Dimensioning

Minimum spacing, Element thickness, Stirrup spacing						
Dowel diam. [mm]	Socket	Stirrup diam. d_s [mm]	Component thickness h_{min} [mm]	Stirrup spacing l_c [mm]	Required dowel spacing e_{min} [mm]	Edge distance a_r [mm]
20	HSD-S + HSD-P	10	160	60	310	160
22		10	160	60	350	175
25		12	175	70	410	200
30		14	210	90	560	240
20	HSD-SV	10	160	80	310	160
22		10	160	90	350	175
25		12	175	100	410	200
30		14	210	110	560	240

l_c = Distance between the first two stirrups
h_{min} = Minimum component thickness
e_{min} = Minimum centre spacing between the single dowels
a_r = Minimum edge distance





Dimensioning for non-reinforced concrete

Design resistances HSD-D in non-reinforced concrete according to volume 346, DAfStb (German association for reinforced concrete construction)

Steel load-bearing capacity: $V_{Rd,s} = f_\mu \cdot 1.25 \cdot (f_{yk}/\gamma_{MS}) \cdot W / (f+\text{diam.})$
Concrete load-bearing capacity: $V_{Rd,c} = 0.4 \cdot f_{ck} \cdot \text{diam.}^{2.1} / (333+12.2 \cdot f)$
$0.4 = (\alpha \cdot \gamma_{MW}) / 3$

where:
f_μ = 0.9 Reduction factor due to friction [-]
f_{yk} = yield strength [N/mm²]
f_{ck} = characteristic compressive cylinder strength of concrete [N/mm²]
f = Joint width [mm]
diam. = Shear dowel diameter [mm]
W = Section modulus [mm³]
γ_{MS} = Material safety factor for steel [-]

- HALFEN Single shear dowels HSD-D require no official approval.
- α = 0.85 (consideration of the long-term effects)
- γ_{MW} = 1.425 (average value from γ_G = 1.35 and γ_Q = 1.5)
- Minimum edge distance to the dowel axis a_r = 8 · diam. (in all directions)
- Minimum axial distance e = 16 · diam.

Dimensioning resistances VRd.s and VRd.c [kN] for non-reinforced concrete							
Dowel type	Concrete grade	Dowel-diam. [mm]	Minimum component thickness [mm]	Design resistances [kN] for joint width f [mm]			
				10	20	30	40
HSD-D 20	≥ C20/25	20	320	9.5	7.1	5.7	4.8
HSD-D 22		22	350	11.6	9.0	7.3	6.1
HSD-D 25		25	400	15.2	12.0	9.9	8.4
HSD-D 30		30	480	22.2	17.5	14.5	12.3

Dimensioning for reinforced concrete

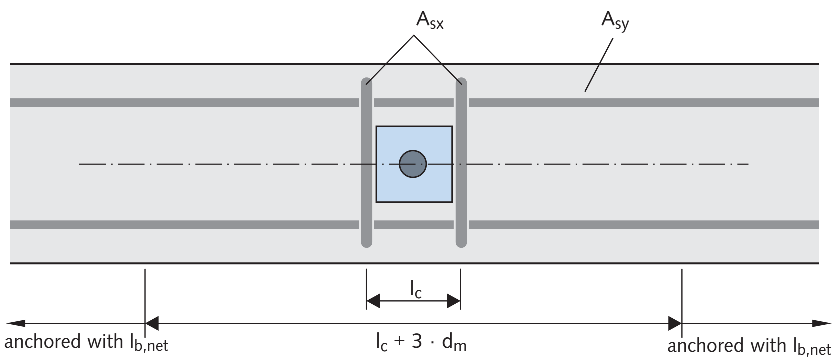
Design resistances HSD-D in reinforced concrete according to volume 346, DAfStb (German association for reinforced concrete construction)

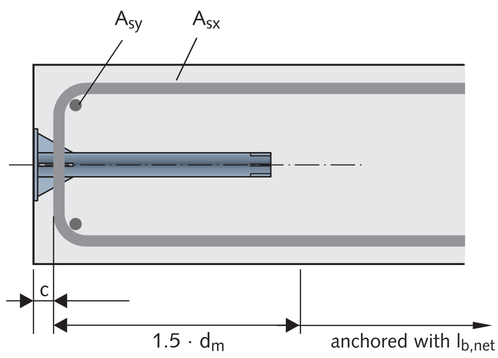
Required proofs:
Proof against punching failure $V_{Rd,ct}$
(acc. to DIN 1045-1)
Proof against concrete edge failure $V_{Rd,ce}$
(acc. to volume 346, DAfStb)
Proof of the steel load capacity $V_{Rd,s}$
Steel load-bearing capacity:
$V_{Rd,s} = f_\mu \cdot 1.25 \cdot (f_{yk}/\gamma_{MS}) \cdot W / (f + diam./2)$

$$V_{Rd} = \min (V_{Rd,s}; V_{Rd,c})$$

$V_{Rd,s}$ Dimensioning resistance of the steel load-bearing capacity
$V_{Rd,c}$ Dimensioning resistance of the concrete load-bearing capacity

where:
f_μ = Reduction factor due to friction [-]
f_{yk} = yield strength [N/mm²]
f = Joint width [mm]
diam. = Shear dowel diameter [mm]
W = Section modulus [mm³]
γ_{MS} = Material safety factor for steel [-]
d_m = effective depth of the cross section





Proof of the steel load-bearing capacity

Design resistances VRd,s for HSD-S and HSD-P - longitudinal movement - for reinforced concrete

Dowel type	concrete grade	Dowel-diam. [mm]	Design resistances $V_{Rd,s}$ [kN] for joint width f [mm]			
			10	20	30	40
HSD-D 20	≥ C20/25	20	14.3	9.5	7.1	5.7
HSD-D 22		22	18.1	12.2	9.3	7.4
HSD-D 25		25	24.8	17.1	13.1	10.6
HSD-D 30		30	38.5	27.5	21.4	17.5

taking account of friction ($f_\mu = 0.9$)

Design resistances VRd,s for HSD-SV - longitudinal and transverse movement - for reinforced concrete

Dowel type	concrete grade	Dowel-diam. [mm]	Design resistances $V_{Rd,s}$ [kN] for joint width f [mm]			
			10	20	30	40
HSD-D 20	≥ C20/25	20	12.8	8.6	6.4	5.1
HSD-D 22		22	16.3	11.0	8.3	6.7
HSD-D 25		25	22.3	15.4	11.8	9.5
HSD-D 30		30	34.6	24.7	19.2	15.7

taking account of friction ($f_\mu = 0.81$)

Dimensioning for reinforced concrete

Proof of the concrete load-bearing capacity

The design resistance for the concrete load-bearing capacity is the smallest dimensioning resistance from the concrete edge failure and punching failure proofs:

A_{sx} = Rear suspension reinforcement
A_{sy} = Longitudinal reinforcement
l_c = Distance between the first two stirrups

Dimensioning resistances VRd,c for HSD-S and HSD-P - longitudinal movement -

Dowel type	Component thickness h [mm]	c_{nom} [mm]	Design resistances $V_{Rd,c}$ [kN] ≥ C20/25	In-situ reinforcement A_{sx}	A_{sy}	Centre spacing l_c [mm]
HSD-D 20	≥160	30	14.2	2 diam. 10	2 diam. 10	60
	≥180		15.8			
HSD-D 22	≥160	30	14.2	2 diam. 10	2 diam. 10	60
	≥180		15.8			
	≥200		17.3			
	≥220		18.9			
	≥240		20.4			
HSD-D 25	≥180	30	20.5	2 diam.12	2 diam.12	70
	≥200		22.4			
	≥220		24.3			
	≥240		26.2			
	≥260		28.0			
HSD-D 30	≥220	30	29.3	2 diam. 14	2 diam. 14	90
	≥240		31.5			
	≥260		33.7			
	≥280		35.9			
	≥300		38.1			
	≥320		40.2			

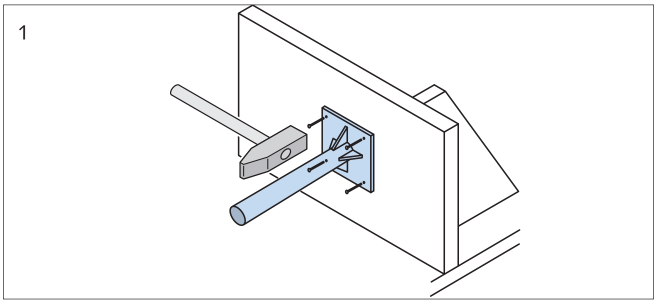
taking account of friction (f_μ = 1.0)

Dimensioning resistances VRd,c for HSD-SV - longitudinal and transverse movement-

Dowel type	Component thickness h [mm]	c_{nom} [mm]	Design resistances $V_{Rd,c}$ [kN] ≥ C20/25	In-situ reinforcement A_{sx}	A_{sy}	Centre spacing l_c [mm]
HSD-D 20	≥160	30	5)	2 diam. 10	2 diam. 10	80
	≥180		13.0			
HSD-D 22	≥160	30	5)	2 diam. 10	2 diam. 10	90
	≥180		12.5			
	≥200		13.9			
	≥220		15.3			
	≥240		16.7			
HSD-D 25	≥180	30	5)	2 diam.12	2 diam.12	100
	≥200		18.0			
	≥220		19.8			
	≥240		21.5			
	≥260		23.2			
HSD-D 30	≥220	30	24.6	2 diam. 14	2 diam. 14	110
	≥240		26.7			
	≥260		28.7			
	≥280		30.7			
	≥300		32.7			
	≥320		34.7			

taking account of friction (f_μ = 0.9) 5) No rear suspension stirrup in the break-out cone

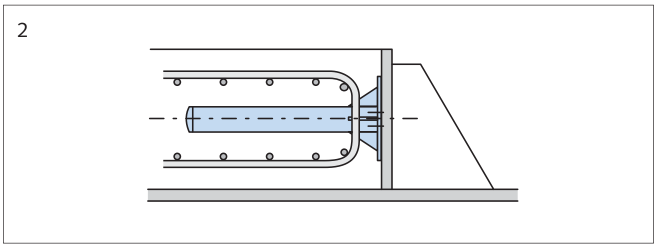
Assembly instructions for HSD single shear dowels



1. Fixing to the formwork

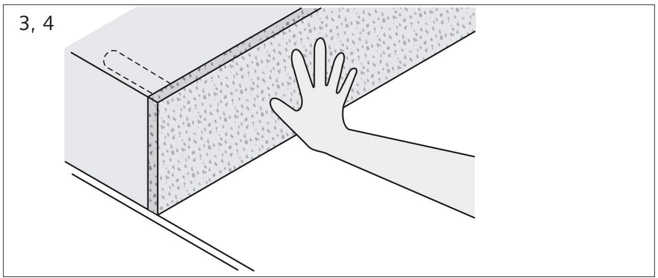
Nail the socket onto the formwork according to the specified position. Important: The socket must be aligned exactly in the direction of slide.

NOTE: Do not remove the label. This protects the socket from the penetration of fresh concrete.



2. Reinforcement

Laying of the in-situ joint and rear suspension reinforcement, as well as the component reinforcement, in the 1st concreting-section.

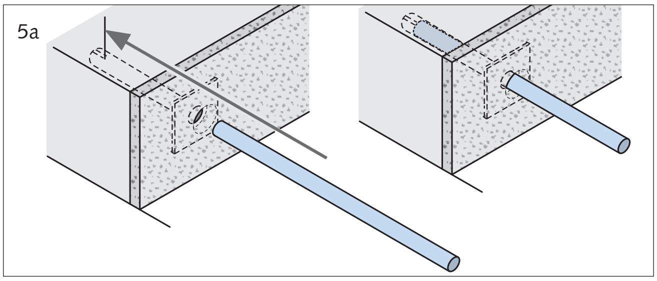


3. Protective label

The protective label can be removed from the socket after the concreting and the removal of the formwork.

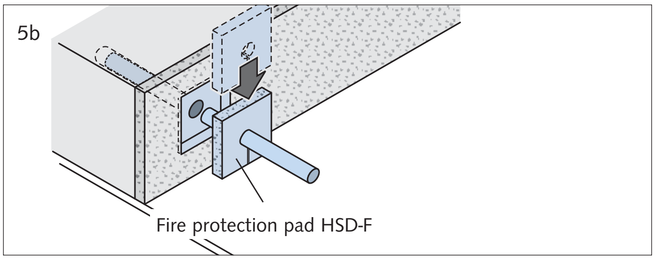
4. Joint material

Application of the joint material. The positions of the shear dowel sockets are to be exactly marked where necessary.



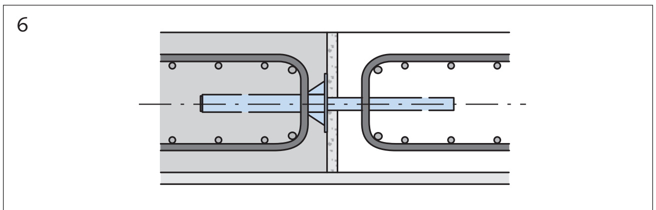
5. a) Shear dowel

The dowel that matches the socket is now inserted through the joint material and is pushed into the socket up to the stop (safety plug).



5. b) Shear dowel

In the case of fire protection requirements according to DIN 4102, a recess is to be provided in the joint material for the HALFEN fire protection pad.



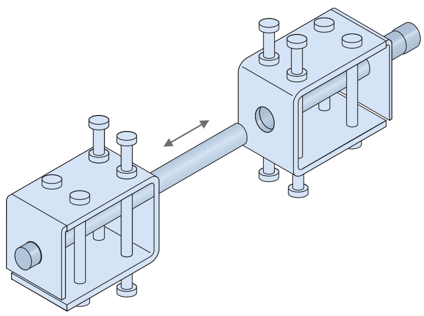
6. Concreting

Positioning of the reinforcement (by contractor) and concreting the 2nd concreting -section.

Tender specification and software

Text for invitation to tender

HALFEN Heavy-duty shear dowel HSD-CRET ...
HALFEN Shear dowel system HSD with technical approval No.: Z-15.7-253, or equivalent, for the transfer of shear forces in expansion joints between components made of steel reinforced concrete. Delivery of dowel- and sleeve, installation according to instructions of the producer.



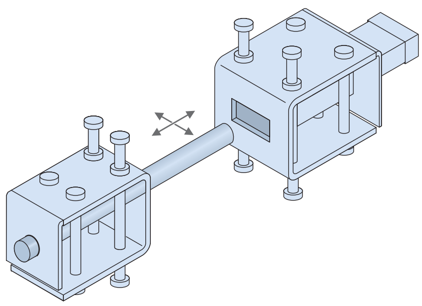
Shear dowel with technical approval No.: Z-15.7-253, movable in longitudinal direction.

- Dowel: stainless steel S690 (grade: 1.4462).
- Anchorage box: stainless steel S275 (grade: 1.4404).
- Fixing rods: Stainless steel class 70 (grade: 1.4401).
- All components fulfil at minimum the requirements of corrosion-resistance-class III.
- Maximum joint width is 60 mm.

Dowel diameter __ mm,
_____ pcs.

Suspension reinforcement according to specifications of the producer or designer.

HALFEN Heavy-duty shear dowel HSD-CRET ... V
HALFEN Shear dowel system HSD-V with technical approval No.: Z-15.7-253, or equivalent, for the transfer of shear forces in expansion joints between components made of steel reinforced concrete. Delivery of dowel- and sleeve, installation according to instructions of the producer.



Shear dowel with technical approval No.: Z-15.7-253, movable in longitudinal and transverse direction.

- Dowel: stainless steel S690 (grade: 1.4462).
- Anchorage box: stainless steel S275 (grade: 1.4404).
- Fixing rods: Stainless steel class 70 (grade: 1.4401).
- All components fulfil at minimum the requirements of corrosion-resistance-class III.
- Maximum joint width is 60 mm.

Dowel diameter __ mm,
_____ pcs.

Suspension reinforcement according to specifications of the producer or designer.

More submission texts are available at www.halfen.com

Software

The most recent version of the design program is available on the Internet for downloading at www.halfen.(→ country code)

If required, a DVD with all design programs, catalogues and approvals is also available. You will find our contact address on the adjacent page of this brochure. System requirements for the HALFEN HSD design software:

- Windows XP, Vista, Windows 7
- Microsoft .Net Framework 3.0

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Furthermore HALFEN is represented with sales offices and distributors worldwide. Please contact us: www.halfen.com

The Quality Management System of Halfen GmbH is certified for the locations in Germany, Switzerland and Poland according to **DIN EN ISO 9001:2008**, Certificate No. QS-281 HH.

GLC CERTIFIED ISO 9001

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