

HALFEN HSD SHEAR DOWEL SYSTEM

TECHNICAL PRODUCT INFORMATION



HALFEN SHEAR DOWEL SYSTEM

HSD EC 10-E

CONCRETE

Acc. to EN 1992-1-1:2008

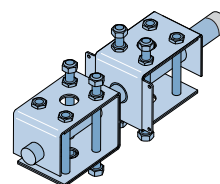
HALFEN HSD SHEAR DOWEL SYSTEM

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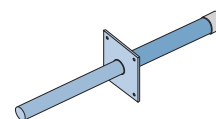
HALFEN HSD-CRET heavy duty shear dowels

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HALFEN HSD single shear dowels

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HALFEN HSD shear dowel system

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HALFEN HSD SHEAR DOWEL SYSTEM

Introduction

Expansion joints to prevent constraint stresses

The effects of

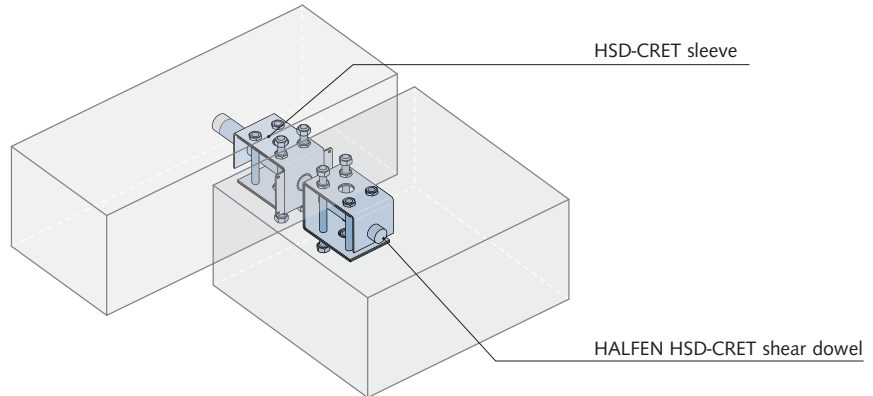
- shrinkage
- temperature
- creep in case of post-tensioning
- subsidence

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:

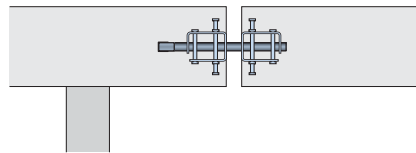
- simple geometry of the formation of the joint
- simple formwork and time saving installation
- simple reinforcement layout
- gain in space through avoidance of double supports
- cost saving and gain in space through staged erection of the construction elements
- approved in several European countries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



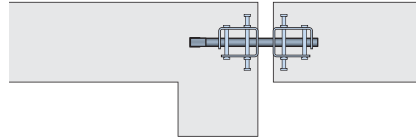
The solution:

the HALFEN HSD Shear dowel system

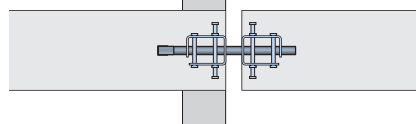
Flat slab (vertical section)



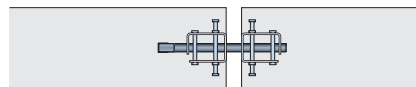
Slab connection with console (vertical section)



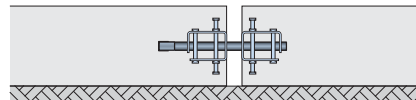
Double column replaced by a single column (vertical section)



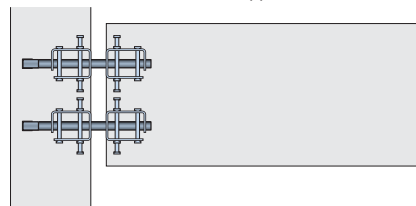
Connection of a supporting wall (horizontal section)



Expansion joint in floor slab (vertical section)

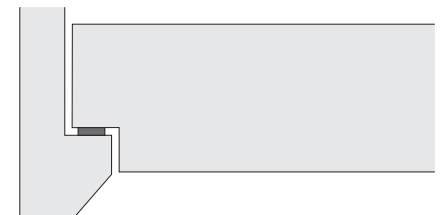
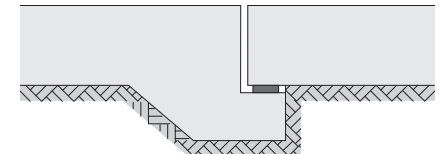
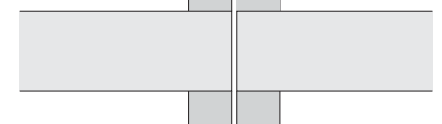
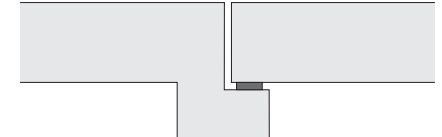
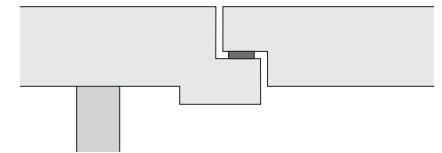


Connection between beam / support (vertical section)



Conventional:

problems with conventional design



HALFEN HSD SHEAR DOWEL SYSTEM

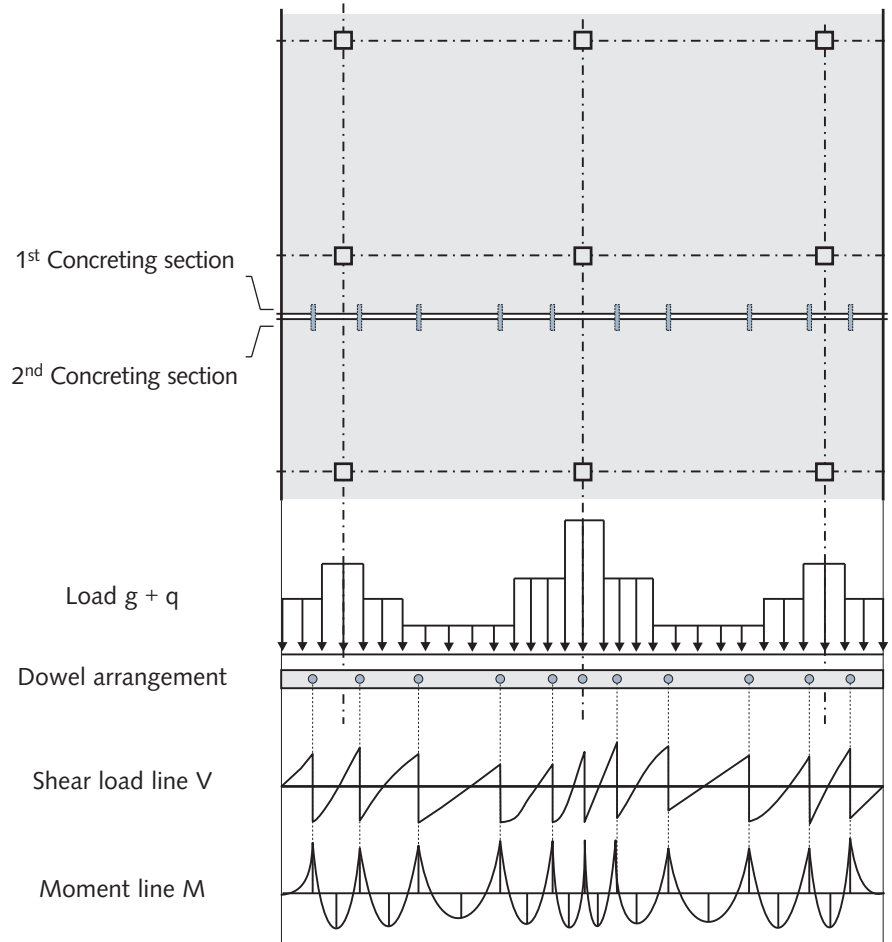
Dimensioning

Expansion joints to prevent constraint stresses

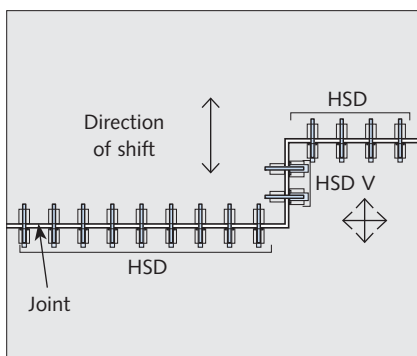
For flat slabs, it is advisable to arrange the dowels at different spacings according to the different shear load concentrations. The value and the distribution of the shear load to be transmitted can be determined by a finite elements slab calculation. The static model of a continuous beam is suitable 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

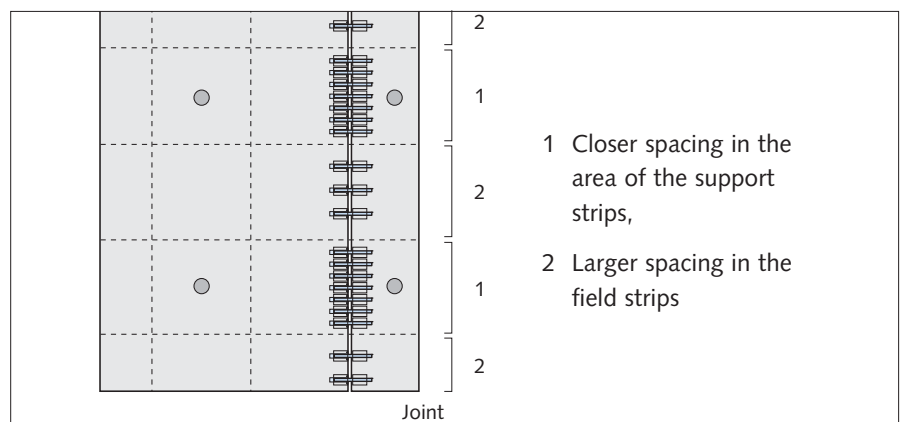


Angled joint run

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

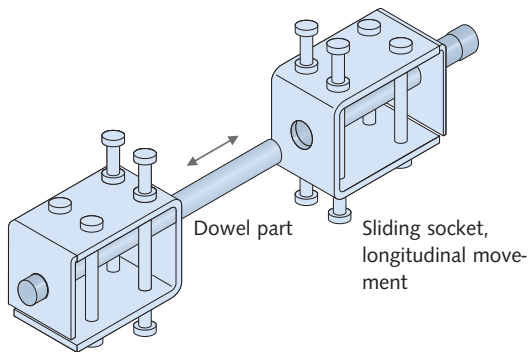
HALFEN HSD SHEAR DOWEL SYSTEM

Heavy-duty shear dowels

Product description

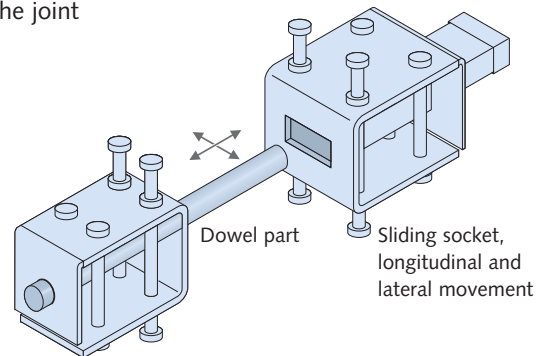
HSD-CRET heavy-duty shear dowel

consisting of dowel part and sliding socket, single-axis movement - along the dowel axis



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



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.

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

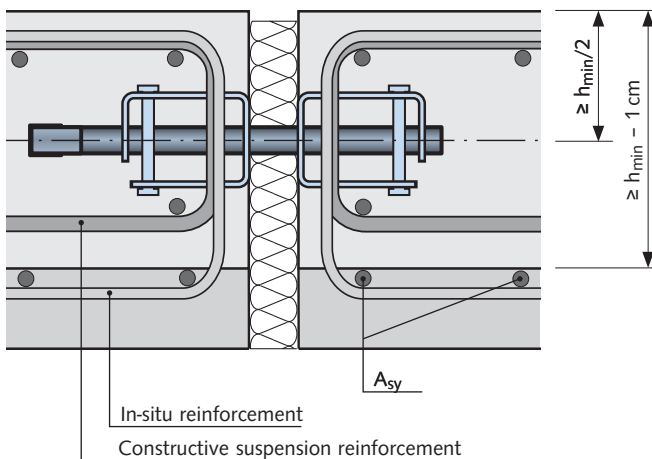
| Dowel diameter and minimum component thickness | | | |
|--|------------|-----------------------|--|
| HSD- | HSD- | Dowel diameter [mm] | Minimum component thickness h_{min} [cm] |
| CRET 122 | CRET 122 V | 22 | 18 |
| CRET 124 | CRET 124 V | 24 | 20 |
| CRET 128 | CRET 128 V | 28 | 24 |
| CRET 134 | 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:

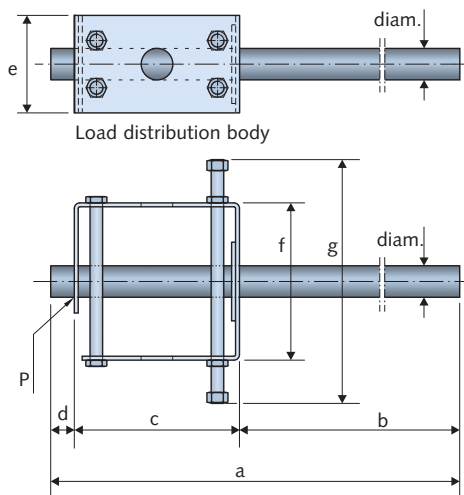
- Insertion of constructive suspension reinforcement in the semi-prefabricated slab (dimensioning for $V_{Rd}/3$).
- Thickness of the in-situ cast concrete = $h_{min} - 1 \text{ cm}$.
- Dimension between the shear dowel axis and upper edge of the in-situ concrete = $h_{min}/2$.
- With a sufficient thickness 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.

HALFEN HSD SHEAR DOWEL SYSTEM

Heavy-duty shear dowels

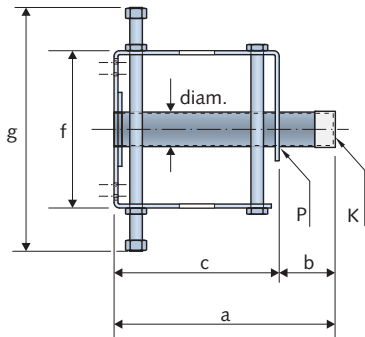
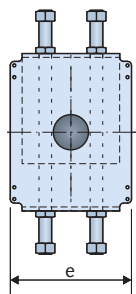
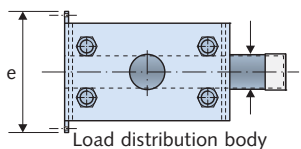
Type selection

Dowel part



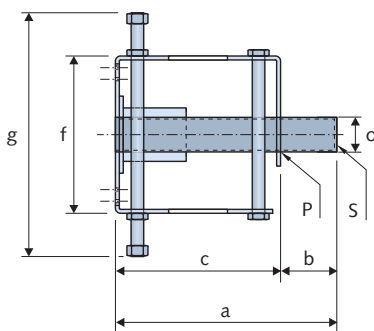
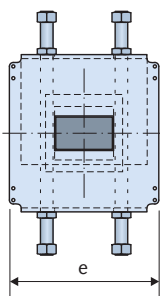
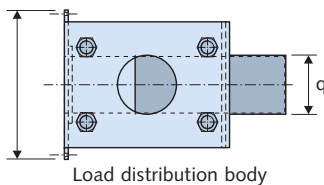
Sliding socket

- 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 / 155 V | 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:

HALFEN heavy-duty shear dowel **HSD-CRET 124 V**
 Load range _____
 V = Transverse and longitudinal movement

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

HALFEN HSD SHEAR DOWEL SYSTEM

Heavy-duty shear dowels

Dimensioning

Ultimate limit state:

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

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

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

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

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

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

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

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.

Dimensioning of the joint width f

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

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. Addresses → page 23

HALFEN HSD SHEAR DOWEL SYSTEM

Heavy-duty shear dowels

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

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

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

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.

Dimensioning of the joint width f

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

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

$V_{Rd,1}$

$V_{Rd,2}$

$V_{Rd,max}$

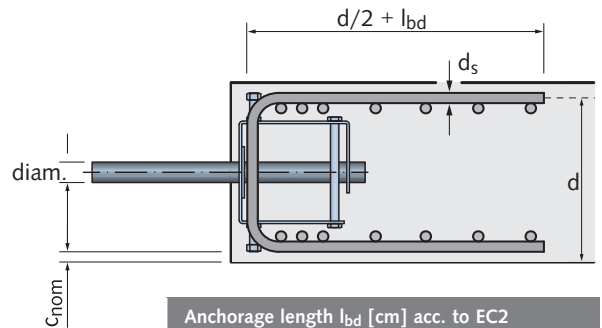
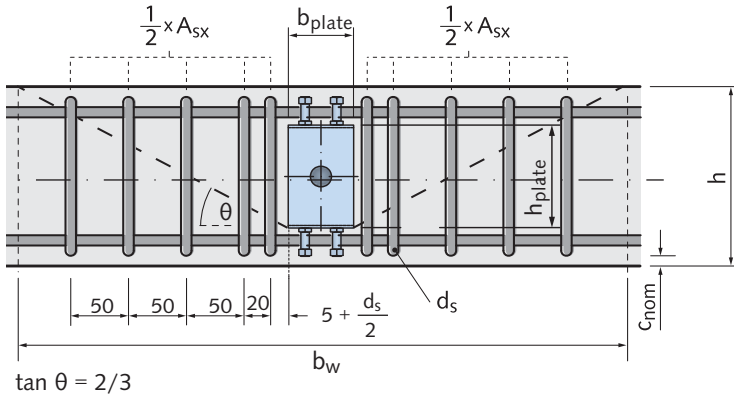
With partial safety factors: $\gamma_s = 1.15$ EN 1992-1-1:2008; $\gamma_c = 1.5$ EN 1992-1-1:2008; $\gamma_{M0} = 1.0$ EN 1993-1-1; $\gamma_{M2} = 1.25$ EN 1993-1-8

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

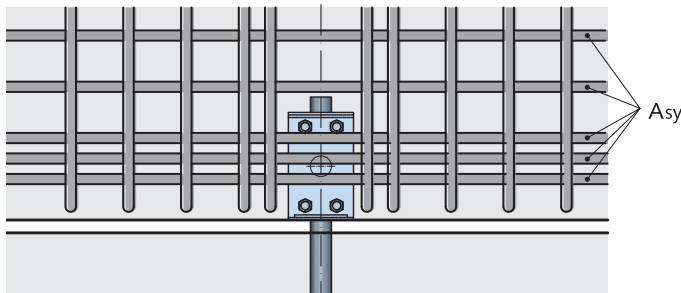
HALFEN HSD SHEAR DOWEL SYSTEM

Heavy-duty shear dowels

In-situ reinforcement



| 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 continuous 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 HSD SHEAR DOWEL SYSTEM

Heavy-duty shear dowels

HALFEN Dimensioning Software

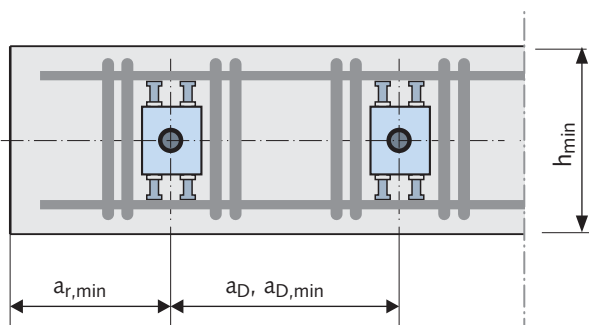
For an optimised suspension reinforcement, please use the HSD-CRET design program, downloadable from: www.halfen.com (→ country code)
If required, a DVD with all design programs, catalogues and approvals is also available.



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 $10 \cdot h$. The optimum is $5 \cdot h$.



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

V_{Rd} acc. page 7 - 8

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

with a minimum of:

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

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

h_{min} acc. adjacent table

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

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

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}

HALFEN HSD SHEAR DOWEL SYSTEM

Heavy-duty shear dowels

Design example - slab

Input

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

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

Concrete: C25/30 $\rightarrow f_{ck} = 25 \text{ MPa}$, $\gamma_c = 1.5$ (EN 1992-1-1:2008)

Concrete cover: $c_{nom} = 30 \text{ mm}$

Slab thickness: $h = 280 \text{ mm} \rightarrow$ effective depth $d = h - c_{nom} - \text{diam.}/2 = 245 \text{ mm}$

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

Joint length: $L = 10 \text{ m}$

Designed joint width: $f = 30 \text{ mm}$ (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 $V_{Rd} = 108.8 \text{ kN}$ (page 7)

Minimum slab thickness $h_{min} = 200 \text{ mm} \leq h = 280 \text{ mm}$ (page 9) \rightarrow condition fulfilled

Sum of loading on the joint: $V_{Ed} = L \cdot v_{Ed} = 10 \cdot 50 = 500 \text{ kN}$

Minimum number of dowels in the joint: $n_{min} = V_{Ed} / V_{Rd} = 500 / 108.8 = 4.59 \text{ pcs.} \rightarrow$ chosen 5 dowels

Distance between dowels: $a_D = L / n_{min} = 10 / 5 = 2.0 \text{ m}$

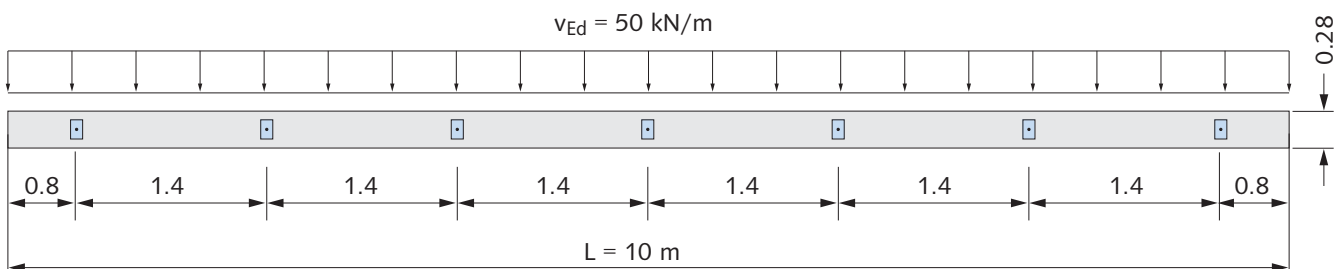
Proof of maximum distance between dowels

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

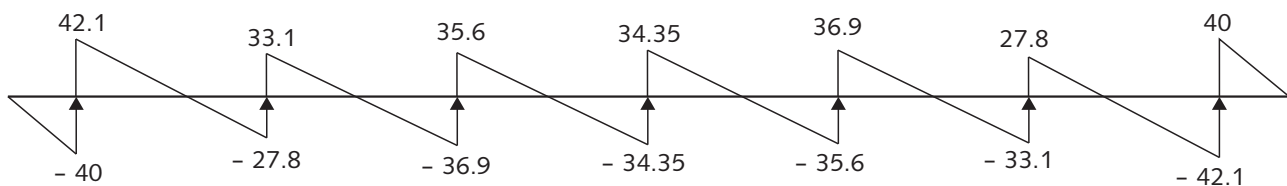
Maximum distance between dowels:

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

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



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



$\max V_{Ed,i} = 82.1 \text{ kN} \leq V_{Rd} = 108.8 \text{ kN} \rightarrow$ condition fulfilled

HALFEN HSD SHEAR DOWEL SYSTEM

Heavy-duty shear dowels

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 continuous 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)

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

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

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

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

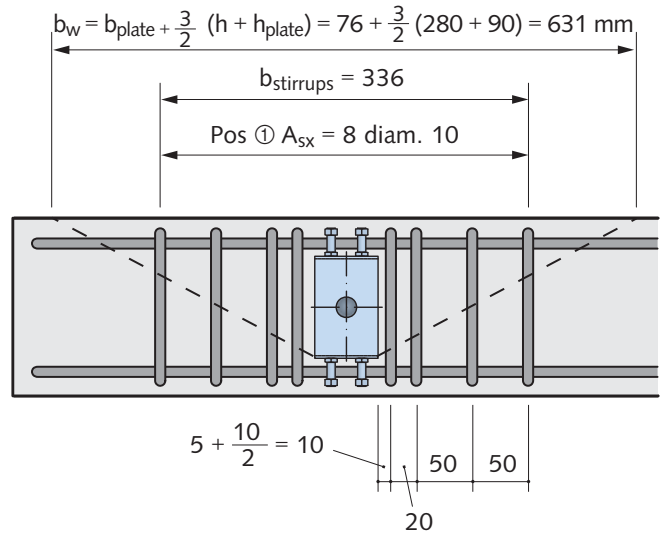
$$\rho_l = \frac{A_{sx}}{b_w \cdot d} = \frac{628}{631 \cdot 245} = 0.0041 \leq 0.02$$

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

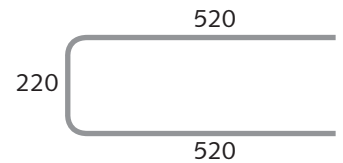
$$v_{min} = 0.035 k^{\frac{2}{3}} \cdot f_{ck}^{\frac{1}{2}} = 0.035 \cdot 1.90^{\frac{2}{3}} \cdot 25^{\frac{1}{2}} = 0.46$$

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

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



Pos ① 8 diam. 10 L = 1260



Proof of minimum distance between dowels

$$a_{D,min} = V_{Ed,i} / v_{Rd,c}$$

$$V_{Ed,i} / v_{Rd,c} = 82.1 / 121.2 = 0.68 \text{ m}$$

$a_{D,min} = 0.68 \leq a_D = 1.40 \rightarrow$ condition fulfilled, no shear reinforcement required

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

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

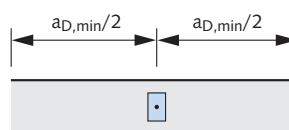
Proof of minimum edge distance

$$a_{r,min} = a_{D,min} / 2$$

$$= 0.68 / 2$$

$$= 0.34 \text{ m} \leq a_r = 0.80 \text{ m} \rightarrow$$
 condition fulfilled

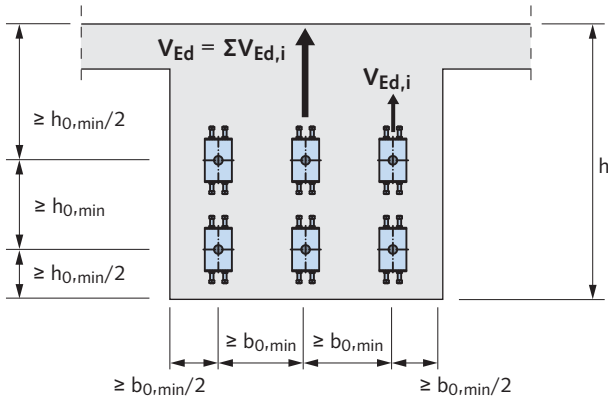
$h_{min} = 0.2 \text{ m} < a_r = 0.80 \text{ m} \rightarrow$ condition fulfilled



HALFEN HSD SHEAR DOWEL SYSTEM

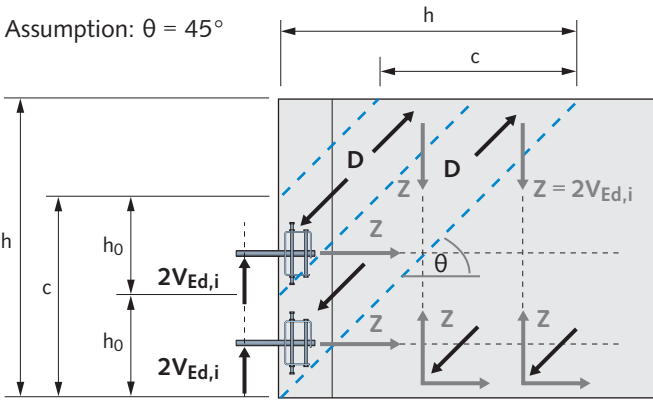
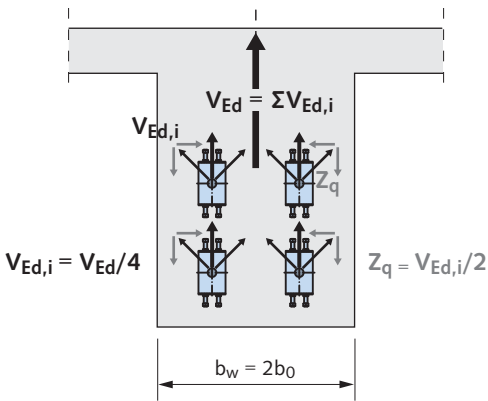
Heavy-duty shear dowels

Minimum dimensions of beam-webs and minimum dowel distances



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

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



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

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

$$V_{Rd,max} = \alpha_{cw} \cdot b_w \cdot z \cdot v_1 \cdot f_{cd} / (\cot \theta + \tan \theta)$$

where: $\alpha_{cw} = 1.0$
 $v_1 = 0.6 \cdot [1 - f_{ck}/250]$
 $z = 0.9 \cdot d$

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

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]

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

* 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 $A_{sw} = 2 \cdot V_{Ed,i} / f_{yd}$

HALFEN HSD SHEAR DOWEL SYSTEM

Heavy-duty shear dowels

Design example - beams

Input

Connection beam column, $V_{Ed} = 750 \text{ kN}$
 Choice: $4 \times \text{HSD-CRET 134}$, Concrete C25/30; $\gamma_c = 1.5$

$b_w = 600 \text{ mm}$; $h = 800 \text{ mm}$
 $d = 760 \text{ mm}$
 Joint width $f = 30 \text{ mm}$

Calculation

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

Minimum dimensions

$\min b_w = 150 + 300 + 150 = 600 \text{ mm} \geq b_w = 600 \text{ mm}$
 $\min h = 150 + 300 + 150 = 600 < h_{ef} = 800 \text{ mm}$

Proof of the resistance of the compression struts

$\alpha_{cw} = 1.0$
 $v_1 = 0.6 \cdot [1 - f_{ck}/250] = 0.54$
 $z = 0.9 \cdot d = 0.9 \cdot 760 \text{ mm} = 684 \text{ mm}$
 $\cot \theta = 1.0$; $\tan \theta = 1.0$

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

$1847 \text{ kN} > 750 \text{ kN} = V_{Ed}$

Reinforcement

Pos 1

Due to $V_{Rd,s} \geq V_{Ed} \rightarrow \text{req. } A_{sw}$
 $= V_{Ed} \cdot s / (z \cdot f_{ywd} \cdot \cot \theta)$
 $= 750 \cdot 10^3 \cdot 150 / (684 \cdot 435 \cdot 1)$
 $= 378 \text{ mm}^2 \text{ per row}$

Choice: diam.12, $s = 150 \text{ mm}$, 4-cutting,
 distributed in area c
 $\rightarrow \text{prov. } A_{sw} = 452 \text{ mm}^2 \text{ per row}$

Pos 2

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

Pos 3

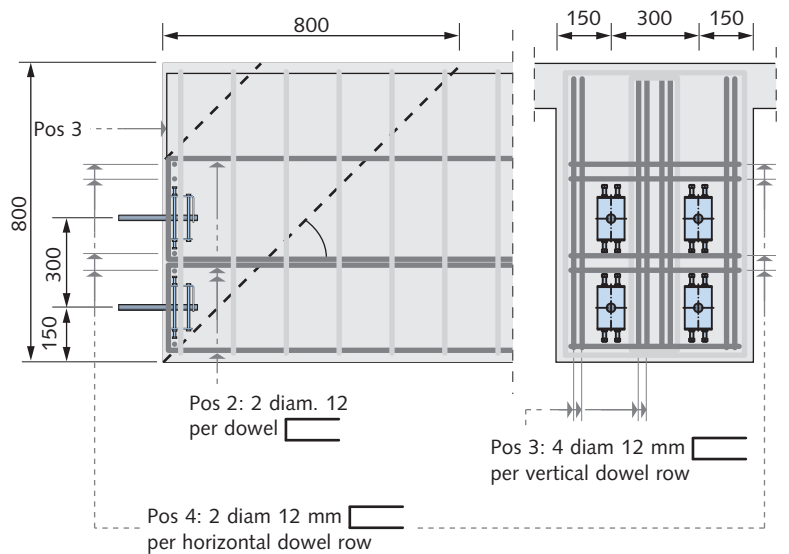
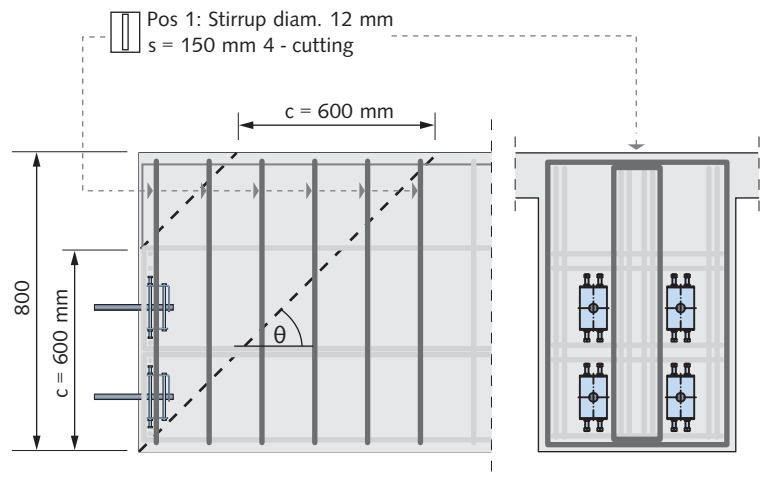
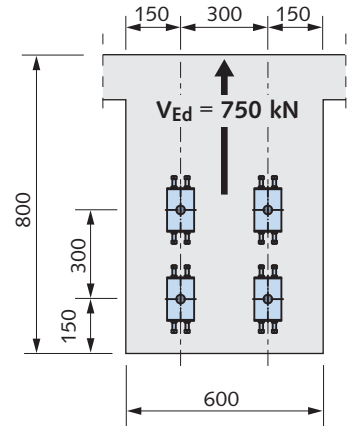
$A_{sw} = V_{Ed,i} / f_{yd} = 187.5 \cdot 10^3 / 435 = 431 \text{ mm}^2$
 Choice: 4 diam.12 per vertical dowel row, U-shaped
 $\rightarrow \text{prov. } A_{sw} = 452 \text{ mm}^2$

Pos 4

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

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)

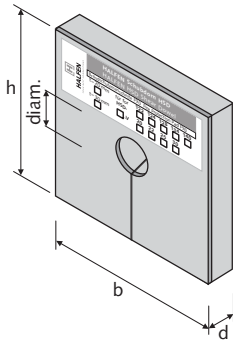


HALFEN HSD SHEAR DOWEL SYSTEM

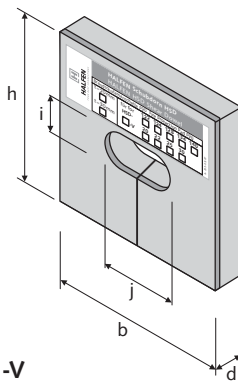
Fire protection

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.



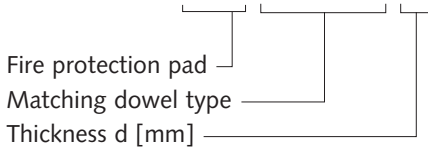
HSD-F
for shear dowels HSD, longitudinal movement



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

Ordering example:

HSD-F - CRET 124 V - 30

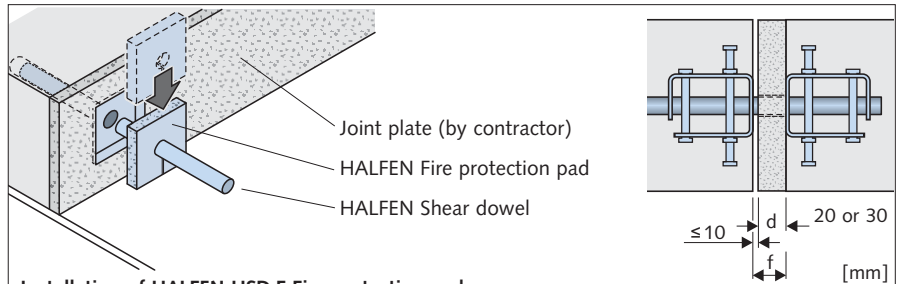


For requirements - smoke tight "enclosure of space" - according to DIN EN 1366-4 in combination with DIN EN 1363-1, we recommend to use the joint element **PROMASEAL-PL** (see fig.).

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.

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.

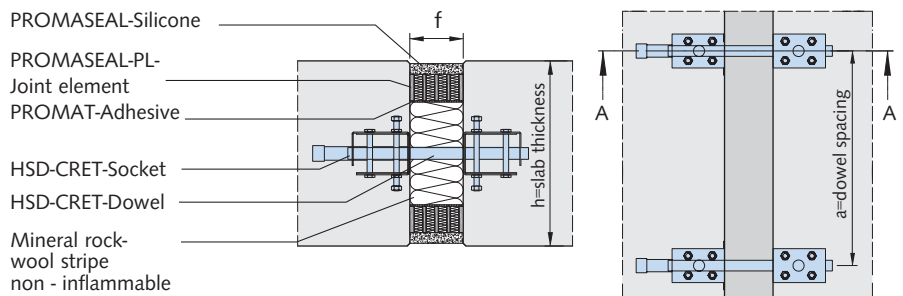


Installation of HALFEN HSD-F Fire protection pad

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.

Fire protection pad selection

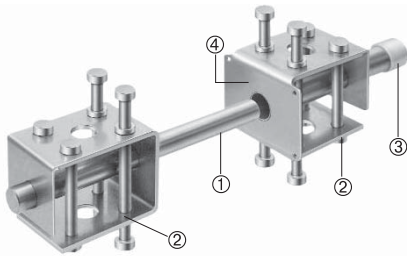
| matching the HALFEN HSD Shear dowel - | Item name $d = 20 \Rightarrow f \leq 30$ $d = 30 \Rightarrow f \leq 40$ | h / b | diam. or i | j |
|--|---|-----------|------------|----|
| Heavy-duty dowel, longitudinal movement | | | | |
| CRET 122 | HSD-F-CRET 122 -d | 120 / 120 | 23 | |
| CRET 124 | HSD-F-CRET 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 |



HALFEN HSD SHEAR DOWEL SYSTEM

Heavy-duty shear dowels

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/m³ 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).

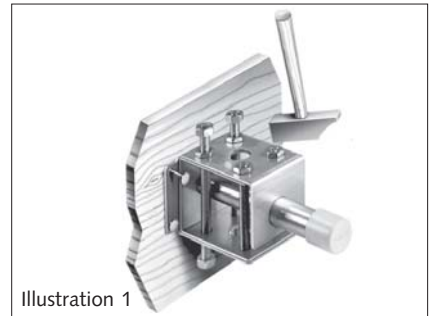


Illustration 1

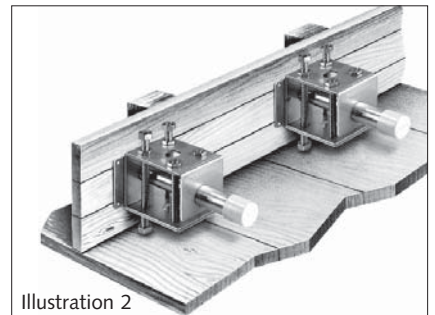


Illustration 2

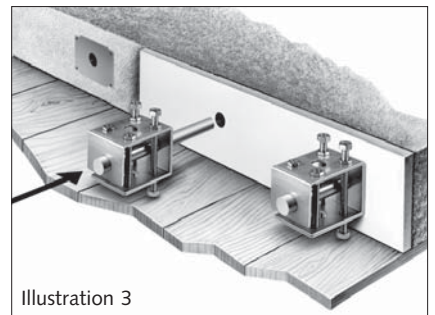
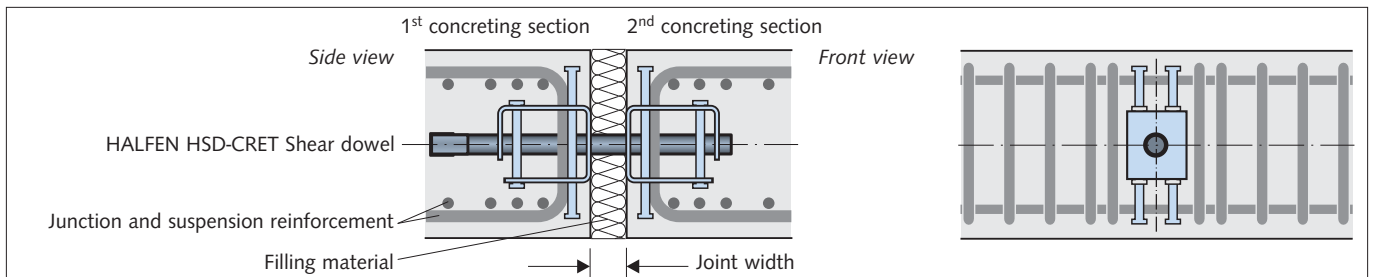


Illustration 3

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.

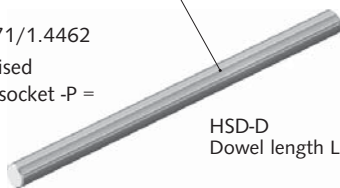
HALFEN Single shear dowels HSD-D require no official approval.

Single shear dowel HSD-D

Material / finish:

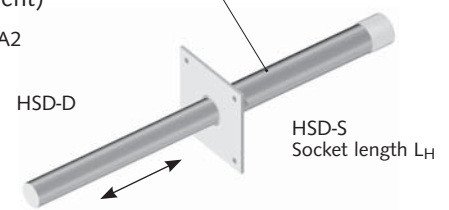
A4 = Stainless steel grade 1.4571/1.4462

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



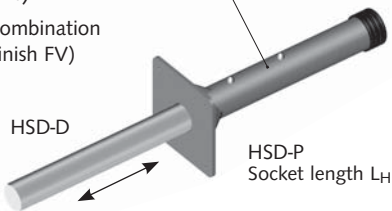
Socket HSD-S (longitudinal movement)

Material: Stainless steel A2



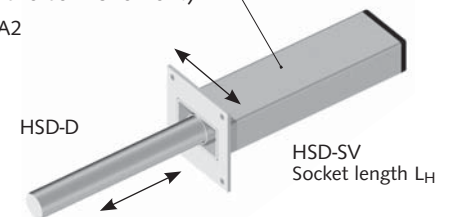
Socket HSD-P (longitudinal movement)

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

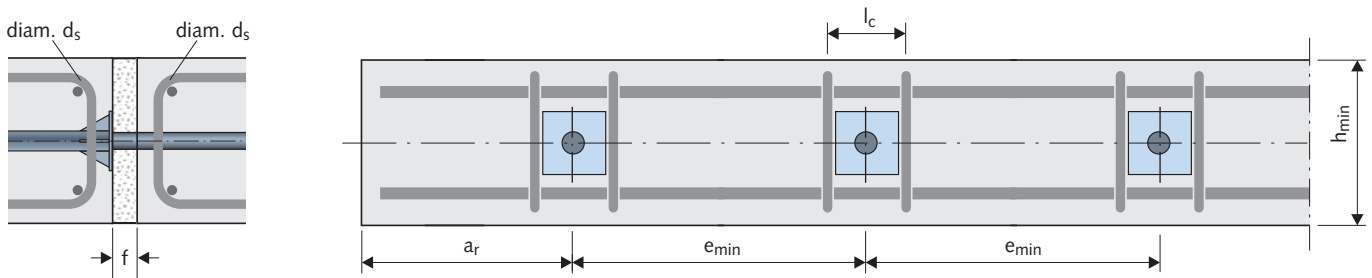
HALFEN HSD SHEAR DOWEL SYSTEM

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 | 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 |
| 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 | |



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:

$$V_{Rd,c} = 0.4 \cdot f_{ck} \cdot \text{diam.}^2 \cdot 1 / (333 + 12.2 \cdot f)$$

$$0.4 = (\alpha \cdot \gamma_{MW}) / 3$$

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.
- $\alpha = 0.85$ (consideration of the long-term effects)
- $\gamma_{MW} = 1.425$ (average value from $\gamma_G = 1.35$ and $\gamma_Q = 1.5$)
- Minimum edge distance to the dowel axis $a_r = 8 \cdot \text{diam.}$ (in all directions)
- Minimum axial distance $e = 16 \cdot \text{diam.}$

Dimensioning resistances $V_{Rd,s}$ and $V_{Rd,c}$ [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 |

HALFEN HSD SHEAR DOWEL SYSTEM

Single shear dowels

Dimensioning for reinforced concrete

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

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

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:

$$V_{Rd,s} = f_{\mu} \cdot 1.25 \cdot (f_{yk} / \gamma_{MS}) \cdot W / (f + \text{diam.} / 2)$$

$V_{Rd,s}$ 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]

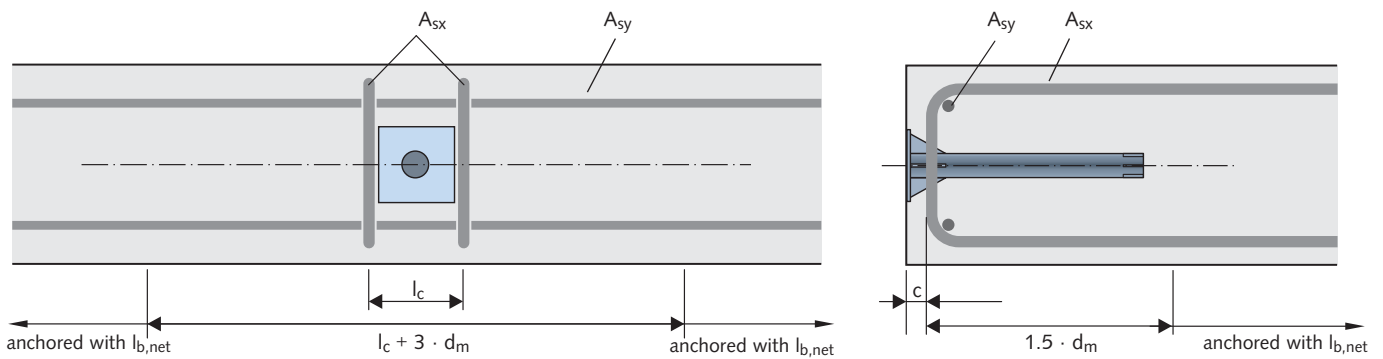
f = Joint width [mm]

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 $V_{Rd,s}$ 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 $V_{Rd,s}$ 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 ($f_{\mu} = 0.81$)

HALFEN HSD SHEAR DOWEL SYSTEM

Single shear dowels

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 $V_{Rd,c}$ for HSD-S and HSD-P - longitudinal movement -

| Dowel type | Component thickness h [mm] | c_{nom} [mm] | Design resistances $V_{Rd,c}$ [kN] $\geq C20/25$ | In-situ reinforcement | | Centre spacing l_c [mm] |
|------------|----------------------------|----------------|--|-----------------------|------------|---------------------------|
| | | | | A_{sx} | A_{sy} | |
| 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 ($f_{\mu} = 1.0$)

Dimensioning resistances $V_{Rd,c}$ for HSD-SV - longitudinal and transverse movement-

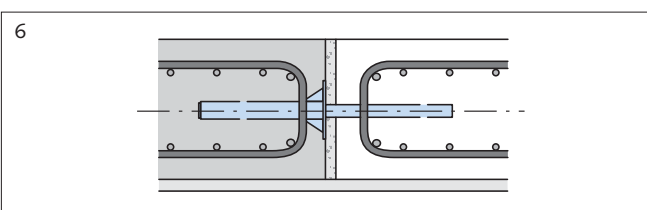
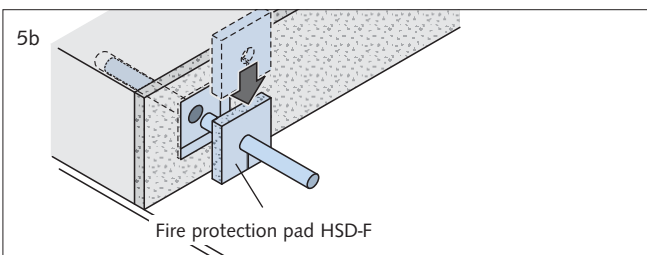
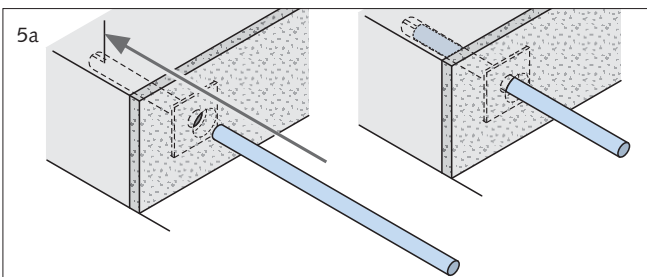
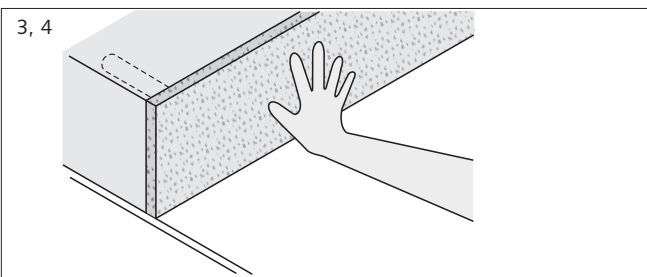
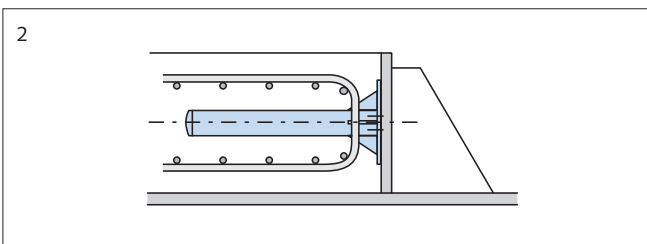
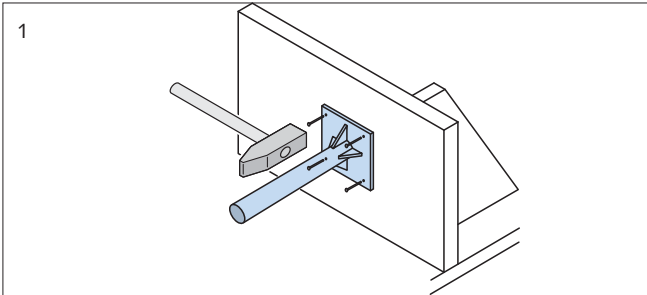
| Dowel type | Component thickness h [mm] | c_{nom} [mm] | Design resistances $V_{Rd,c}$ [kN] $\geq C20/25$ | In-situ reinforcement | | Centre spacing l_c [mm] |
|------------|----------------------------|----------------|--|-----------------------|------------|---------------------------|
| | | | | A_{sx} | A_{sy} | |
| 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 ($f_{\mu} = 0.9$) ⁵⁾ No rear suspension stirrup in the break-out cone

HALFEN HSD SHEAR DOWEL SYSTEM

Single shear dowels

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.

HALFEN HSD SHEAR DOWEL SYSTEM

Tender specification and software

Text for invitation to tender

HALFEN Heavy-duty shear dowel HSD-CRET ...

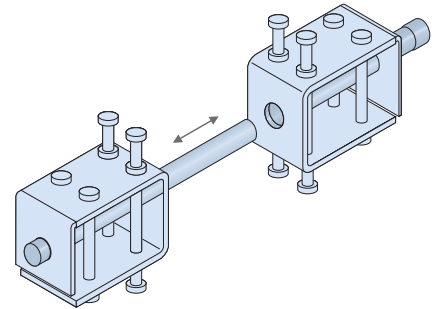
HALFEN Shear dowel system HSD with technical approval No.: Z-15.7-253, or equivalent, for the transfer of shear forces in expansion joints between components made of steel reinforced concrete. Delivery of dowel- and sleeve, installation according to instructions of the producer.

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

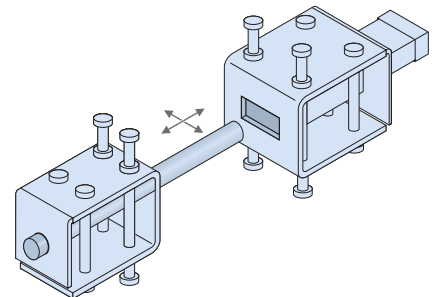
HALFEN Shear dowel system HSD-V with technical approval No.: Z-15.7-253, or equivalent, for the transfer of shear forces in expansion joints between components made of steel reinforced concrete. Delivery of dowel- and sleeve, installation according to instructions of the producer.

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.com. (→ 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

CONTACT HALFEN WORLDWIDE

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