HALFEN HSD SHEAR DOWEL SYSTEM
TECHNICAL PRODUCT INFORMATION

HALFEN SHEAR DOWEL SYSTEM
CONCRETE

Acc. to EN 1992-1-1:2008
**HALFEN HSD SHEAR DOWEL SYSTEM**

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HALFEN HSD SHEAR DOWEL SYSTEM

Introduction

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

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

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**

\[ f = \text{calculated joint width} + \text{safety supplement (approx. 1cm)} \]

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

<table>
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<tr>
<th>Dowel diameter and minimum component thickness</th>
<th>HSD-</th>
<th>HSD-</th>
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<th>Minimum component thickness hmin [cm]</th>
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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]

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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 -
Load range
V = Transverse and longitudinal movement

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

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

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

With partial safety factors: \(\gamma_c = 1.15\) 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
Relevant dimensioning resistances \( V_{Rd} \) [kN] HSD-CRET V shear dowels with longitudinal and transverse movement

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<td>290.4</td>
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<td>309.4</td>
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<tr>
<td>( \geq 400 )</td>
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<td>322.0</td>
<td>304.5</td>
<td>275.6</td>
<td>250.2</td>
</tr>
</tbody>
</table>

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

With partial safety factors: \( \gamma_c = 1.15 \) 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

\[
\tan \theta = \frac{2}{3}
\]

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

<table>
<thead>
<tr>
<th>(h) [mm]</th>
<th>CRET-122(V)</th>
<th>CRET-124(V)</th>
<th>CRET-128(V)</th>
<th>CRET-134(V)</th>
<th>CRET-140(V)</th>
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<tbody>
<tr>
<td>10</td>
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<td>540</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

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.
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.

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

with a minimum of:
\[ V_{Ed,c} = (v_{min} + k_1 \cdot \sigma_{cp}) \cdot d \quad (6.2b) \]
\[ v_{min} = 0.035 \cdot k \cdot \frac{f_{ck}}{d} \quad (6.3) \]

where: \[ pL = \frac{A_{sx} \cdot b_w \cdot d}{b_w} \]
\[ b_w = \text{width of the concrete cone} = b_{plate} + \frac{3}{2} (h + h_{plate}) \]
\[ A_{sx} \text{ acc. page 9 [mm}^2\text{]} \]

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

\( a_0 \) = 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

\[ C_{Rd,c} = 0.18 / \gamma_c \approx 0.12 \]

size factor: \[ k = 1 + \frac{200}{d} \leq 2 \text{ mit } d \text{ in mm} \]

coefficient: \[ k_1 = 0.10 \]

compressive concrete stress from axial load or prestressing: \( \sigma_{cp} \)
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 \( f_{ck} = 25 \text{MPa}, \gamma_c = 1.5 \) (EN 1992-1-1:2008)
Concrete cover: \( c_{nom} = 30 \text{mm} \)
Slab thickness: \( h = 280 \text{mm} \) \to 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) \to 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: \( n_{min} = V_{Ed} / V_{Rd} = 500 / 108.8 = 4.59 \text{pcs.} \to chosen 5 \text{dowels} \)
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} \to it is necessary to increase the number of dowels, because of exceeding \( a_{D,max} \)
Number of dowels in the joint: \( n = L / a_{D,max} = 10 / 1.4 = 7.14 \text{pcs.} \; chosen 7 \text{dowels with arrangement as on the drawing below} \)

Shear force distribution for continuous beam \( V_{Ed} [\text{kN}] \):

\( \max V_{Ed,i} = 82.1 \text{kN} \leq V_{Rd} = 108.8 \text{kN} \to condition fulfilled \)
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)

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

but not less than $v_{Rd,c} = \nu_{min} + k_1 \cdot \sigma_{cp}$

(EN 1992-1-1:2008, 6.2a and 6.2b)

where:

- $k = 1 + \frac{200}{d} = 1 + \frac{200}{245} = 1.90 \leq 2.0$

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

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

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

- $\nu_{min} = 0.035 \cdot k_1 \cdot f_{ck}^{\frac{1}{3}} = 0.035 \cdot 1.90^{\frac{1}{3}} \cdot 25^{\frac{1}{3}} = 0.46$

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

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

Proof of minimum distance between dowels

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

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

$a_{D,min} = 0.68 \leq a_D = 1.40 \rightarrow$ 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**

![Diagram showing minimum dimensions and dowel distances]

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

![Diagram showing design of beam connections]

**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:
- \( \alpha_{cw} = 1.0 \)
- \( \nu_1 = 0.6 \cdot [1 - f_{ck}/250] \)
- \( z = 0.9 \cdot d \)

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

- \( f_{ywd} \) 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 \( c \)
- Vertical reinforcement per dowel, U-shaped
- Vertical reinforcement, face of beam *
- Horizontal transverse reinforcement per dowel row, face of beam

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

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

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HALFEN HSD SHEAR DOWEL SYSTEM
Heavy-duty shear dowels

Design example - beams

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

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

Calculation
$V_{Rd,i}$ according table page 7 $\rightarrow V_{Rd,i} = 219.3$ 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 $\geq b_w = 600$ mm
$\min h = 150 + 300 + 150 = 600 < h_{ef} = 800$ mm

Proof of the resistance of the compression struts
$a_{cw} = 1.0$
$v_1 = 0.6 \cdot \left[1 - \frac{f_{ck}}{250}\right] = 0.54$
z = $0.9 \cdot d = 0.9 \cdot 760$ mm $= 684$ mm
cot $\theta = 1.0$; tan $\theta = 1.0$

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

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

Reinforcement

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

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

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

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

Pos 4
$A_{sw} = 0.5 \cdot V_{Ed,i}/f_{yd} = 93.8 \cdot 10^3 / 435 = 215$ mm$^2$
Choice: 2 diam.12 per horizontal dowel row, U-shaped
$\rightarrow$ prov. $A_{sw} = 226$ mm$^2$

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.

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.

Fire protection pad selection

<table>
<thead>
<tr>
<th>matching the HALFEN HSD Shear dowel</th>
<th>Item name</th>
<th>h / b</th>
<th>diam. or i</th>
<th>j</th>
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<tbody>
<tr>
<td>Heavy-duty dowel, longitudinal movement</td>
<td>CRET 122</td>
<td>HSD-F-CRET 122 -d</td>
<td>120 / 120</td>
<td>23</td>
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<td>CRET 124</td>
<td>HSD-F-CRET 124 -d</td>
<td>130 / 130</td>
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<td>CRET 128</td>
<td>HSD-F-CRET 128 -d</td>
<td>140 / 140</td>
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<td>CRET 134</td>
<td>HSD-F-CRET 134 -d</td>
<td>180 / 160</td>
<td>35</td>
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<td>CRET 140</td>
<td>HSD-F-CRET 140 -d</td>
<td>220 / 180</td>
<td>41</td>
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<tr>
<td>Single dowel, longitudinal movement</td>
<td>Set 20</td>
<td>HSD-F 20 -d</td>
<td>110 / 110</td>
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<tr>
<td></td>
<td>Set 22</td>
<td>HSD-F 22 -d</td>
<td>110 / 110</td>
<td>23</td>
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<td>Set 30</td>
<td>HSD-F 30 -d</td>
<td>110 / 110</td>
<td>31</td>
</tr>
<tr>
<td>Heavy-duty dowel, longitudinal and transverse movement</td>
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<td>HSD-F-CRET 122 V -d</td>
<td>150 / 150</td>
<td>23</td>
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<td>HSD-F 20 V -d</td>
<td>110 / 160</td>
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<tr>
<td></td>
<td>Set 30 V</td>
<td>HSD-F 30 V -d</td>
<td>110 / 160</td>
<td>31</td>
</tr>
</tbody>
</table>

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

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).

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

<table>
<thead>
<tr>
<th>Dowel type</th>
<th>Single shear dowel</th>
<th>Sliding sockets HSD-P -S</th>
<th>Sliding sockets HSD-SV</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Dowel diam. [mm]</td>
<td>Dowel length L [mm]</td>
<td>Socket length LH [mm]</td>
</tr>
<tr>
<td>HSD-D 20</td>
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<td>160</td>
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<tr>
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<tr>
<td>HSD-D 30</td>
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<td>185</td>
</tr>
</tbody>
</table>

### Ordering examples:

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

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

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

Single shear dowels

**Dimensioning**

<table>
<thead>
<tr>
<th>Dowel diam. [mm]</th>
<th>Socket</th>
<th>Stirrup diam. [mm]</th>
<th>Component thickness hmin [mm]</th>
<th>Stirrup spacing lc [mm]</th>
<th>Required dowel spacing emin [mm]</th>
<th>Edge distance ar [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>HSD-S</td>
<td>10</td>
<td>160</td>
<td>60</td>
<td>310</td>
<td>160</td>
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<tr>
<td>22</td>
<td>HSD-P</td>
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<td>160</td>
<td>60</td>
<td>350</td>
<td>175</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>12</td>
<td>175</td>
<td>70</td>
<td>410</td>
<td>200</td>
</tr>
<tr>
<td>30</td>
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<td>14</td>
<td>210</td>
<td>90</td>
<td>560</td>
<td>240</td>
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<td>200</td>
</tr>
<tr>
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<td></td>
<td>14</td>
<td>210</td>
<td>110</td>
<td>560</td>
<td>240</td>
</tr>
</tbody>
</table>

- lc = Distance between the first two stirrups
- hmin = Minimum component thickness
- emin = Minimum centre spacing between the single dowels
- ar = 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: 
\[ V_{Rd,s} = f_u \cdot 1.25 \cdot \left( \frac{f_{yk}}{\gamma_{MS}} \right) \cdot \frac{W}{(f+diam.)} \]

Concrete load-bearing capacity: 
\[ V_{Rd,c} = 0.4 \cdot f_{ck} \cdot \text{diam.}^2 \cdot \frac{1}{(333+12.2 \cdot f)} \]

where:
- \( f_u \) = 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]
- Shear dowel diameter [mm]
- \( W \) = Section modulus [mm³]
- \( \gamma_{MS} \) = Material safety factor for steel [-]

- HALFEN Single shear dowels HSD-D require no official approval.
- \( \alpha \approx 0.85 \) (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 VRd.s and VRd.c [kN] for non-reinforced concrete**

<table>
<thead>
<tr>
<th>Dowel type</th>
<th>Concrete grade</th>
<th>Dowel-diam. [mm]</th>
<th>Minimum component thickness [mm]</th>
<th>Design resistances [kN] for joint width f [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSD-D 20</td>
<td>≥ C20/25</td>
<td>20</td>
<td>320</td>
<td>9.5</td>
</tr>
<tr>
<td>HSD-D 22</td>
<td></td>
<td>22</td>
<td>350</td>
<td>11.6</td>
</tr>
<tr>
<td>HSD-D 25</td>
<td></td>
<td>25</td>
<td>400</td>
<td>15.2</td>
</tr>
<tr>
<td>HSD-D 30</td>
<td></td>
<td>30</td>
<td>480</td>
<td>22.2</td>
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</table>

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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)

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:

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

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

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

where:
- $f_{\mu}$ - Reduction factor due to friction [-]
- $f_{yk}$ - yield strength [N/mm²]
- $f$ - Joint width [mm]
- diam. - Shear dowel diameter [mm]
- $W$ - Section modulus [mm³]
- $\gamma_{MS}$ - 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

<table>
<thead>
<tr>
<th>Dowel type</th>
<th>concrete grade</th>
<th>Dowel-diam. [mm]</th>
<th>Design resistances $V_{Rd,s}$ [kN] for joint width $f$ [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSD-D 20</td>
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<td>20</td>
<td>14.3</td>
</tr>
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<td>HSD-D 22</td>
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<td>12.2</td>
</tr>
<tr>
<td>HSD-D 25</td>
<td>25</td>
<td>24.8</td>
<td>17.1</td>
</tr>
<tr>
<td>HSD-D 30</td>
<td>30</td>
<td>38.5</td>
<td>27.5</td>
</tr>
</tbody>
</table>

Taking account of friction ($f_{\mu} = 0.9$)

Design resistances $V_{Rd,s}$ for HSD-SV - longitudinal and transverse movement - for reinforced concrete

<table>
<thead>
<tr>
<th>Dowel type</th>
<th>concrete grade</th>
<th>Dowel-diam. [mm]</th>
<th>Design resistances $V_{Rd,s}$ [kN] for joint width $f$ [mm]</th>
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</thead>
<tbody>
<tr>
<td>HSD-D 20</td>
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<td>20</td>
<td>12.8</td>
</tr>
<tr>
<td>HSD-D 22</td>
<td>22</td>
<td>16.3</td>
<td>11.0</td>
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<td>HSD-D 25</td>
<td>25</td>
<td>22.3</td>
<td>15.4</td>
</tr>
<tr>
<td>HSD-D 30</td>
<td>30</td>
<td>34.6</td>
<td>24.7</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Dowel type</th>
<th>Component thickness h [mm]</th>
<th>c nom [mm]</th>
<th>Design resistances V Rd,c [kN] ≥ C20/25</th>
<th>In-situ reinforcement A sx</th>
<th>A sy</th>
<th>Centre spacing l c [mm]</th>
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</thead>
<tbody>
<tr>
<td>HSD-D 20</td>
<td>≥160</td>
<td>30</td>
<td>14.2</td>
<td>2 diam. 10</td>
<td>2 diam. 10</td>
<td>60</td>
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<tr>
<td></td>
<td>≥180</td>
<td></td>
<td>15.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>30</td>
<td>14.2</td>
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<td>2 diam. 10</td>
<td>60</td>
</tr>
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<td></td>
<td>≥180</td>
<td></td>
<td>15.8</td>
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<td></td>
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<tr>
<td></td>
<td>≥200</td>
<td></td>
<td>17.3</td>
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<td>≥220</td>
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<td>20.5</td>
<td>2 diam. 12</td>
<td>2 diam. 12</td>
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<tr>
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<td>24.3</td>
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<td></td>
<td></td>
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<tr>
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<td>35.9</td>
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<tr>
<td>HSD-D 30</td>
<td>≥220</td>
<td>30</td>
<td>29.3</td>
<td>2 diam. 14</td>
<td>2 diam. 14</td>
<td>90</td>
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<td>38.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥320</td>
<td></td>
<td>40.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Taking account of friction ($f_\mu = 1.0$)

<table>
<thead>
<tr>
<th>Dowel type</th>
<th>Component thickness h [mm]</th>
<th>c nom [mm]</th>
<th>Design resistances V Rd,c [kN] ≥ C20/25</th>
<th>In-situ reinforcement A sx</th>
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<tbody>
<tr>
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<td>2 diam. 10</td>
<td>2 diam. 10</td>
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<td>12.5</td>
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</tr>
<tr>
<td>HSD-D 22</td>
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<td>13.9</td>
<td>2 diam. 10</td>
<td>2 diam. 10</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>≥200</td>
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<tr>
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<tr>
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<td>2 diam. 14</td>
<td>110</td>
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<tr>
<td></td>
<td>≥320</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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

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.
HALFEN HSD SHEAR DOWEL SYSTEM

Text specification and software

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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