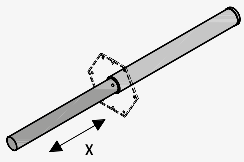
Schöck Dorn type LD, LD-Q

Schöck Dorn type LD
Dowel for the transmission of shear forces in expansion joints between structural components with simultaneous movement in the direction of the dowel axis.

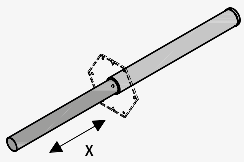
Schöck Dorn type LD-Q
Dowel for the transmission of shear forces in expansion joints between structural components with simultaneous movement in the direction along and rectangular to the dowel axis.

Summary of types | Type designations

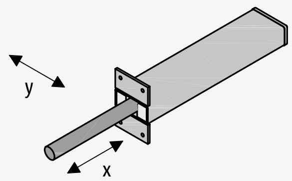
Schöck Dorn type LD



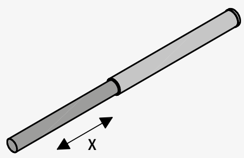
LD ⌀ S-A4
The dowel and the sleeve are made of stainless steel. This dowel system is particularly suited for structural component joints with frequent movement such as, for example, in the exterior of buildings.



LD ⌀ P-A4 or LD ⌀ P-Zn
The sleeve of this set is made of plastic and can be combined with a dowel made from stainless steel (A4) or hot galvanised carbon steel (Zn). This dowel system is especially suitable for structural joints with less movements such as, for example, in the interior of buildings.

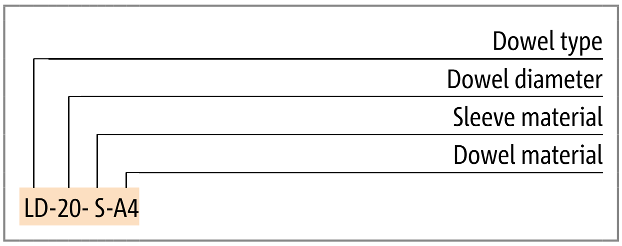


LD-Q ⌀ S-A4
The dowel and the laterally movable sleeve are made of stainless steel. This dowel system allows displacement of structural components axially and transversely to the dowel axis and can be employed in interior and exterior areas.



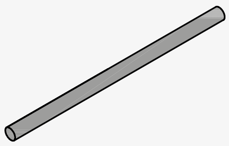
LD ⌀ F-A4 or LD ⌀ F-Zn
The dowel is available in stainless steel (A4) or hot galvanised carbon steel (Zn). The one-sided sleeve, made of plastic, is already assembled. This dowel system is primarily employed with concealed joints in road construction or with foundation slabs, if both sides of the expansion joint are concreted in one step.

Type designations in planning documents

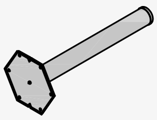


Summary of types | Product selection

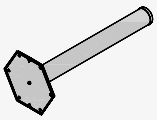
Schöck Dorn type LD components



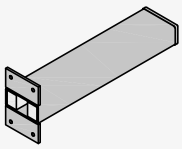
LD ⌀ Part A4 or LD ⌀ Part Zn
The dowel is available in stainless steel (A4) or hot galvanised carbon steel (Zn). The hot galvanised dowel should be employed in dry interior areas of buildings only.



LD ⌀ Part S
The sleeve is made of stainless steel with a mounting nail plate for fixing to the formwork. This sleeve can be combined with the stainless steel Dowel LD Part A4 only and is particularly suitable for structural component joints with frequent movement such as, for example, in the exterior area.



LD ⌀ Part P
The sleeve and the mounting plate are made of plastic. The sleeve can be fixed simply to the formwork using the mounting plate. The sleeve can be combined with a stainless steel (A4) dowel or hot galvanised carbon steel (Zn) dowel and is particularly suitable for the joints of structural components with less movements in the interior area of buildings.



LD-Q ⌀ Part S
The rectangular sleeve is made of stainless steel and can be combined with the stainless steel (A4) dowel. It can be used in structural component joints in interior and exterior areas, if movements axially and transverse to the dowel axis are to be expected.

Schöck Dorn type LD variants

The configuration of the Schöck Dorn type LD can be varied as follows:

- Dowel diameter ⌀:
  16, 20, 22, 25 and 30
- Sleeve material:
  S for stanless steel
  P for plastic
- Dowel material:
  A4 for stainless steel S690
  Zn for hot galvanised carbon steel S690

Product characteristics | Corrosion protection/materials | Application areas

Product characteristics

The Schöck Dorn type LD (load dowel) consists of a sleeve and a dowel part, which are embedded in the respective concrete structural components adjacent to the joint. The dowel transmits the loads from one structural component by bending in the sleeve and thus into the other structural component. Within the concrete structural component the load is taken up through the on-site reinforcement in the area of the dowel.
The sleeve of the Schöck Dorn type LD is round and thus enables a longitudinal moveability in the direction of the dowel axis in order to prevent induced stresses due to structural component deformation. The forces can be transmitted perpedicularly and transversely to the dowel axis.
The LD-Q can be employed should a movement transversely to the dowel axis be required. The sleeve of this dowel is rectangular and thus enables a displacement of ± 12 mm.

Corrosion protection and materials

For the dowel and the sleeve there is a choice of various materials. To ensure the correct load-bearing capacity and maintenance free functionality of the dowel, the appropriate material for the environmental conditions must be selected. In the following table are listed the recommended combinations of materials and environmental conditions in accordance with ETAG 030.

Category	Typical examples	Dowel		Sleeve	
		Part A4	Part Zn	Part S	Part P
Within buildings					
C1	Heated buildings with neutral atmospheres (offices, schools, hotels)	✓	✓	✓	✓
C2	Unheated buildings, in which condensation can occur (storage, sports halls)	✓	-	✓	✓
C3	Production rooms with high air humidity and some air pollution (food production, laundries, breweries)	✓	-	✓	✓
C4	Chemical plants, swimming pools	-	-	-	-
Exterior areas					
C2	Rural climate	✓	-	✓	✓
C3	City and industrial atmospheres with moderate air pollution, coast with low salt content	✓	-	✓	✓
C4	Industrial areas, coastal areas with moderate salt content	-	-	-	-

Schöck Dorn type LD / LD-Q	Dowel		Sleeve	
	Part A4	Part Zn	Part S	Part P
Materials	1.4362	1.7225 hot galvanised	1.4401, 1.4404, 1.4571	PE
Yield strength	$f_{yk} \geq 690$ N/mm²	$f_{yk} \geq 690$ N/mm²	$f_{yk} \geq 235$ N/mm²	-

Application areas

The Schöck Dorn type LD is technically approved at European level for the transmission of mainly latent loadings in expansion joints. The European Technical Assessment ETA 16/0545 regulates the dimensioning according to the harmonised product standard ETAG 030 for the concrete strength classes C20/25 to C50/60. The joint width can vary between 10 and 60 mm. In accordance with harmonised European product standard ETAG 030 only the Schöck Dorn type LD ⌀ S-A4 can be used as stability component between two building parts as only this dowel can transmit horizontal forces. The employment of the Schöck Dorn type LD under earthquake or fatigue loads, is not regulated in the assessment.
All following design and reinforcement tables have been determined with a concrete cover of 20 mm.

Minimum dowel spacing/component dimensions

Schöck Dorn type LD / LD-Q	16	20	22	25	30
Minimum component dimensions	Dimension [mm]				
Slab thickness h_{min}	180	180	180	180	210
Wall thickness b_w	215	240	255	275	305
Beam width b_u	160	160	160	180	210
Minimum dowel spacing					
Horizontal $e_{h,min}$	240	240	240	270	315
Vertical $e_{v,min}$	120	120	120	140	170
Minimum edge distance					
Horizontal $e_{R,min}$	120	120	120	140	160

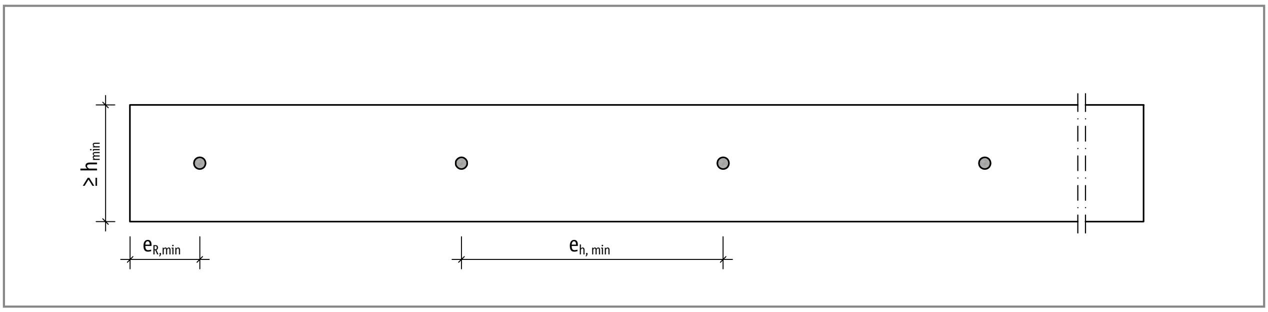


Fig. 36: Schöck Dorn type LD: Minimum structural component dimensions and dowel spacings for a slab

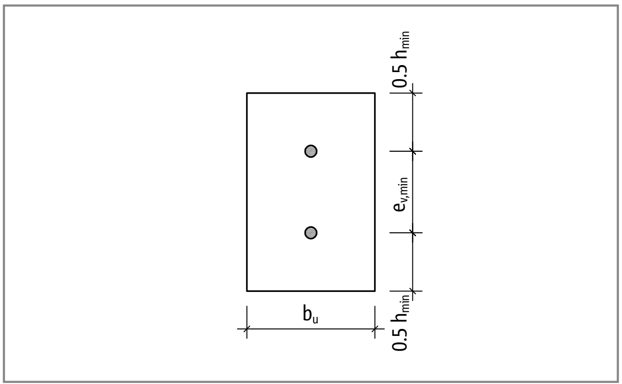


Fig. 37: Schöck Dorn type LD: Minimum structural component dimesnions and dowel spacings on the front face of a beam or a wall

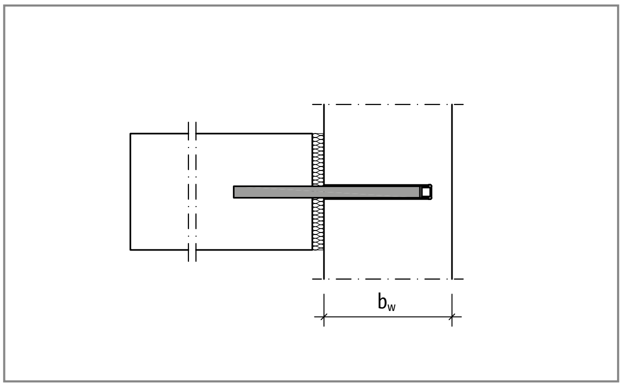


Fig. 38: Schöck Dorn type LD: Minimum structural component thickness of a wall or column

LD

Critical dowel spacings/edge distances

The following critical edge separations and dowel spacings were taken as a basis for the design values in the tables from page 50 onwards. Should these spacings/distances be undercut an additional punching shear design is required taking into account the shortened perimeters.
The maximum dowel spacing is limited in the product standard ETAG 030 to 8 times the slab height.

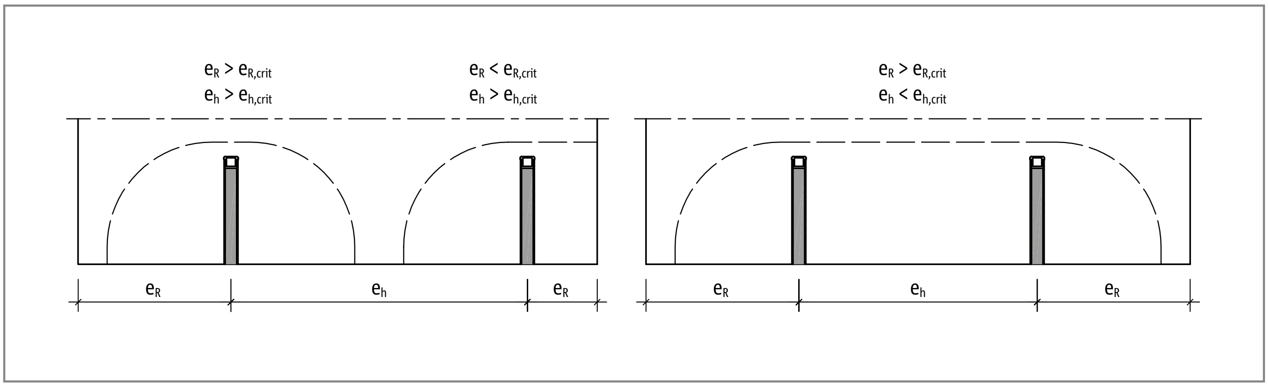


Fig. 39: Schöck Dorn type LD: Perimeter dependent on the critical dowel spacing and edge distance

Schöck Dorn type LD	16	20	22	25	30
Slab thickness [mm]	Critical dowel spacings $e_{h,crit}$ [mm]				
180	500	500	500	490	-
200	510	570	570	580	-
220	550	630	630	640	650
250	630	670	720	720	730
280	700	710	810	810	820
300	750	750	860	870	880
350	880	880	880	1020	1030
Slab thickness [mm]	Critical edge distances $e_{R,crit}$ [mm]				
180	270	270	270	260	-
200	270	350	350	340	-
220	280	350	420	420	410
250	320	360	440	500	570
280	350	380	450	520	590
300	380	390	470	530	610
350	440	440	460	560	640

Critical dowel spacings/edge distances

Schöck Dorn type LD	Q 16	Q 20	Q 22	Q 25	Q 30
Slab thickness [mm]	Critical dowel spacings $e_{h,crit}$ [mm]				
180	450	500	500	480	-
200	500	510	570	590	-
220	550	550	580	650	650
250	630	630	630	680	730
280	700	700	700	700	820
300	750	750	750	750	880
350	880	880	880	880	890
Slab thickness [mm]	Critical edge distances $e_{R,crit}$ [mm]				
180	230	270	270	260	-
200	250	270	330	330	-
220	280	280	310	380	410
250	320	320	320	370	500
280	350	350	350	360	500
300	380	380	380	380	490
350	440	440	440	440	480

Design LD C20/25 – C50/60

Design resistance V_{Rd} = min [Steel load-bearing capacity $V_{Rd,s}$, concrete edge resistance $V_{Rd,c}$, Punching shear resistance $V_{Rd,ct}$]

The following design values were determined according to BS EN 1992-1-1 (EC2) using a concrete cover of 20 mm. With high concrete cover the load-bearing capacity for an appropriately reduced slab height must be used. The maximum load-bearing capacities listed here apply only in connections with a reinforcement arrangement in accordance with pages 52 and under observance of the critical dowel spacings/edge distances in accordance with page 48.

Schöck Dorn type LD		16	20	22	25	30
Slab thickness [mm]	**Joint width [mm]**	**Design resistances V_{Rd} [kN/dowel]**				
180	**20**	18.8	20.6	20.6	20.1	
	30	15.1	20.6	20.6	20.1	
	40	12.6	20.6	20.6	20.1	
	50	10.9	20.1	20.6	20.1	
	60	9.5	17.7	20.6	20.1	
200	**20**	18.8	32.1	32.1	31.3	
	30	15.1	27.4	32.1	31.3	
	40	12.6	23.2	29.9	31.3	
	50	10.9	20.1	26.0	31.3	
	60	9.5	17.7	23.0	31.3	
220	**20**	18.8	33.5	42.6	45.1	44.1
	30	15.1	27.4	35.2	45.1	44.1
	40	12.6	23.2	29.9	42.0	44.1
	50	10.9	20.1	26.0	36.8	44.1
	60	9.5	17.7	23.0	32.7	44.1
250	**20**	18.8	33.5	42.6	58.8	77.6
	30	15.1	27.4	35.2	49.0	77.6
	40	12.6	23.2	29.9	42.0	67.7
	50	10.9	20.1	26.0	36.8	59.8
	60	9.5	17.7	23.0	32.7	53.5
280	**20**	18.8	33.5	42.6	58.8	81.7
	30	15.1	27.4	35.2	49.0	78.2
	40	12.6	23.2	29.9	42.0	67.7
	50	10.9	20.1	26.0	36.8	59.8
	60	9.5	17.7	23.0	32.7	53.5
300	**20**	18.8	33.5	42.6	58.8	84.3
	30	15.1	27.4	35.2	49.0	78.2
	40	12.6	23.2	29.9	42.0	67.7
	50	10.9	20.1	26.0	36.8	59.8
	60	9.5	17.7	23.0	32.7	53.5
350	**20**	18.8	33.5	42.6	58.8	90.7
	30	15.1	27.4	35.2	49.0	78.2
	40	12.6	23.2	29.9	42.0	67.7
	50	10.9	20.1	26.0	36.8	59.8
	60	9.5	17.7	23.0	32.7	53.5

Design LD-Q C20/25 – C50/60

Design resistance V_{Rd} = min [Steel load-bearing capacity $V_{Rd,s}$, Concrete edge resistance $V_{Rd,c}$, Punching shear resistance $V_{Rd,ct}$]

The following design values were determined according to BS EN 1992-1-1 (EC2) using a concrete cover of 20 mm. With high concrete cover the load-bearing capacity for an appropriately reduced slab height must be used. The maximum load-bearing capacities listed here apply only in connections with a reinforcement arrangement in accordance with pages 52 and under observance of the critical dowel spacings/edge distances in accordance with page 49.

Schöck Dorn type LD		Q 16	Q 20	Q 22	Q 25	Q 30
Slab thickness [mm]	Joint width [mm]	Design resistances V_{Rd} [kN/dowel]				
180	20	10.4	18.6	20.6	19.5	
	30	8.4	15.2	19.5	19.5	
	40	7.0	12.9	16.6	19.5	
	50	6.0	11.2	14.5	19.5	
	60	5.3	9.8	12.8	18.2	
200	20	10.4	18.6	23.7	30.5	
	30	8.4	15.2	19.5	27.2	
	40	7.0	12.9	16.6	23.3	
	50	6.0	11.2	14.5	20.4	
	60	5.3	9.8	12.8	18.2	
220	20	10.4	18.6	23.7	32.7	44.1
	30	8.4	15.2	19.5	27.2	43.4
	40	7.0	12.9	16.6	23.3	37.6
	50	6.0	11.2	14.5	20.4	33.2
	60	5.3	9.8	12.8	18.2	29.7
250	20	10.4	18.6	23.7	32.7	51.3
	30	8.4	15.2	19.5	27.2	43.4
	40	7.0	12.9	16.6	23.3	37.6
	50	6.0	11.2	14.5	20.4	33.2
	60	5.3	9.8	12.8	18.2	29.7
280	20	10.4	18.6	23.7	32.7	51.3
	30	8.4	15.2	19.5	27.2	43.4
	40	7.0	12.9	16.6	23.3	37.6
	50	6.0	11.2	14.5	20.4	33.2
	60	5.3	9.8	12.8	18.2	29.7
300	20	10.4	18.6	23.7	32.7	51.3
	30	8.4	15.2	19.5	27.2	43.4
	40	7.0	12.9	16.6	23.3	37.6
	50	6.0	11.2	14.5	20.4	33.2
	60	5.3	9.8	12.8	18.2	29.7
350	20	10.4	18.6	23.7	32.7	51.3
	30	8.4	15.2	19.5	27.2	43.4
	40	7.0	12.9	16.6	23.3	37.6
	50	6.0	11.2	14.5	20.4	33.2
	60	5.3	9.8	12.8	18.2	29.7

On-site reinforcement

On-site reinforcement

All load-bearing levels of the Schöck Dorn type LD respectively require only one slip-in stirrup right and left of the dowel as well as a longitudinal reinforcement bar (A_{sy}) at the top and bottom edge of the slab.

<table>
<tr><th>Schöck Dorn type LD</th><th colspan="2">16</th><th colspan="2">20</th><th colspan="2">22</th><th colspan="2">25</th><th colspan="2">30</th></tr>
<tr><th>Slab thickness [mm]</th><th>A_{sx}</th><th>A_{sy}</th><th>A_{sx}</th><th>A_{sy}</th><th>A_{sx}</th><th>A_{sy}</th><th>A_{sx}</th><th>A_{sy}</th><th>A_{sx}</th><th>A_{sy}</th></tr>
<tr><td>180</td><td rowspan="4">2 • H8</td><td rowspan="4">2 • H8</td><td>2 • H8</td><td>2 • H8</td><td>2 • H8</td><td>2 • H8</td><td>2 • H8</td><td>2 • H8</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>200</td><td rowspan="3">2 • H10</td><td rowspan="3">2 • H10</td><td>2 • H10</td><td>2 • H10</td><td>2 • H10</td><td>2 • H10</td></tr>
<tr><td>220</td><td rowspan="2">2 • H12</td><td rowspan="2">2 • H12</td><td>2 • H12</td><td>2 • H12</td><td>2 • H12</td><td>2 • H12</td></tr>
<tr><td>> 250</td><td>2 • H16</td><td>2 • H16</td><td>2 • H16</td><td>2 • H16</td></tr>
<tr><td>Stirrup spacing l_{c1} in [mm]</td><td colspan="2">60</td><td colspan="2">60</td><td colspan="2">60</td><td colspan="2">70</td><td colspan="2">80</td></tr>
</table>

<table>
<tr><th>Schöck Dorn type LD-Q</th><th colspan="2">16</th><th colspan="2">20</th><th colspan="2">22</th><th colspan="2">25</th><th colspan="2">30</th></tr>
<tr><th>Slab thickness [mm]</th><th>A_{sx}</th><th>A_{sy}</th><th>A_{sx}</th><th>A_{sy}</th><th>A_{sx}</th><th>A_{sy}</th><th>A_{sx}</th><th>A_{sy}</th><th>A_{sx}</th><th>A_{sy}</th></tr>
<tr><td>180</td><td rowspan="4">2 • H8</td><td rowspan="4">2 • H8</td><td rowspan="4">2 • H8</td><td rowspan="4">2 • H8</td><td>2 • H8</td><td>2 • H8</td><td>2 • H8</td><td>2 • H8</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>200</td><td rowspan="3">2 • H10</td><td rowspan="3">2 • H10</td><td>2 • H10</td><td>2 • H10</td></tr>
<tr><td>220</td><td rowspan="2">2 • H12</td><td rowspan="2">2 • H12</td><td>2 • H12</td><td>2 • H12</td></tr>
<tr><td>> 250</td><td>2 • H16</td><td>2 • H16</td></tr>
<tr><td>Stirrup spacing l_{c1} in [mm]</td><td colspan="2">60</td><td colspan="2">60</td><td colspan="2">60</td><td colspan="2">80</td><td colspan="2">80</td></tr>
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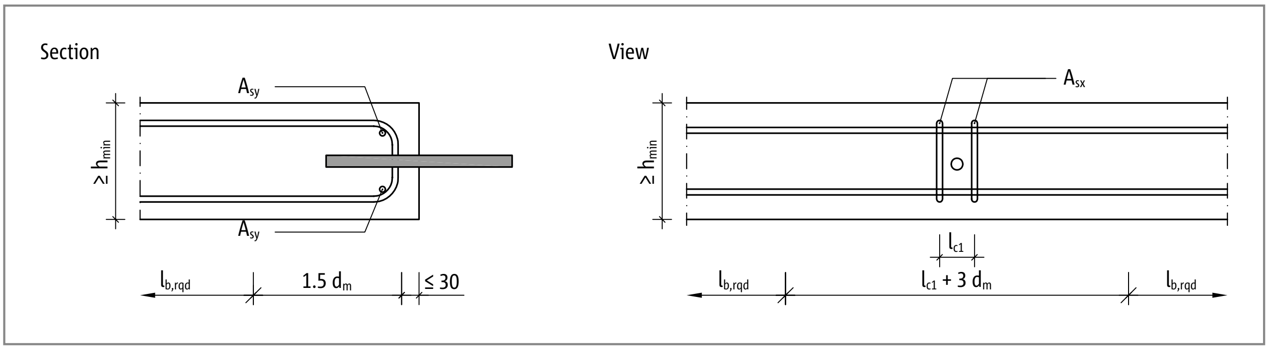


Fig. 40: Schöck Dorn type LD: On-site reinforcement

LD

On-site reinforcement

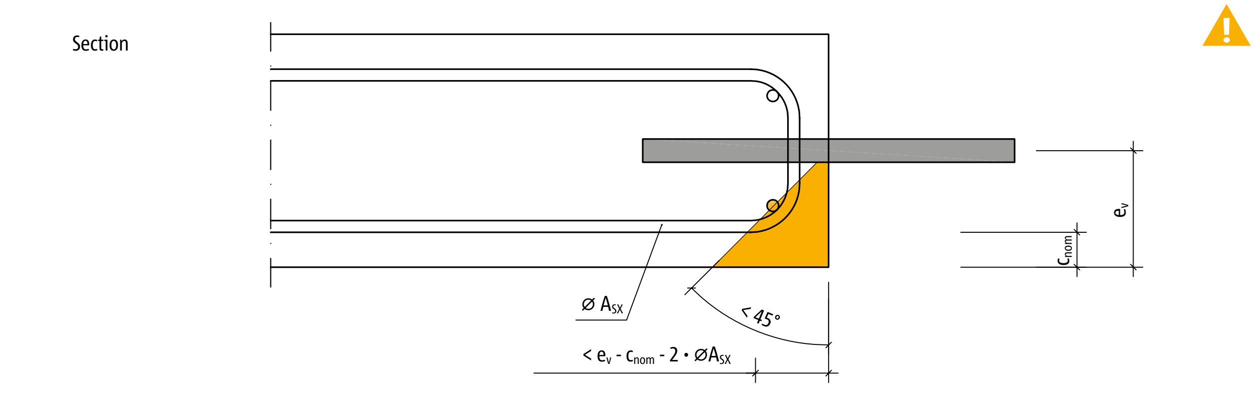


Fig. 41: Schöck Dorn type LD: Position of the longitudunal reinforcement in relation to the front face of the slab

Do not modify on-site reinforcement

The distance of the longitudinal reinforcement to the front edge of the concrete slab is very important for the load-bearing capacity of the reinforcement. If this distance is too large the lateral stirrups alongside the dowel will not contribute to the resistance. If stirrup diameters larger than in the table on page 52 are used, the longitudinal reinforcement is displaced. For this reason the reinforcement diameters given in the table must be used or the concrete cover at the front face of the slab must be reduced.

Hazard note - separation longitudinal reinforcement to front face too large

- If the longitudinal reinforcement is too far removed from the front face the concrete edge can break off and the structural component cratered.
- The distance between main bars and front face of the slab must be checked after installation.

LD

Product description

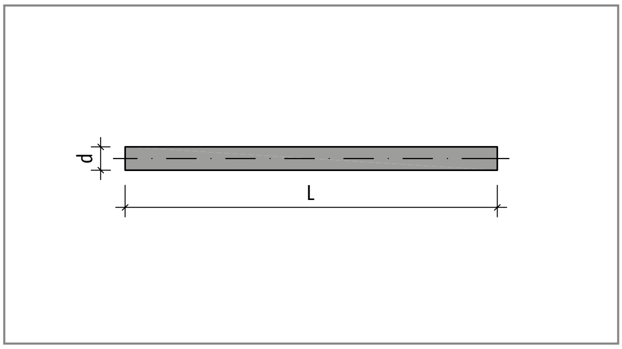


Fig. 42: Schöck Dorn type LD Part A4, LD Part Zn: Dimensions of the dowel

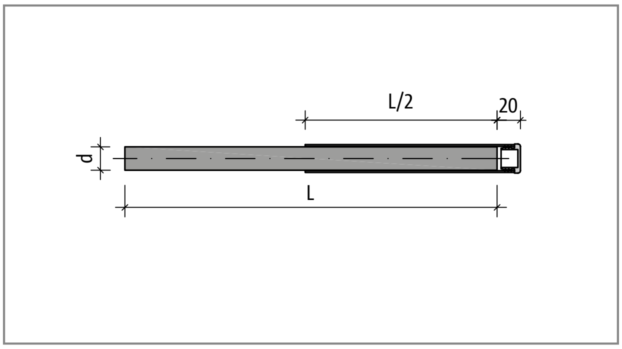


Fig. 43: Schöck Dorn type LD F-A4, LD F-Zn: Dimensions of the dowel with plastic sleeve

Schöck Dorn type LD		16	20	22	25	30
Dowel		Dimensions [mm]				
Dowel length	L	270	320	350	390	450
Dowel diameter	d	16	20	22	25	30

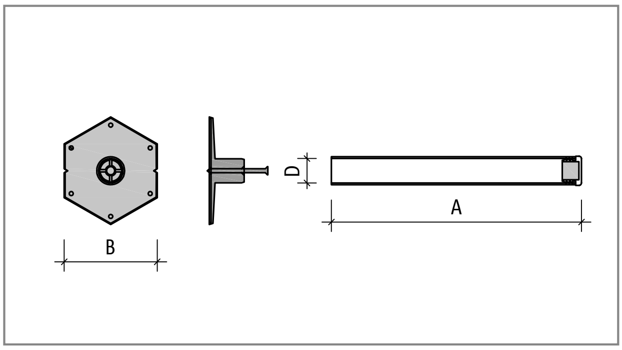


Fig. 44: Schöck Dorn type LD Part S, LD Part P: Dimensions of the sleeve, stainless steel and plastic

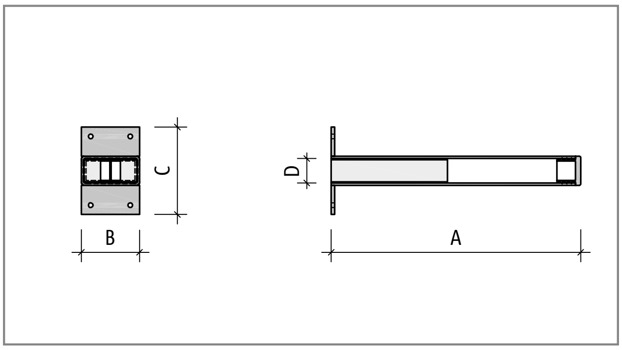


Fig. 45: Schöck Dorn type LD-Q Part S: Dimensions of the laterally movable sleeve

Schöck Dorn type LD		16	Q 16	20	Q 20	22	Q 22	25	Q 25	30	Q 30
Sleeve		Dimensions [mm]									
Sleeve length	A	185	185	210	210	225	225	245	245	275	275
Width of the mounting plate	B	80	50	80	50	80	50	80	60	80	60
Height of the mounting plate	C	80	70	80	75	80	77	80	80	80	85
Internal diameter	D	17	17	21	21	23	23	26	26	31	31

Verification of the load-bearing capacity | steel load-bearing capacity

Verification of the load-bearing capacity in accordance with Assessment ETA 16/0545

The load-bearing capacity of an expansion joint connection using the Schöck Dorn type is determined as being the minimum verifiable resistance to punching through shear failure, concrete edge failure and steel load-bearing resistance.

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

with:

V_{Ed} - design value of the shear force
V_{Rd} - design resistance of the dowel connection
$V_{Rd,ct}$ - design resistance against punching shear failure
$V_{Rd,c}$ - design resistance against concrete edge failure
$V_{Rd,s}$ - design resistance against steel failure of the dowel

These verifications are necessary if the constraints for the design tables are not observed. The punching shear design must be carried out if the critical spacings in accordance with page 48 are undercut or the on-site reinforcement in accordance with page 52 has been modified. The load-bearing capacity of the concrete edge must be additionally checked if the on-site reinforcement deviates from the recommendations on page 52.

Steel load-bearing capacity in accordance with Assessment ETA 16/0545

Steel load-bearing capacity of the Schöck dowel type LD corresponds with the bending load-bearing capacity of the dowel. It is thus dependent on the surrounding concrete. This load-bearing capacity is important in structural components in which concrete edge and punching shear failure can be excluded. This is the case, for example, in walls or columns.

Schöck Dorn type LD	16	20	22	25	30
Joint width in mm	Steel load-bearing capacity $V_{Rd,s}$ [kN]				
10	24.9	43.0	54.2	73.5	112.9
20	18.8	33.5	42.6	58.8	92.4
30	15.1	27.4	35.2	49.0	78.2
40	12.6	23.2	29.9	42.0	67.7
50	10.9	20.1	26.0	36.8	59.8
60	9.5	17.7	23.0	32.7	53.5

Schöck Dorn type LD	Q 16	Q 20	Q 22	Q 25	Q 30
Joint width in mm	Steel load-bearing capacity $V_{Rd,s}$ [kN]				
10	13.8	23.9	30.1	40.8	62.7
20	10.4	18.6	23.7	32.7	51.3
30	8.4	15.2	19.5	27.2	43.4
40	7.0	12.9	16.6	23.3	37.6
50	6.0	11.2	14.5	20.4	33.2
60	5.3	9.8	12.8	18.2	29.7

Punching shear design

Punching shear design in accordance with Assessment ETA 16/0545

The punching shear design in the harmonised product standard ETAG 030, in deviation to the standard BS EN 1992-1-1 (EC2) is carried with a distance of 1.5d. This procedure of verification has proved itself over years and enables smaller critical edge distances and dowel spacings compared with a punching shear design with a distance of 2d in accordance with EC2.

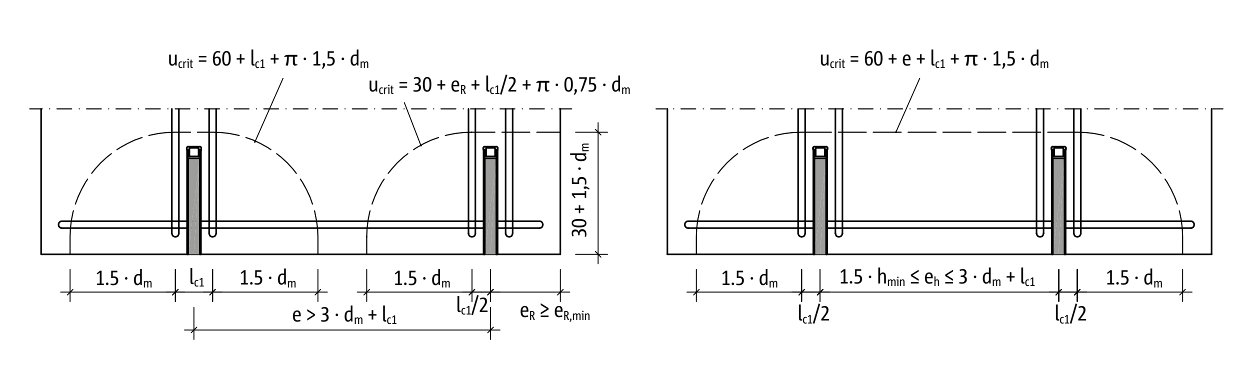


Fig. 46: Schöck Dorn type LD: Lengths of the perimeter for the punching shear design depending on the dowel spacings

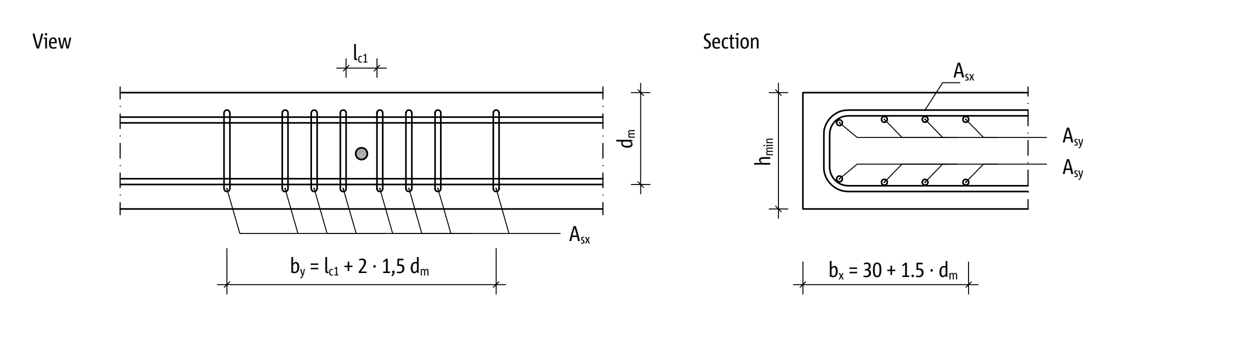


Fig. 47: Schöck Dorn type LD: Dimensions of the punching area

Punching shear resistance:

	$V_{Rd,ct}$	$= 0.14 \cdot \eta_1 \cdot \kappa \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3} \cdot d_m \cdot u_{crit}/\beta$
with:	η_1	= 1.0 for standard concrete
	κ	$= 1 + (200 / d_m)^{1/2} \leq 2.0$
	d_m	- mean static effective height [mm] $d_m = (d_x + d_y) / 2$
	ρ_l	- reinforcement ratio of longitudinal reinforcement within the perimeter considered $\rho_l = (\rho_x \cdot \rho_y)^{1/2} \leq 0.5 \cdot f_{cd} / f_{yd} \leq 0.02$ $\rho_x = A_{sx} / (d_x \cdot b_y)$ $\rho_y = A_{sy} / (d_y \cdot b_x)$
	f_{ck}	- characteristic compression strength of the concrete
	β	- coefficient for consideration of non-uniform load application; with dowels at the corners 1.5, otherwise 1.4
	u_{crit}	- length of the critical perimeter (see diagram)

Concrete edge failure

Verification against concrete edge failure in accordance with Assessment ETA 16/0545

The verification against concrete edge failure is a product-specific verification and is based on the evaluation of tests. For the verification, the load-bearing capacity is calculated with the aid of the suspended reinforcement on both sides of the dowel. However, only the legs of the suspended reinforcement, whose effective anchorage length (l'_i) in the breakout cone is greater than zero, may be taken into account. Otherwise these legs are too far from the dowel and are thus ineffective.

$$V_{Rd,ce} = \Sigma V_{Rd,1,i} + \Sigma V_{Rd,2,i} \leq \Sigma A_{sx,i} \cdot f_{yd}$$

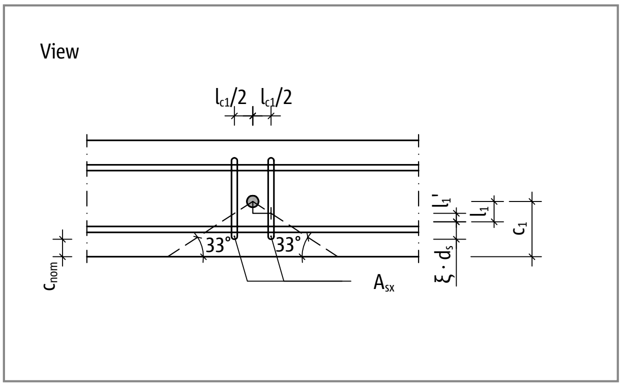


Fig. 48: Schöck Dorn type SLD: Dimensions of the breakout cone of the concrete edge

$V_{Rd,1i}$ - hook load-bearing capacity of a stirrup alongside the dowel

$$V_{Rd,1i} = X_1 \cdot X_2 \cdot \psi_i \cdot A_{sx,i} \cdot f_{yk} \cdot (f_{ck} / 30)^{1/2} / \gamma_c$$

with:

- X_1 = 0.61
- X_2 = 0.92
- ψ_i - coefficient to take into account the the spacing of the suspended reinforcement from the dowel
  - $\psi_i = 1 - 0.2 \cdot (l_{ci} / 2) / c_1$
  - $l_{ci}/2$ - distance $A_{sx,i}$ from the dowel of the suspended reinforcement considered
  - l_{c1} - distance of the first stirrup row from the dowel, see page 52
  - c_1 - edge distance starting from the dowel centre up to the free edge
- $A_{sx,i}$ - cross-section of a leg of the suspended reinforcement in the break out cone
- f_{yk} - characteristic yield strength of the suspended reinforcement
- f_{ck} = 30 N/mm² (for all concrete classes in accordance with ETA 16/0545)
- γ_c - $\gamma_c = 1.5$

$V_{Rd,2i}$ - Bond resistance of a stirrup alongside the dowel

$$V_{Rd,2i} = \pi \cdot d_s \cdot l'_i \cdot f_{bd}$$

with:

- d_s - diameter of the suspended reinforcement in [mm]
- l'_i - effective anchoring length of the suspended reinforcement in the breakout cone
  - $l'_i = l_1 - (l_{ci} / 2) \cdot \tan 33°$
  - $l_{ci}/2$ - distance $A_{sx,i}$ from the dowel of the suspended reinforcement considered
  - $l_1 = h / 2 - \xi \cdot d_s - c_{nom}$
  - $\xi = 3$ for $d_s \leq 16$ mm
  - $\xi = 4.5$ for $d_s > 16$ mm
  - c_{nom} - concrete cover of the suspended reinforcement
- f_{bd} - design value of the bond resistance between reinforcing steel and concrete

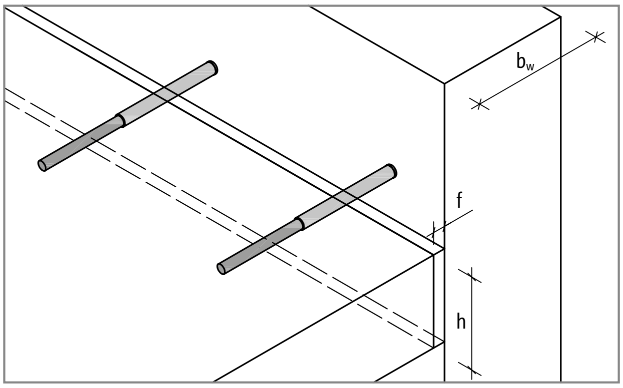
LD

Design example

Connection of a floor slab to a wall

Concrete:	C25/30	
Slab thickness:	h	= 200 mm
Wall thickness:	b_w	= 300 mm
Concrete cover:	$c_{nom,u} = c_{nom,o}$	= 20 mm
Design value of the shear force:	v_{Ed}	= 35 kN/m
Joint length	l_f	= 5.0 m
Joint width on installation:	f_E	= 20 mm
Maximum joint opening:	f	= 32 mm
Environmental conditions:	Joint inside a heated building category C1	

The maximum joint opening to be expected is relevant for the design of the Schöck Dorn type LD. This dimension can be determined through superimposition of the deformations from the shrinkage, loading and temperature changes which occur. Further information on the calculation of maximum joint width is given on page 12.
In accordance with ETA 16/0545, for the design, the maximum joint opening to be expected must be rounded up to a full 10 mm. For this reason in the following design a maximum joint width of 40 mm is assumed.



Selection of the suitable materials for the dowel and the sleeve

Determination of the materials in accoordance with page 46:

Constraints:	Environment Category C1 interior area, no horizontal bracing in the joint
Sleeve material:	Plastic (Part P)
Dowel material:	Galvanised engineering steel (Part Zn)

Design Schöck Dorn typeLD

Determination of the design load for the dowel:

Maximum dowel spacing:	$e_{h,max}$	$= 8 \cdot h = 8 \cdot 200 = 1600$ mm = 1.6 m
Minimum possible number of dowels:	n_{Dorn}	$= l_f / e_{h,max} = 5.0 / 1.6 = 3.13 \approx 4$ dowels
Maximum possible dowel spacing:	e_h	$= l_f / n_{Dorn} = 5 / 4 = 1.25$ m
Loading per dowel:	$V_{Ed,\,LD}$	$= e_h \cdot v_{Ed} = 1.25 \cdot 35.0 = 43.8$ kN

Seletion of the dowel diameter on the basis of the design tables page 50:

Constraints:	slab height = 200 mm and joint width = 40 mm	
	selected: LD 25 P-Zn	
Load-bearing capacity LD 25:	$V_{Rd,\,LD\,25}$	$= 31.3$ kN $\leq V_{Ed,\,LD} = 43.8$ kN
	The dowel spacing must be reduced	

Design example

Determination of optimum dowel spacings:

Maximum dowel spacing:	$e_{h,max,LD\,25}$	$= V_{Rd,LD} / v_{Ed} = 31.3 / 35 \approx 0.89$ m
Required number of dowels:	n_{Dorn}	$= l_f / e_{h,max,LD\,25} = 5.0 / 0.89 = 5.62 \approx 6$ dowels
Dowel spacing:	$e_{h,LD\,25}$	$= l_f / n_{Dorn} = 5.0 / 6 = 0.84$ m
Loading per dowel:	$V_{Ed,LD\,25}$	$= e_{h,LD\,25} \cdot v_{Ed} = 0.84 \cdot 35 = 29.4$ kN

Checking of the minimum structural component dimensions in accordance with page 47:

Minimum slab thickness:	h_{min}	$= 180$ mm $\leq h = 200$ mm
Minimum wall thickness:	$b_{w,min}$	$= 280$ mm $\leq b_w = 300$ mm

Checking of the critical dowel spacing and edge separation in accordance with page 48:

Critical dowel spacing:	$e_{h,crit}$	$= 580$ mm $\leq e_{h,LD\,25} = 840$ mm
Critical edge separation:	$e_{R,crit}$	$= 340$ mm $\leq e_R = e_{h,LD\,25} / 2 = 840 / 2 = 420$ mm

Determination of the on-site reinforcement in accordance with page 52:

Longitudinal reinforcement:	A_{sy}	= 1 • H10 (at top and bottom structural component edge)
Suspended reinforcement:	A_{sx}	= 1 • H10 (right and left of dowel)

Thus all constraints for the application of the design tables are observed and no further verification for the dowel connection is required. The reinforcement along the slab edge and in the slab must be verified separately.
For information the detailed verification of the dowel connection is carried out below.

Steel load-bearing capacity

Load-bearing capacity: $V_{Rd,s}$ = in accordance with table page 55 for LD 25 with a joint width of 40 mm
$V_{Rd,s}$ = 42.0 kN

Punching shear design

Loas-bearing capacity: $V_{Rd,ct} = 0.14 \cdot \eta_1 \cdot \kappa \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3} \cdot d_m \cdot u_{crit}/\beta$

with:

η_1 = 1.0 for standard concrete

$d_m = (d_x + d_y) / 2 = (175 + 165) / 2 = 170$ mm

$d_x = h - c_{nom} - \varnothing_{Asx} / 2 = 200 - 20 - 10 / 2 = 175$ mm

$d_y = h - c_{nom} - \varnothing_{Asx} - \varnothing_{Asy} / 2 = 200 - 20 - 10 - 10 / 2 = 165$ mm

$\kappa = 1 + (200 / d_m)^{1/2} = 1 + (200 / 170)^{1/2} = 2.08 \leq 2.0$

$\rho_l = (\rho_x \cdot \rho_y)^{1/2} = (0.0015 \cdot 0.0017)^{1/2} = 0.0016$

$\rho_x = A_{sx} / (d_x \cdot b_y) = 2 \cdot 78.5 / (175 \cdot 580) = 0.0015$

$\rho_y = A_{sy} / (d_y \cdot b_x) = 1 \cdot 78.5 / (165 \cdot 285) = 0.0017$

$b_y = 3 \cdot d_m + l_{c1} = 3 \cdot 170 + 70 = 580$ mm

$b_x = 1.5 \cdot d_m + 30 = 1.5 \cdot 170 + 30 = 285$ mm

$l_{c1} = 70$ mm see page 52

$f_{ck} = 25$ N/mm²

β = 1.4 - dowel in edge area

$u_{crit} = 60 + l_{c1} + 1.5 \cdot d_m \cdot \pi = 60 + 70 + 1.5 \cdot 170 \cdot \pi = 931$ mm

Load-bearing capacity: $V_{Rd,ct} = 0.14 \cdot \eta_1 \cdot \kappa \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3} \cdot d_m \cdot u_{crit}/\beta$
$= 0.14 \cdot 1.0 \cdot 2.0 \cdot (100 \cdot 0.0016 \cdot 25)^{1/3} \cdot 170 \cdot 931 / 1.4 = 50.2$ kN

LD

Design example

Concrete edge failure

Load-bearing capacity: $V_{Rd,ce} = \Sigma V_{Rd,1,i} + \Sigma V_{Rd,2,i} \leq \Sigma A_{sx,i} \cdot f_{yd}$

Hook load-bearing capacity: $V_{Rd,1,i} = 0.61 \cdot 0.92 \cdot \psi_i \cdot A_{sx,i} \cdot f_{yk} \cdot (f_{ck} / 30)^{1/2} / \gamma_c$

with:

$A_{sx,i} = 78.5\ mm^2\ (\varnothing\ 10)$
$f_{yk} = 500\ N/mm^2\ (B500)$
$f_{ck} = 30\ N/mm^2$ (for all concrete classes in accordance with ETA 16/0545)
$\gamma_c = 1.5$
$c_1 = h / 2 = 200 / 2 = 100\ mm$
$\psi_i = 1 - 0.2 \cdot (l_{ci} / 2) / c_1$
$l_{c1} = 70\ mm$ (see page 52)
$\psi_1 = 1 - 0.2 \cdot (70 / 2) / 100\ mm = 0.93$
$V_{Rd,1,1} = 0.61 \cdot 0.92 \cdot 0.93 \cdot 78.5 \cdot 500 \cdot (30 / 30)^{1/2} / 1.5 = 13.65\ kN$

Bond resistance capacity: $V_{Rd,2,i} = \pi \cdot d_s \cdot l'_i \cdot f_{bd}$

with:

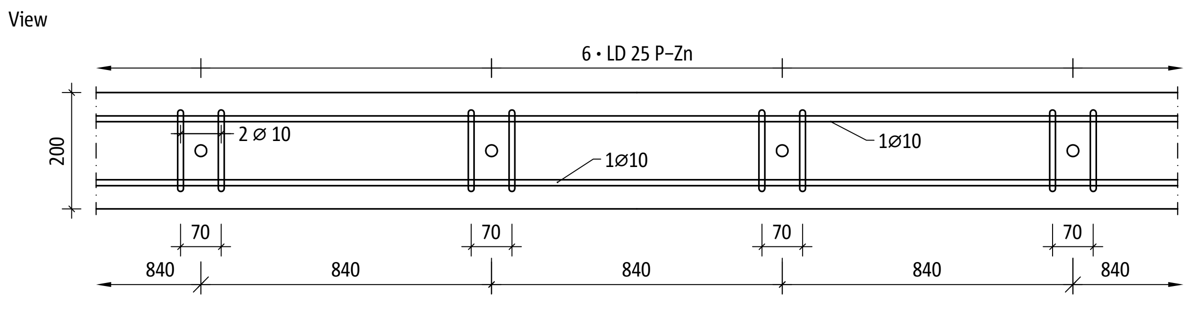
$d_s = 10\ mm$
$\xi = 3$ for d_s
$c_{nom} = 20\ mm$
$f_{bd} = 2.7\ N/mm^2$
$l_1 = h / 2 - \xi \cdot d_s - c_{nom}$
$l_1 = 200 / 2 - 3 \cdot 10 - 20 = 50\ mm$
$l'_i = l_1 - (l_{ci} / 2) \cdot \tan 33°$

$l_{c1} = 70\ mm$ (see page 52)
$l'_1 = 50 - (70 / 2) \cdot \tan 33° = 27.3\ mm$
$V_{Rd,2,1} = \pi \cdot 10 \cdot 27.3 \cdot 2.7 = 2.32\ kN$

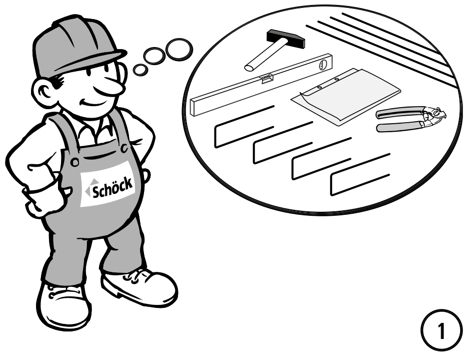
Load-bearing capacity: $V_{Rd,ce} = \Sigma V_{Rd,1,i} + \Sigma V_{Rd,2,i} \leq \Sigma A_{sx,i} \cdot f_{yd}$
$= 2 \cdot 13.65 + 2 \cdot 2.32$
$= 31.94\ KN \leq 2 \cdot 78.5 \cdot 43.5 = 68.3\ kN$

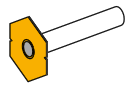
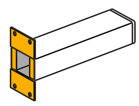
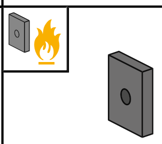
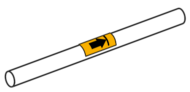
Verificatons

Punching through flat slabs:	$V_{Rd,ct} = 46.6\ kN$	$\geq V_{Ed,LD\ 25} = 29.4\ kN$
Concrete edge fracture:	$V_{Rd,ce} = 31.94\ kN$	$\geq V_{Ed,LD\ 25} = 29.4\ kN$
Steel failure:	$V_{Rd,s} = 42.0\ kN$	$\geq V_{Ed,LD\ 25} = 29.4\ kN$



Installation instructions



LD ⌀ Part P LD ⌀ Part S	
LD-Q ⌀ Part S	
LD ⌀ BSM LD-Q ⌀ BSM	
LD ⌀ Part A4 LD ⌀ Part Zn	

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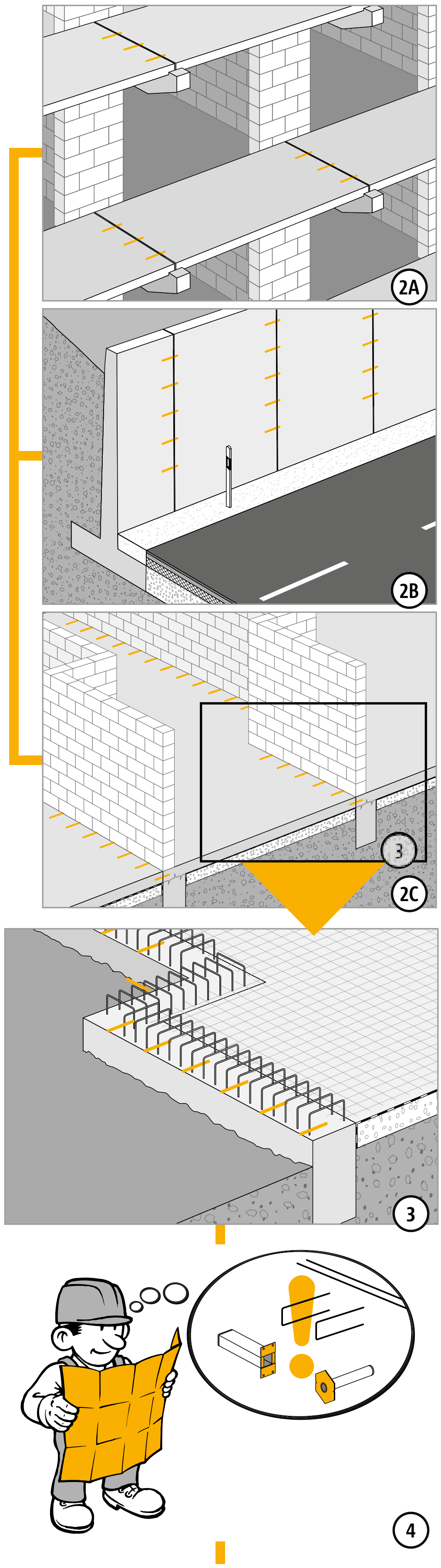

LD

Installation instructions