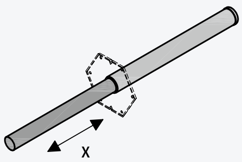
Schöck Stacon® type LD, LD-Q

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

Schöck Stacon® type LD-Q
Load dowel for the transmission of shear forces in expansion joints between structural components with simultaneous movement in the direction along and at right angles to the dowel axis.

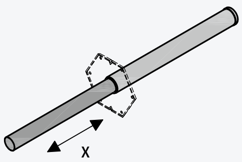
Summary of types | Type designations

Schöck Stacon® type LD



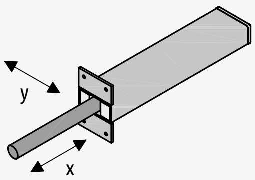
LD ⌀ S-A4

The dowel and sleeve are made of stainless steel of corrosion protection class 3 This dowel system is particularly suited for structural component joints subject to frequent movement such as, for example, on the exterior of buildings.



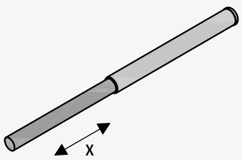
LD ⌀ P-A4 or LD ⌀ P-Zn

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

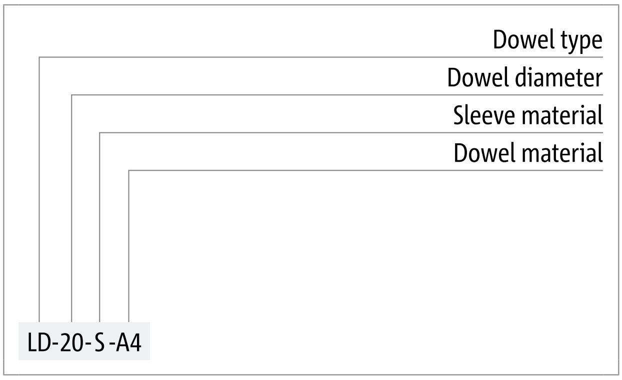
The dowel and the transversely movable sleeve are made of stainless steel of corrosion protection class 3 This dowel system allows displacement of structural components longitudinally and transversely to the dowel axis and can be used in interior and exterior areas.



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

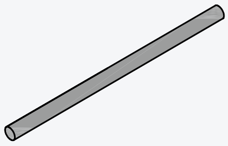


LD

Structural design

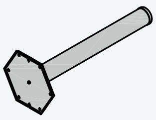
Summary of types | Product selection

Schöck Stacon® type LD components



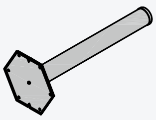
LD ⌀ Part A4 or LD ⌀ Part Zn

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.



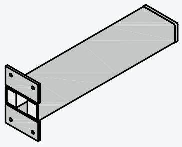
LD ⌀ Part S

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 Stacon® type LD variants

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

- Dowel diameter ⌀:
  16, 20, 22, 25 and 30
- Sleeve material:
  S: Stainless steel of corrosion protection class 3
  P: Plastic
- Dowel material:
  A4: Stainless steel S690 of corrosion protection class 3
  Zn: Structural steel S690 hot-dip galvanized

Product characteristics | Corrosion protection/materials | Application areas

Product features

The Schöck Stacon® type LD (heavy duty dowel) consists of a sleeve part and a dowel part, which are concreted into the respective concrete components adjacent to the joint. The load is transferred from one structural component through the dowel into the sleeve then to the other structural component. Within the concrete structural components, the load is taken up by the on-site reinforcement in the area of the dowel.
The sleeve of the Schöck Stacon® type LD is round and thus enables freedom of movement in the direction of the dowel axis, in order to prevent induced stresses due to structural component elongation. The forces can be transmitted perpendicularly and transversely to the dowel axis.
The LD-Q can be used to allow movement transversely to the dowel axis. 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 Stacon® 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 Stacon® type LD is technically approved primarily for the transmission of static loadings in expansion joints. The United Kingdom Technical Assessment UKTA 23/6892 regulates the dimensioning according to the harmonised product standard ETAG 030 for the concrete strength classes C20/25 to C50/60. The joint widths can vary between 10 mm and 60 mm. In accordance with harmonised European product standard ETAG 030 only the Schöck Stacon® Type LD ⌀ S-A4 can be used as bracing component between two building parts as only this dowel can transmit horizontal forces. Use of the Schöck Stacon® type LD under earthquake or fatigue loads, is not addressed in the assessment.
All of the following design and reinforcement tables have been determined with a concrete cover of 20 mm.

Product description

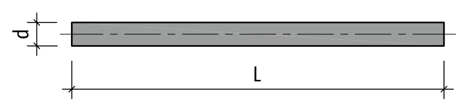


Fig. 47: Schöck Stacon® Type LD part A4, LD part Zn: Dimensions of the dowel

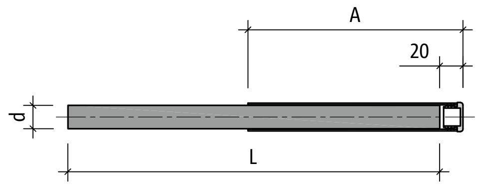


Fig. 48: Schöck Stacon® type LD F-A4, LD F-Zn: Dimensions of the dowel with plastic sleeve

Schöck Stacon® type LD		16	20	22	25	30
Dowel element dimensions [mm]						
Dowel length	L	270	320	350	390	450
Dowel diameter	d	16	20	22	25	30

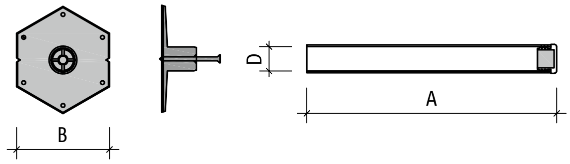


Fig. 49: Schöck Stacon® type LD part S, LD part P: Dimensions of the sleeves made of stainless steel and plastic

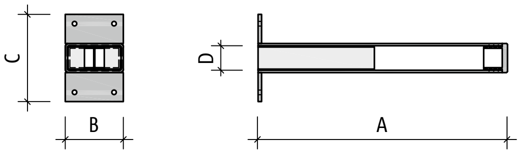
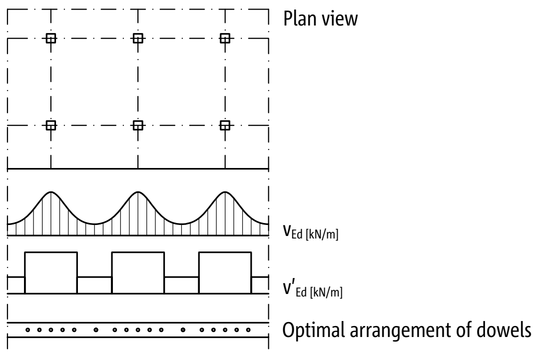


Fig. 50: Schöck Stacon® type LD-Q part S: Dimensions of the transversely movable sleeve

Schöck Stacon® type LD		16	20	22	25	30
Sleeve element dimensions [mm]						
Sleeve length	A	185	210	225	245	275
Width of the mounting plate	B	80	80	80	80	80
Height of the mounting plate	C	80	80	80	80	80
Internal diameter	D	17	21	23	26	31

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

Design process



Determination of the shear force path v_{Ed} in the joint using FEM software or using simplified structural models.

Determination of a simplified shear force path v'_{Ed} for the design.

Determination of the expected maximum joint width. See page 11

Are transversely movable dowels required? See page 12

Design using tables

Examination of the minimum structural component dimensions and the applicable shear force dowels. See page 55

Selection of a dowel spacing e between critical dowel spacing and 8-times the slab thickness. See page 57

Calculation of the dowel load $V_{dowel} = v'_{Ed} \cdot e$

Selection of the matching dowel in accordance with design tables and according to the boundary conditions. See page 58

Determination of the required edge reinforcement. See page 60

Schöck Stacon® type LD-Q		16	20
Design values with		V_{Rd} [kN/dowel]	
Slab thickness [mm]	Joint width [mm]		
160	20	...	...
	30	...	...
	40	...	...
	50	...	...
180	20	...	...
	30	xx.x	...
	40	...	...
	50	...	...

Design using Schöck Scalix® design software

Design software on the www.schoeck.com website Details see page 10

Input of the boundary conditions and the load.

Automatic calculation and graphic display of the shear force dowels and the reinforcement.

Saving of the project and the position.

Input of further positions.

Minimum dowel spacing/component dimensions

Schöck Stacon® type LD/LD-Q	16	20	22	25	30
Minimum structural component dimension [mm]					
Minimum slab thickness h_{min} for c_v = 20 mm	160	160	160	180	210
Minimum slab thickness h_{min} for c_v = 30 mm	180	180	180	200	230
Minimum wall thickness b_w	215	240	255	275	305
Beam width b_u	160	160	160	180	210
Dowel spacing [mm]					
Minimum horizontal $e_{h,min}$	240	240	240	270	315
Minimum vertical $e_{v,min}$	120	120	120	140	170
Edge distances [mm]					
Minimum horizontal $e_{Rh,min}$	120	120	120	140	160

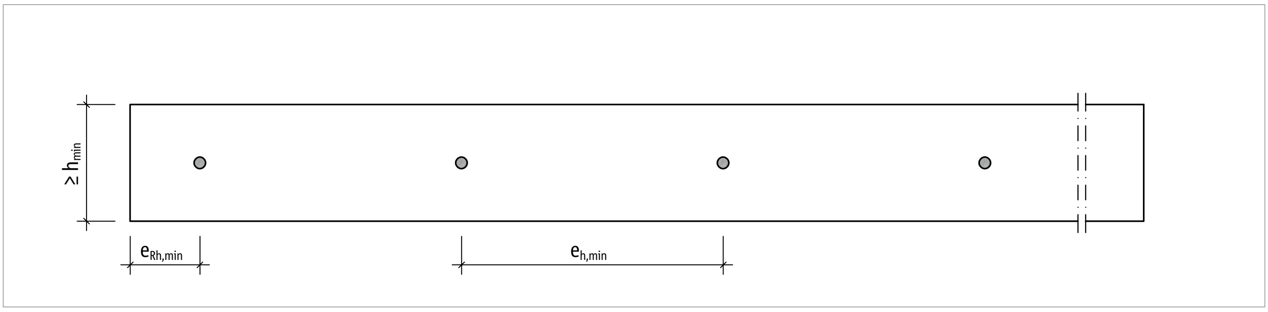


Fig. 51: Schöck Stacon® type LD: Minimum structural component measurements and dowel spacings with one slab

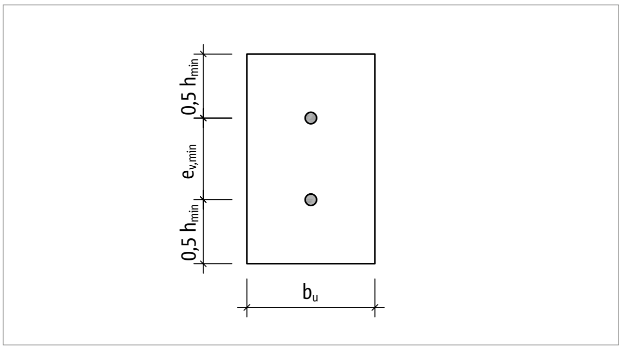


Fig. 52: Schöck Stacon® type LD: Minimum structural component measurements and dowel spacings in the front face of a balcony or a wall

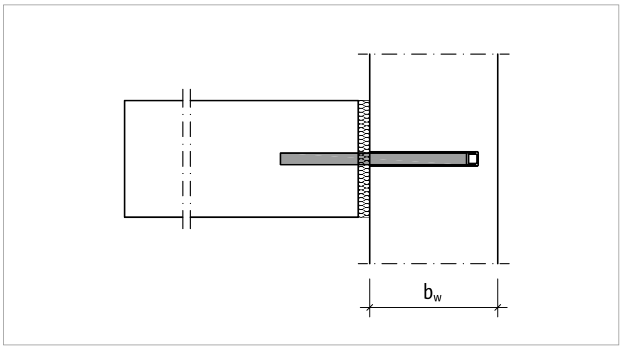


Fig. 53: Schöck Stacon® type LD: Minimum structural component thickness of a wall or column

Critical dowel spacings/edge distances

The following critical edge distances and dowel spacings were taken as a basis for the design values in the tables from page 58 onwards. If these spacings are reduced, an additional proof of punching is required taking into account the shortened round cuts. The maximum dowel spacing is limited in the Product Standard ETAG 030 to 8 times the slab thickness.

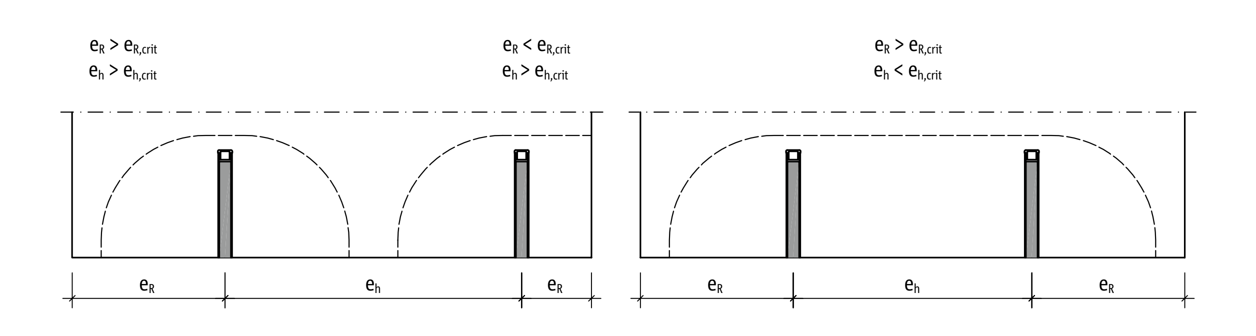


Fig. 54: Schöck Stacon® type LD: Round cuts dependent on the critical dowel spacing and edge distance

Schöck Stacon® type LD		16	20	22	25	30
Critical dowel spacings for		$e_{h,crit}$ [mm]				
Slab thickness [mm]	160	400	400	400	-	-
	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

Schöck Stacon® type LD		16	20	22	25	30
Critical edge distances for		$e_{R,crit}$ [mm]				
Slab thickness [mm]	160	200	200	200	-	-
	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 Stacon® type LD-Q		16	20	22	25	30
Critical dowel spacings for		$e_{h,crit}$ [mm]				
Slab thickness [mm]	160	400	400	400	-	-
	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

Schöck Stacon® type LD-Q		16	20	22	25	30
Critical edge distances for		$e_{R,crit}$ [mm]				
Slab thickness [mm]	160	200	200	200	-	-
	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 $V_{Rd,s}$, slab load-bearing capacity $V_{Rd,c}$, punching load-bearing capacity $V_{Rd,ct}$]

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 thickness must be used. The maximum load-bearing capacities listed here apply only in connection with a reinforcement arrangement in accordance with page 60 and only if the critical dowel spacing or edge distances in accordance with page 56 are adhered to.

Schöck Stacon® type LD		16	20	22	25	30
Design values with		V_{Rd} [kN/dowel]				
Slab thickness [mm]	Joint width [mm]					
160	20	11.8	11.8	11.8	-	-
	30	11.8	11.8	11.8	-	-
	40	11.8	11.8	11.8	-	-
	50	10.9	11.8	11.8	-	-
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	-
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	-
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
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
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
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
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

Design LD-Q C20/25 – C50/60

Design resistance V_{Rd} = min [steel load-bearing capacity $V_{Rd,s}$, slab load-bearing capacity $V_{Rd,c}$, punching load-bearing capacity $V_{Rd,ct}$]

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 thickness must be used. The maximum load-bearing capacities listed here apply only in connection with a reinforcement arrangement in accordance with page 60 and only if the critical dowel spacing or edge distances in accordance with page 57 have been adhered to.

Schöck Stacon® type LD-Q		16	20	22	25	30
Design values with		V_{Rd} [kN/dowel]				
Slab thickness [mm]	Joint width [mm]					
160	20	10.4	11.8	11.8	-	-
	30	8.4	11.8	11.8	-	-
	40	7.0	11.8	11.8	-	-
	50	6.0	11.2	11.8	-	-
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	-
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	-
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
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
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
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
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

On-site reinforcement | Precast construction

On-site reinforcement

All load-bearing levels of the Schöck Stacon® type LD respectively require only one slip-in stirrup (Pos. 1) right and left of the dowel as well as a longitudinal reinforcement rod (Pos. 2) at the top and bottom edge of the slab.

Schöck Stacon® type LD		16		20		22		25		30	
On-site reinforcement for		Pos. 1	Pos. 2	Pos. 1	Pos. 2	Pos. 1	Pos. 2	Pos. 1	Pos. 2	Pos. 1	Pos. 2
Slab thickness [mm]	160	2 ⌀ 6	2 ⌀ 6	2 ⌀ 6	2 ⌀ 6	2 ⌀ 6	2 ⌀ 6	-	-	-	-
	180	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	-	-
	200	2 ⌀ 8	2 ⌀ 8	2 ⌀ 10	2 ⌀ 10	2 ⌀ 10	2 ⌀ 10	2 ⌀ 10	2 ⌀ 10	-	-
	220	2 ⌀ 8	2 ⌀ 8	2 ⌀ 10	2 ⌀ 10	2 ⌀ 12	2 ⌀ 12	2 ⌀ 12	2 ⌀ 12	2 ⌀ 12	2 ⌀ 12
	250–350	2 ⌀ 8	2 ⌀ 8	2 ⌀ 10	2 ⌀ 10	2 ⌀ 12	2 ⌀ 12	2 ⌀ 16	2 ⌀ 16	2 ⌀ 16	2 ⌀ 16
Stirrup spacing l_{c1} in [mm]		60		60		60		70		80	

Schöck Stacon® type LD-Q		16		20		22		25		30	
On-site reinforcement for		Pos. 1	Pos. 2	Pos. 1	Pos. 2	Pos. 1	Pos. 2	Pos. 1	Pos. 2	Pos. 1	Pos. 2
Slab thickness [mm]	160	2 ⌀ 6	2 ⌀ 6	2 ⌀ 6	2 ⌀ 6	2 ⌀ 6	2 ⌀ 6	-	-	-	-
	180	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	-	-
	200	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 10	2 ⌀ 10	2 ⌀ 10	2 ⌀ 10	-	-
	220	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 10	2 ⌀ 10	2 ⌀ 12	2 ⌀ 12	2 ⌀ 12	2 ⌀ 12
	250–350	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 8	2 ⌀ 10	2 ⌀ 10	2 ⌀ 12	2 ⌀ 12	2 ⌀ 16	2 ⌀ 16
Stirrup spacing l_{c1} in [mm]		60		60		60		80		80	

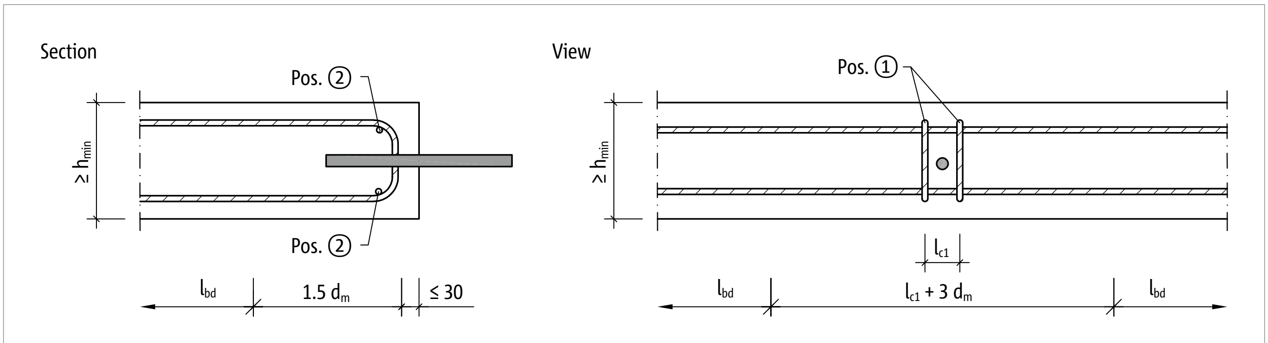


Fig. 55: On-site reinforcement with Schöck Stacon® type LD

Precast construction

If the end faces of the connected structural components are separated by compound joints, only the undisturbed part of the structural component height can be used for the design. Accordingly, the on-site reinforcement for the dowel must also only be located in this area.

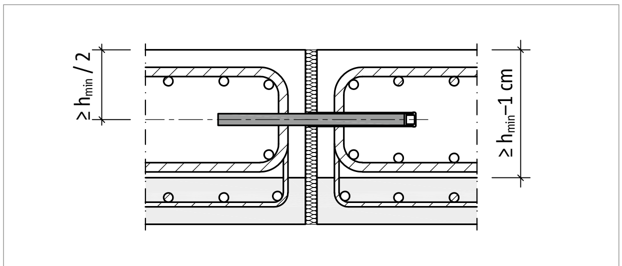


Fig. 56: Schöck Stacon® type LD: Arrangement of on-site reinforcement in half-precast slabs

On-site reinforcement

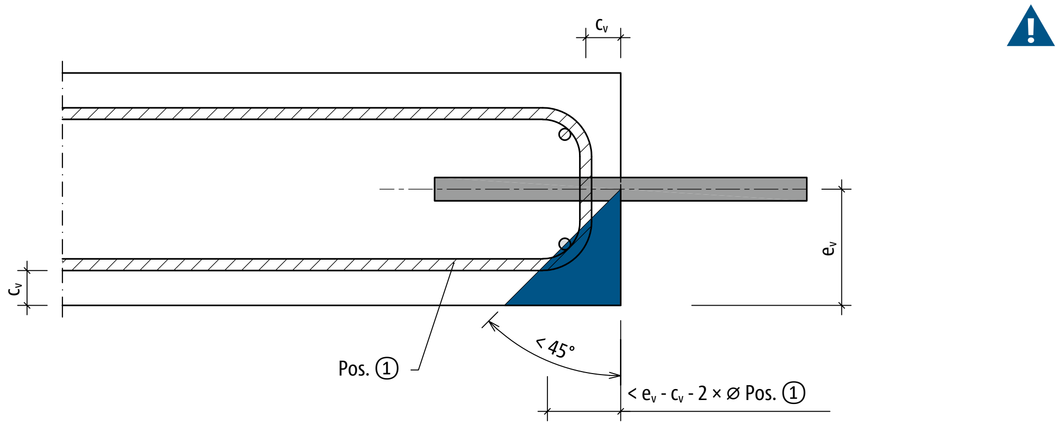


Fig. 57: Schöck Stacon® type LD: Position of the longitudinal reinforcement in relation to the front face of the slab

Do not modify on-site reinforcement

The distance between the longitudinal reinforcement and 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 cannot contribute to the resistance. If stirrup diameters larger than those specified in the table on page 60 are used, the longitudinal reinforcement is displaced. For this reason the reinforcement diameters stated in the table must be used, or the concrete cover at the front face of the slab 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.

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

Verification of the load-bearing capacity in accordance with UKTA 23/6892

The load-bearing capacity of an expansion joint connection with the Schöck Stacon® type LD results from the minimum of the verifications against punching shear failure, concrete edge failure and steel load-bearing capacity.

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

with:

V_{Ed}: Design value for the applied 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 failures of the dowel

These verifications are necessary if the boundary conditions for the design tables are not observed. The punching shear failure must be verified if the critical spacings in accordance with page 56 are reduced or the on-site reinforcement in accordance with page 60 has been modified. The load-bearing capacity of the concrete edge must, in addition, be checked if the on-site reinforcement deviates from the recommendations on page 60.

Steel load-bearing capacity in accordance with UKTA 23/6892

The steel load-bearing capacity of the Schöck Stacon® type LD corresponds to the bending resistance of the dowel. It is thus independent of the surrounding concrete. This load-bearing capacity is decisive in structural components in which concrete failure due to concrete edge failure or punching shear failure can be excluded. This is the case, for example, in walls or columns.

Schöck Stacon® type LD		16	20	22	25	30
Steel load-bearing capacity for		$V_{Rd,s}$ [kN]				
Joint width [mm]	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 Stacon® type LD-Q		16	20	22	25	30
Steel load-bearing capacity for		$V_{Rd,s}$ [kN]				
Joint width [mm]	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

Verification of punching shear failure in accordance with UKTA 23/6892

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

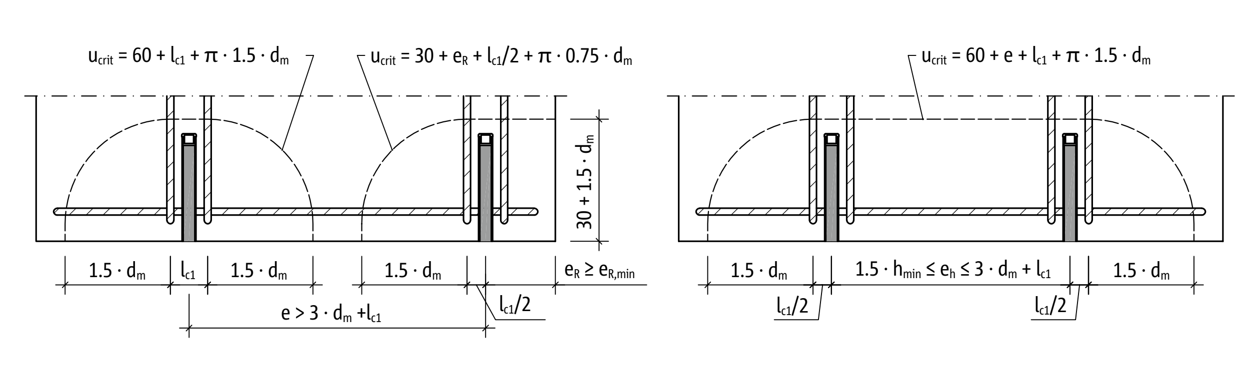


Fig. 58: Schöck Stacon® type LD: Lengths of the round cuts for the punching verification depending on the dowel spacings

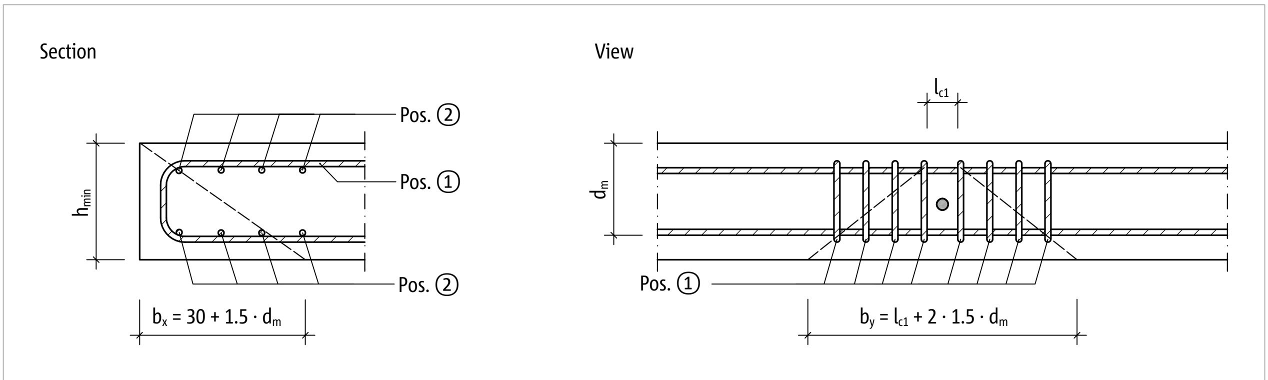


Fig. 59: Schöck Stacon® type LD: Dimensions of the punching area

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

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

d_m: Mean static useful height [mm]
$d_m = (d_x + d_y) / 2$

ρ_l: Mean degree of longitudinal reinforcement within the round cut under consideration
$\rho_l = (\rho_x \cdot \rho_y)^{1/2} \leq 0.5 \cdot f_{cd} / f_{yd} \leq 0.02$
$\rho_x = A_{Pos.1} / (d_x \cdot b_y)$
$\rho_y = A_{Pos.2} / (d_y \cdot b_x)$

f_{ck}: Characteristic concrete cylinder compressive strength

β: Coefficient for the taking into account of non-uniform load application; with dowels at the corners 1.5, otherwise 1.4

u_{crit}: Circumference of the critical round cut (see diagram)

LD

Structural design

Concrete edge failure

Verification against concrete edge failure in accordance with UKTA 23/6892

The verification against concrete edge failure is a product-specific verification and is based trial evaluations. 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 0, may be taken into account. Otherwise these legs are too far from the dowel and are thus ineffective.

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

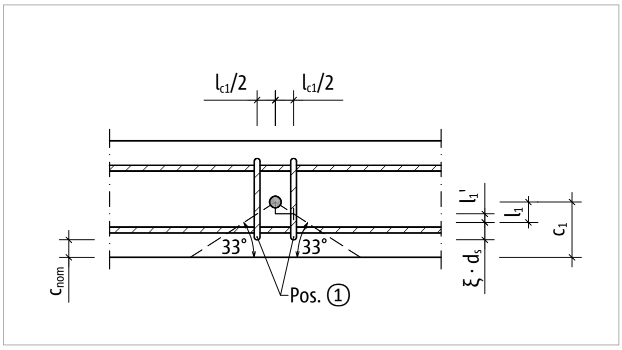


Fig. 60: Schöck Stacon® type LD: Dimensions of the breakout cone of the concrete edge

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

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

with:

- X_1 = 0.61
- X_2 = 0.92
- ψ_i: Coefficient for the taking the spacing of the suspended reinforcement from the dowel into account
  - $\psi_i = 1 - 0.2 \cdot (l_{ci} / 2) / c_1$
  - $l_{ci}/2$: Centre distance of the considered suspended reinforcement $A_{Pos.\,1,i}$ from the dowel
  - l_{c1}: Centre distance of the first row of stirrups from the dowel, see page 60
  - c_1: Edge distance starting from the middle of the dowel to the free edge
- $A_{Pos.\,1,i}$: Cross-section of a leg of the suspended reinforcement in the breakout cone
- f_{yk}: Characteristic yield point of the suspended reinforcement
- f_{ck} = 30 N/mm² (for all concrete classes in accordance with UKTA 23/6892)
- γ_c: Partial safety factor for the concrete $\gamma_c = 1.5$

$V_{Rd,2i}$ – composite load-bearing capacity 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 anchorage length of the suspended reinforcement in the break out cone
  - $l'_i = l_1 - (l_{ci} / 2) \cdot \tan 33°$
  - $l_{ci}/2$: Centre distance of the considered suspended reinforcement $A_{Pos.\,1,i}$ from the dowel
  - $l_1 = h / 2 - \xi \cdot d_s - c_{nom}$
  - $\xi = 3$ 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 composite stress between reinforcing steel and concrete

LD

Structural design

Design example

Connection of a floor plate to a wall

Concrete:	C28/35	
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 decisive for the design of the Schöck Stacon® type LD. This dimension can be determined by superimposing the deformations occurring as a result of the shrinkage, loading and temperature changes. Further information on the calculation of maximum joint width is provided on page 11.
In accordance with UKTA 23/6892, for design purposes 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.

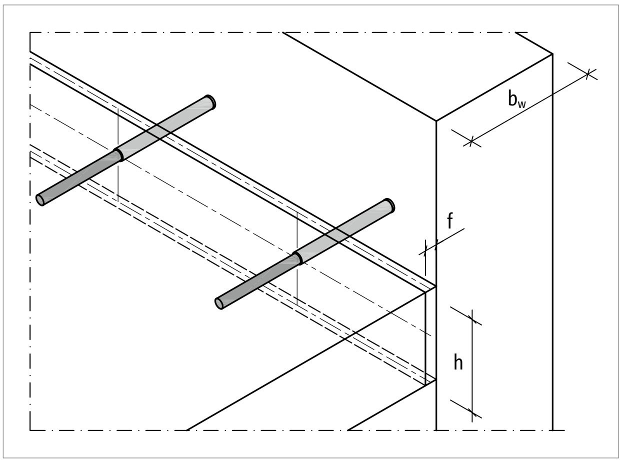


Fig. 61: Design example of floor-wall connection

Selection of the suitable materials for the dowel and the sleeve

Determination of the materials in accordance with page 52:
Boundary conditions: Environmental category C1 indoor, exclusively vertical forces, no bracing forces lengthwise to the joint
Sleeve material: Plastic (Part P)
Dowel material: Galvanised engineering steel (Part Zn)

Design Schöck Stacon® type LD

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_{dowel}	$= l_f / e_{h,max} = 5.0 / 1.6 = 3.13 \approx 4$ dowels
Maximum possible dowel spacing:	e_h	$= l_f / n_{dowel} = 5 / 4 = 1.25$ m
Load per dowel:	$V_{Ed, LD}$	$= e_h \cdot v_{Ed} = 1.25 \cdot 35.0 = 43.8$ kN

Selection of the dowel diameter based on design table page 58:

Boundary conditions:	slab thickness = 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.	

LD

Structural design

Design example

Determination of the 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_{dowel}	$= l_f / e_{h,max,LD\ 25} = 5.0 / 0.89 = 5.62 \approx 6$ dowels
Dowel spacing:	$e_{h,LD\ 25}$	$= l_f / n_{dowel} = 5.0 / 6 = 0.84$ m
Load 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 measurements in accordance with page 55:

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 spacings and edge distances in accordance with page 56:

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

Determination of the on-site reinforcement in accordance with page 60:

Longitudinal reinforcement:	$A_{Pos.\ 2}$	= 1 ⌀ 10 (at top and bottom edge of structural component)
Suspended reinforcement:	$A_{Pos.\ 1}$	= 1 ⌀ 0 (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 62 for LD 25 with a joint width of 40 mm
$V_{Rd,s}$ = 42.0 kN

Punching shear failure verification

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

with:

η_1 = 1.0 for standard concrete

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

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

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

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

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

$\rho_x = A_{Pos.\ 1} / (d_x \cdot b_y) = 2 \cdot 78.5 / (175 \cdot 580) = 0.0015$

$\rho_y = A_{Pos.\ 2} / (d_y \cdot b_x) = 1 \cdot 78.5 / (165 \cdot 285) = 0.0017$

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

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

$l_{c1} = 70$ mm see page 60

$f_{ck} = 28$ N/mm²

β = 1.4 - Dowel in the 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: $V_{Rd,ct} = 0.14 \cdot \eta_1 \cdot \kappa \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3} \cdot d_m \cdot u_{crit}/\beta$
$= 0.14 \cdot 1.0 \cdot 2.0 \cdot (100 \cdot 0.0016 \cdot 28)^{1/3} \cdot 170 \cdot 931 / 1{,}4 = 50.2$ kN

LD

Structural design

Design example

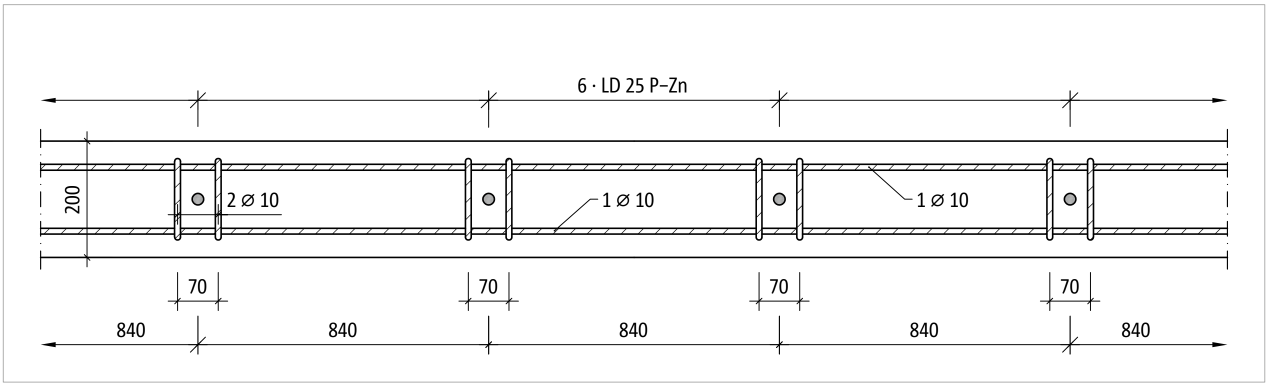


Fig. 62: Arrangement of reinforcement in the slab

Concrete edge failure

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

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

with:
$A_{Pos.\,1,i}$ $= 78.5\ mm^2$ (⌀ 10)
f_{yk} $= 550\ N/mm^2$ (B550)
f_{ck} $= 30\ N/mm^2$ (for all concrete classes in accordance with UKTA 23/6892)
γ_c $= 1.5$
c_1 $= h / 2 = 200 / 2 = 100$ mm
ψ_i $= 1 - 0.2 \cdot (l_{ci} / 2) / c_1$
l_{c1} = 70 mm (see page 60)
ψ_1 $= 1 - 0.2 \cdot (70 / 2) / 100$ mm $= 0.93$
$V_{Rd,1,1}$ $= 0.61 \cdot 0.92 \cdot 0.93 \cdot 78.5 \cdot 550 \cdot (30 / 30)^{1/2} / 1.5 = 15.0$ kN

Composite load-bearing effect: $V_{Rd,2,i}$ $= \pi \cdot d_s \cdot l'_i \cdot f_{bd}$

with:
d_s = 10 mm
ξ = 3 for d_s
c_{nom} = 20 mm
f_{bd} $= 2.9\ N/mm^2$
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 60)
l'_1 $= 50 - (70 / 2) \cdot \tan 33° = 27.3$ mm
$V_{Rd,2.1}$ $= \pi \cdot 10 \cdot 27.3 \cdot 2.9 = 2.32$ kN

Load-bearing capacity: $V_{Rd,ce}$ $= \Sigma V_{Rd,1,i} + \Sigma V_{Rd,2,i} \leq \Sigma\, A_{Pos.\,1,i} \cdot f_{yd}$
$= 2 \cdot 15.0 + 2 \cdot 2.32$
$= 34.64$ KN $\leq 2 \cdot 0.785 \cdot 43.5 = 68.3$ kN.

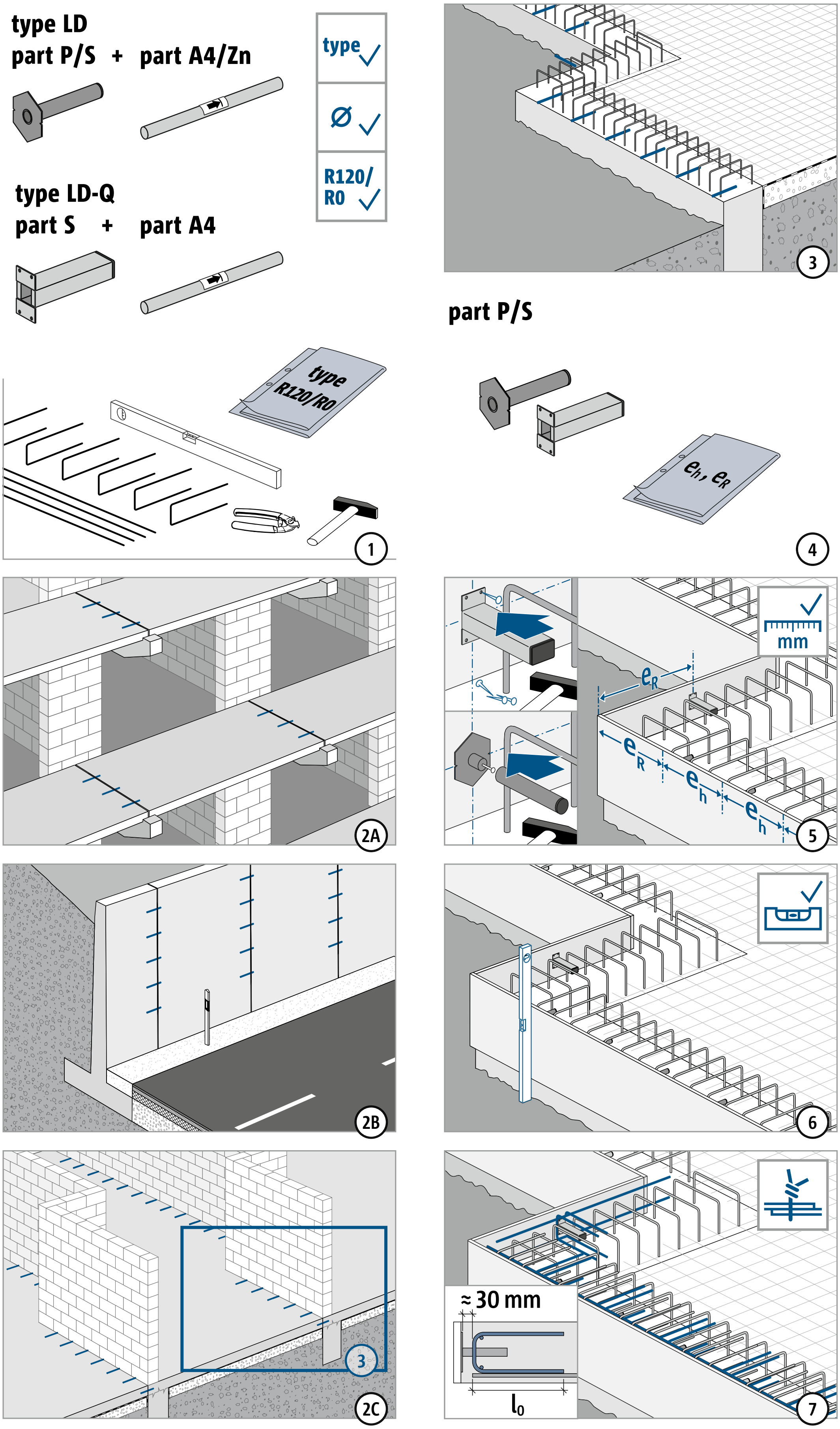
Verifications

Punching shear failure:	$V_{Rd,ct} = 50.2$ kN	$\geq V_{Ed,LD\,25} = 29.4$ kN
Concrete edge failure:	$V_{Rd,ce} = 34.64$ 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

LD

Structural design

Installation instructions



Installation instructions