Technical Information
Schöck Dorn

January 2018

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Planning and consulting service

The engineers of Schöck's application engineering department would be very happy to advise you on static, structural and building-physics questions and will produce for you proposals for your solution with calculations and detailed drawings.
For this please send your planning documentation (general arrangements, sections, static data) with the address of the building project to:

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Notes | Symbols

ⓘ Technical Information

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▷ The current Technical Information is to be applied. A current version is available at www.schoeck.co.uk/download.

Tags

⚠ Hazard note

The yellow triangle with the exclamation mark indicates a hazard note. This means there is a danger to life and limb with non-observance!

ⓘ Info

The square with „i“ indicates important information which, for example, is to be taken into account with the design.

☑ Check list

The square with tick indicates the check list. Here the essential points of the design are summarised in brief.
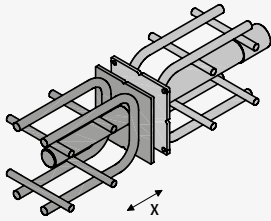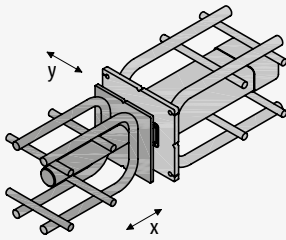
SLD

LD

Summary of types

Schöck Dorn type SLD

SLD

The heavy duty dowel serves the transmission of high shear forces in building joints and with this enables free movement in the direction of the dowel axis. Through the stiff anchoring body it is particularly suited for the connection of thin structural components.
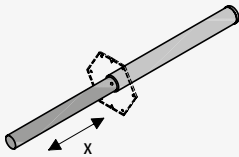
SLD-Q

This heavy duty dowel serves the transmission of high shear forces in bulding joints and with this enables free movement in the longitudinal and transverse direction to the dowel axis. Through the stiff anchoring body it is particularly suited for the connection of thin structural components.
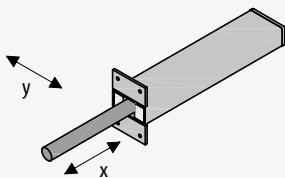
Schöck Dorn type LD

LD

The load dowel serves the transmission of small to medium shear forces in building and structural component joints and with this enables free movement in the direction of the dowel axis.

LD-Q

The load dowel serves the transmission of small to medium shear forces in building and structural component joints and with this enables a moveability in the direction of the longitudinal and traverse direction to the dowel axis.

Schöck fire protection sleeve BSM
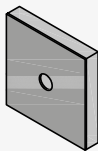
BSM

In the case of fire the fire protection sleeve protects the dowel from direct flame impingement and heat. Thus a classification of the shear force connection in the fire resistance class R120 is possible. With an appropriate joint configuration the requirements on the fire resistance class REI120 can be met.

Scheduled expansion joints | Schöck Dorn solution

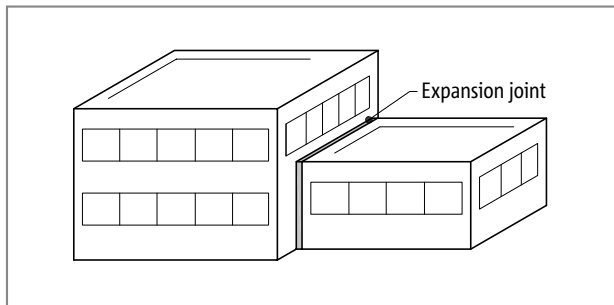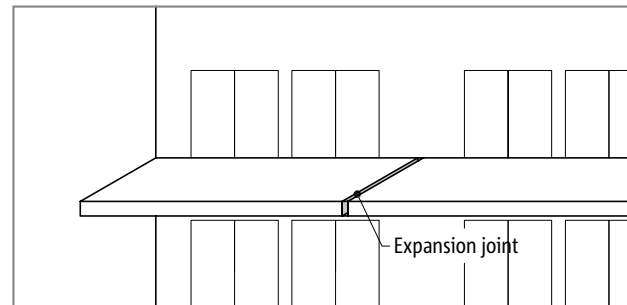Fig. 1: Building joint - expansion joint severs the complete building

Fig. 2: Structural component joint - expansion joint separates individual structural components only

Scheduled expansion joints

In long concrete structural components, due to temperature elongation, shrinkage, swelling or creeping of the concrete, considerable forced stresses can arise. These stresses lead to cracks or other structural damage. For this reason expansion joints are arranged in order to enable a zero-stress deformation of the structural components. These expansion joints can separate complete parts of a building or only individual structural components. A typical structural component expansion joint is, for example, positioned in long balconies. On the other hand, with a building expansion joint, attention must be paid that all structural components are severed by a joint.
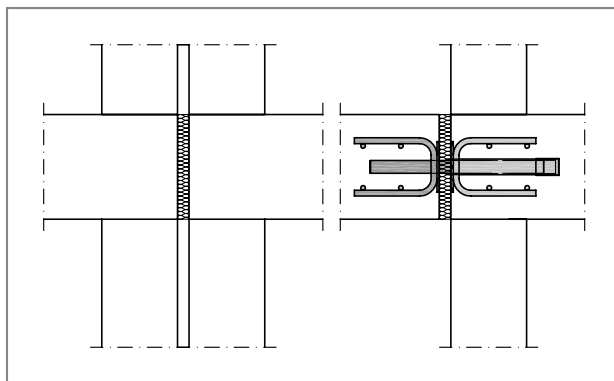

Fig. 3: Expansion joint using a Schöck Dorn instead of a twin column or double wall
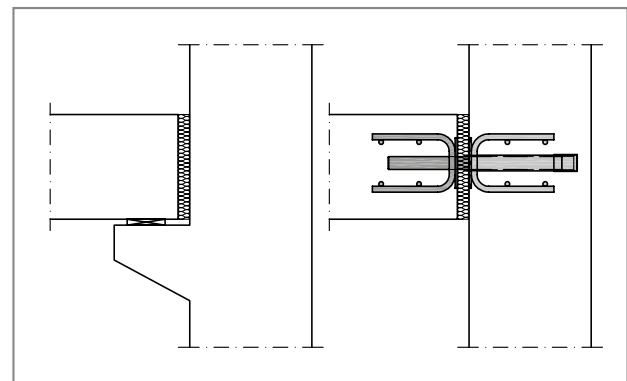

Fig. 4: Expansion joint using a Schöck Dorn instead of a support corbel

Schöck Dorn solution

In the area of the joint the structural components separated by the joint must be supported. Furthermore, different deformations of the building parts are also to be avoided. Conventionally, for this, corbels with slide bearings or a double arrangement of the load bearing walls and columns have been used at the structural component joint. These solutions are expensive to reinforce and to form. In addition, they require space which limits later development and usage.

Using the Schöck Dorn, horizontal movements are enabled and vertical loads transmitted. This system offers many advantages:

▶ Simpler formwork and reinforcement management
▶ Better use of space through doing away with double supports and corbels
▶ Production in one or in separate building phases possible
▶ Schöck Dorn type SLD (heavy duty dowel) with general building supervisory approval Z-15.7-236
▶ Schöck Dorn type LD (load dowel) with European Technical Assessment ETA 16/0545
▶ User-friendly design program for free download at www.schoeck.de
▶ Joint configuration in fire resistance class 120 or REI120 possible
▶ Secure and maintenance-free connection through the employment of high-grade stainless steels

Connection situations
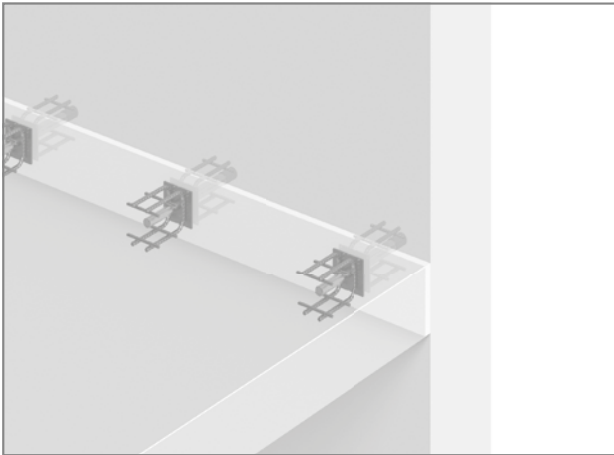
Fig. 5: Schöck Dorn type SLD: Connection slab-wall
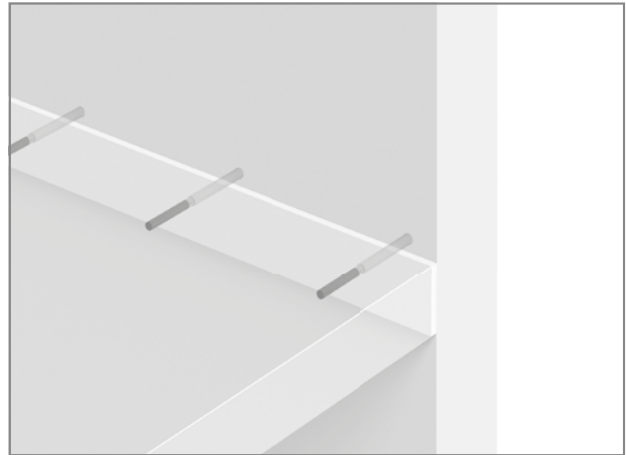
Fig. 6: Schöck Dorn type LD: Connection slab-wall
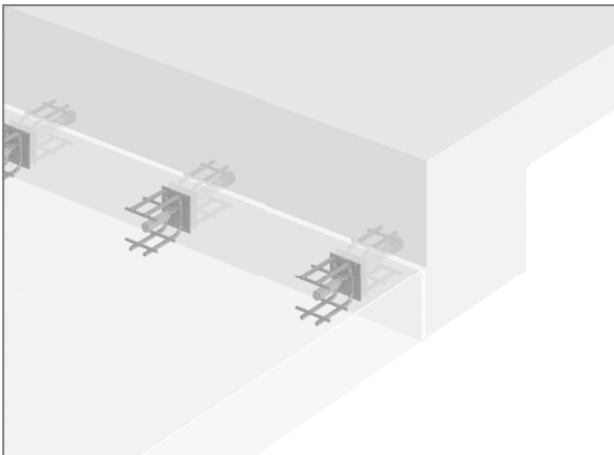
Fig. 7: Schöck Dorn type SLD: Connection slab-downstand beam
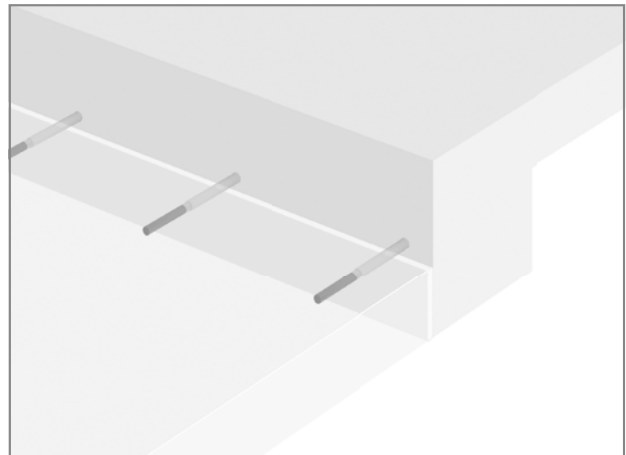
Fig. 8: Schöck Dorn type LD: Connection slab-downstand beam
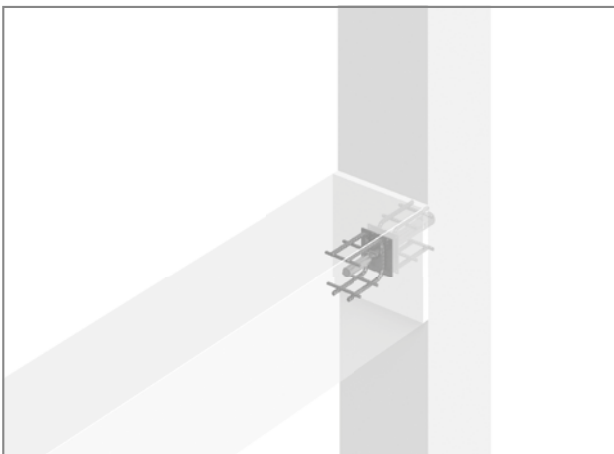
Fig. 9: Schöck Dorn: Connection balcony-column

Fig. 10: Schöck Dorn: Connection slab-column

Connection situations

Fig. 11: Schöck Dorn: Connection wall-wall (face-flank)

Fig. 12: Schöck Dorn: Connection wall-wall (face-face)
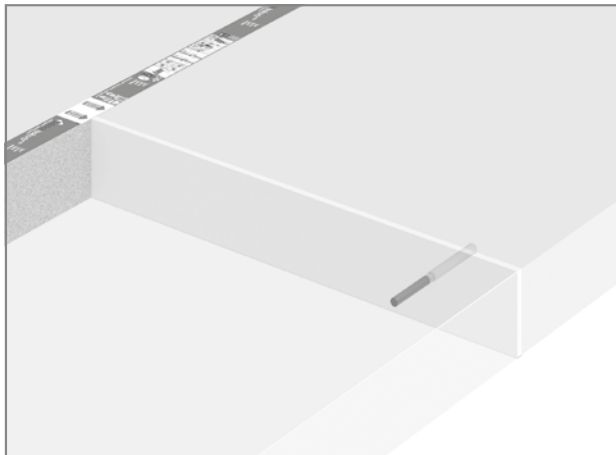
Fig. 13: Schöck Dorn: Expansion joints in balcony slabs
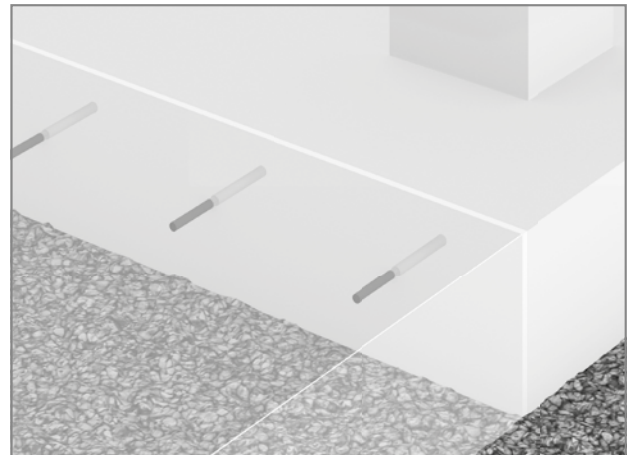
Fig. 14: Schöck Dorn: Expansion joints in base slab
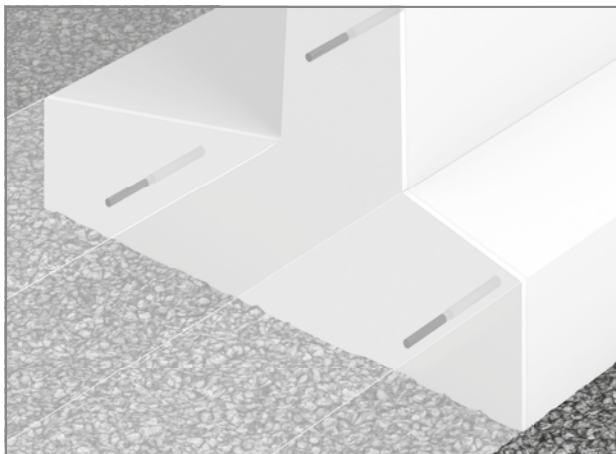
Fig. 15: Schöck Dorn: Expansion joint in cantilevered wall

Fig. 16: Schöck Dorn: Position security of a balcony on a corbel

Design process

Determination of the shear force path in the joint using FEM software or through simplified static models

Determination of a simplified shear force path for the design

Determination of the maximum joint width to be expected in accordance with page 12

Are transversely movable dowels required? (See page 13)

Plan view

V_{Ed}

V'_{Ed}

Optimal arrangement of dowels

Design using tables	**Design using Schöck Dorn design program**
Verification of the minimum structural component dimensions and the applicable shear force dowels see page 19 or 47	Design software for the free download at www.schoeck.de (Details see page 11)
Selection of a dowel spacing in between critical dowel separation in accordance with page 20 or 48 and 8-times slab thickness	Input of the boundary conditions and the loading
Calculation of the dowel load $V_{Dorn} = v_{Ed} \cdot e$	Automatic calculation and graphic output of the shear force dowels and the reinforcement
Selection of the matching dowel from diesign tables from page 24 or 50 according to the boundary conditions	Saving of the project and the position
Optimisation of the dowel spacing according to the design resistance $e = V_{Rd,dowel} / v_{Ed} < 8 \cdot$ slab thickness	Input of further positions
Determination of the required edge reinforcement in accordance with page 30 or 52	

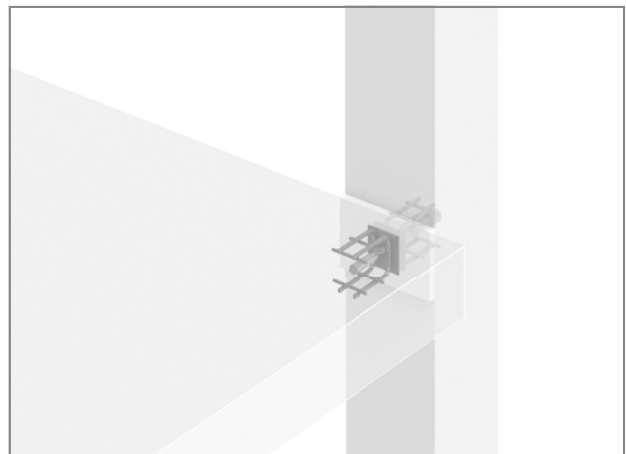| Load capacity		40	50
Slab thickness [mm]	Joint width [mm]	Design resistances V_{Rd} [kN/Dorn]	
160	20	..	...
	30	..	...
	40	..	...
	50	..	...
180	20	..	...
	30	xx,x	...
	40	...	...
	...	...	...

Design software

The Schöck Dorn software allows a simple and rapid design of expansion joints using the Schöck Dorn type SLD and LD.

▸ Design takes place in accordance with approvals and BS EN 1992-1-1 (EC2)
▸ Many different application cases are verifiable (slab-slab, slab-wall, slab-downstand beam, etc.)
▸ Automatic determination of the dowel spacings and dowel types
▸ Flexible load input through distributed loads, triangular loads or with free arrangement
▸ Automatic determination and graphic representation of the edge reinforcement
▸ Easy transfer of the design results onto the drawing through dxf output
▸ Free download without registration at www.schoeck.de
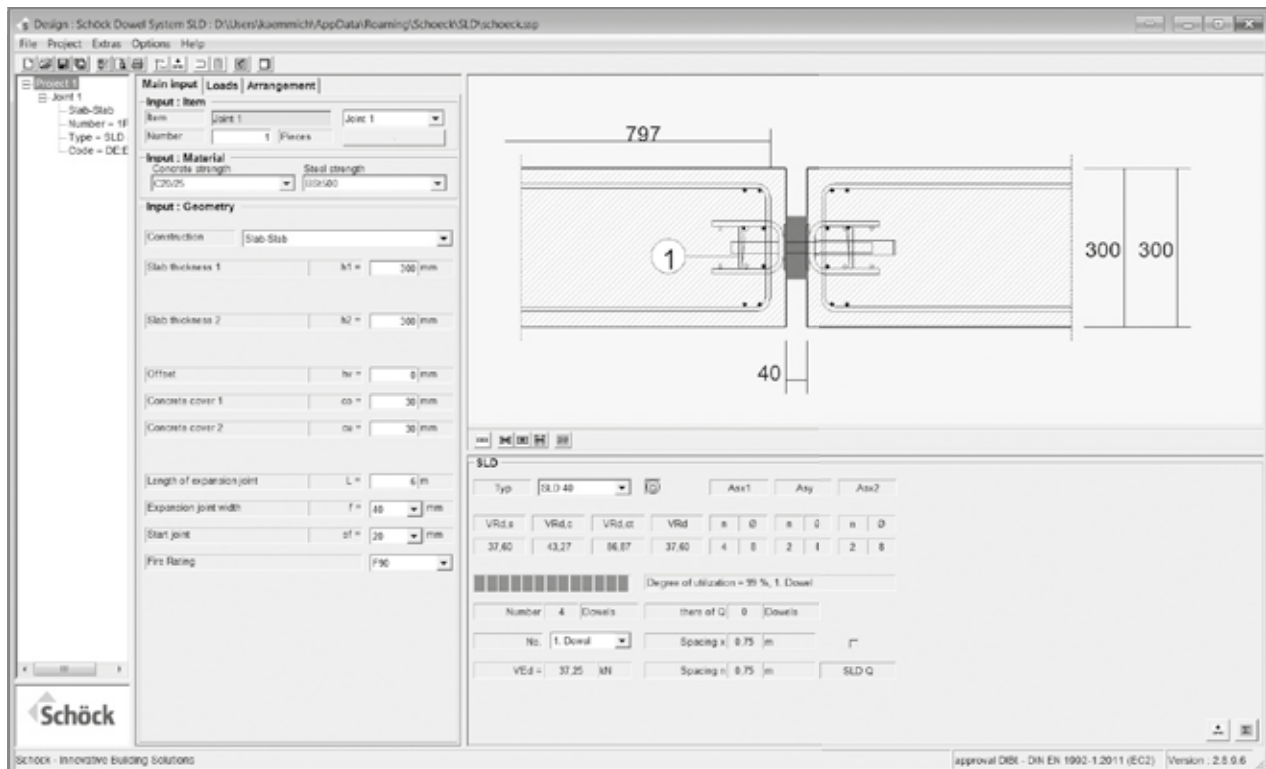
Calculation of maximum joint width

Calculation of maximum joint width

The maximum occurring joint width is relevant for the design of the shear force dowel. This is calculated from the initial joint width as well as the temperature and the shrinkage expansion of the neighbouring structural components. The influence of the creeping is only to be taken into account if a continuous direct stress is acting on the structural component, e.g. through prestressing. The maximum joint width can be estimated according to the following equation:

$$\text{Joint width } f = f_i + L_w \cdot (\Delta T \cdot \alpha_t + \varepsilon_{cd} + \varepsilon_{ca})$$

with:

f_i	- initial joint width at manufacture [mm]	
	$f_i = L_w / 1200$	
L_w	- effective structural component length for expansion	
ΔT	- maximum temperature change of the structural component in accordance with BS EN 1991-1-5	
α_t	- $1.5 \cdot 10^{-5}$ [1/K] in accordance with BS EN 1992-1-1, Sect. 3.1.3 (6)	
ε_{cd}	- drying shrinkage expansion in accordance with BS EN 1992-1-1, para. 3.1.4 (6)	
ε_{ca}		

Example joint width calculation
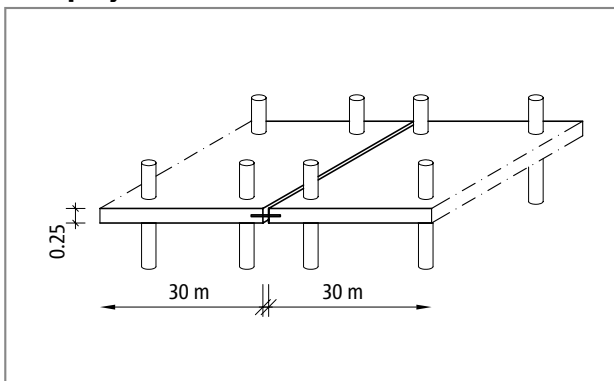
Fig. 17: Flat floor in an office building

Expansion joint in a flat floor:

 Slab thickness 25 cm
 Concrete C25/30 with cement strength class 32.5 N
 Effective structural component length to centre line of the flat floor 15 m
 Air humidity 60 %
 Temperature expansion can be ignored as the building is heated later

Calculation accordiung to BS EN 1992-1-1:

 $f_i = 2 \cdot 15.000 / 1200 = 25$ mm - selected: 30 mm
 $\varepsilon_{cd} = 0.0435$ % in accordance with BS EN 1992-1-1, para. 3.1.4 (6)
 $\varepsilon_{ca} = 0.00375$ % in accordance with BS EN 1992-1-1, para. 3.1.4 (6)

 $f = 30 + 2 \cdot 15.000 \cdot (0.000435 + 0.0000375) = \textbf{44 mm}$

With the calculated shrinkage expansions it is a matter of mean values with variation coefficients of ca. 30 %. For this reason an additional safety margin of 0.5 to 1 cm should be taken into account.

Selection of Schöck Dorn | Design information

Selection of Schöck Dorn

The Schöck Dorn types LD and SLD are approved for constructional and load-bearing structure-relevant shear force connections. The selection of the correct Schöck Dorn results from the load-bearing capacity in the respective installation situation. Thus the Schöck Dorn type SLD, due to its anchoring body, transmits high shear forces also in thin structural components. This is also clear in the following diagram, which compares the maximum load-bearing capacity of the Schöck Dorn types with certain slab heights.
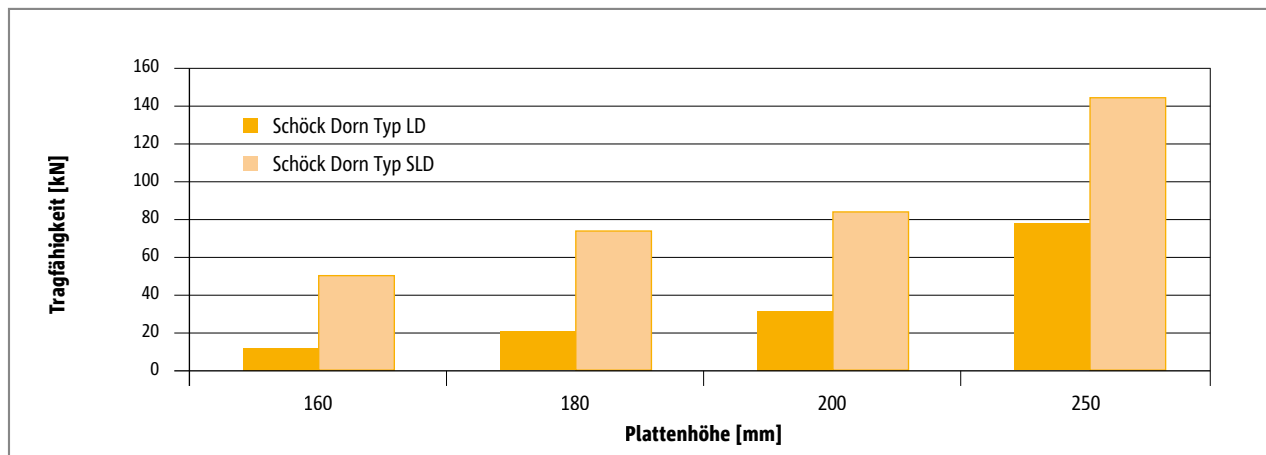
Fig. 18: Load-bearing capacity of the Schöck Dorn types with certain slab heights

Design information

Expansion joints are to be planned systematically for the prevention of constraints in structural components. Thus the connected structural components must be investigated in the longitudinal and transverse direction for possible motional influences such as temperature changes, shrinkage, creeping, swelling and settling of buildings. With long expansion joints upwards of 8m or with expansion joints which do not run in a straight line, biaxial displaceable dowel type SLD-Q or LD-Q are to be used.
In the case of scheduled forces along and perüendicular to the joint these are to be incorporated separately. For this, transversely movable dowel type SLD-Q or LD-Q are to be arranged over the complete joint. Dowels for the planned acceptance of joint longitudinal force are installed at rightangles to the joint axis. Thus it is ensured that these dowels are not loaded unscheduled due to vertical loads.
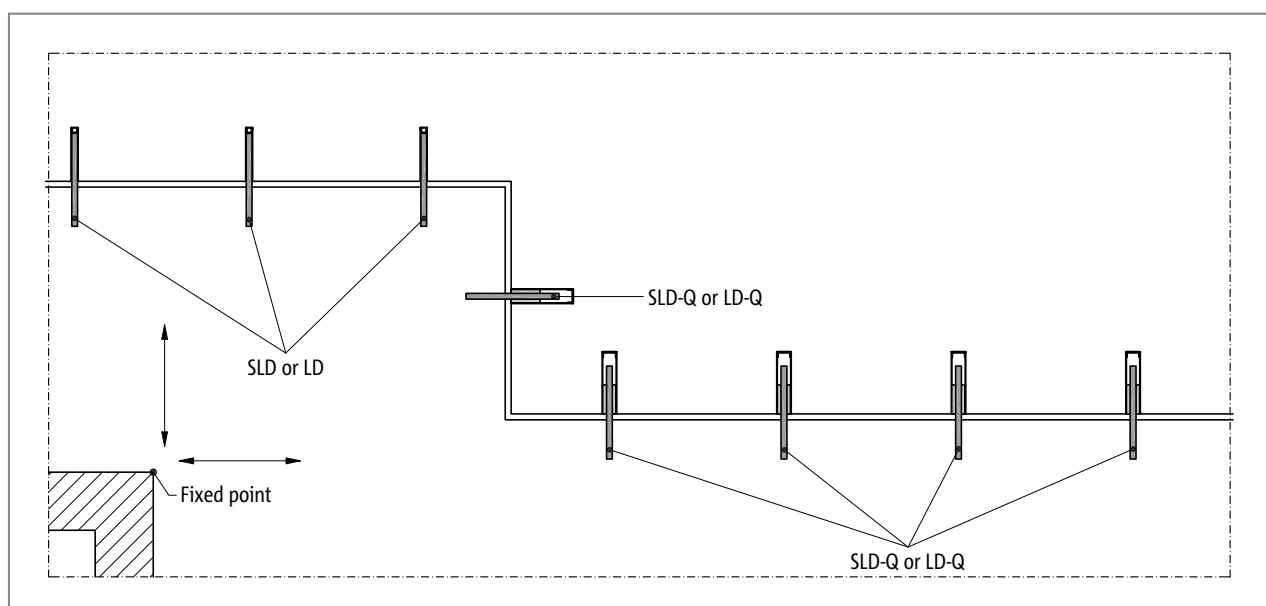
Fig. 19: Arrangement of axially and transversely movable dowels in building joints

Fire protection sleeve | Fire protection requirement R120/REI120

Schöck fire protection sleeve BSM

Using the Schöck fire protection sleeve the joint design with the Schöck Dorn type LD and type SLD can be configured in a fire resistance class R120. This sleeve consists of an incombustible mineral fibre plate with a 2 mm thick Promaseal® PL strip. In the case of fire the Promaseal® expands in order to close an air gap in the joint of up to 10 mm and thus to protect the dowel. Thus no further cladding of the joint is necessary.

Depending on the planned joint width the fire protection sleeve is available with a thickness of 20 or 30 mm. For larger joint widths several fire protection sleeves can be combined.
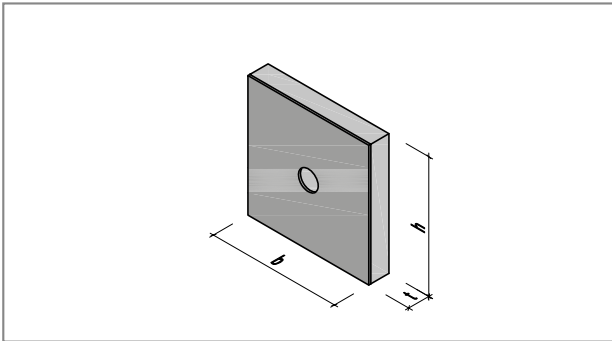
Fig. 20: Configuration of the Schöck fire protection sleeve
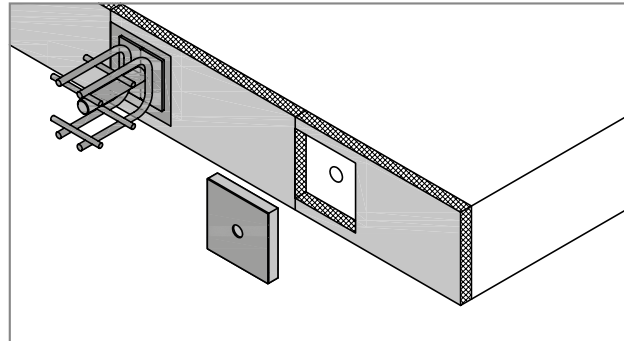
Fig. 21: Configuration of the Schöck fire protection sleeve in the joint

Joints with fire protection requirement REI120

Many joints also have a room-enclosing function in order to prevent a spread of smoke and fire. This can also be achieved by the employment of a Promaseal® PL expansion strip. This joint configuration is presented in the following diagram and has been tested in the fire protection laboratory of the ITB in Poland. With this arrangement and a minimum slab thickness of 200 mm the requirements of fire resistance class REI120 in accordance with BS EN 13501-2 could be achieved.
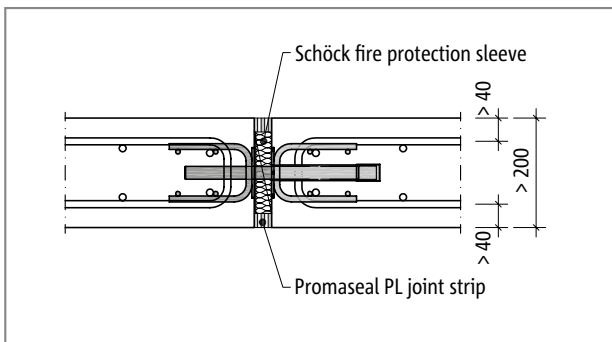
Fig. 22: Configuration of an expansion joint with REI120 fire protection classification

Promaseal® is a registered brand of Promat GmbH.

Fire protection sleeve

Fire protection sleeve for Schöck Dorn type SLD and SLD-Q

Fire protection sleeve for Schöck Dorn type SLD / SLD-Q	Thickness	Height	Width
	Dimension [mm]		
SLD 40/50 BSM 20	20	120	150
SLD 40/50 BSM 30	30		
SLD 60/70 BSM 20	20	150	160
SLD 60/70 BSM 30	30		
SLD 80 BSM 20	20	170	190
SLD 80 BSM 30	30		
SLD 120/150 BSM 20	20	250	250
SLD 120/150 BSM 30	30		

Fire protection sleeve for Schöck Dorn type LD and LD-Q

Fire protection sleeve for Schöck Dorn type LD / LD-Q	Thickness	Height	Width
	Dimension [mm]		
LD 16-22 BSM 20	20	120	150
LD 16-22 BSM 30	30		
LD 25-30 BSM 20	20	150	160
LD 25-30 BSM 30	30		

Schöck Dorn type SLD, SLD-Q
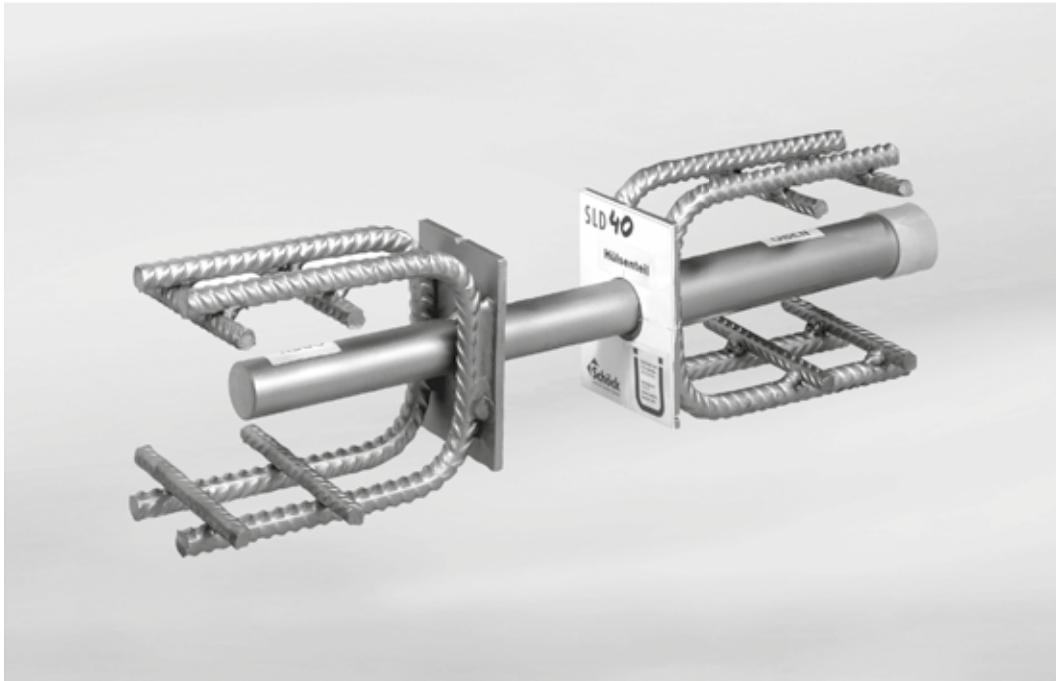
Schöck Dorn type SLD

For the transmission of high transverse forces in expansion joints between thin concrete structural components with freedom of movement in the direction of the dowel axis.

Schöck Dorn type SLD-Q

For the transmission of high shear forces between thin concrete structural components with freedom of movement along and transverse to the dowel axis.

Type designations | Product characteristics | Application areas

Schöck Dorn type SLD

SLD

The heavy duty dowel serves the transmission of high shear forces in building joints and with this enables free movement in the direction of the dowel axis. Through the stiff anchoring body it is particularly suited for the connection of thin structural components.

SLD-Q

This heavy duty dowel serves the transmission of high shear forces in bulding joints and with this enables free movement in the longitudinal and transverse direction to the dowel axis. Through the stiff anchoring body it is particularly suited for the connection of thin structural components.

Type designations in planning documents

Dowel type
Sleeve movable transversely (optional)
Load-bearing level

SLD - Q - 60
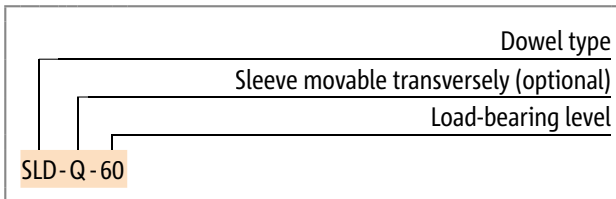
Product characteristics

The Schöck Dorn type SLD (heavy duty dowel) consists of a sleeve part and a dowel part, which is concreted into the building components respectively adjacent to the joint. The dowel transmits the loads from one structural component through bending in the sle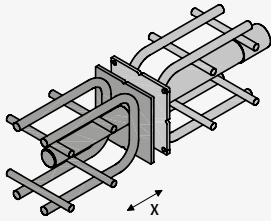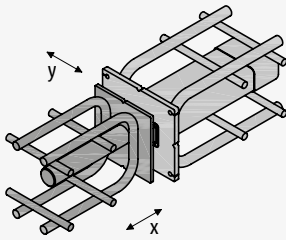eve and thus into the other structural component. With this, the welded-on stirrups and the face plate ensure an optimum anchoring of the concrete.

The sleeve of the Schöck Dorn type SLD is round and thus enables a moveability 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. Should a movement lateral to the dowel axis be required, the Schöck Dorn type SLD-Q can be used. The sleeve of this dowel is rectangular and thus enables displacement of ± 12 mm in the transverse direction.

Application areas

The Schöck Dorn type SLD has general building supervisory approval from the German Institute for Structural Engineering (DIBt) for the transmission of mainly dormant, statically relevant shear forces with expansion joints. Approval Z-15.7-236 regulates the design according to BS EN 1992-1-1 (EC2) for the concrete strength classes C20/25 to C50/60. The joint widths can vary between 10 and 60 m. The Schöck Dorn type SLD is approved as form-fit connecting element between reinforced concrete structural components, which fulfil the conditions for the limitation of deflection in accordance with BS EN 1992-1-1para. 7.4.2.

Dowel and sleeve consist of stainless steels of the material numbers 1.4362, 1.4571 as well as 1.4404 and thus meet the requirements of corrosion resistance class 3 in accordance with BS EN 1993-1-4.

All dimensions, reinforcement and geometry tables below apply according to BS EN 1992-1-1 (EC2). The concrete load-bearing capabilities for this were determined with a concrete cover of von 30 mm.

Minimum dowel spacing/structural component measurements

Schöck Dorn type SLD	40	50	60	70	80	120	150
Minimum structural component measurements	Dimension [mm]						
Slab thickness h_{min}	160	160	180	200	240	300	350
Wall thickness b_w	185	200	215	255	275	460 + c_{nom}	460 + c_{nom}
Balcony width b_u	240	240	270	300	360	450	530
Minimum dowel spacing							
Horizontal $e_{h,min}$	240	240	270	300	360	450	530
Vertical $e_{v,min}$	120	120	140	160	200	215	235
Minimum edge separation							
Horizontal $e_{R,min}$	120	120	135	150	180	225	265

Schöck Dorn type SLD	Q 40	Q 50	Q 60	Q 70	Q 80	Q 120	Q 150
Minimum structural component measurements	Dimension [mm]						
Slab thickness h_{min}	160	160	180	200	240	300	350
Wall thickness b_w	200	210	215	250	305 + c_{nom}	460 + c_{nom}	540 + c_{nom}
Balcony width b_u	240	240	270	300	360	450	530
Minimum dowel spacing							
Horizontal $e_{h,min}$	240	240	270	300	360	450	530
Vertical $e_{v,min}$	120	120	140	160	200	215	235
Minimum edge separation							
Horizontal $e_{R,min}$	120	120	135	150	180	225	265

SLD

Fig. 23: Schöck Dorn type SLD: Minimum structural component measurements and dowel spacings with one slab
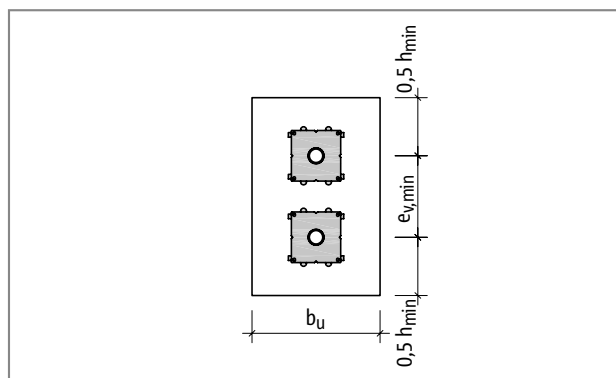
Fig. 24: Schöck Dorn typeSLD: Minimum structural component measurements and dowel spacings in the front face of a balcony or a wall
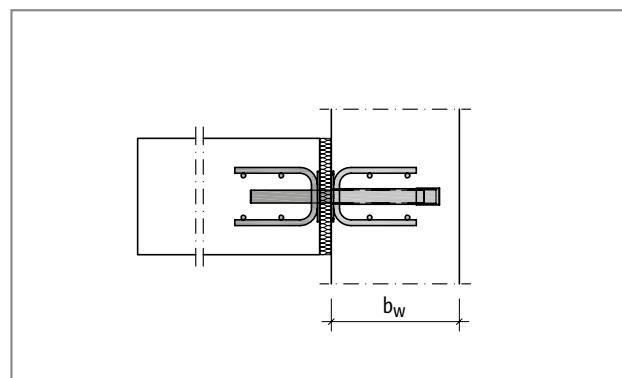
Fig. 25: Schöck Dorn type SLD: Minimum structural component thickness of a wall or column

Critical dowel spacings/edge separations

With the observation of the critical edge separations and dowel spacings no mutual influencing of the punching cone is to be taken in to account. The design tables onwards from page 24 are based on these spacings. Should these spacings be undercut an additional punching shear design taking into account the shortened circular cuts is required.
The maximum dowel spacing is limited in the Product Standard ETAG 030 to 8 times the slab height.
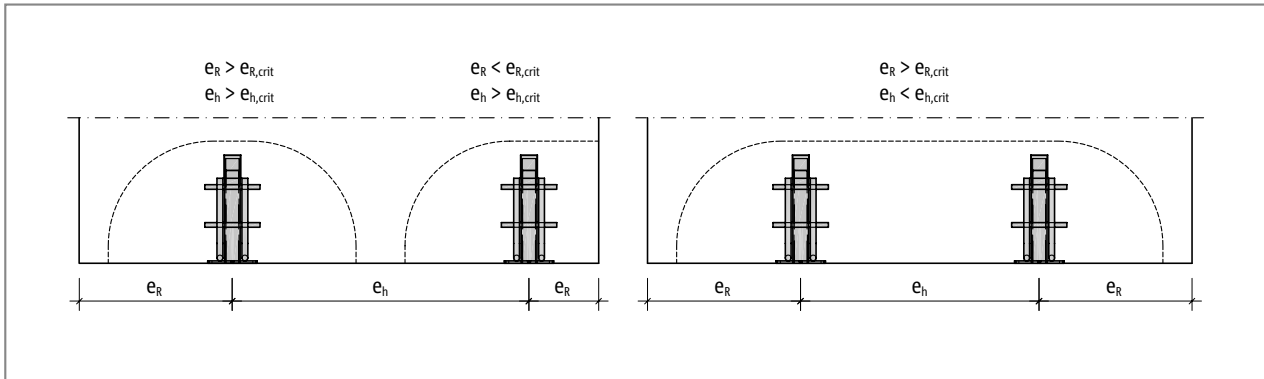
Fig. 26: Schöck Dorn type SLD: Circular cut depending on critical dowel spacing and edge separation

Schöck Dorn type SLD	40	50	60	70	80	120	150
Slab thickness [mm]	Critical dowel spacings $e_{h,crit}$ [mm]						
160	425	420	-	-	-	-	-
180	470	470	480	-	-	-	-
200	515	515	530	550	-	-	-
220	560	560	575	595	-	-	-
250	695	690	645	660	700	-	-
280	785	780	780	730	765	-	-
300	845	840	840	850	810	880	-
350	995	990	990	1000	925	1030	1035
Slab thickness [mm]	Critical edge spacings $e_{R,crit}$ [mm]						
160	345	340	-	-	-	-	-
180	380	380	390	-	-	-	-
200	415	415	425	440	-	-	-
220	450	450	460	475	-	-	-
250	555	555	515	530	555	-	-
280	625	625	625	580	605	-	-
300	675	670	670	675	640	685	-
350	790	790	790	795	730	805	805

Critical dowel spacings/edge separations

Schöck Dorn type SLD	Q 40	Q 50	Q 60	Q 70	Q 80	Q 120	Q 150
Slab thickness [mm]	Critical dowel spacings $e_{h,crit}$ [mm]						
160	455	455	-	-	-	-	-
180	500	500	515	-	-	-	-
200	545	545	565	585	-	-	-
220	590	590	610	630	-	-	-
250	725	725	675	695	730	-	-
280	815	815	815	765	795	-	-
300	875	875	875	885	840	915	-
350	1025	1025	1025	1035	955	1065	1075
Slab thickness [mm]	Critical edge spacings $e_{R,crit}$ [mm]						
160	360	360	-	-	-	-	-
180	395	395	405	-	-	-	-
200	430	430	445	455	-	-	-
220	465	465	480	495	-	-	-
250	570	570	530	545	570	-	-
280	640	640	640	600	620	-	-
300	690	690	690	695	655	705	-
350	805	805	805	815	745	825	825

SLD

Product description SLD 40-80
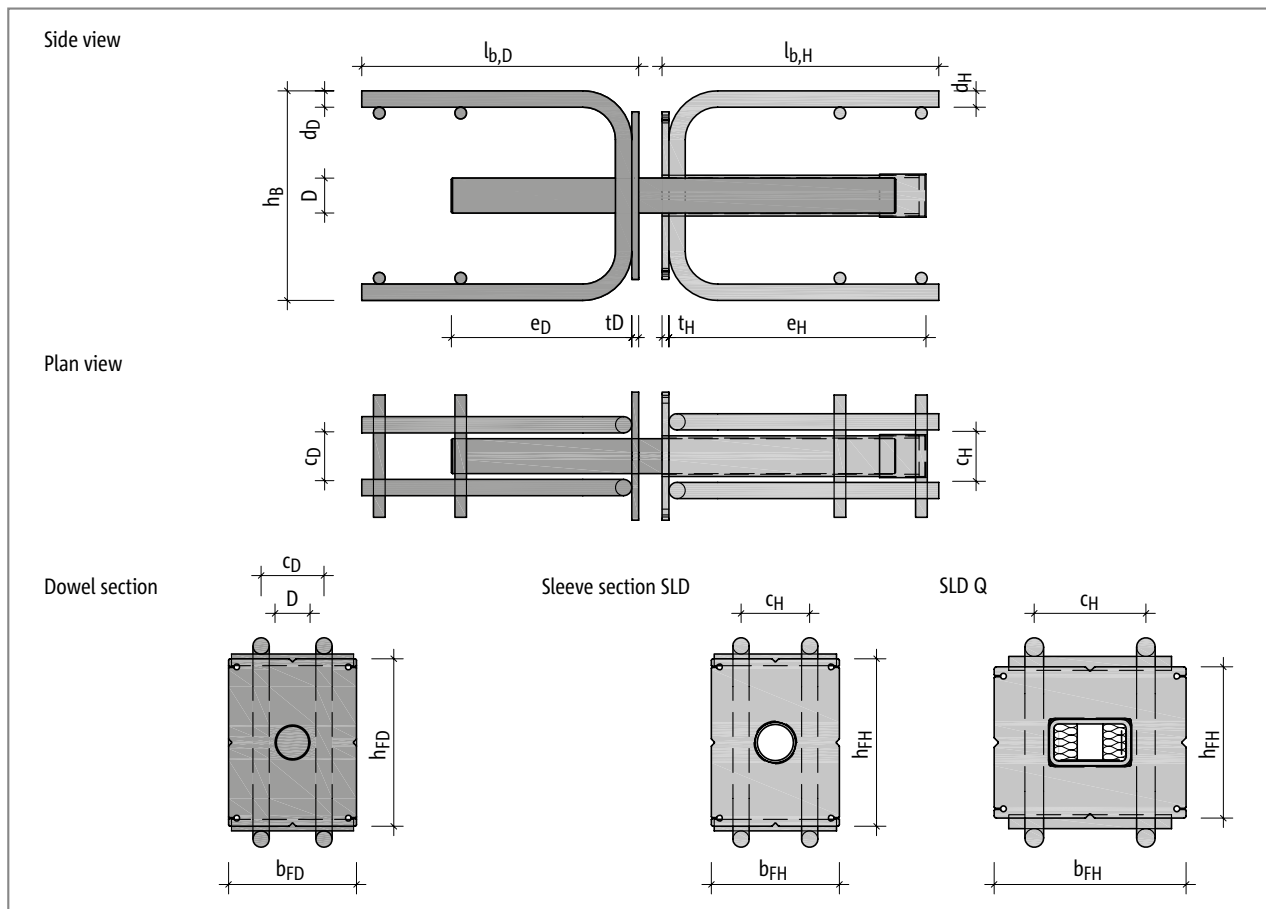
Fig. 27: Schöck Dorn type SLD 40 bis SLD 80: Dimensions

Schöck Dorn type SLD		40	Q 40	50	Q 50	60	Q 60	70	Q 70	80	Q 80
Dowel part		Dimensions [mm]									
∅ Dowel	D	22		22		24		27		30	
Dowel anchoring depth	e_D	100		115		130		145		155	
∅ Stirrup	d_D	10		10		12		12		14	
Stirrup height	h_B	100		100		120		140		180	
Stirrup length	$l_{b,D}$	146		146		169		220		238	
Stirrup spacing	c_D	42		42		46		49		54	
Face plate thickness	t_D	4		4		4		5		6	
Face plate height	h_{FD}	85		87		117		129		144	
Face plate width	b_{FD}	65		85		85		95		110	
Sleeve part											
Sleeve length	e_H	165	165	180	180	195	195	211	211	221	221
∅ Stirrup	d_H	10	10	10	12	12	12	12	14	14	16
Stirrup length	$l_{b,H}$	146	168	146	175	169	171	220	214	238	294
Stirrup spacing	c_H	43	76	43	78	46	82	50	86	59	96
Face plate thickness	t_H	4	5	4	6	4	6	5	8	6	8
Face plate height	h_{FH}	85	95	87	95	117	110	129	110	144	130
Face plate width	b_{FH}	65	105	85	110	85	120	95	130	110	165

SLD

Product description SLD 120-150
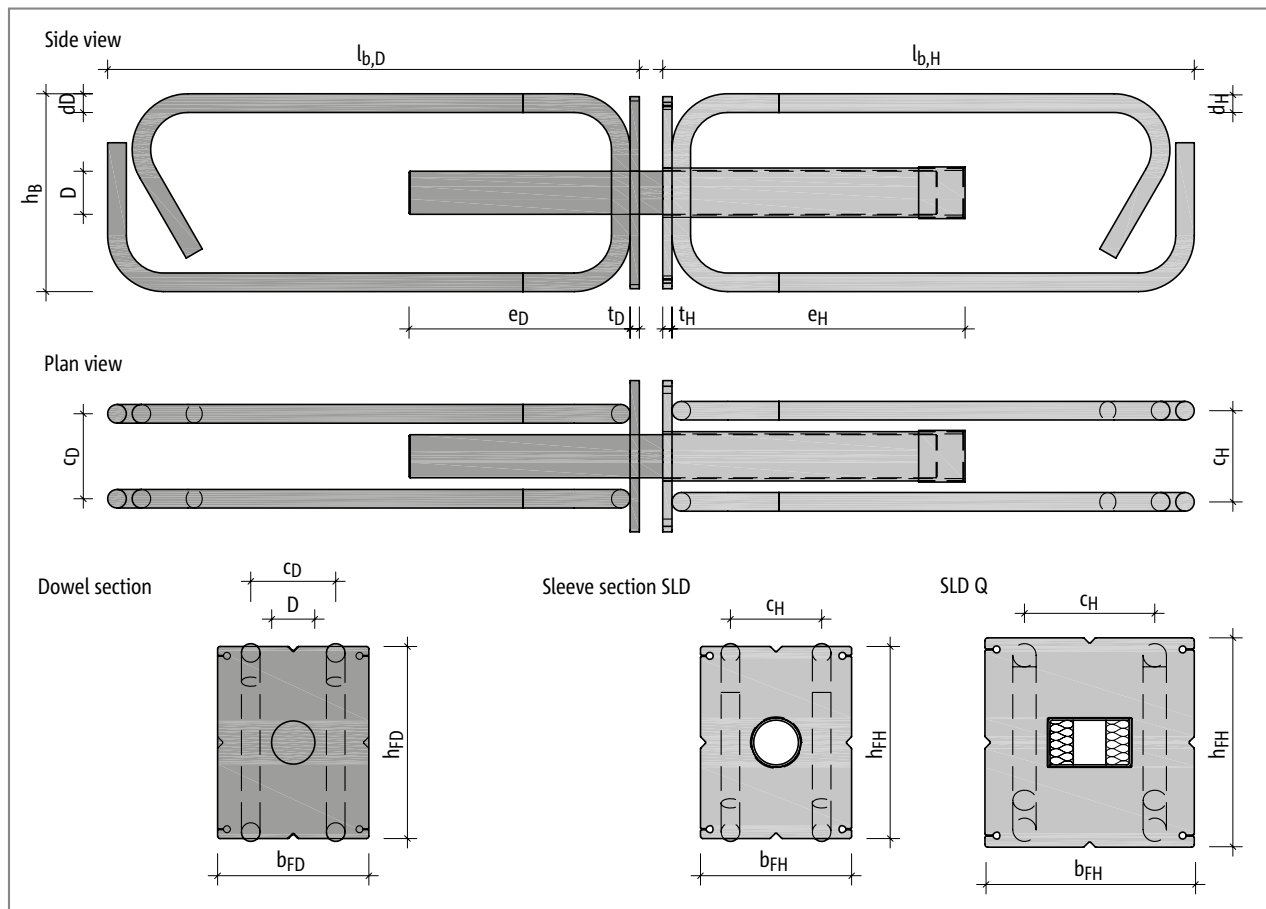
Fig. 28: Schöck Dorn type SLD 120, SLD 150: Dimensions

Schöck Dorn type SLD		120	Q 120	150	Q 150
Dowel part		Dimensions [mm]			
∅ Dowel	D	37		42	
Dowel anchoring depth	e_D	190		230	
∅ Stirrup	d_D	16		20	
Stirrup height	h_B	170		210	
Stirrup length	$l_{b,D}$	457		458	
Stirrup spacing	c_D	73		82	
Face plate thickness	t_D	8		10	
Face plate height	h_{FD}	165		180	
Face plate width	b_{FD}	130		145	
Sleeve part					
Sleeve length	e_H	258	258	300	302
∅ Stirrup	d_H	16	20	20	25
Stirrup length	$l_{b,H}$	457	448	458	536
Stirrup spacing	c_H	78	112	88	122
Face plate thickness	t_H	8	10	10	10
Face plate height	h_{FH}	165	180	180	210
Face plate width	b_{FH}	130	180	145	200

Design SLD C20/25

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

The following design values have been determined in accordance with BS EN 1992-1-1 (EC2) with a concrete cover of 30 mm. With higher concrete cover the load-bearing capacity for a correspondingly reduced slab height must be applied. The maximum load-bearing capacities listed here apply only in connection with a reinforcement arrangement in accordance with page 30 or 31 and under observation of the critical dowel spacing or edge separation in accordance with page 20.

Schöck Dorn type		SLD 40	SLD 50	SLD 60	SLD 70	SLD 80	SLD 120	SLD 150
Slab thickness [mm]	Joint width [mm]	Design resistances V_{Rd}, Concrete strength class C20/25 [kN/dowel]						
160	20	35.8	46.7					
	30	35.8	46.7					
	40	35.8	46.7					
	50	30.1	40.1					
	60	25.1	33.4					
180	20	39.1	50.8	52.6				
	30	39.1	50.8	52.6				
	40	37.6	50.1	52.6				
	50	30.1	40.1	52.0				
	60	25.1	33.4	43.4				
200	20	55.4	54.7	66.9	73.1			
	30	50.2	54.7	66.9	73.1			
	40	37.6	50.1	65.0	73.1			
	50	30.1	40.1	52.0	73.1			
	60	25.1	33.4	43.4	61.7			
220	20	60.3	72.4	75.0	81.8			
	30	50.2	66.4	75.0	81.8			
	40	37.6	50.1	65.0	81.8			
	50	30.1	40.1	52.0	74.1			
	60	25.1	33.4	43.4	61.7			
250	20	67.5	85.6	87.6	95.1	125.9		
	30	50.2	66.4	84.8	95.1	125.9		
	40	37.6	50.1	65.0	92.6	125.9		
	50	30.1	40.1	52.0	74.1	101.6		
	60	25.1	33.4	43.4	61.7	84.7		
280	20	67.6	85.6	98.2	106.6	139.7		
	30	50.2	66.4	84.8	106.6	139.7		
	40	37.6	50.1	65.0	92.6	125.9		
	50	30.1	40.1	52.0	74.1	101.6		
	60	25.1	33.4	43.4	61.7	84.7		
300	20	67.6	85.6	103.9	126.5	149.1	167.6	
	30	50.2	66.4	84.8	116.1	149.1	167.6	
	40	37.6	50.1	65.0	92.6	125.9	167.6	
	50	30.1	40.1	52.0	74.1	101.6	167.6	
	60	25.1	33.4	43.4	61.7	84.7	158.9	
350	20	67.6	85.6	105.7	139.6	172.9	201.3	232.1
	30	50.2	66.4	84.8	116.1	152.0	201.3	232.1
	40	37.6	50.1	65.0	92.6	125.9	201.3	232.1
	50	30.1	40.1	52.0	74.1	101.6	189.4	232.1
	60	25.1	33.4	43.4	61.7	84.7	158.9	232.1

SLD

Design SLD C25/30

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

The following design values have been determined in accordance with BS EN 1992-1-1 (EC2) with a concrete cover of 30 mm. With higher concrete cover the load-bearing capacity for a correspondingly reduced slab height must be applied. The maximum load-bearing capacities listed here apply only in connection with a reinforcement arrangement in accordance with page 30 or 31 and under observation of the critical dowel spacing or edge separation in accordance with page 20.

Schöck Dorn type		SLD 40	SLD 50	SLD 60	SLD 70	SLD 80	SLD 120	SLD 150
Slab thickness [mm]	Joint width [mm]	Design resistances V_{Rd}, Concrete strength class C25/30 [kN/dowel]						
160	20	40.4	52.3					
	30	40.4	52.3					
	40	37.6	50.1					
	50	30.1	40.1					
	60	25.1	33.4					
180	20	44.2	57.2	59.3				
	30	44.2	57.2	59.3				
	40	37.6	50.1	59.3				
	50	30.1	40.1	52.0				
	60	25.1	33.4	43.4				
200	20	62.5	61.8	72.0	78.8			
	30	50.2	61.8	72.0	78.8			
	40	37.6	50.1	65.0	78.8			
	50	30.1	40.1	52.0	74.1			
	60	25.1	33.4	43.4	61.7			
220	20	67.6	78.0	80.8	88.1			
	30	50.2	66.4	80.8	88.1			
	40	37.6	50.1	65.0	88.1			
	50	30.1	40.1	52.0	74.1			
	60	25.1	33.4	43.4	61.7			
250	20	67.6	85.6	94.4	102.4	135.6		
	30	50.2	66.4	84.8	102.4	135.6		
	40	37.6	50.1	65.0	92.6	125.9		
	50	30.1	40.1	52.0	74.1	101.6		
	60	25.1	33.4	43.4	61.7	84.7		
280	20	67.6	85.6	105.7	114.8	150.5		
	30	50.2	66.4	84.8	114.8	150.5		
	40	37.6	50.1	65.0	92.6	125.9		
	50	30.1	40.1	52.0	74.1	101.6		
	60	25.1	33.4	43.4	61.7	84.7		
300	20	67.6	85.6	105.7	136.3	160.6	180.5	
	30	50.2	66.4	84.8	116.1	152.0	180.5	
	40	37.6	50.1	65.0	92.6	125.9	180.5	
	50	30.1	40.1	52.0	74.1	101.6	180.5	
	60	25.1	33.4	43.4	61.7	84.7	158.9	
350	20	67.6	85.6	105.7	139.6	178.2	216.8	250.0
	30	50.2	66.4	84.8	116.1	152.0	216.8	250.0
	40	37.6	50.1	65.0	92.6	125.9	216.8	250.0
	50	30.1	40.1	52.0	74.1	101.6	189.4	250.0
	60	25.1	33.4	43.4	61.7	84.7	158.9	232.2

SLD

Design SLD C30/37 – C50/60

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

The following design values have been determined in accordance with BS EN 1992-1-1 (EC2) with a concrete cover of 30 mm. With higher concrete cover the load-bearing capacity for a correspondingly reduced slab height must be applied. The maximum load-bearing capacities listed here apply only in connection with a reinforcement arrangement in accordance with page 30 or 31 and under observation of the critical dowel spacing or edge separation in accordance with page 20.

Schöck Dorn type		SLD 40	SLD 50	SLD 60	SLD 70	SLD 80	SLD 120	SLD 150
Slab thickness [mm]	Joint width [mm]	Design resistances V_{Rd}, Concrete strength class C30/37 [kN/dowel]						
160	20	44.6	55.6					
	30	44.6	55.6					
	40	37.6	50.1					
	50	30.1	40.1					
	60	25.1	33.4					
180	20	48.9	63.1	65.6				
	30	48.9	63.1	65.6				
	40	37.6	50.1	65.0				
	50	30.1	40.1	52.0				
	60	25.1	33.4	43.4				
200	20	67.6	68.3	76.5	83.7			
	30	50.2	66.4	76.5	83.7			
	40	37.6	50.1	65.0	83.7			
	50	30.1	40.1	52.0	74.1			
	60	25.1	33.4	43.4	61.7			
220	20	67.6	82.9	85.8	93.6			
	30	50.2	66.4	84.8	93.6			
	40	37.6	50.1	65.0	92.6			
	50	30.1	40.1	52.0	74.1			
	60	25.1	33.4	43.4	61.7			
250	20	67.6	85.6	100.3	108.9	144.1		
	30	50.2	66.4	84.8	108.9	144.1		
	40	37.6	50.1	65.0	92.6	125.9		
	50	30.1	40.1	52.0	74.1	101.6		
	60	25.1	33.4	43.4	61.7	84.7		
280	20	67.6	85.6	105.7	122.0	160.0		
	30	50.2	66.4	84.8	116.1	152.0		
	40	37.6	50.1	65.0	92.6	125.9		
	50	30.1	40.1	52.0	74.1	101.6		
	60	25.1	33.4	43.4	61.7	84.7		
300	20	67.6	85.6	105.7	139.6	170.7	191.8	
	30	50.2	66.4	84.8	116.1	152.0	191.8	
	40	37.6	50.1	65.0	92.6	125.9	191.8	
	50	30.1	40.1	52.0	74.1	101.6	189.4	
	60	25.1	33.4	43.4	61.7	84.7	158.9	
350	20	67.6	85.6	105.7	139.6	178.2	230.4	265.7
	30	50.2	66.4	84.8	116.1	152.0	230.4	265.7
	40	37.6	50.1	65.0	92.6	125.9	221.6	265.7
	50	30.1	40.1	52.0	74.1	101.6	189.4	265.7
	60	25.1	33.4	43.4	61.7	84.7	158.9	232.2

SLD

Design SLD Q C20/25

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

The following design values have been determined in accordance with BS EN 1992-1-1 (EC2) with a concrete cover of 30 mm. With higher concrete cover the load-bearing capacity for a correspondingly reduced slab height must be applied. The maximum load-bearing capacities listed here apply only in connection with a reinforcement arrangement in accordance with page 30 or 31 and under observation of the critical dowel spacing or edge separation in accordance with page 21.

Schöck Dorn type		SLD Q 40	SLD Q 50	SLD Q 60	SLD Q 70	SLD Q 80	SLD Q 120	SLD Q 150
Slab thickness [mm]	Joint width [mm]	Design resistances V_{Rd}, Concrete strength class C20/25 [kN/dowel]						
160	20	28.6	36.8					
	30	28.6	36.8					
	40	28.6	36.8					
	50	27.1	36.1					
	60	22.6	30.1					
180	20	31.7	40.7	42.3				
	30	31.7	40.7	42.3				
	40	31.7	40.7	42.3				
	50	27.1	36.1	42.3				
	60	22.6	30.1	39.0				
200	20	34.7	44.4	46.1	63.0			
	30	34.7	44.4	46.1	63.0			
	40	33.9	44.4	46.1	63.0			
	50	27.1	36.1	46.1	63.0			
	60	22.6	30.1	39.0	55.6			
220	20	49.3	48.0	65.5	68.7			
	30	45.2	48.0	65.5	68.7			
	40	33.9	45.1	58.5	68.7			
	50	27.1	36.1	46.8	66.7			
	60	22.6	30.1	39.0	55.6			
250	20	56.0	71.2	73.7	77.0	124.2		
	30	45.2	59.8	73.7	77.0	124.2		
	40	33.9	45.1	58.5	77.0	113.3		
	50	27.1	36.1	46.8	66.7	91.5		
	60	22.6	30.1	39.0	55.6	76.2		
280	20	60.8	77.0	81.7	101.2	141.9		
	30	45.2	59.8	76.3	101.2	136.8		
	40	33.9	45.1	58.5	83.3	113.3		
	50	27.1	36.1	46.8	66.7	91.5		
	60	22.6	30.1	39.0	55.6	76.2		
300	20	60.8	77.0	87.0	108.4	151.3	157.9	
	30	45.2	59.8	76.3	104.5	136.8	157.9	
	40	33.9	45.1	58.5	83.3	113.3	157.9	
	50	27.1	36.1	46.8	66.7	91.5	157.9	
	60	22.6	30.1	39.0	55.6	76.2	143.0	
350	20	60.8	77.0	95.1	119.1	160.3	175.2	182.0
	30	45.2	59.8	76.3	104.5	136.8	175.2	182.0
	40	33.9	45.1	58.5	83.3	113.3	175.2	182.0
	50	27.1	36.1	46.8	66.7	91.5	170.5	182.0
	60	22.6	30.1	39.0	55.6	76.2	143.0	182.0

SLD

Design SLD Q C25/30

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

The following design values have been determined in accordance with BS EN 1992-1-1 (EC2) with a concrete cover of 30 mm. With higher concrete cover the load-bearing capacity for a correspondingly reduced slab height must be applied. The maximum load-bearing capacities listed here apply only in connection with a reinforcement arrangement in accordance with page 30 or 31 and under observation of the critical dowel spacing or edge separation in accordance with page 21.

Schöck Dorn type		SLD Q 40	SLD Q 50	SLD Q 60	SLD Q 70	SLD Q 80	SLD Q 120	SLD Q 150
Slab thickness [mm]	Joint width [mm]	Design resistances V_{Rd}, Concrete strength class C25/30 [kN/dowel]						
160	20	32.2	41.3					
	30	32.2	41.3					
	40	32.2	41.3					
	50	27.1	36.1					
	60	22.6	30.1					
180	20	35.8	45.8	47.7				
	30	35.8	45.8	47.7				
	40	33.9	45.1	47.7				
	50	27.1	36.1	46.8				
	60	22.6	30.1	39.0				
200	20	39.3	50.1	52.0	71.1			
	30	39.3	50.1	52.0	71.1			
	40	33.9	45.1	52.0	71.1			
	50	27.1	36.1	46.8	66.7			
	60	22.6	30.1	39.0	55.6			
220	20	55.7	54.3	73.9	77.7			
	30	45.2	54.3	73.9	77.7			
	40	33.9	45.1	58.5	77.7			
	50	27.1	36.1	46.8	66.7			
	60	22.6	30.1	39.0	55.6			
250	20	60.8	77.0	83.4	87.2	137.9		
	30	45.2	59.8	76.3	87.2	136.8		
	40	33.9	45.1	58.5	83.3	113.3		
	50	27.1	36.1	46.8	66.7	91.5		
	60	22.6	30.1	39.0	55.6	76.2		
280	20	60.8	77.0	92.6	114.6	152.9		
	30	45.2	59.8	76.3	104.5	136.8		
	40	33.9	45.1	58.5	83.3	113.3		
	50	27.1	36.1	46.8	66.7	91.5		
	60	22.6	30.1	39.0	55.6	76.2		
300	20	60.8	77.0	95.1	122.9	160.3	178.3	
	30	45.2	59.8	76.3	104.5	136.8	178.3	
	40	33.9	45.1	58.5	83.3	113.3	178.3	
	50	27.1	36.1	46.8	66.7	91.5	170.5	
	60	22.6	30.1	39.0	55.6	76.2	143.0	
350	20	60.8	77.0	95.1	125.6	160.3	198.3	205.2
	30	45.2	59.8	76.3	104.5	136.8	198.3	205.2
	40	33.9	45.1	58.5	83.3	113.3	198.3	205.2
	50	27.1	36.1	46.8	66.7	91.5	170.5	205.2
	60	22.6	30.1	39.0	55.6	76.2	143.0	205.2

SLD

Design SLD Q C30/37 – C50/60

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

The following design values have been determined in accordance with BS EN 1992-1-1 (EC2) with a concrete cover of 30 mm. With higher concrete cover the load-bearing capacity for a correspondingly reduced slab height must be applied. The maximum load-bearing capacities listed here apply only in connection with a reinforcement arrangement in accordance with page 30 or 31 and under observation of the critical dowel spacing or edge separation in accordance with page 21.

Schöck Dorn type		SLD Q 40	SLD Q 50	SLD Q 60	SLD Q 70	SLD Q 80	SLD Q 120	SLD Q 150
Slab thickness [mm]	Joint width [mm]	Design resistances V_{Rd}, Concrete strength class C30/37 [kN/dowel]						
160	20	35.5	45.4					
	30	35.5	45.4					
	40	33.9	45.1					
	50	27.1	36.1					
	60	22.6	30.1					
180	20	39.5	50.4	52.6				
	30	39.5	50.4	52.6				
	40	33.9	45.1	52.6				
	50	27.1	36.1	46.8				
	60	22.6	30.1	39.0				
200	20	43.4	55.3	57.5	78.4			
	30	43.4	55.3	57.5	78.4			
	40	33.9	45.1	57.5	78.4			
	50	27.1	36.1	46.8	66.7			
	60	22.6	30.1	39.0	55.6			
220	20	60.8	60.0	81.5	85.9			
	30	45.2	59.8	76.3	85.9			
	40	33.9	45.1	58.5	83.3			
	50	27.1	36.1	46.8	66.7			
	60	22.6	30.1	39.0	55.6			
250	20	60.8	77.0	92.3	96.6	146.5		
	30	45.2	59.8	76.3	96.6	136.8		
	40	33.9	45.1	58.5	83.3	113.3		
	50	27.1	36.1	46.8	66.7	91.5		
	60	22.6	30.1	39.0	55.6	76.2		
280	20	60.8	77.0	95.1	124.4	160.3		
	30	45.2	59.8	76.3	104.5	136.8		
	40	33.9	45.1	58.5	83.3	113.3		
	50	27.1	36.1	46.8	66.7	91.5		
	60	22.6	30.1	39.0	55.6	76.2		
300	20	60.8	77.0	95.1	125.6	160.3	195.7	
	30	45.2	59.8	76.3	104.5	136.8	195.7	
	40	33.9	45.1	58.5	83.3	113.3	195.7	
	50	27.1	36.1	46.8	66.7	91.5	170.5	
	60	22.6	30.1	39.0	55.6	76.2	143.0	
350	20	60.8	77.0	95.1	125.6	160.3	219.6	226.5
	30	45.2	59.8	76.3	104.5	136.8	219.6	226.5
	40	33.9	45.1	58.5	83.3	113.3	199.4	226.5
	50	27.1	36.1	46.8	66.7	91.5	170.5	226.5
	60	22.6	30.1	39.0	55.6	76.2	143.0	209.0

SLD

On-site reinforcement

Schöck Dorn type SLD / SLD Q	40	50	60	70	80
A_{sx} (right / left)	$2 \cdot 3 \cdot H10$	$2 \cdot 3 \cdot H12$	$2 \cdot 3 \cdot H12$	$2 \cdot 4 \cdot H12$	$2 \cdot 5 \cdot H16$
s_1 for slab thickness ≤ 300 mm	30	32	34	32	36
s_1 for slab thickness > 300 mm	50	50	50	50	50
s_i	50	50	50	50	50
A_{sy} (top / bottom)	$2 \cdot 3 \cdot H12$	$2 \cdot 3 \cdot H12$	$2 \cdot 3 \cdot H12$	$2 \cdot 3 \cdot H12$	$2 \cdot 3 \cdot H16$
Pos. 1	$2 \cdot H8$	$2 \cdot H8$	$2 \cdot H8$	$2 \cdot H8$	$2 \cdot H8$
e_1	65	80	95	105	115
l_{c1} SLD	62	64	72	73	89
l_{c1} SLD Q	92	98	106	111	122
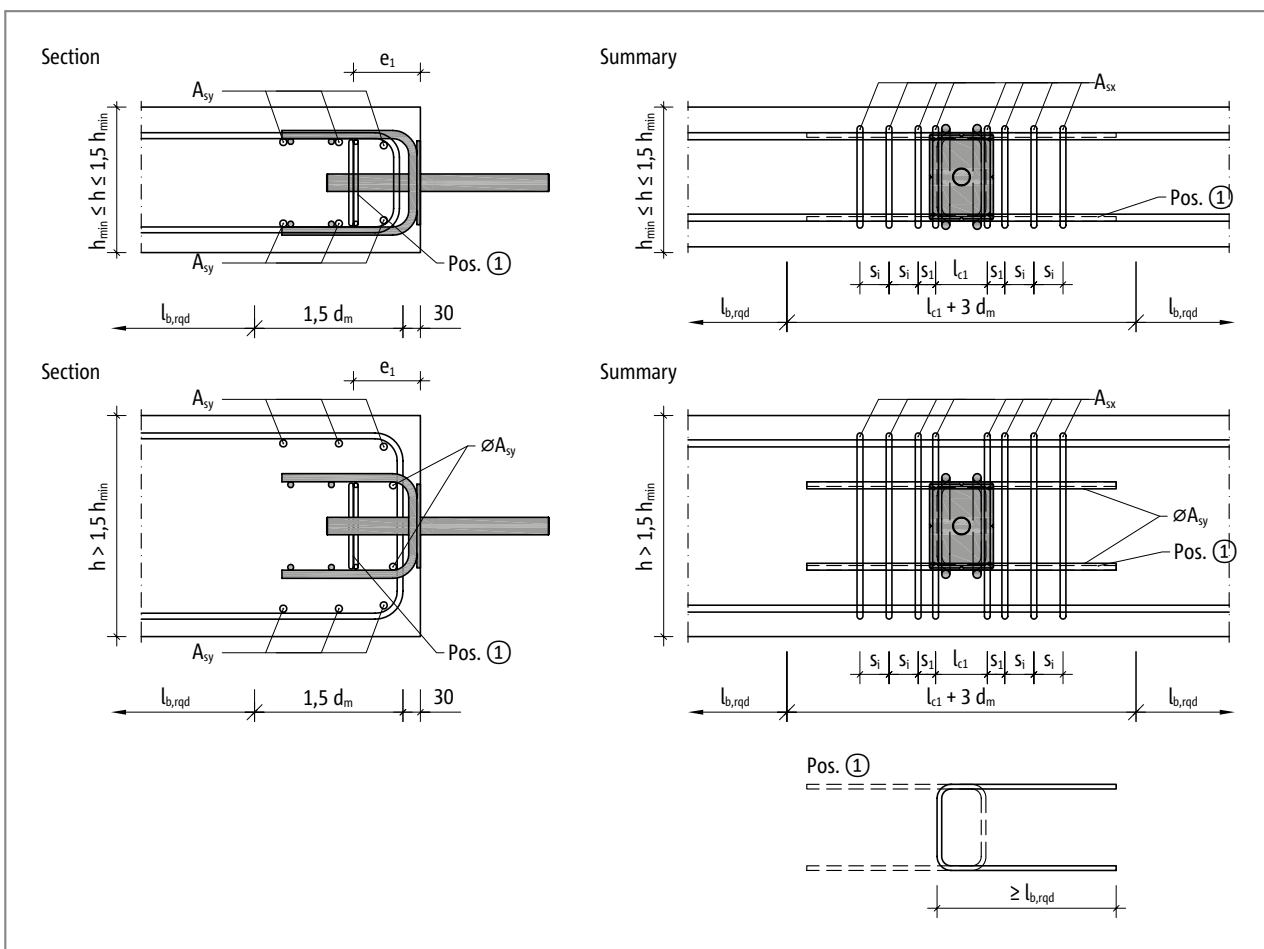
Fig. 29: Schöck Dorn type SLD 40 to SLD 80: On-site reinforcement

On-site reinforcement

Schöck Dorn type SLD / SLD Q	120	150
A_{sx} (right / left)	$2 \cdot 5 \cdot H16$	$2 \cdot 5 \cdot H20$
s_1	50	50
s_i	50	50
A_{sy} (top / bottom)	$2 \cdot 4 \cdot H16$	$2 \cdot 4 \cdot H20$
Pos. 1	$2 \cdot H10$	$2 \cdot H12$
e_1	150	185
l_{c1} SLD	114	131
l_{c1} SLD Q	151	171
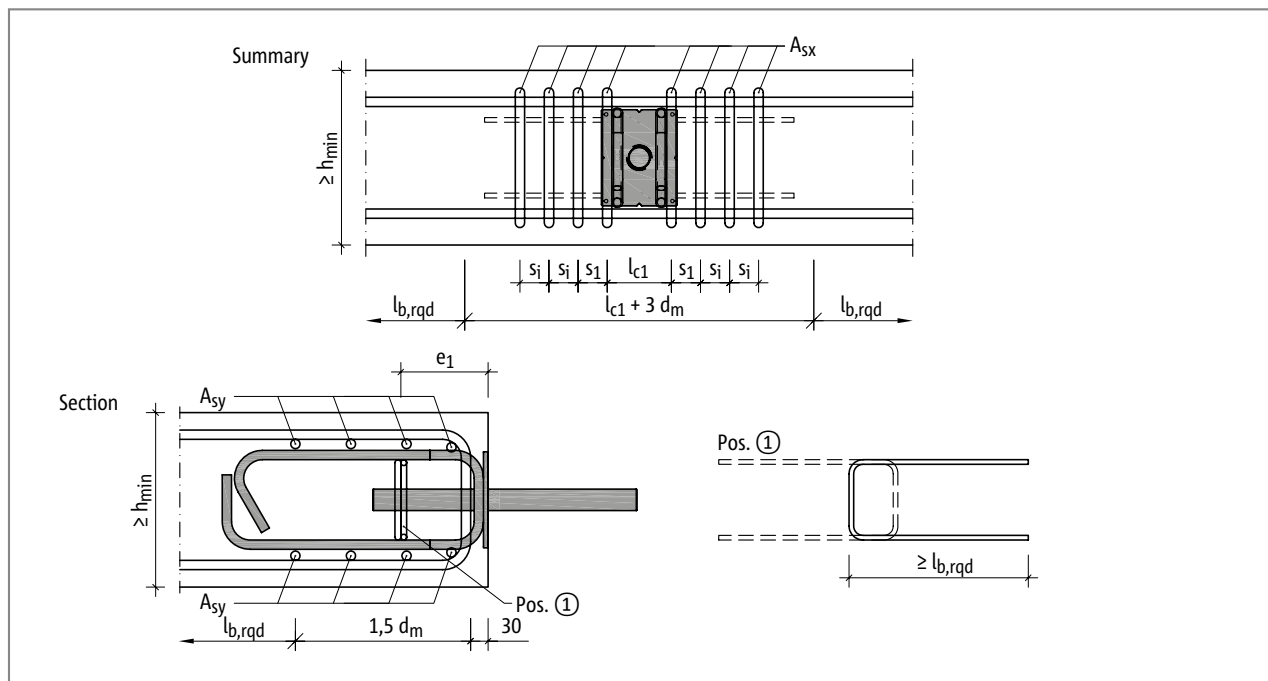
Fig. 30: Schöck Dorn type SLD 120, SLD 150: On-site reinforcement

SLD

On-site reinforcement
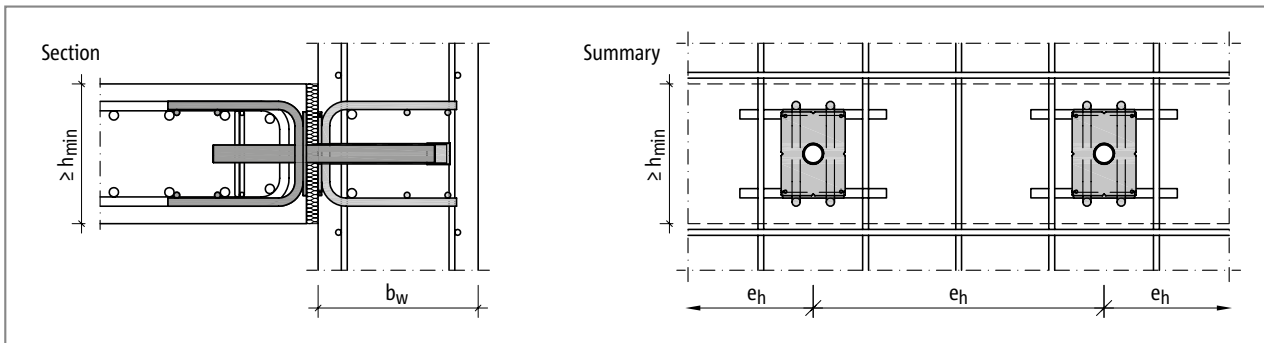
Fig. 31: Schöck Dorn type SLD: On-site reinforcement with floor-wall connection
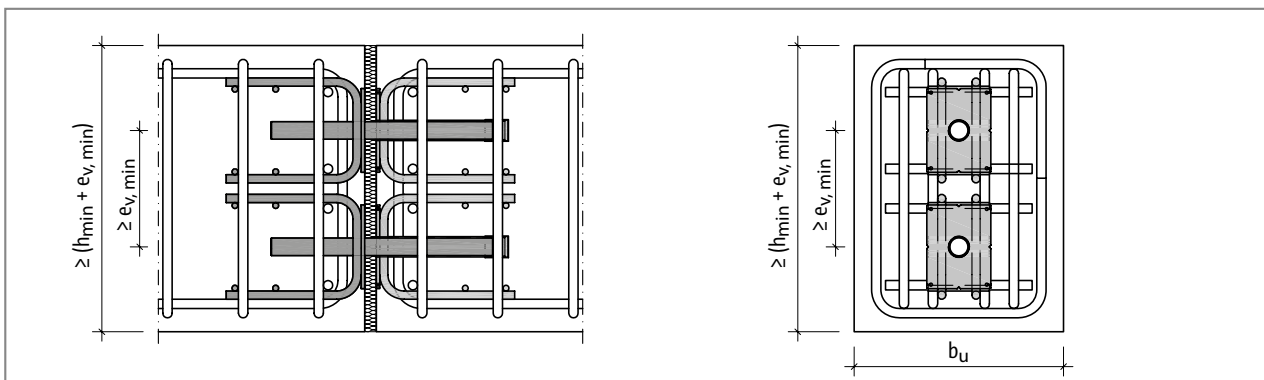
Fig. 32: Schöck Dorn type SLD: On-site reinforcement with balcony connection

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

Verification of the load-bearing capacity in accordance with approval document Z-15.7-236
The load-bearing capacity of an expansion joint connection using the Schöck Dorn type results from the minimum of the verifications against punching through flat slabs, concrete edge fracture 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 of the effective shear force
V_{Rd}	- design resistance of the dowel connection
$V_{Rd,ct}$	- design resistance against punching of punching through flat slabs
$V_{Rd,c}$	- design resistance against concrete edge fracture
$V_{Rd,s}$	- design resistance against steel failures of the dowel

These verifications are necessary if the constraints for the design tables are not observed. The punching shear design must be conducted if the critical spacings according to page 20 are undercut or the on-site reinforcement according to page 30 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 30.

Steel load-bearing capacity in accordance with approval document Z-15.7-236
The steel load-bearing capacity of the Schöck Dorn type SLD is determined from the minimum of the load-bearing capacities of the welded-on stirrups, the welded seams, the face plate and the dowel. It is thus independent of the surrounding concrete. The load-bearing capacity is always relevant in structural components in which concrete failures due to concrete edge fracture or punching through of flat slabs can be ruled out. This is the case, for example, in walls or columns.

Schöck Dorn type SLD	40	50	60	70	80	120	150
Joint width [mm]	Steel load-bearing capacity $V_{Rd,s}$ [kN]						
10	85.0	102.5	126.6	163.1	204.3	270.7	372.0
20	67.6	85.6	105.7	139.6	178.2	270.7	372.0
30	50.2	66.4	84.8	116.1	152.0	253.8	341.9
40	37.6	50.1	65.0	92.6	125.9	221.6	305.3
50	30.1	40.1	52.0	74.1	101.6	189.4	268.7
60	25.1	33.4	43.4	61.7	84.7	158.9	232.2

Schöck Dorn type SLD	Q 40	Q 50	Q 60	Q 70	Q 80	Q 120	Q 150
Joint width [mm]	Steel load-bearing capacity $V_{Rd,s}$ [kN]						
10	76.5	94.3	113.9	146.8	183.8	270.7	372.0
20	60.8	77.0	95.1	125.6	160.3	257.4	340.6
30	45.2	59.8	76.3	104.5	136.8	228.4	307.7
40	33.9	45.1	58.5	83.3	113.3	199.4	274.8
50	27.1	36.1	46.8	66.7	91.5	170.5	241.9
60	22.6	30.1	39.0	55.6	76.2	143.0	209.0

SLD

Punching shear design

Punching shear design in accordance with approval document Z-15.7-236

The punching shear design in accordance with approval document Z-15.7-236, in deviation from the standard BS EN 1992-1-1 (EC2,) is carried out with a spacing of 1.5d. This verification management has proven itself over years and enables smaller, critical edge separations and dowel spacings compared with a punching shear design in a spacing of 2d in accordance with EC2.
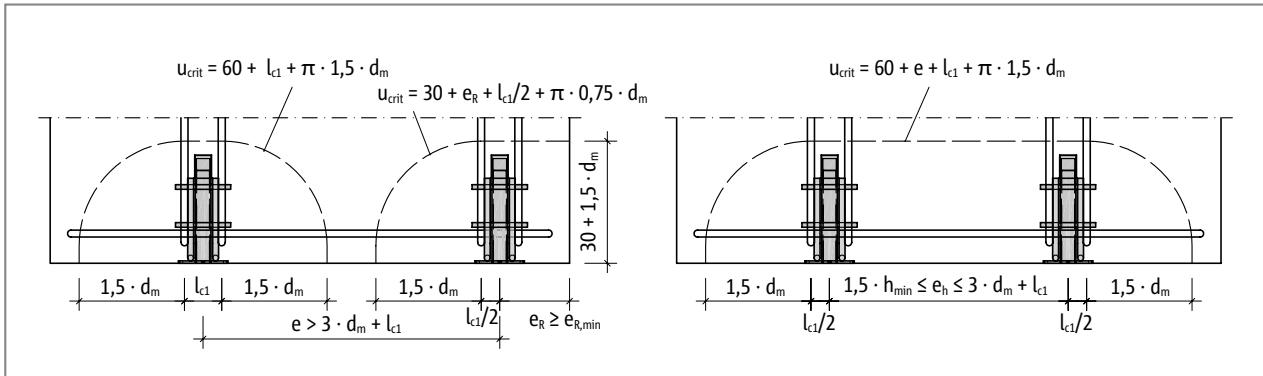
Fig. 33: Schöck Dorn type SLD: Lengths of the round cuts for the punching shear design dependent on the dowel spacings
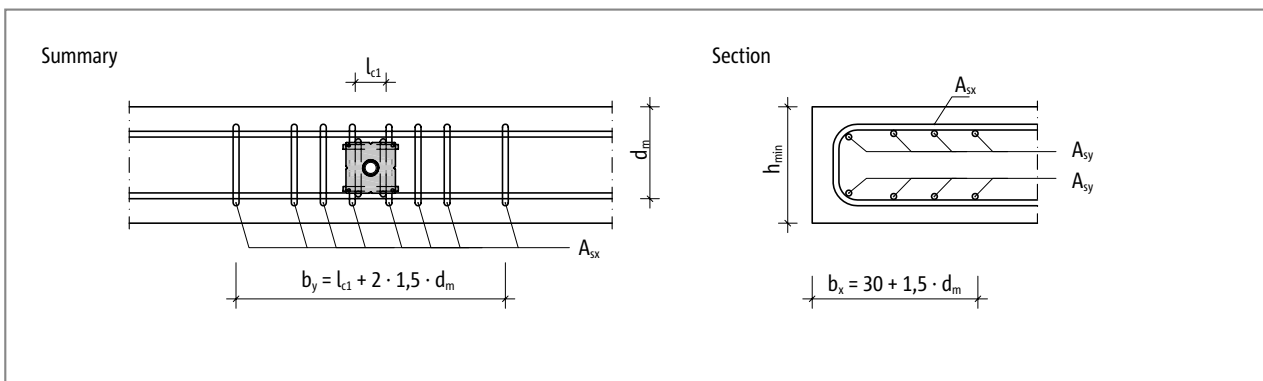
Fig. 34: Schöck Dorn type SLD: Dimensions of the punching area

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 depth [mm]
       $d_m = (d_x + d_y) / 2$

ρ_l - mean degree of longitudinal reinforcement within the round cut
       $\rho_l = (\rho_x \cdot \rho_y)^{1/2} \leq 0.5 \cdot f_{cd} / f_{yd} \leq 0.02$
       $\rho_x = A_{sx} / (d_x \cdot b_y)$
       $\rho_y = A_{sy} / (d_y \cdot b_x)$

f_{ck} - characteristic cylinder strength of the concrete

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)

Concrete edge fracture

Verification against concrete edge fracture in accordance with approval document Z-15.7-236

The verification against concrete edge fracture is a product-specific verification and is based on the evaluation of trials. 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 may be taken into account, whose effective anchoring length (l'_i) in the breakout cone is greater than zero. Otherwise these legs are too far from the dowel and are thus ineffective.

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

$$f_\mu = 0.9 \text{ for type SLD Q, otherwise } f_\mu = 1.0$$
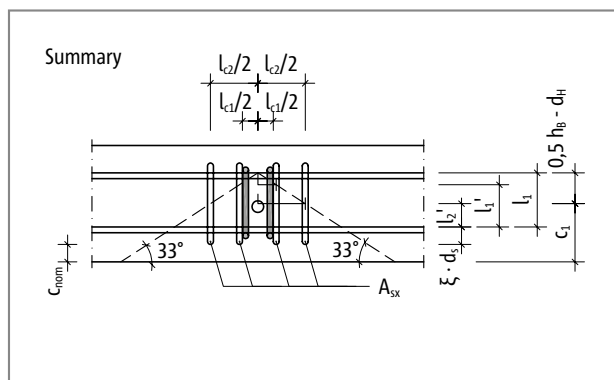
Fig. 35: Schöck Dorn type SLD: Dimensions of the breakout cone of the concrete edge

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

$$V_{Rd,1,i} = 0.357 \cdot \psi_i \cdot A_{sx,i} \cdot f_{yk} \cdot (f_{ck} / 30)^{1/2} / \gamma_c$$

with:
- ψ_i — coefficient to take into account the spacing of the suspended reinforcement of the dowel
  $\psi_i = 1 - 0.2 \cdot (l_{ci} / 2) / c_1$
  $l_{ci}/2$ = distance $A_{sx,i}$ from dowel, of the suspended reinforcement considered
  l_{c1} - distance of the first stirrup row of the dowel, see page 30
  c_1 - edge separation starting from the dowel centre up to the free edge
- $A_{sx,i}$ — cross-section of a leg of the suspended reinforcement in the breakout cone
- f_{yk} — characteristic yield point of the suspended reinforcement
- f_{ck} — characteristic cylinder strength of the concrete
- γ_c — $\gamma_c = 1.5$

$V_{Rd,2,i}$ - compound load-bearing capacity of a stirrup alongside the dowel

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

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 dowel of the suspended reinforcement considered
  $l_1 = h / 2 + (0.5 \cdot h_b - d_h) - \xi \cdot d_s - c_{nom}$
  $\xi = 3$ for $d_s \leq 16$ mm
  $\xi = 4.5$ for $d_s > 16$ mm
  h_b, d_h - dimensions of the Schöck Dorn type SLD, see page 22 and 23
  c_{nom} - concrete cover of the suspended reinforcement
- f_{bd} — design value of the transfer bond between reinforcing steel and concrete in accordance with BS EN 1992-1-1 (EC2)

Design example

Connection of a floor slab to a wall

Concrete:	C25/30	
Slab thickness:	h	= 250 mm
Wall thickness:	b_w	= 300 mm
Concrete cover:	$c_{nom,u} = c_{nom,o}$	= 30 mm
Design value of the shear force:	v_{Ed}	= 100 kN/m
Joint length:	l_f	= 5.0 m
Joint width on installation:	f_E	= 20 mm
Maximum joint opening:	f	= 32 mm

The maximum joint opening to be expected is relevant for the design of the Schöck Dorn type SLD. 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 approval document Z-15.7-236, 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.
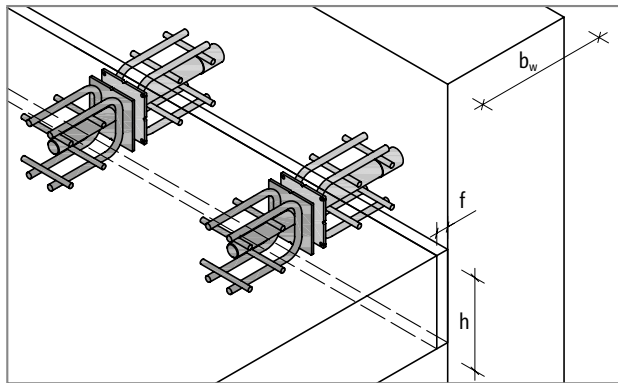
Design example

Design Schöck Dorn type SLD

Determination of the design load for the dowel:

Maximum dowel spacing:	$e_{h,max}$	$= 8 \cdot h = 8 \cdot 250 = 2000 \text{ mm} = 2.0 \text{ m}$
Minimum possible number of dowels:	n_{Dorn}	$= l_f / e_{h,max} = 5.0 / 2.0 = 2.5 \approx 3$ dowels
Maximum possible dowel spacing:	e_h	$= l_f / n_{Dorn} = 5 / 3 = 1.6 \text{ m}$
Loading per dowel:	$V_{Ed,SLD}$	$= e_h \cdot v_{Ed} = 1.6 \cdot 100 = 160 \text{ kN}$

Selection of the dowel using the design table page 24:

Edge conditions:		Slab height = 250 mm and joint width = 40 mm
		Selected: SLD 80
Load-bearing capacity SLD 80:	$V_{Rd,SLD\ 80}$	$= 125.9 \text{ kN} \leq V_{Ed,SLD} = 160 \text{kN}$
		The dowel spacing must be reduced

Determination of the optimum dowel spacing:

Maximum dowel spacing:	$e_{h,max,SLD\ 80}$	$= V_{Rd,SLD\ 80} / v_{Ed} = 125.9 / 100 \approx 1.25 \text{ m}$
Number of dowels required:	n_{Dorn}	$= l_f / e_{h,max,SLD\ 80} = 5.0 / 1.25 = 4$ dowels
Loading per dowel:	$V_{Ed,SLD\ 80}$	$= e_{h,max,SLD\ 80} \cdot v_{Ed} = 1.25 \cdot 100 = 125 \text{ kN}$

Checking of the minimum structural component measurements in accordance with page 19:

Minimum slab thickness:	h_{min}	$= 240 \text{ mm} \leq h = 250 \text{ mm}$
Minimum wall thickness:	$b_{w,min}$	$= 275 \text{ mm} \leq b_w = 300 \text{ mm}$

Checking of the critical dowel spacings and edge separations in accordance with page 20:

Critical dowel spacing:	$e_{h,crit}$	$= 700 \text{ mm} \leq e_{h,max,SLD\ 80} = 1250 \text{ mm}$
Critical edge separation:	$e_{R,crit}$	$= 555 \text{ mm} \leq e_R = e_{h,max,SLD\ 80} / 2 = 1250 / 2 \approx 630 \text{ mm}$

On-site reinforcement in accordance with page 30:

Longitudinal reinforcement:	A_{sy}	$= 2 \cdot 3 \cdot H16$
Suspended reinforcement:	A_{sx}	$= 2 \cdot 5 \ 16$

Thus all the constraints for the application of the design tables are met and no further verification for the dowel connection is required. The reinforcement along the slab edge and in the slab must be cerified as separated.
Below are listed for information the detailed verifications of the dowel connection.

Steel load-bearing capacity

Load-bearing capacity:	$V_{Rd,s}$	= in accordance with Table page 33 for SLD 80 with a joint width of 40 mm
	$V_{Rd,s}$	= 125.9 kN

SLD

Design example

Punching shear design

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 = $(d_x + d_y) / 2 = (212 + 193) / 2 = 202$ mm

$d_x = h - c_{nom} - \varnothing_{Asx} / 2 = 250 - 30 - 16 / 2 = 212$ mm

$d_y = h / 2 + h_B / 2 - d_D - \varnothing_{Asy} / 2 = 250 / 2 + 180 / 2 - 14 - 16 / 2 = 193$ mm

h_B and d_D see page 22

κ = $1 + (200 / d_m)^{1/2} = 1 + (200 / 202)^{1/2} = 2.0$

ρ_l = $(\rho_x \cdot \rho_y)^{1/2} = (0.0138 \cdot 0.00938)^{1/2} = 0.0113$

$\rho_x = A_{sx} / (d_x \cdot b_y) = 10 \cdot 201 / (212 \cdot 695) = 0.0136$

$\rho_y = A_{sy} / (d_y \cdot b_x) = 3 \cdot 201 / (193 \cdot 333) = 0.00938$

$b_y = 3 \cdot d_m + l_{c1} = 3 \cdot 202 + 89 = 695$ mm

$b_x = 1.5 \cdot d_m + 30 = 1.5 \cdot 202 + 30 = 333$ mm

$l_{c1} = 89$ mm see page 30

f_{ck} = 25 N/mm²

β = 1.4 - Dowel in the edge area

u_{crit} = $60 + l_{c1} + 1.5 \cdot d_m \cdot \pi = 60 + 89 + 1.5 \cdot 202 \cdot \pi = 1100$ mm

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

= $0.14 \cdot 1.0 \cdot 2.0 \cdot (100 \cdot 0.0113 \cdot 25)^{1/3} \cdot 202 \cdot 1100 / 1.4 = 135.3$ kN

Concrete edge fracture

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

Hook load-bearing capacity: $V_{Rd,1,i}$ = $0.357 \cdot \psi_i \cdot A_{sx,i} \cdot f_{yk} \cdot (f_{ck} / 30)^{1/2} / \gamma_c$

with:

$A_{sx,i}$ = 201 mm² ($\varnothing$ 16)

f_{yk} = 500 N/mm² (B500)

f_{ck} = 25 N/mm²

γ_c = 1.5

c_1 = $h / 2 = 250 / 2 = 125$ mm

ψ_i = $1 - 0.2 \cdot (l_{ci} / 2) / c_1$

1. Stirrup alongside the dowel

l_{c1} = 89 mm see page 30

ψ_1 = $1 - 0.2 \cdot (89 / 2) / 125$ mm = 0.93

$V_{Rd,1,1}$ = $0.357 \cdot 0.93 \cdot 201 \cdot 500 \cdot (25 / 30)^{1/2} / 1.5 = 20.3$ kN

2. Stirrup alongside the dowel

l_{c2} = $l_{c1} + 2 \cdot s_1 = 89 + 2 \cdot 36 = 161$ mm see page 30

ψ_2 = $1 - 0.2 \cdot (161 / 2) / 125 = 0.87$

$V_{Rd,1,2}$ = $0.357 \cdot 0.87 \cdot 201 \cdot 500 \cdot (25 / 30)^{1/2} / 1.5 = 19.0$ kN

3. Stirrup alongside the dowel

l_{c3} = $l_{c2} + 2 \cdot s_i = 161 + 2 \cdot 50 = 261$ mm see page 30

ψ_3 = $1 - 0.2 \cdot (261 / 2) / 125 = 0.79$

$V_{Rd,1,3}$ = $0.357 \cdot 0.79 \cdot 201 \cdot 500 \cdot (25 / 30)^{1/2} / 1.5 = 17.3$ kN

4. Stirrup alongside the dowel

l_{c4} = $l_{c3} + 2 \cdot s_i = 261 + 2 \cdot 50 = 361$ mm see page 30

ψ_4 = $1 - 0.2 \cdot (361 / 2) / 125 = 0.71$

$V_{Rd,1,4}$ = $0.357 \cdot 0.71 \cdot 201 \cdot 500 \cdot (25 / 30)^{1/2} / 1.5 = 15.5$ kN

Design example

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

with:

d_s	= 16 mm
h_b	= 180 mm see page 22
d_h	= 14 mm see page 22
ξ	= 3 for $d_s \leq$ 16 mm
c_{nom}	= 30 mm
f_{bd}	= 2.7 N/mm²
l_1	= h / 2 + (0.5 · h_b - d_h) - ξ · d_s - c_{nom}
	= 250 / 2 + (0.5 · 180 - 14) - 3 · 16 - 30 = 123 mm
l'_i	= l_1 - (l_{ci} / 2) · tan 33°

1. Stirrup alongside the dowel

l_{c1}	= 89 mm see page 30
l'_1	= 123 - (89 / 2) · tan 33° = 94 mm
$V_{Rd,2,1}$	= π · 16 · 94 · 2.7 = 12.8 kN

2. Stirrup alongside the dowel

l_{c2}	= l_{c1} + 2 · s_1 = 89 + 2 · 36 = 161 mm
l'_2	= 123 - (161 / 2) · tan 33° = 71 mm
$V_{Rd,2,2}$	= π · 16 · 71 · 2.7 = 9.6 kN

3. Stirrup alongside the dowel

l_{c3}	= l_{c2} + 2 · s_i = 161 + 2 · 50 = 261 mm
l'_3	= 123 - (261 / 2) · tan 33° = 38 mm
$V_{Rd,2,3}$	= π · 16 · 38 · 2.7 = 5.2 kN

4. Stirrup alongside the dowel

l_{c4}	= l_{c3} + 2 · s_i = 261 + 2 · 50 = 361 mm
l'_4	= 123 - (361 / 2) · tan 33° = 6 mm
$V_{Rd,2,4}$	= π · 16 · 6 · 2.7 = 0.8 kN

A maximum of 4 stirrups per side of the dowel can be taken into account.

Load-bearing capacity: $V_{Rd,ce}$ $= (\Sigma V_{Rd,1,i} + \Sigma V_{Rd,2,i}) \cdot f_\mu \leq \Sigma A_{sx,i} \cdot f_{yd} \cdot f_\mu$
                                        = [2 · (20.3 + 19.0 + 17.3 +15.5) +2 · (12.8 + 9.6 + 5.2 + 0.8)] · 1.0
                                        = 201.0 kN ≤ 8 · 201 · 43.5 = 699.7 kN

Verification

Punching force:	$V_{Rd,ct}$ = 125.9 kN	≥ $V_{Ed,SLD\ 80}$ = 125 kN
Concrete edge fracture:	$V_{Rd,ce}$ = 201.0 kN	≥ $V_{Ed,SLD\ 80}$ = 125 kN
Steel failure:	$V_{Rd,s}$ = 125.9 kN	≥ $V_{Ed,SLD\ 80}$ = 125 kN
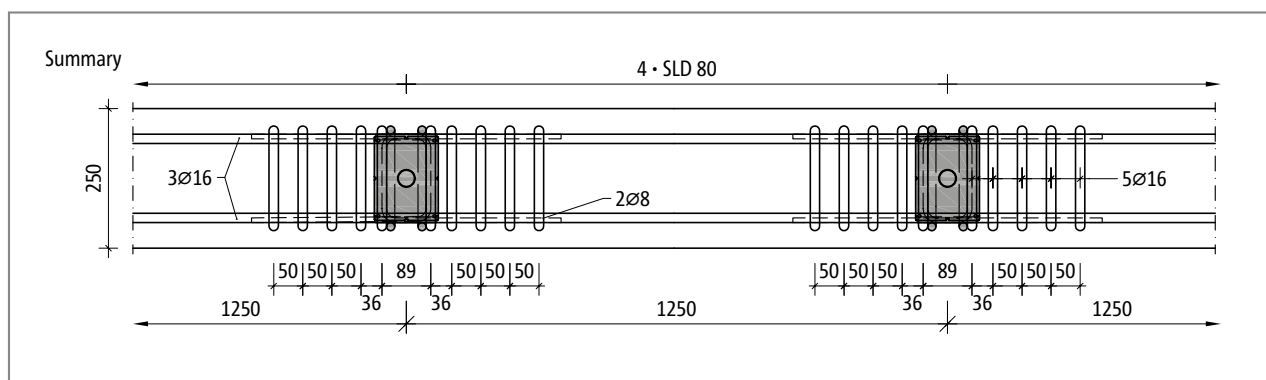
Summary

SLD

Installation instructions

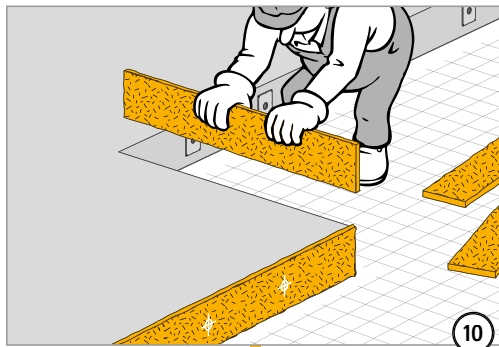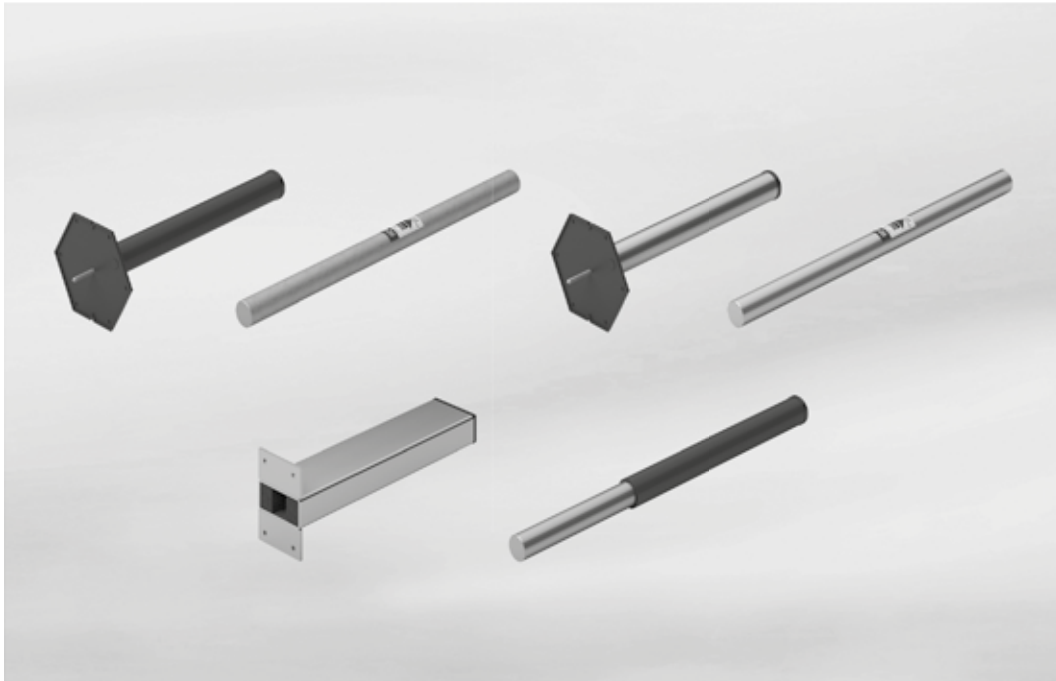| Typ SLD	Typ SLD Q

Installation instructions

≈ 30 mm

l_S

e_1

e_1
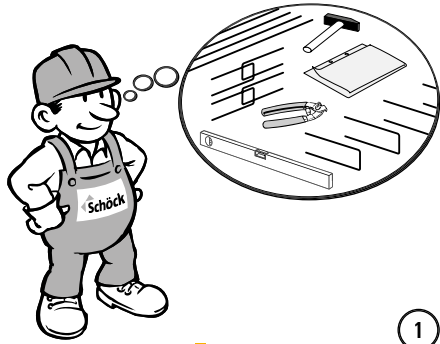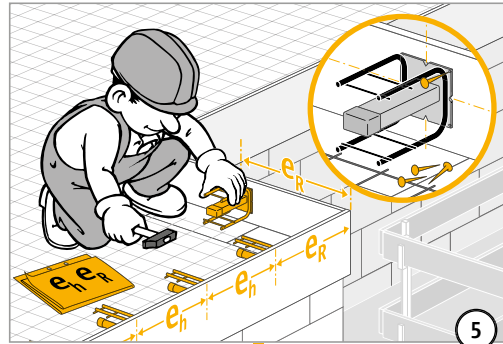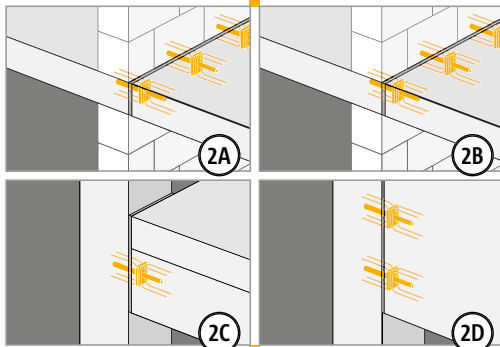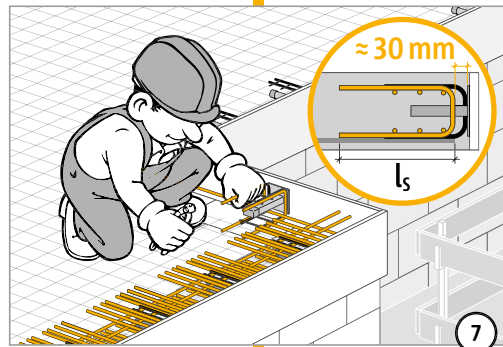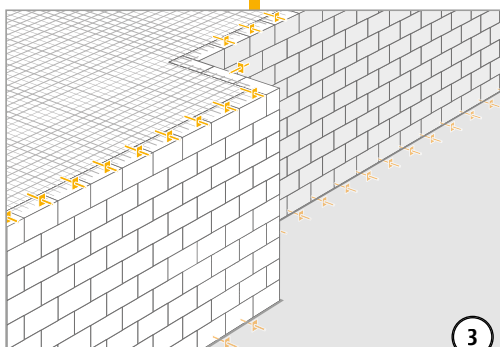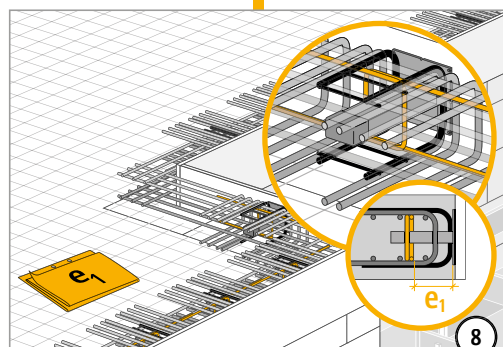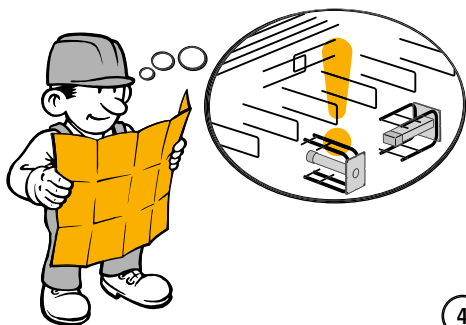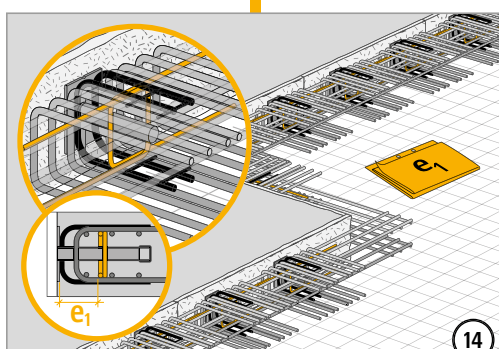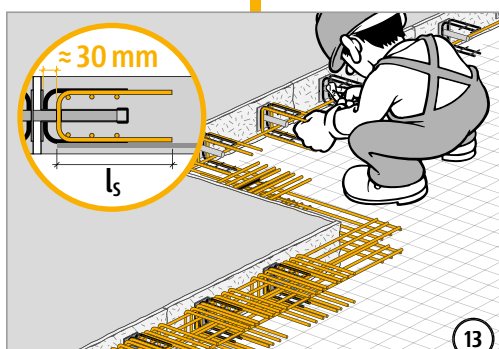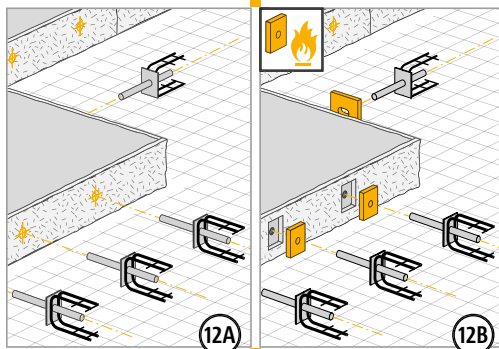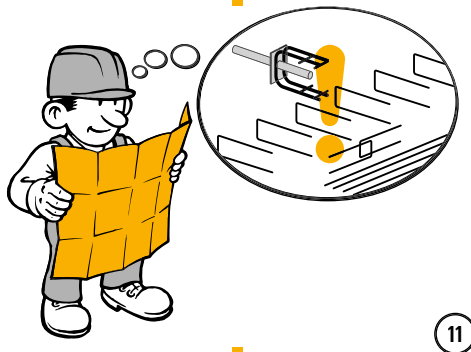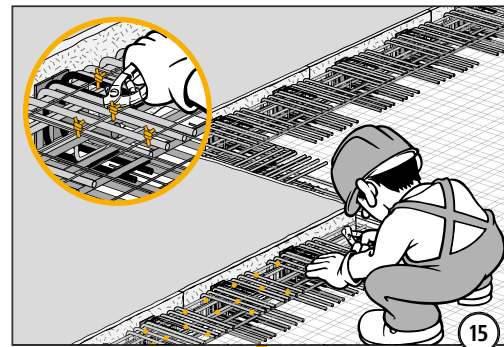
SLD

# Schöck Dorn type LD, LD-Q

Schöck Dorn type LD
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
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 Dorn type LD
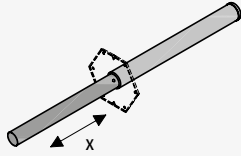
LD ⌀ S-A4

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, on the exterior of buildings.
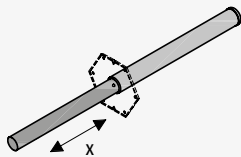
LD ⌀ P-A4 or LD ⌀ P-Zn

The sleeve of this set is made of plastic and can be combined with a dowel made from stainless steel (A4) or hot galvanised engineering steel (Zn). This dowel system is particularly suitable for constructive structural component joints with little movement such as, for example, in the interior of buildings.
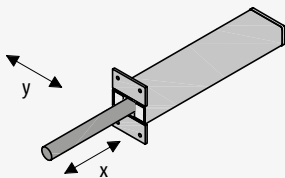
LD-Q ⌀ S-A4

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.
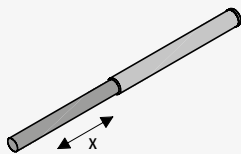
LD ⌀ F-A4 or LD ⌀ F-Zn

The dowel is available in stainless steel (A4) or hot galvanised engineering steel (Zn). The one-sided sleeve, made from 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.
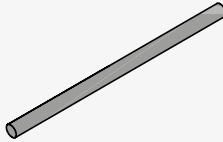
Type designations in planning documents

Dowel type
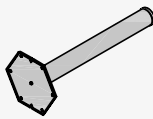Dowel diameter
Sleeve material
Dowel material

LD-20- S-A4

# Summary of types | Product selection

LD ⌀ Part A4 or LD ⌀ Part Zn

The dowel is available in stainless steel (A4) or hot galvanised engineering 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 plastic nail plate for securing to the formwork. This dowel can be combined with 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.
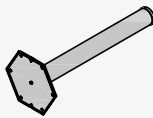
LD ⌀ Part P

The sleeve and the nail plate are made of platsic. The sleeve can be secured simply to the framework using the nail plate. The sleeve can be combined with a stainless steel (A4) dowel or hot galvanised enginering steel (Zn) dowel and is particularly suitable for the joints of constructive structural components with little movement in the interior area of buildings.
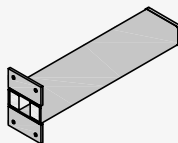
LD-Q ⌀ Part S

The rectangular sleeve is made of stainless steel and can be combineed 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.

LD

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 engineering 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 moveament 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. In order to be able, free of maintenance, to ensure functionality and a load-bearing capacity of the load dowel, the correct material must be selected appropriate for the environmental conditions. 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 Euripean product standard ETAG 030 only the Schöck Dorn type LD ∅ S-A4 can be used as bracing 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.

LD

Minimum dowel spacing/structural component measurements

Schöck Dorn type LD / LD-Q	16	20	22	25	30
Minimum structural component measurements	Dimension [mm]				
Slab thickness h_{min}	180	180	180	180	210
Wall thickness b_w	215	240	255	275	305
Balcony 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 separation					
Horizontal $e_{R,min}$	120	120	120	140	160
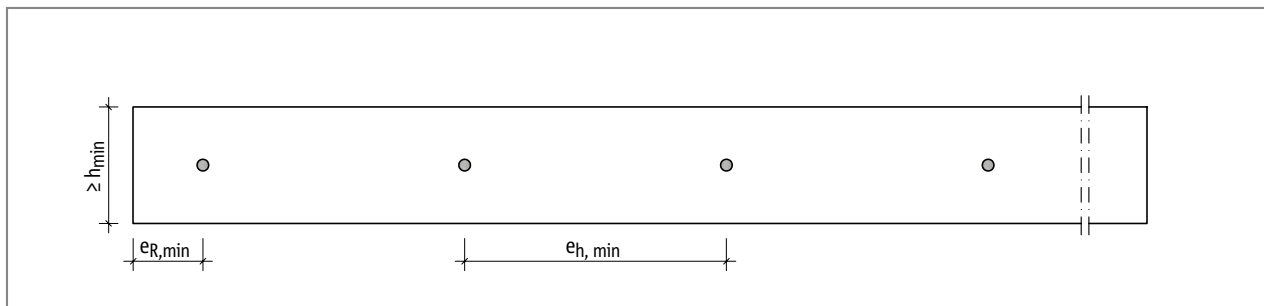
Fig. 36: Schöck Dorn type LD: Minimum structural component dimensions and dowel spacings for a slab
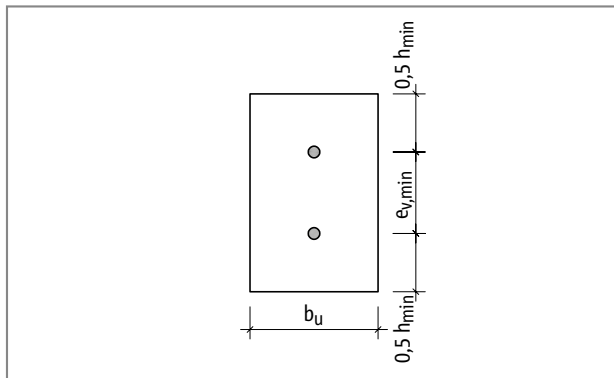
LD

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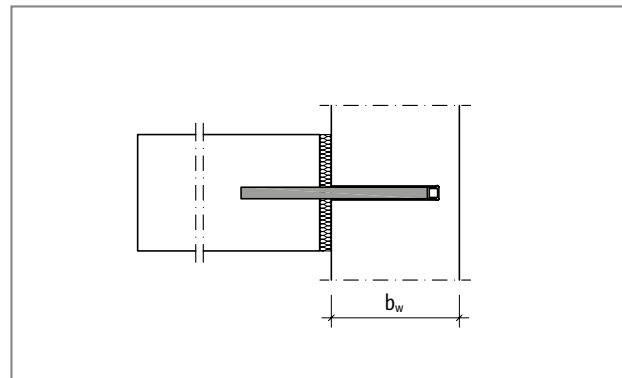

Fig. 38: Schöck Dorn type LD: Minimum structural component thickness of a wall or column

Critical dowel spacings/edge separations

The following critical edge separations and dowel spacings were taken as a basis for the design values in the tables onwards from page 50. Should these spacings/separations 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 030 to 8 times the slab height.
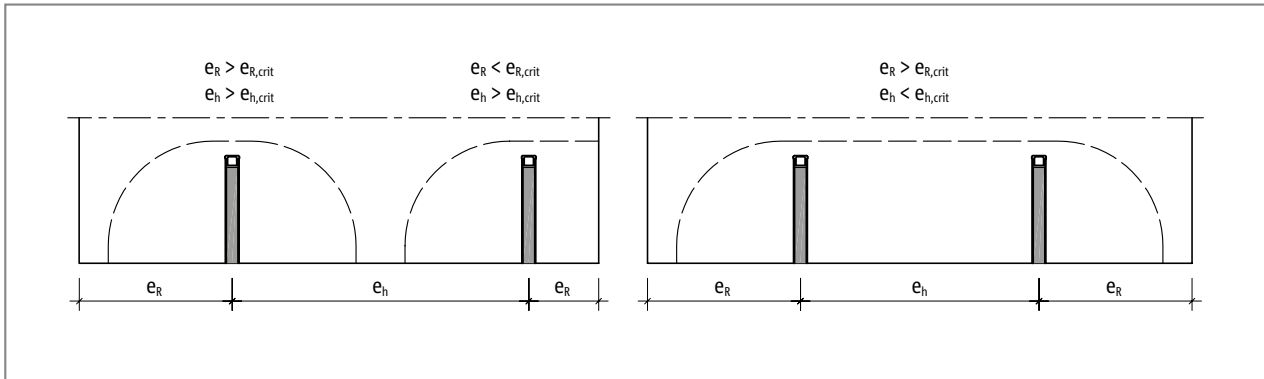

Fig. 39: Schöck Dorn type LD: Perimeter dependent on the critical dowel spacing and edge separation

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 spacings $e_{R,crit}$ [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 separations

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 spacings $e_{R,crit}$ [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

LD

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 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 connection with a reinforcement arrangement in accordance with page 52 and under observance of the critical dowel spacings/edge separations 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

LD

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 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 connection with a reinforcement arrangement in accordance with page 52 and under observance of the critical dowel spacings/edge separations 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

LD
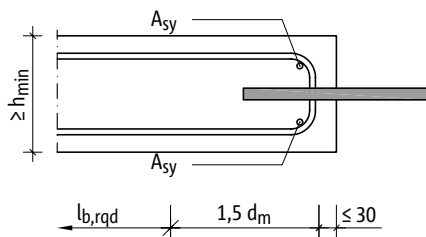
On-site reinforcement

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 rod (A_{sy}) at the top and bottom edge of the slab.

Schöck Dorn type LD	16		20		22		25		30	
Slab thickness [mm]	A_{sx}	A_{sy}	A_{sx}	A_{sy}	A_{sx}	A_{sy}	A_{sx}	A_{sy}	A_{sx}	A_{sy}
180	2 · H8	2 · H8	2 · H8	2 · H8	2 · H8	2 · H8	2 · H8	2 · H8		
200	2 · H8	2 · H8	2 · H10	2 · H10	2 · H10	2 · H10	2 · H10	2 · H10		
220	2 · H8	2 · H8	2 · H10	2 · H10	2 · H12	2 · H12	2 · H12	2 · H12	2 · H12	2 · H12
> 250	2 · H8	2 · H8	2 · H10	2 · H10	2 · H12	2 · H12	2 · H16	2 · H16	2 · H16	2 · H16
Stirrup spacing l_{c1} in [mm]	60		60		60		70		80	

Schöck Dorn type LD-Q	16		20		22		25		30	
Slab thickness [mm]	A_{sx}	A_{sy}	A_{sx}	A_{sy}	A_{sx}	A_{sy}	A_{sx}	A_{sy}	A_{sx}	A_{sy}
180	2 · H8	2 · H8	2 · H8	2 · H8	2 · H8	2 · H8	2 · H8	2 · H8		
200	2 · H8	2 · H8	2 · H8	2 · H8	2 · H10	2 · H10	2 · H10	2 · H10		
220	2 · H8	2 · H8	2 · H8	2 · H8	2 · H10	2 · H10	2 · H12	2 · H12	2 · H12	2 · H12
> 250	2 · H8	2 · H8	2 · H8	2 · H8	2 · H10	2 · H10	2 · H12	2 · H12	2 · H16	2 · H16
Stirrup spacing l_{c1} in [mm]	60		60		60		80		80	

Section

Summary

$\geq h_{min}$ · A_{sy} · A_{sy} · $l_{b,rqd}$ · 1,5 d_m · ≤ 30

$\geq h_{min}$ · A_{sx} · $l_{b,rqd}$ · l_{c1} · l_{c1} + 3 d_m · $l_{b,rqd}$
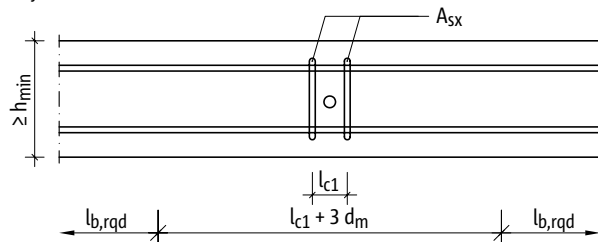
Fig. 40: Schöck Dorn type LD: On-site reinforcement

LD

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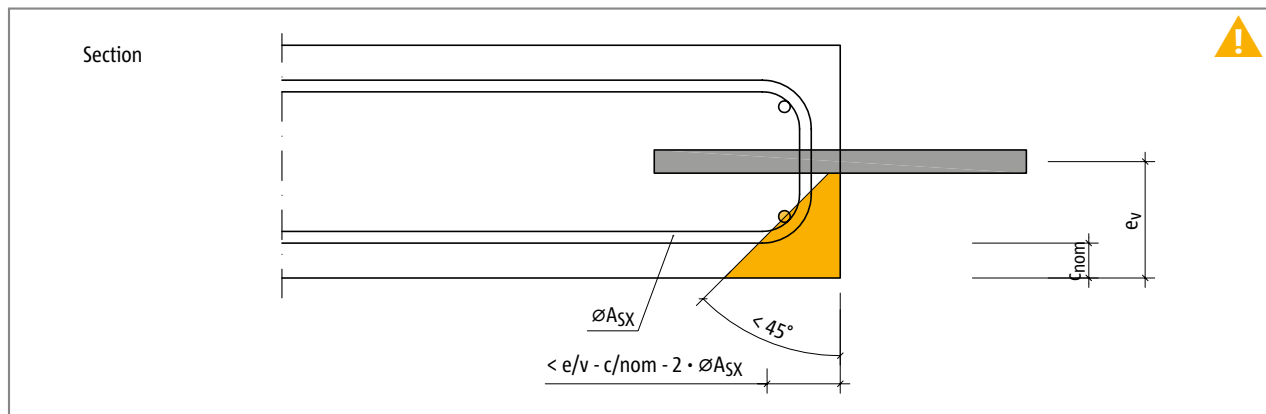
Fig. 41: Schöck Dorn type LD: Position of the longitudunal reinforcement in relation to the front face of the slab

ℹ Do not modify on-site reinforcement

The separation 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 separation is too large the lateral stirrups alongside the dowel cwill not contribute to theresistance. 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 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

LD

Product description
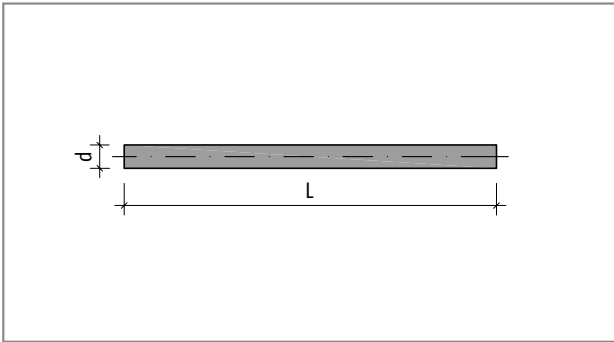
Fig. 42: Schöck Dorn type LD Part A4, LD Part Zn: Dimensions of the dowel
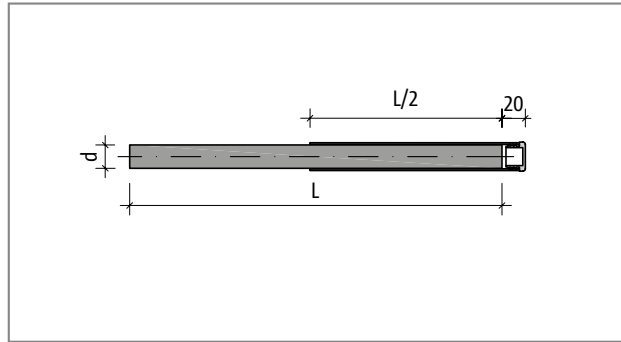
Fig. 43: Schöck Dorn type LD F-A4, LD F-Zn: Dimensions of the dowel with plastic sleeve

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
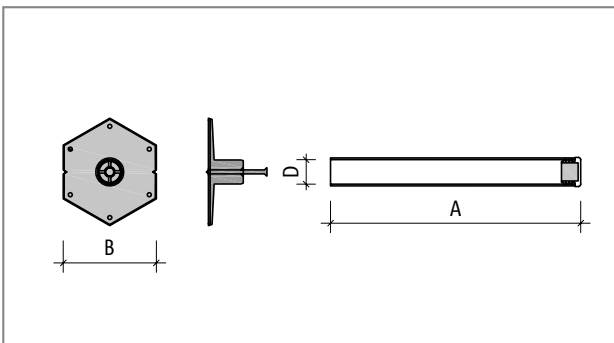
Fig. 44: Schöck Dorn type LD Part S, LD Part P: Dimensions of the sleeve, stainless steel and plastic
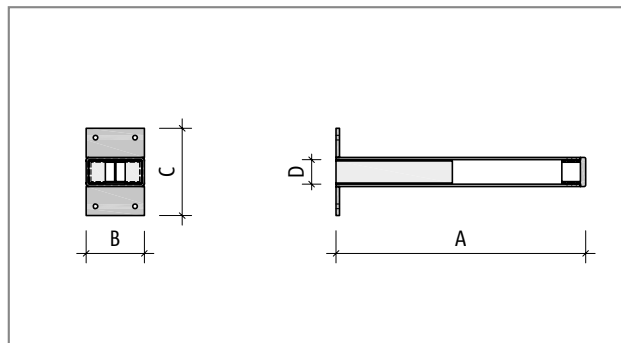
Fig. 45: Schöck Dorn type LD-Q Part S: Dimensions of the laterally movable sleeve

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 nail plate	B	80	50	80	50	80	50	80	60	80	60
Height of the nail 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 LD results from the minimum of the verification against punching through the slab, concrete edge fracture 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 of the influencing shear force
V_{Rd} - design resistance of the dowel connection
$V_{Rd,ct}$ - design resistance against punching through flat slabs
$V_{Rd,c}$ - design resistance against concrete edge fracture
$V_{Rd,s}$ - 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 Schick dowel type LD correspond 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 failure through concrete edge fracture or punching through flat slabs 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

LD

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 separation of 1.5d. This procedure of furnishing proof has proved itself over years and enables smaller critical edge separations and dowel spacings compared with a punching shear design with a separation of 2d in accordance with EC2.
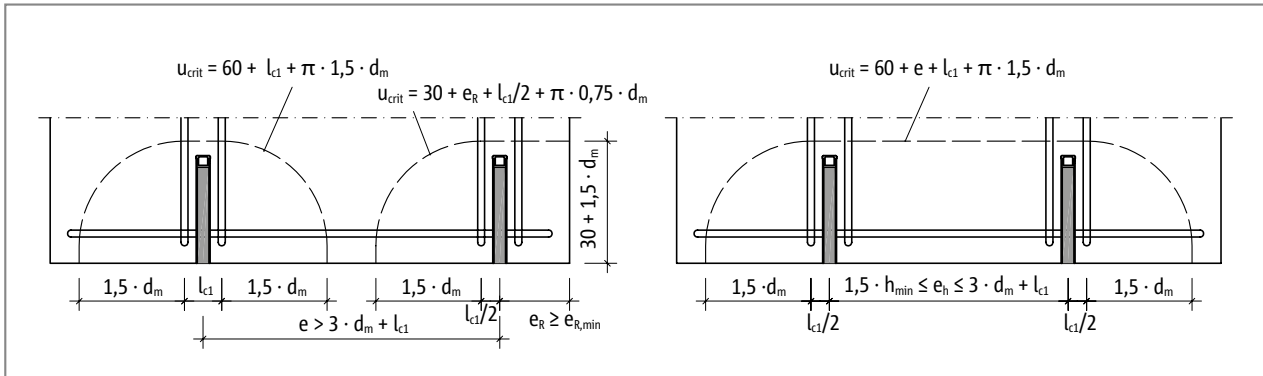

Fig. 46: Schöck Dorn type LD: Lengths of the round cut for the punching shear design depending on the dowel spacings
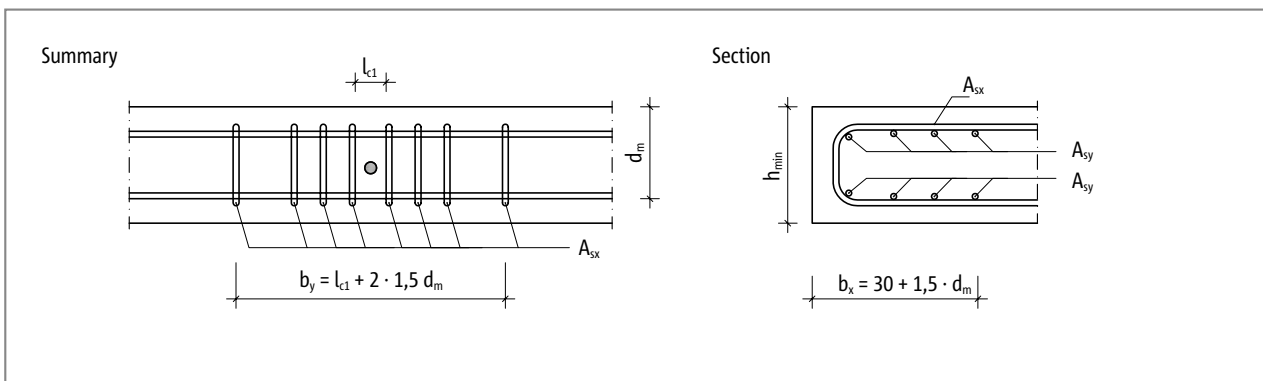
Fig. 47: Schöck Dorn type LD: Dimensions of the punching area

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 - mean level 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 cylinder load-bearing capacity of the concrete

β - coefficient for taking into account uneven load application; with dowels at corners 1.5, otherwise 1.4

u_{crit} - circumference of the critical perimeter (see diagram)

LD

Concrete edge fracture

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

The verification against concrete edge fracture is a product-specific verification and is based on the evaluation of trials. 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.

$$V_{Rd,ce} = \Sigma V_{Rd,1,i} + \Sigma V_{Rd,2,i} \leq \Sigma A_{sx,i} \cdot f_{yd}$$
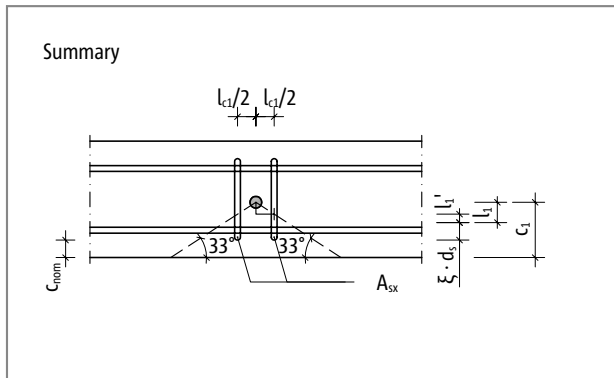
Fig. 48: Schöck Dorn type SLD: Dimensions of the breakout cone of the concrete edge

$V_{Rd,1i}$ - 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 point of the suspended reinforcement
f_{ck}	= 30 N/mm² (for all concrete classes in accordance with ETA 16/0545)
γ_c	- γ_c = 1.5

$V_{Rd,2i}$ - Compound 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 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 composite stress between reinforcing steel and concrete

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 superposition 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.
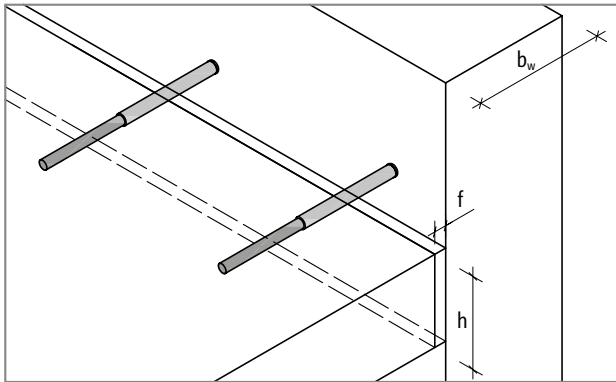
Selection of the suitable materials for the dowel and the sleeve

Determination of the materials in accordance 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

LD

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}	$= 1 \cdot H10$ (at top and bottom structural component edge)
Suspended reinforcement:	A_{sx}	$= 1 \cdot H10$ (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
	κ	$= 1 + (200 / d_m)^{1/2} = 1 + (200 / 170)^{1/2} = 2.08 \leq 2.0$
	ρ_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 fracture

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:	$A_{sx,i}$	$= 78.5$ mm² (Ø 10)
	f_{yk}	$= 500$ N/mm² (B500)
	f_{ck}	$= 30$ N/mm² (for all concrete classes in accordance with ETA 16/0545)
	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 52)
	ψ_1	$= 1 - 0.2 \cdot (70 / 2) / 100$ mm $= 0.93$
	$V_{Rd,1,1}$	$= 0.61 \cdot 0.92 \cdot 0.93 \cdot 78.5 \cdot 500 \cdot (30 / 30)^{1/2} / 1.5 = 13.65$ kN

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

with:	d_s	$= 10$ mm
	ξ	$= 3$ for d_s
	c_{nom}	$= 20$ mm
	f_{bd}	$= 2.7$ N/mm²
	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

Summary

Installation instructions

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

⌀ 16, 20, 22, 25, 30

Installation instructions

Schöck

Dependable by design