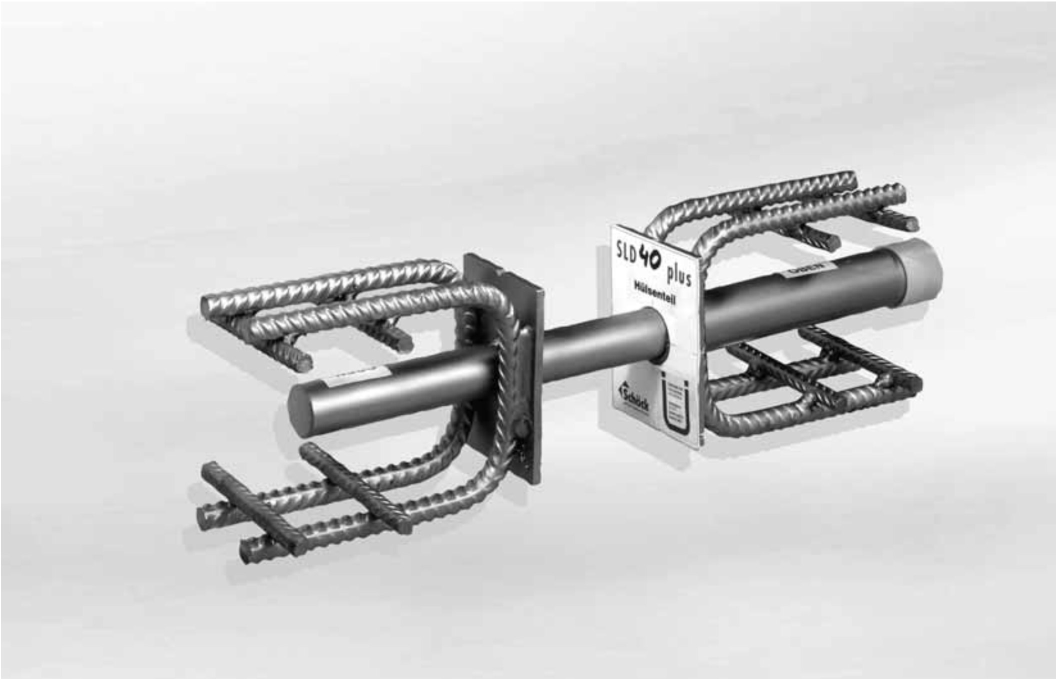
Schöck dowel Type SLD plus



Schöck dowel type SLD plus

Contents **Page**

Schöck dowel Type SLD plus

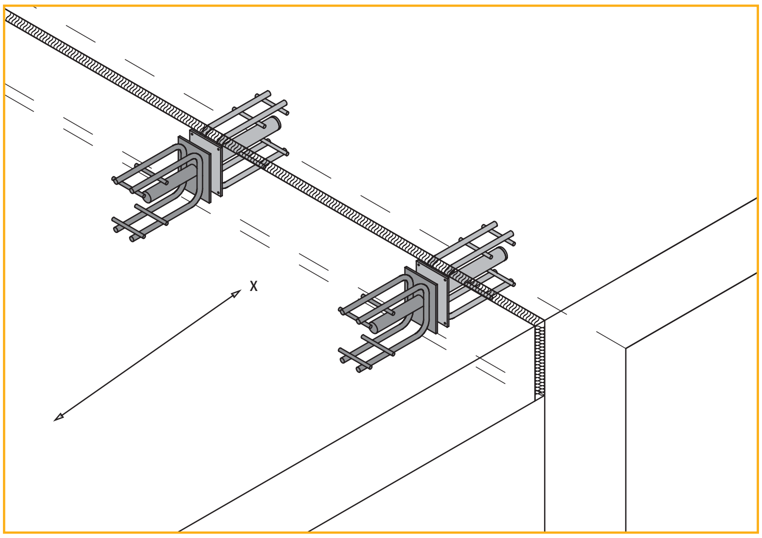
Design joints

Why are expansion joints required?

Expansion joints are required to enable structural components to move in relation to one another. This avoids restraint forces and therefore construction damage.

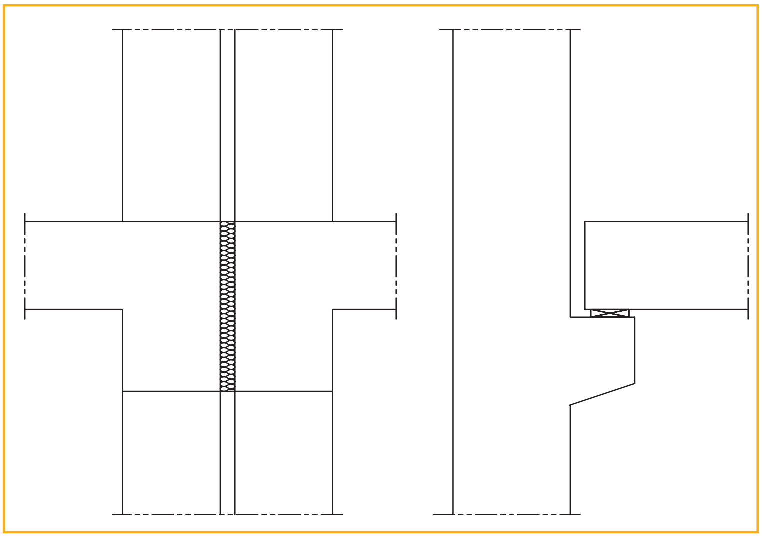
Potential causes of construction element movement are:

- Temperature changes
- Shrinkage
- Creeping
- Expansion
- Differential settlement



Complex and expensive structures

The implementation of expansion joint structures with downstand beams or corbels is time-consuming and requires elaborate formwork and reinforcement. These corbels are not only expensive to manufacture, but time-consuming work on the ensuing interior finishing make corbels uneconomic.



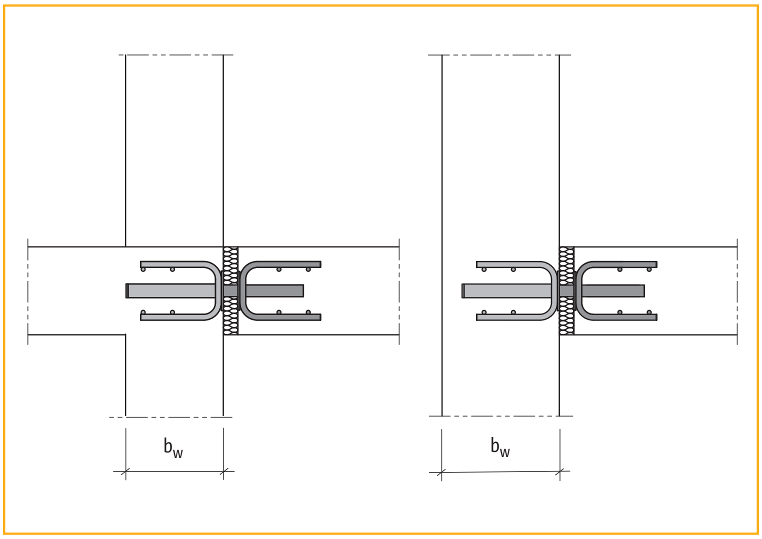
The solution

The Schöck dowel Type SLD plus system.

The constant high bearing capacity for joint widths up to 40 mm provides a high level of safety during design and implementation.

The formwork and reinforcement costs are significantly reduced due to the dowel construction.

The resulting gain in volume and area improves the spatial potential.



Schöck dowel Type SLD plus

Connection options

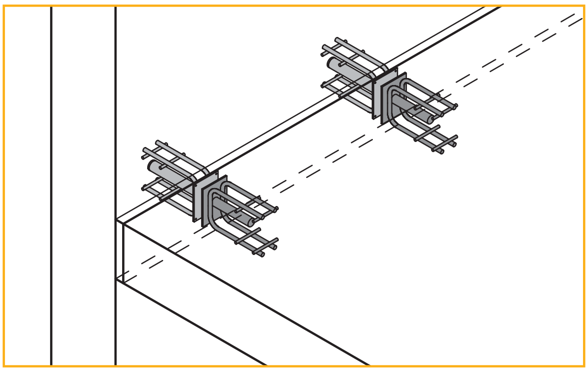


Figure 1: Connection between slab and wall

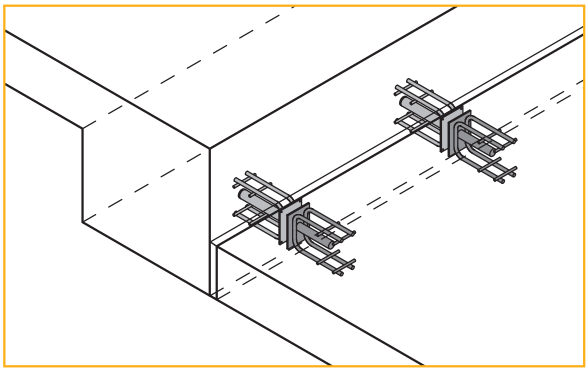


Figure 2: Connection between slab and downstand edge

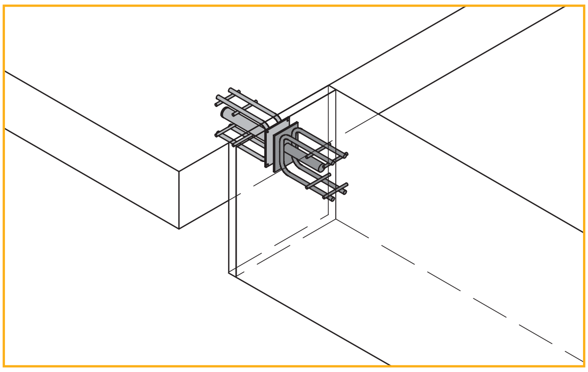


Figure 3: Connection between slab and beam face

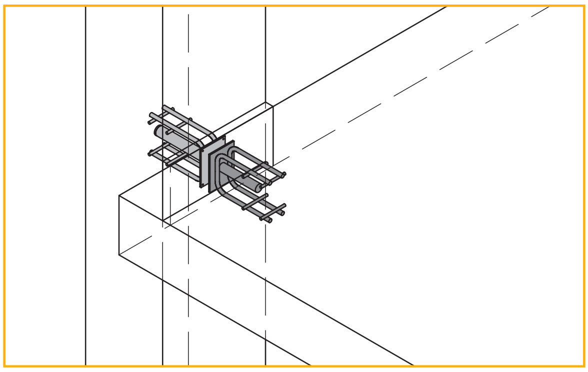


Figure 4: Connection between slab and support column

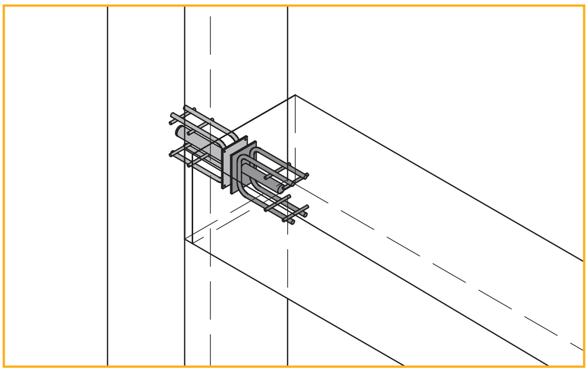


Figure 5: Connection between beam face and support column

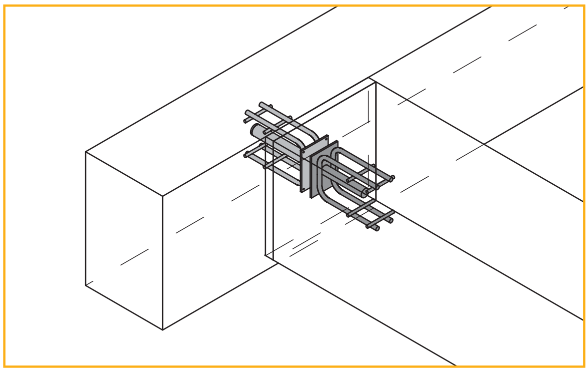


Figure 6: Connection between beam edge and beam face

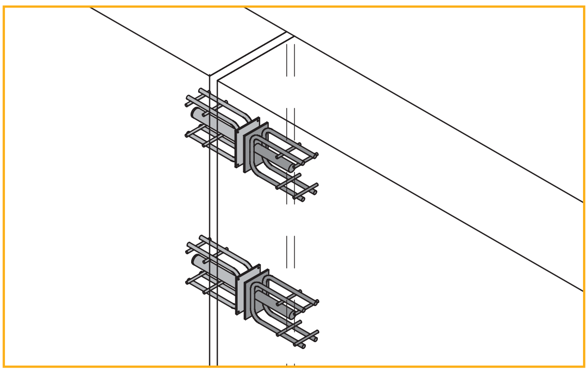


Figure 7: Connection between wall and wall (face to face)

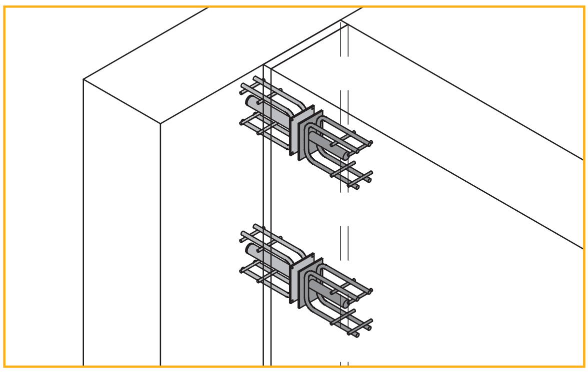
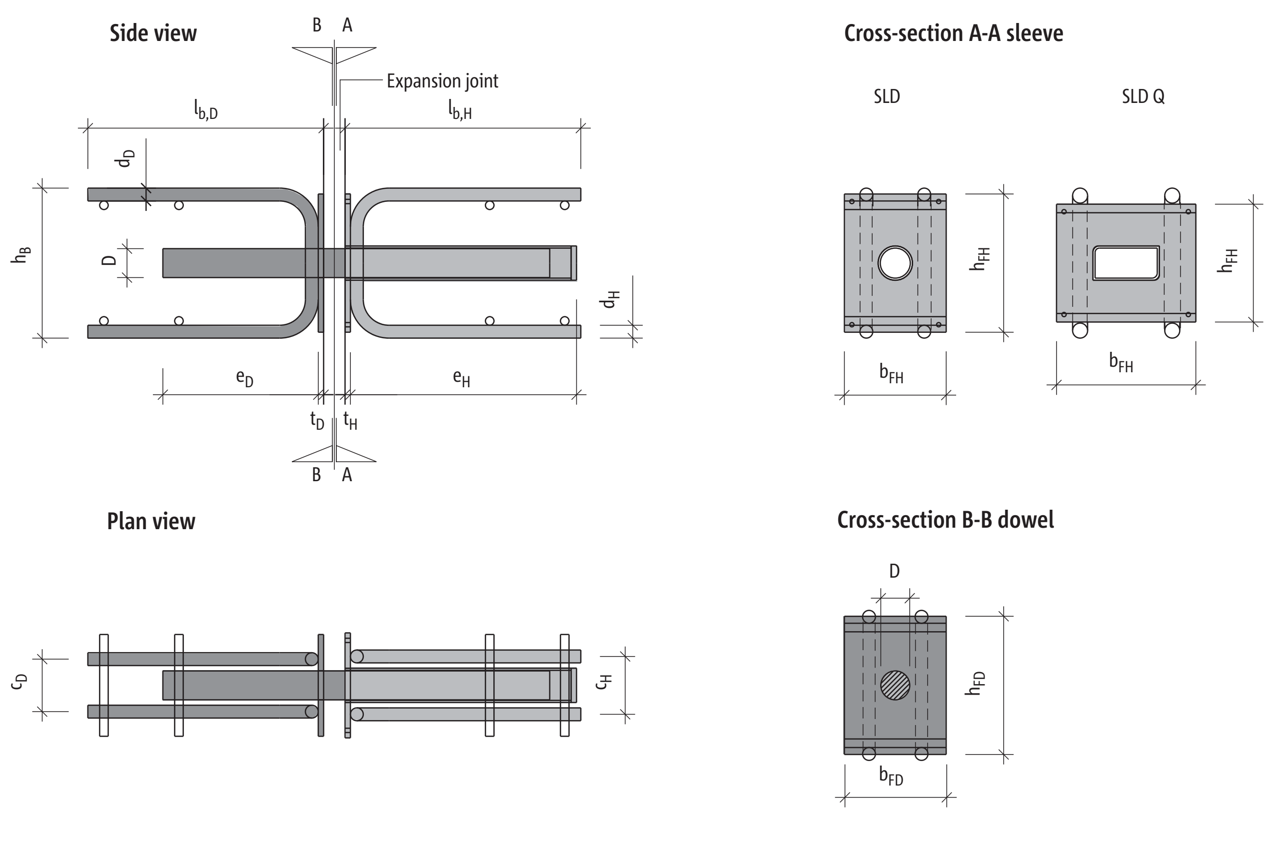


Figure 8: Connection between wall and wall (face to edge)

Schöck dowel Type SLD plus

Dimensions SLD 40 plus to SLD 80 plus/or SLD Q 40 plus to SLD Q 80 plus



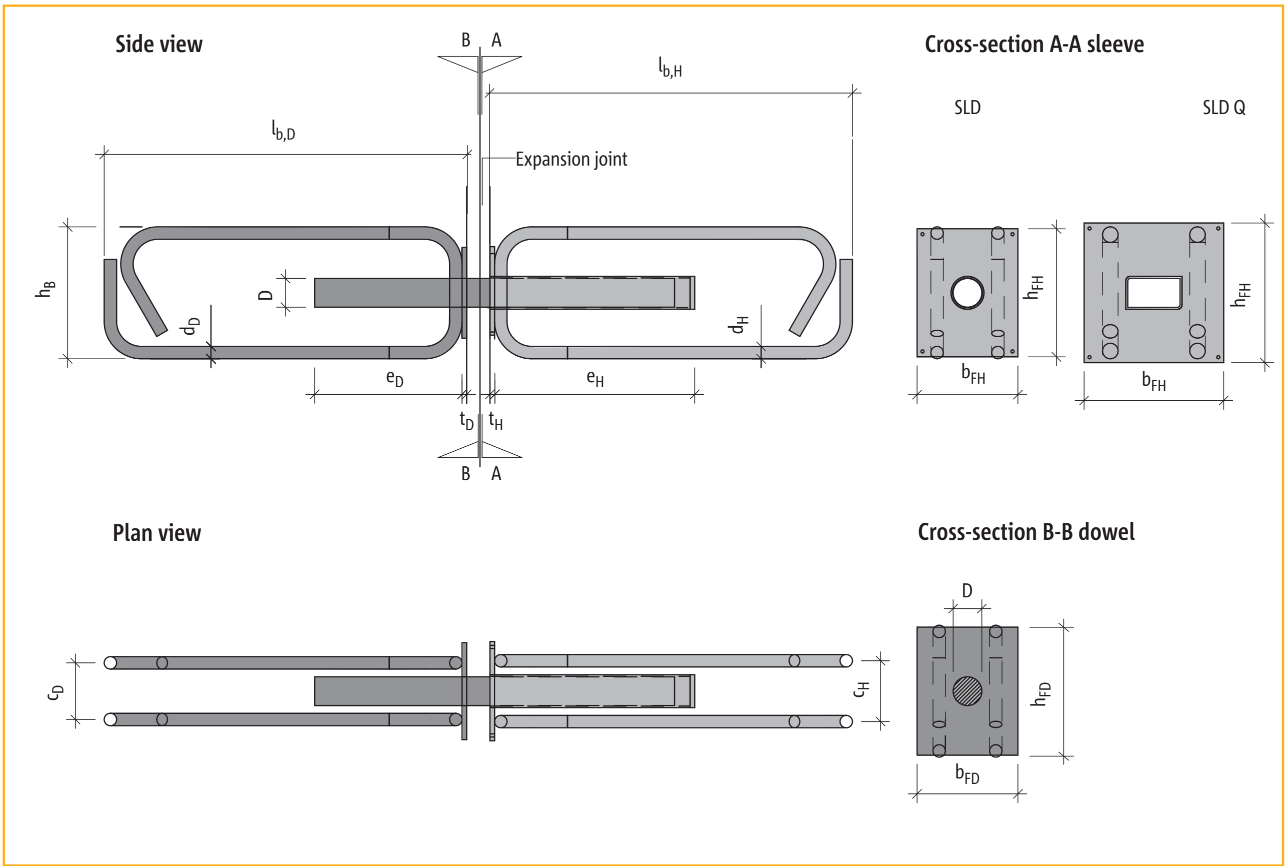
Maximum shear force $V_{Rd,s}$ from 24.2 kN to 111.2 kN

Dimensions [mm]			Schöck dowel Type SLD plus									
			40	Q 40	50	Q 50	60	Q 60	70	Q 70	80	Q 80
Dowel	Ø Dowel	D	22		22		24		27		30	
	Dowel length	e_D	100		115		130		145		155	
	Ø U-bar	d_D	10		10		12		12		14	
	U-bar length[1]	$l_{b,D}$	146		146		169		220		238	
	U-bar height[2]	h_B	100		100		120		140		180	
	U-bar spacing	c_D	42		42		46		49		54	
	Faceplate	t_D	4		4		4		5		6	
	Faceplate height	h_{FD}	85		87		117		129		144	
	Faceplate width	b_{FD}	65		85		85		95		110	
Sleeve	Sleeve length	e_H	165		180		195		211		221	
	Ø U-bar	d_H	10		10	12	12		12	14	14	16
	U-bar length[1]	$l_{b,H}$	146	168	146	175	169	171	220	214	238	294
	U-bar spacing	c_H	45	80	45	80	48	83	53	86	61	97
	Faceplate	t_H	4	5	4	6	4	6	5	8	6	8
	Faceplate height	h_{FH}	85	95	87	95	117	110	129	110	144	130
	Faceplate width	b_{FH}	65	105	85	110	85	120	95	130	110	165

[1] Manufactory tolerances for bent bar length: ± 10 mm
[2] Manufactory tolerances for bent bar height: ± 5 mm

Schöck dowel Type SLD plus

Dimensions SLD 120 plus/SLD 150 plus and SLD Q 120 plus/SLD Q 150 plus



Maximum shear force $V_{Rd,s}$ from 144.3 kN to 263.5 kN

Dimensions [mm]			Schöck dowel Type SLD plus			
			120	Q 120	150	Q 150
Dowel	∅ Dowel	D	37		42	
	Dowel length	e_D	190		230	
	∅ U-bar	d_D	16		20	
	U-bar length[1]	$l_{b,D}$	457		458	
	U-bar height[2]	h_B	170		210	
	U-bar spacing	c_D	73		82	
	Faceplate	t_D	8		10	
	Faceplate height	h_{FD}	165		180	
	Faceplate width	b_{FD}	130		145	
Sleeve	Sleeve length	e_H	258	258	300	300
	∅ U-bar	d_H	16	20	20	25
	U-bar length[1]	$l_{b,H}$	457	448	458	536
	U-bar spacing	c_H	75	110	85	120
	Faceplate	t_H	8	10	10	10
	Faceplate height	h_{FH}	165	180	180	210
	Faceplate width	b_{FH}	130	180	145	200

[1] Manufactory tolerances for bent bar length: ± 10 mm
[2] Manufactory tolerances for bent bar height: ± 5 mm

Schöck dowel Type SLD plus
Installation information

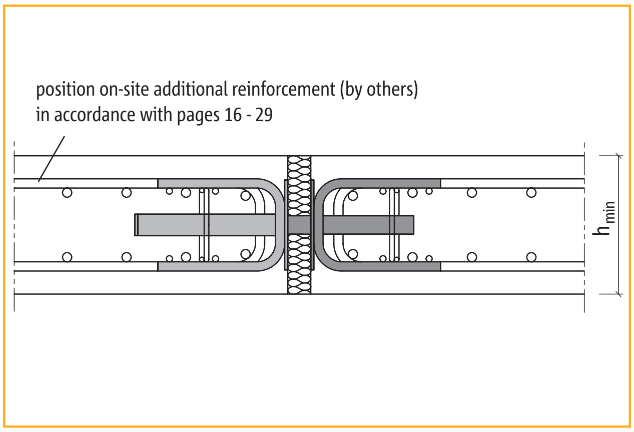


Figure 1: Installation for minimum slab thickness h_{min}

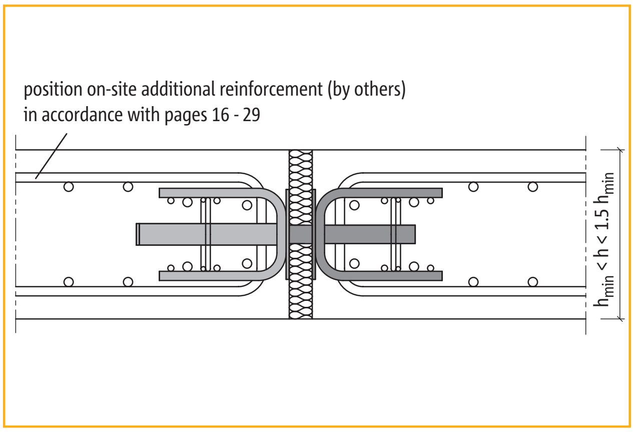


Figure 2: Installation for slab thickness $h_{min} < h < 1.5\ h_{min}$

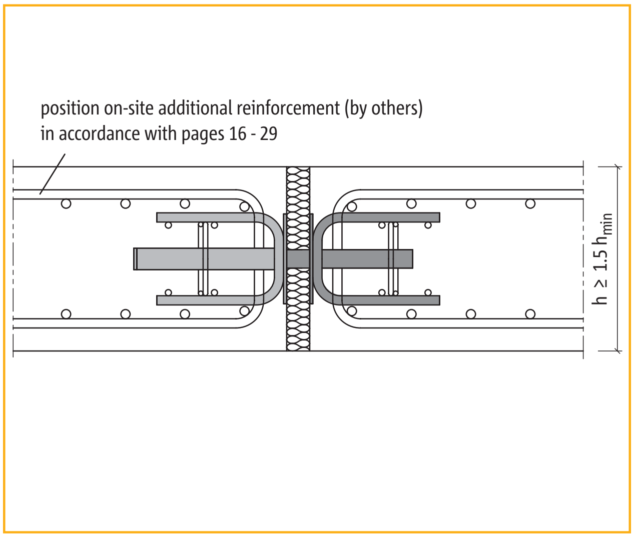


Figure 3: Installation for large slab thicknesses $h \geq 1.5\ h_{min}$

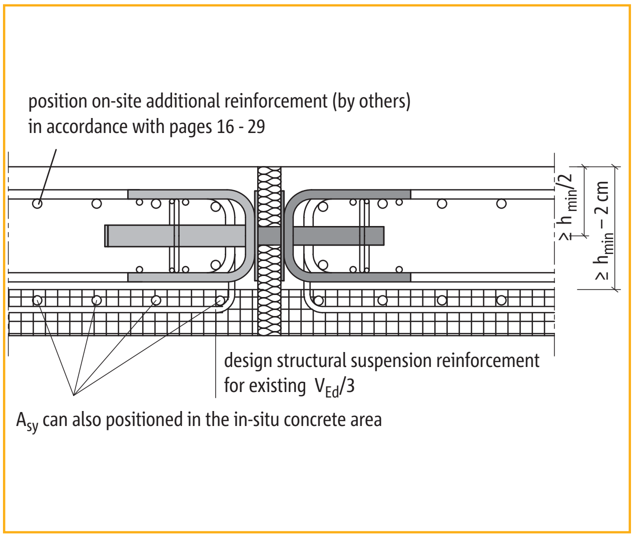


Figure 4: Installation for precast floor slabs

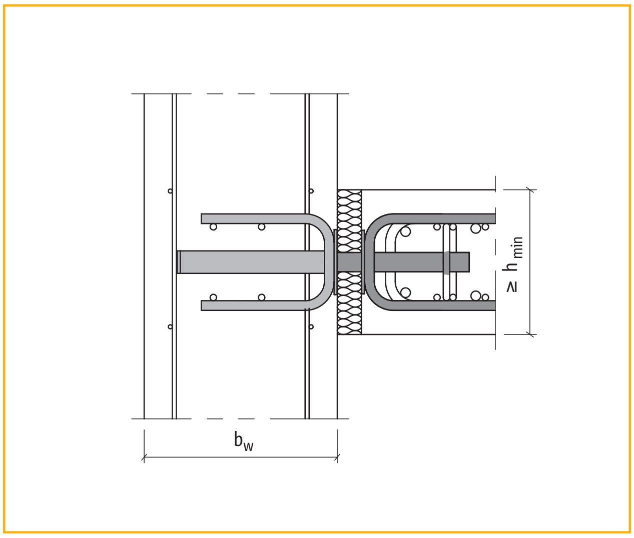


Figure 5: Connection of slab to wall

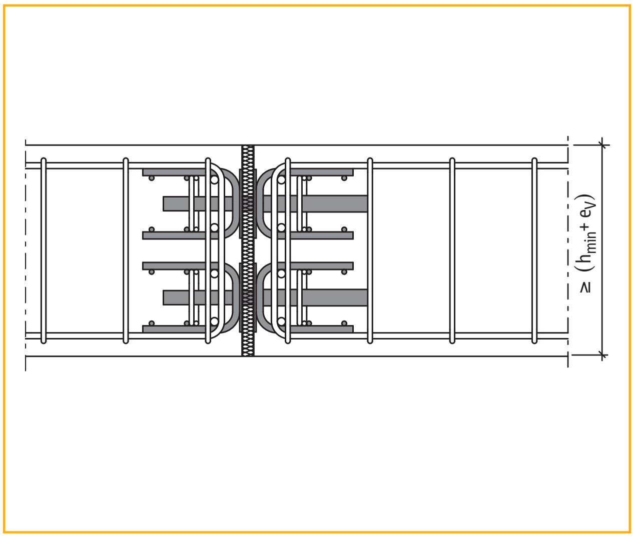


Figure 6: Beam joint configuration

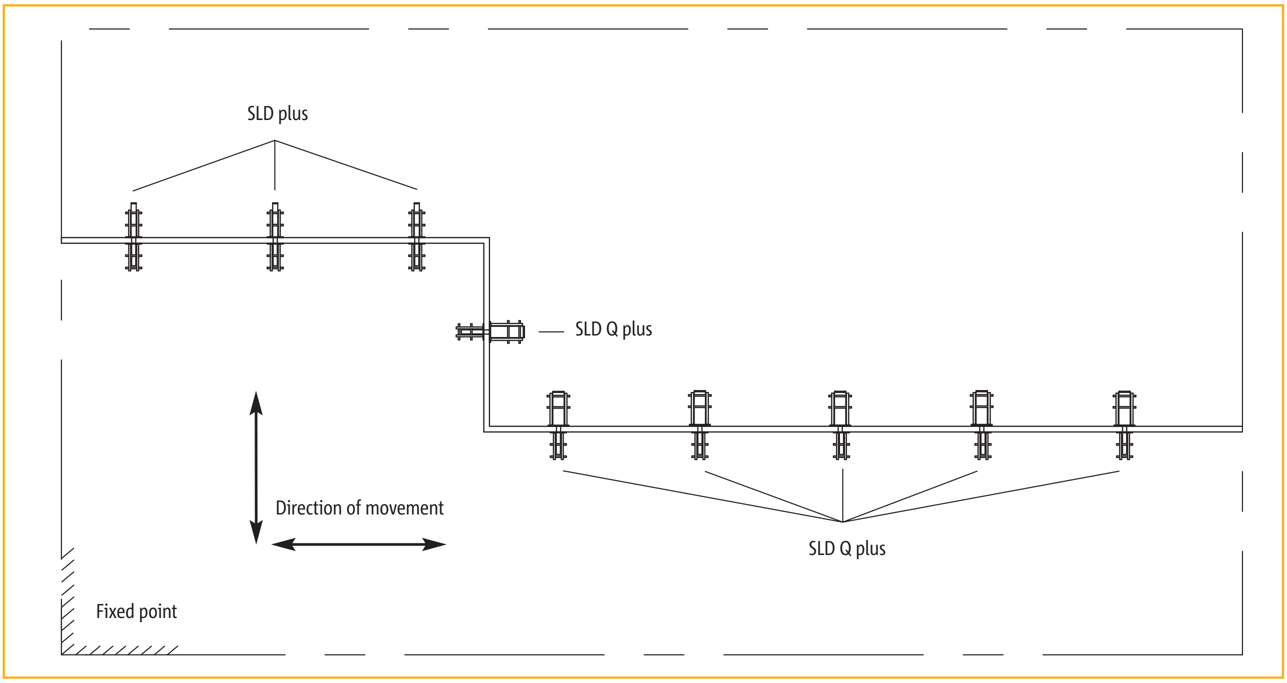
Schöck dowel Type SLD plus
Notes

Area of application for the use of the Schöck dowel system

- The Schöck heavy duty dowel SLD plus is for the transfer of primarily stationary, structurally relevant shear forces in expansion joints.
- Expansion joints up to a 60 mm joint width can be produced using the SLD plus.
- The constant dowel bearing strength up to a joint width of 40 mm offers maximum design safety.
  This takes tolerances into account and helps the structural engineers to determine the appropriate joint width with respect to the design calculation.
- The dowel and sleeve are made of approved stainless steel with material numbers 1.4462, 1.4571 and 1.4404 under the German technical approval Z-30.3-6 and therefore offer durable and maintenance-free solutions for all corrosion resistance class III applications.
- The dowel system covers all expansion joints using all standard concretes from C20/25 to C50/60.
- The existing construction element reinforcement may be taken into account for the required reinforcement A_{sy} and A_{sx2}.
- The additional hanging reinforcement A_{sx1} must always be installed.

Construction notes

- Expansion joints are systematically included for the avoidance of stresses in construction elements. Great care must be taken to ensure that longitudinal and transverse directions in the slab are investigated for possible movement effects such as temperature changes, shrinkage, creeping, expansion and differential settlement. For long expansion joints or expansion joints which follow structural corners, Type SLD Q plus heavy duty dowels which are movable along two axes must be used.
- Single axis movement (only along dowel axis): Schöck shear load dowel Type SLD plus
- Double axis movement (along dowel axis and horizontally in direction of the expansion joint): Schöck shear load dowel Type SLD Q plus



Dowel choice for recessed corners or long expansion joints

Schöck dowel Type SLD 40 plus

Design/On-site reinforcement

The shear resistance of SLD plus is the smaller value of $V_{Rd,s}$ (table 1) and $V_{Rd,b}$ (table 4).

SLD

Design resistance steel $V_{Rd,s}$

Schöck dowel type	Joint width f [mm]	$V_{Rd,s}$ [kN] C 20/25	$V_{Rd,s}$ [kN] ≥ C 30/37
SLD 40 plus	≤ 40	31.4	35.1
	≤ 50	29.6	31.9
	≤ 60	26.9	
SLD Q 40 plus	≤ 40	31.4	35.1
	≤ 50	28.7	
	≤ 60	24.2	

Table 1

Minimum member dimensions and dowel spacings

Dimension in [mm]	SLD 40 plus	SLD Q 40 plus
Minimum slab thickness h_{min}	160	
Wall thickness b_w	≥ 185	≥ 200
Minimum horizontal dowel spacing $e_{h, min}$	240	
Minimum distance to edge $e_{R,min}$	120	
Beam width b_u	≥ 240	
Minimum vertical dowel spacing $e_{v, min}$	120	

Table 2

Geometrical minimum for dowel arrangement

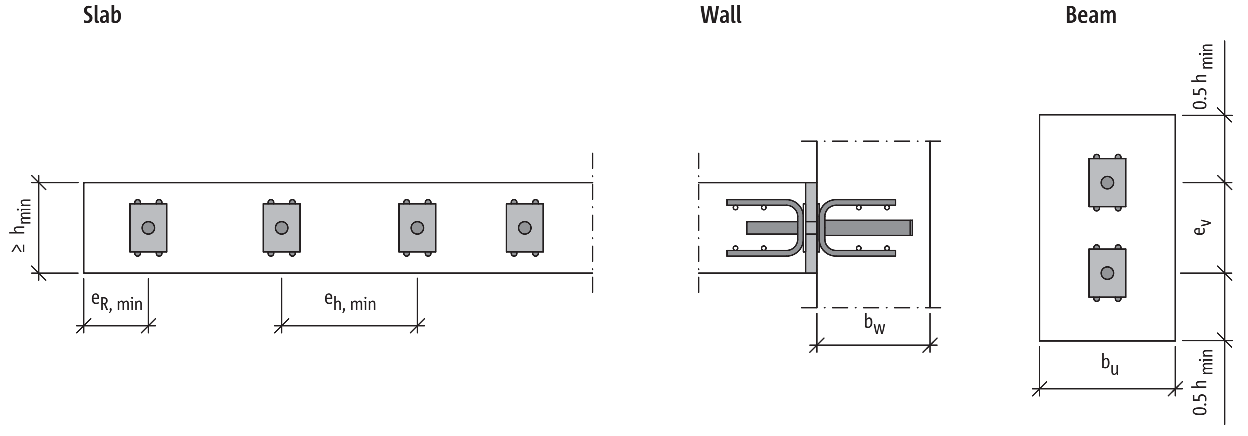


Table 3

Schöck dowel Type SLD 40 plus
Design/On-site reinforcement

Design resistance concrete $V_{Rd,b}$

Schöck dowel type	Slab depth h [mm]	$V_{Rd,b} = \min \{V_{Rd,c}; V_{Rd,ct}\}$ [kN] C 20/25	C 30/37	A_{sx1} [1]	A_{sx2} [1]	A_{sy} [1]	Pos. 1
SLD 40 plus	160	25.9	31.7	4 Ø 8	2 Ø 10	3 Ø 10	2 Ø 8 e_1 = 65 mm
	180	38.7	47.4	4 Ø 10		3 Ø 12	
	200	41.8	51.2				
SLD Q 40 plus	160	31.6	38.7	4 Ø 10	2 Ø 10	3 Ø 10	2 Ø 8 e_1 = 65 mm
	180	34.9	42.8			3 Ø 12	
	200	38.2	46.7				

Table 4

Required minimum dowel spacing for design resistance concrete $V_{Rd,b}$ from table 4

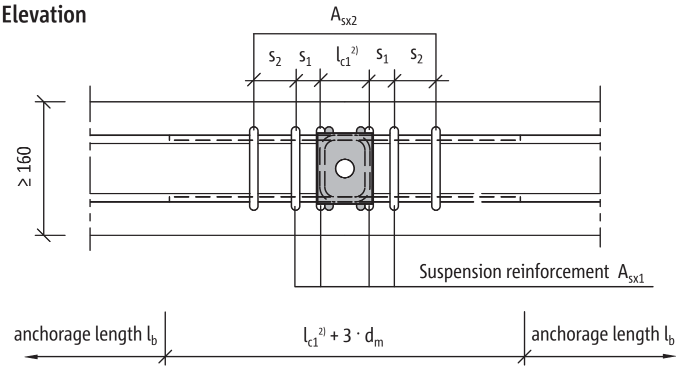
Dimension in [mm]	Slab thickness h in [mm]	SLD 40 plus	SLD Q 40 plus
Critical dowel spacing $e_{h,crit}$	160	425	455
	180	480	510
	200	510	540
Critical edge distance $e_{R,crit}$	160	350	360
	180	390	405
	200	415	430

Table 5

If smaller spacing is necessary the punching shear proof must be carried out in accordance with page 30.
The smallest possible dowel spacings are $e_{h,min}$ and $e_{R,min}$.

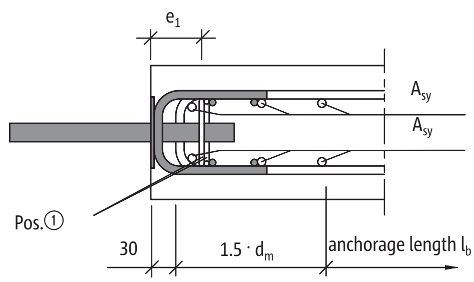
Position on-site reinforcement (by others)

Elevation



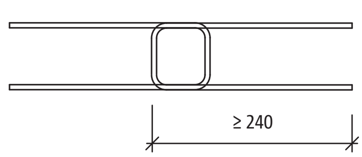
Cross-section

All dimensions in [mm]



	h ≤ 300 mm	h > 300 mm
s_1 [3]	30 mm	50 mm
$s_{2,3}$ [3]	50 mm	

Pos.①: 2 Ø 8 U-bar



[3] If s_1, s_2, s_3 are exceeded, then the slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 31.

Table 6

[1] The selected U-bar A_{sx} and the longitudinal reinforcement A_{sy} are examples. Other U-bars and longitudinal reinforcement are permitted. If the specified reinforcement or the critical dowel spacings ($e_{h,crit}$, $e_{R,crit}$) are not met, then the punching shear ($V_{Rd,ct}$) and slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 30 - 31.
[2] SLD 40 plus: l_{c1} = 62 mm SLD Q 40 plus: l_{c1} = 92 mm

Schöck dowel Type SLD 50 plus

Design/On-site reinforcement

The shear resistance of SLD plus is the smaller value of $V_{Rd,s}$ (table 1) and $V_{Rd,b}$ (table 4).

Design resistance steel $V_{Rd,s}$

Schöck dowel type	Joint width f [mm]	$V_{Rd,s}$ [kN]	
		C 20/25	≥ C 30/37
SLD 50 plus	≤ 40	42.7	47.7
	≤ 50	40.7	42.1
	≤ 60	35.6	
SLD Q 50 plus	≤ 40	42.7	46.3
	≤ 50	37.9	
	≤ 60	32.0	

Table 1

Minimum member dimensions and dowel spacings

Dimension in [mm]	SLD 50 plus	SLD Q 50 plus
Minimum slab thickness h_{min}	160	
Wall thickness b_w	≥ 200	≥ 210
Minimum horizontal dowel spacing $e_{h, min}$	240	
Minimum distance to edge $e_{R,min}$	120	
Beam width b_u	≥ 240	
Minimum vertical dowel spacing $e_{v, min}$	120	

Table 2

Geometrical minimum for dowel arrangement

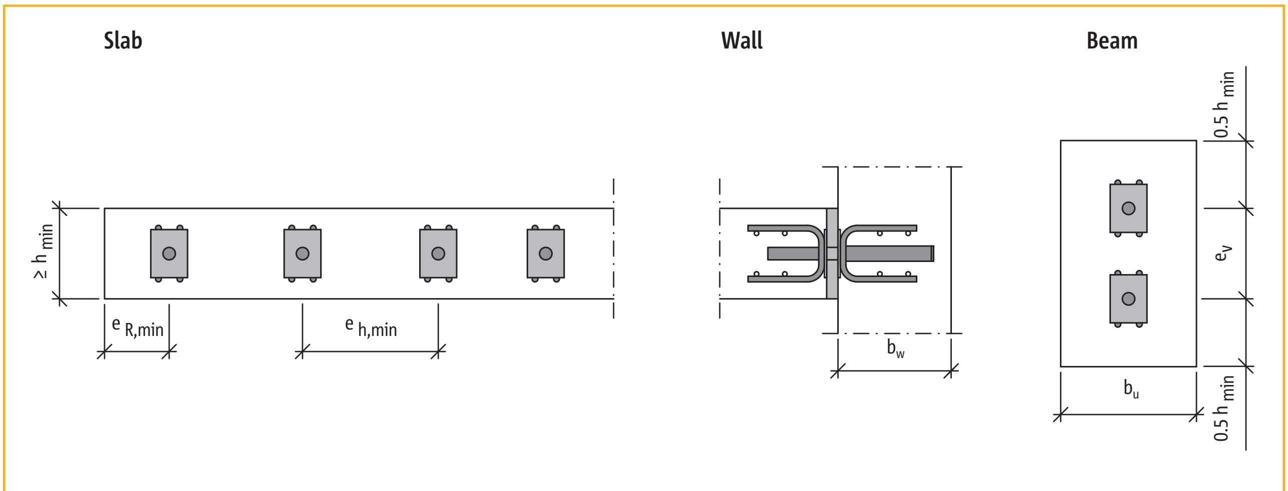


Table 3

Schöck dowel Type SLD 50 plus

Design/On-site reinforcement

Design resistance concrete $V_{Rd,b}$

Schöck dowel type	Slab depth h [mm]	$V_{Rd,b} = \min \{V_{Rd,c}; V_{Rd,ct}\}$ [kN]		A_{sx1} [1]	A_{sx2} [1]	A_{sy} [1]	Pos. 1
		C 20/25	C 30/37				
SLD 50 plus	160	45.7	56.0	4 ⌀ 12	2 ⌀ 10	3 ⌀ 12	2 ⌀ 8, e_1 = 80 mm
	180	49.7	60.8		2 ⌀ 12		
	200	53.5	65.5				
SLD Q 50 plus	160	40.2	49.3	4 ⌀ 12	2 ⌀ 10	3 ⌀ 12	2 ⌀ 8, e_1 = 80 mm
	180	44.3	54.2		2 ⌀ 12		
	200	48.3	59.1				

Table 4

Required minimum dowel spacing for design resistance concrete $V_{Rd,b}$ from table 4

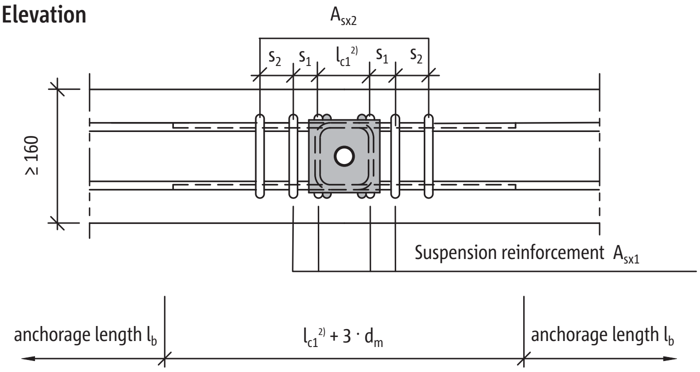
Dimension in [mm]	Slab thickness h in [mm]	SLD 50 plus	SLD Q 50 plus
Critical dowel spacing $_{eh, crit}$	160	420	455
	180	480	515
	200	515	550
Critical edge distance $e_{R, crit}$	160	345	360
	180	390	405
	200	415	430

Table 5

If smaller spacing is necessary the punching shear proof must be carried out in accordance with page 30.
The smallest possible dowel spacings are $e_{h, min}$ and $e_{R, min}$.

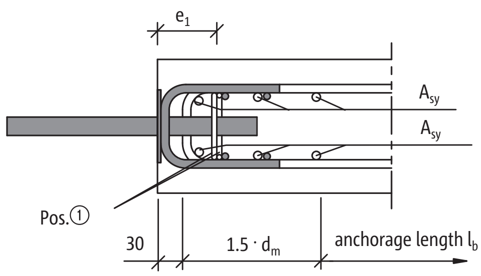
Position on-site reinforcement (by others)

Elevation



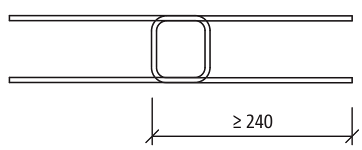
Cross-section

All dimensions in [mm]



	h ≤ 300 mm	h > 300 mm
s_1 [3]	32 mm	50 mm
$s_{2,3}$ [3]	50 mm	

Pos.①: 2 ⌀ 8 U-bar



[3] If s_1, s_2, s_3 are exceeded, then the slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 31.

Table 6

[1] The selected U-bar A_{sx} and the longitudinal reinforcement A_{sy} are examples. Other U-bars and longitudinal reinforcement are permitted. If the specified reinforcement or the critical dowel spacings ($e_{h,crit}$, $e_{R,crit}$) are not met, then the punching shear ($V_{Rd,ct}$) and slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 30 - 31.
[2] SLD 50 plus: l_{c1} = 64 mm SLD Q 50 plus: l_{c1} = 98 mm

Schöck dowel Type SLD 60 plus

Design/On-site reinforcement

The shear resistance of SLD plus is the smaller value of $V_{Rd,s}$ (table 1) and $V_{Rd,b}$ (table 4).

Design resistance steel $V_{Rd,s}$

SLD

Schöck dowel type	Joint width f [mm]	$V_{Rd,s}$ [kN]	
		C 20/25	≥ C 30/37
SLD 60 plus	≤ 40	61.5	65.9
	≤ 50	54.3	
	≤ 60	46.0	
SLD Q 60 plus	≤ 40	59.2	59.3
	≤ 50	48.8	
	≤ 60	41.4	

Table 1

Minimum member dimensions and dowel spacings

Dimension in [mm]	SLD 60 plus	SLD Q 60 plus
Minimum slab thickness h_{min}	180	
Wall thickness b_w	≥ 215	
Minimum horizontal dowel spacing $e_{h, min}$	270	
Minimum distance to edge $e_{R,min}$	135	
Beam width b_u	≥ 270	
Minimum vertical dowel spacing $e_{v, min}$	140	

Table 2

Geometrical minimum for dowel arrangement

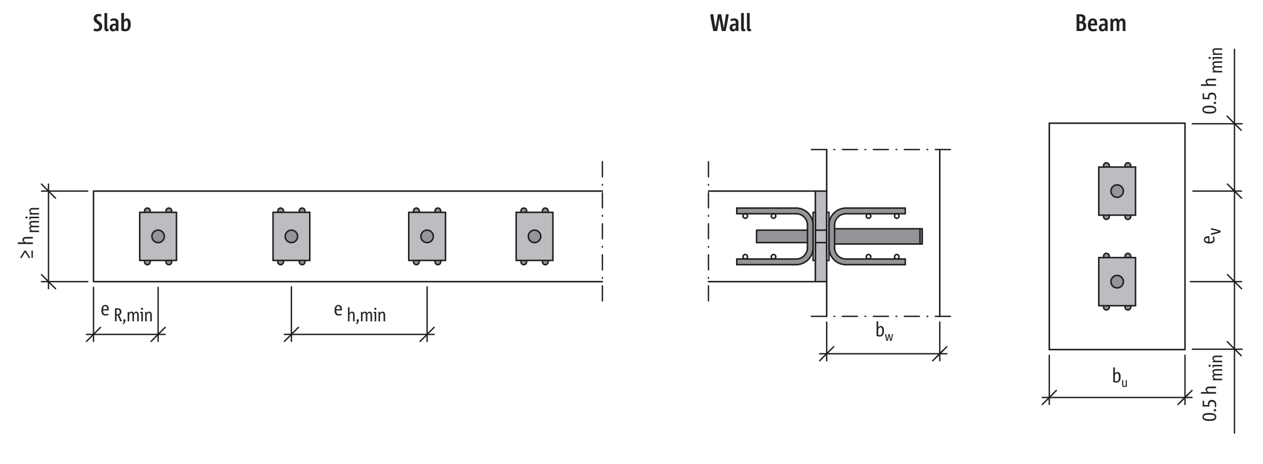


Table 3

Schöck dowel Type SLD 60 plus

Design/On-site reinforcement

Design resistance concrete $V_{Rd,b}$

Schöck dowel type	Slab depth h [mm]	$V_{Rd,b} = \min \begin{cases} V_{Rd,c} \\ V_{Rd,ct} \end{cases}$ [kN] C 20/25	C 30/37	A_{sx1} [1)]	A_{sx2} [1)]	A_{sy} [1)]	Pos. 1
SLD 60 plus	180	61.1	69.9	2 ⌀ 16	4 ⌀ 12	3 ⌀ 12	2 ⌀ 8 e_1 = 95 mm
	200	69.8	79.8				
	220	75.4	89.8				
SLD Q 60 plus	180	60.5	71.9	2 ⌀ 16	4 ⌀ 12	3 ⌀ 12	2 ⌀ 8 e_1 = 95 mm
	200	65.2	79.9				
	220	69.9	85.6				

Table 4

Required minimum dowel spacing for design resistance concrete $V_{Rd,b}$ from table 4

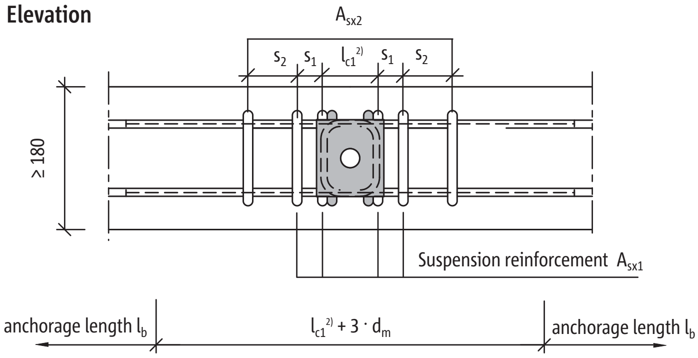
Dimension in [mm]	Slab thickness h in [mm]	SLD 60 plus	SLD Q 60 plus
Critical dowel spacing $_{eh, crit}$	180	485	520
	200	540	575
	220	575	610
Critical edge distance $e_{R, crit}$	180	390	405
	200	435	450
	220	460	475

Table 5

If smaller spacing is necessary the punching shear proof must be carried out in accordance with page 30.
The smallest possible dowel spacings are $e_{h, min}$ and $e_{R, min}$.

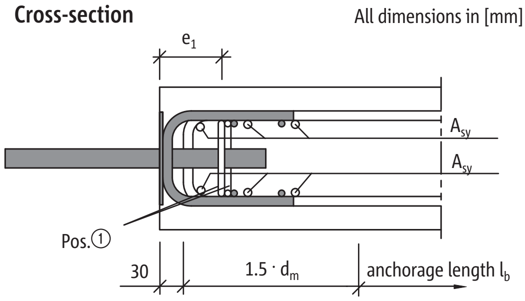
Position on-site reinforcement (by others)

Elevation



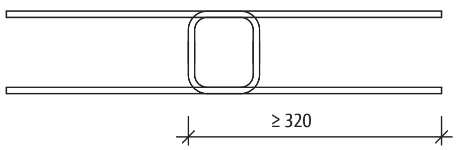
Cross-section

All dimensions in [mm]



	h ≤ 300 mm	h > 300 mm
s_1 [3)]	34 mm	50 mm
$s_{2,3}$ [3)]	50 mm	

Pos.①: 2 ⌀ 8 U-bar



[3)] If s_1, s_2, s_3 are exceeded, then the slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 31.

Table 6

[1)] The selected U-bar A_{sx} and the longitudinal reinforcement A_{sy} are examples. Other U-bars and longitudinal reinforcement are permitted. If the specified reinforcement or the critical dowel spacings ($e_{h,crit}$, $e_{R,crit}$) are not met, then the punching shear ($V_{Rd,ct}$) and slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 30 - 31.
[2)] SLD 60 plus: l_{c1} = 72 mm   SLD Q 60 plus: l_{c1} = 106 mm

Schöck dowel Type SLD 70 plus

Design/On-site reinforcement

The shear resistance of SLD plus is the smaller value of $V_{Rd,s}$ (table 1) and $V_{Rd,b}$ (table 4).

Design resistance steel $V_{Rd,s}$

Schöck dowel type	Joint width f [mm]	$V_{Rd,s}$ [kN] C 20/25	$V_{Rd,s}$ [kN] ≥ C 30/37
SLD 70 plus	≤ 40	71.1	79.5
	≤ 50	68.4	76.2
	≤ 60	64.8	
SLD Q 70 plus	≤ 40	71.1	79.5
	≤ 50	68.4	
	≤ 60	58.3	

Table 1

Minimum member dimensions and dowel spacings

Dimension in [mm]	SLD 70 plus	SLD Q 70 plus
Minimum slab thickness h_{min}	200	
Wall thickness b_w	≥ 255	≥ 250
Minimum horizontal dowel spacing $e_{h, min}$	300	
Minimum distance to edge $e_{R,min}$	150	
Beam width b_u	≥ 300	
Minimum vertical dowel spacing $e_{v, min}$	160	

Table 2

Geometrical minimum for dowel arrangement

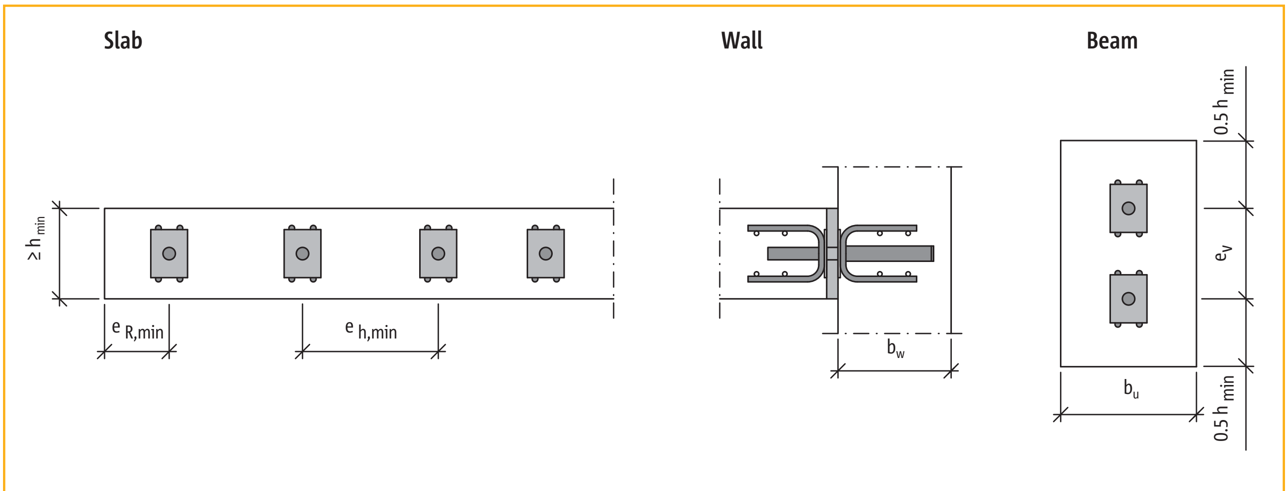


Table 3

Schöck dowel Type SLD 70 plus

Design/On-site reinforcement

Design resistance concrete $V_{Rd,b}$

Schöck dowel type	Slab depth h [mm]	$V_{Rd,b} = \min \begin{cases} V_{Rd,c} \\ V_{Rd,ct} \end{cases}$ [kN] C 20/25	C 30/37	A_{sx1} [1)]	A_{sx2} [1)]	A_{sy} [1)]	Pos. 1
SLD 70 plus	200	67.9	77.7	6 Ø 12	2 Ø 12	3 Ø 12	2 Ø 8 e_1 = 105 mm
	240	84.8	97.0				
	280	93.8	114.9				
SLD Q 70 plus	200	69.0	84.3	6 Ø 12	2 Ø 12	3 Ø 12	2 Ø 8 e_1 = 105 mm
	240	77.8	95.3				
	280	103.1	125.3				

Table 4

Required minimum dowel spacing for design resistance concrete $V_{Rd,b}$ from table 4

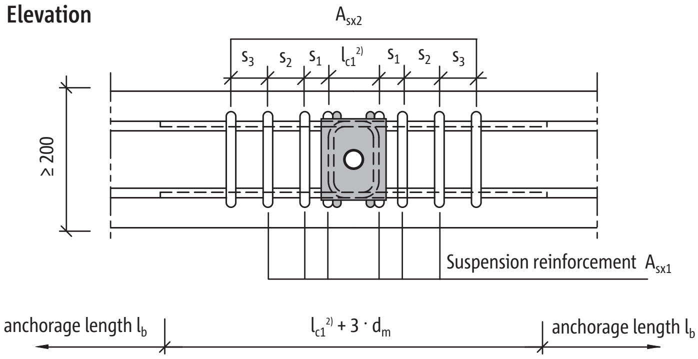
Dimension in [mm]	Slab thickness h in [mm]	SLD 70 plus	SLD Q 70 plus
Critical dowel spacing $_{eh,\,crit}$	200	550	585
	240	640	675
	280	790	825
Critical edge distance $e_{R,\,crit}$	200	440	460
	240	510	530
	280	630	645

Table 5

If smaller spacing is necessary the punching shear proof must be carried out in accordance with page 30.
The smallest possible dowel spacings are $e_{h,\,min}$ and $e_{R,\,min}$.

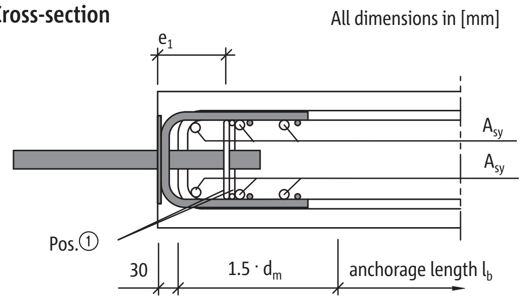
Position on-site reinforcement (by others)

Elevation



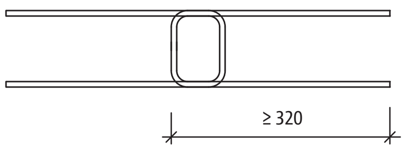
Cross-section

All dimensions in [mm]



	h ≤ 300 mm	h > 300 mm
s_1 [3)]	32 mm	50 mm
$s_{2,3}$ [3)]	50 mm	

Pos.①: 2 Ø 8 U-bar



[3)] If s_1, s_2, s_3 are exceeded, then the slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 31.

Table 6

[1)] The selected U-bar A_{sx} and the longitudinal reinforcement A_{sy} are examples. Other U-bars and longitudinal reinforcement are permitted. If the specified reinforcement or the critical dowel spacings ($e_{h,crit}$, $e_{R,crit}$) are not met, then the punching shear ($V_{Rd,ct}$) and slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 30 - 31.

[2)] SLD 70 plus: l_{c1} = 73 mm SLD Q 70 plus: l_{c1} = 111 mm

Schöck dowel Type SLD 80 plus

Design/On-site reinforcement

The shear resistance of SLD plus is the smaller value of $V_{Rd,s}$ (table 1) and $V_{Rd,b}$ (table 4).

Design resistance steel $V_{Rd,s}$

Schöck dowel type	Joint width f [mm]	$V_{Rd,s}$ [kN] C 20/25	$V_{Rd,s}$ [kN] ≥ C 30/37
SLD 80 plus	≤ 40	98.5	110.1
	≤ 50	95.0	103.0
	≤ 60	87.9	
SLD Q 80 plus	≤ 40	98.5	110.1
	≤ 50	92.7	
	≤ 60	79.1	

Table 1

Minimum member dimensions and dowel spacings

Dimension in [mm]	SLD 80 plus	SLD Q 80 plus
Minimum slab thickness h_{min}	240	
Wall thickness b_w	≥ 275	≥ 305 + c_{nom}*
Minimum horizontal dowel spacing $e_{h,\,min}$	360	
Minimum distance to edge $e_{R,min}$	240	
Beam width b_u	≥ 360	
Minimum vertical dowel spacing $e_{v,\,min}$	200	

Table 2

Geometrical minimum for dowel arrangement

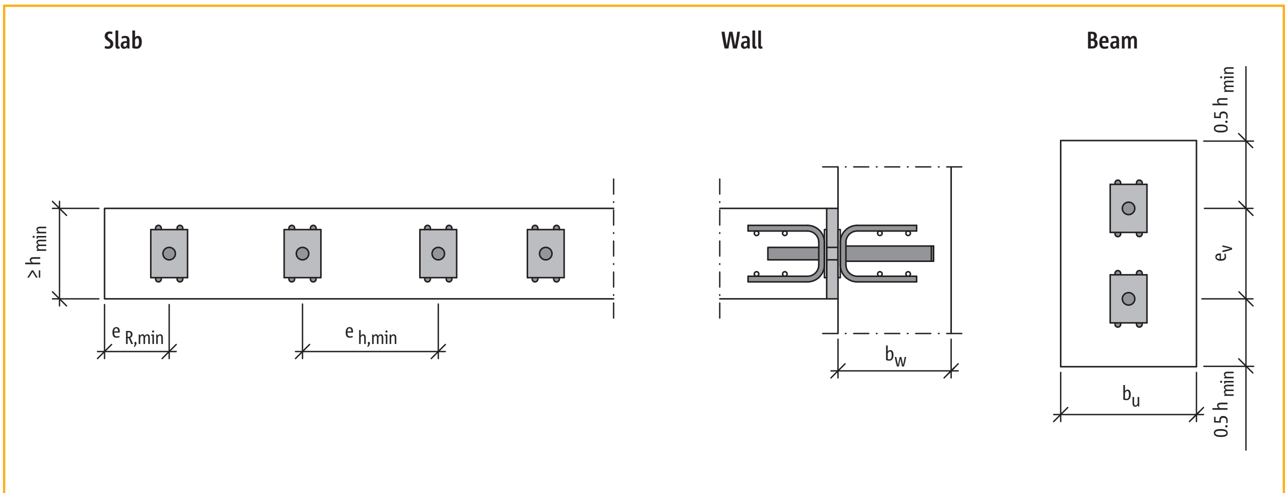


Table 3

*c_{nom} according to DIN 1045-1: 2008-08

Schöck dowel Type SLD 80 plus

Design/On-site reinforcement

Design resistance concrete $V_{Rd,b}$

Schöck dowel type	Slab depth h [mm]	$V_{Rd,b} = \min \{V_{Rd,c}; V_{Rd,ct}\}$ [kN] C 20/25	C 30/37	A_{sx1} [1]	A_{sx2} [1]	A_{sy} [1]	Pos. 1
SLD 80 plus	240	104.8	119.9	6 ∅ 16	2 ∅ 12	3 ∅ 16	2 ∅ 8, e_1 = 115 mm
	280	134.6	154.0	8 ∅ 16	2 ∅ 16		
	320	157.7	180.5				
SLD Q 80 plus	240	107.1	122.6	6 ∅ 16	2 ∅ 12	3 ∅ 16	2 ∅ 8, e_1 = 115 mm
	280	137.0	156.8	8 ∅ 16	2 ∅ 16		
	320	160.1	183.3				

Table 4

Required minimum dowel spacing for design resistance concrete $V_{Rd,b}$ from table 4

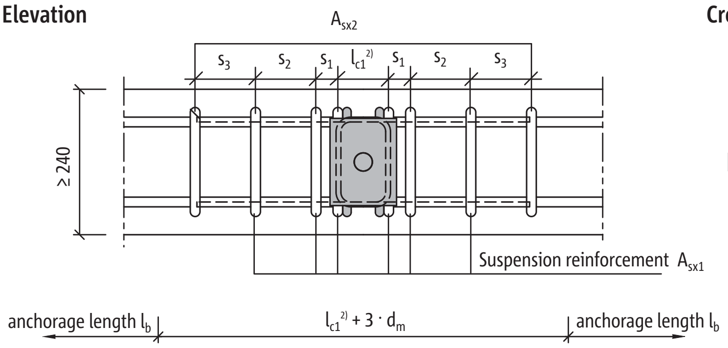
Dimension in [mm]	Slab thickness h in [mm]	SLD 80 plus	SLD Q 80 plus
Critical dowel spacing $_{eh, crit}$	240	670	705
	280	765	800
	320	910	945
Critical edge distance $e_{R, crit}$	240	535	550
	280	605	620
	320	720	735

Table 5

If smaller spacing is necessary the punching shear proof must be carried out in accordance with page 30.
The smallest possible dowel spacings are $e_{h, min}$ and $e_{R, min}$.

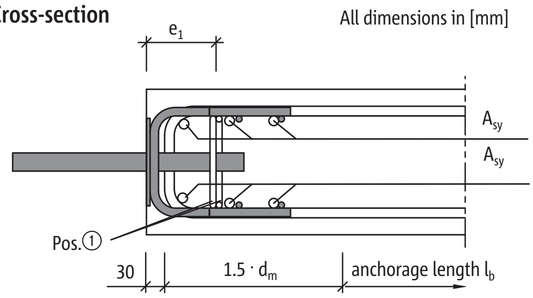
Position on-site reinforcement (by others)

Elevation



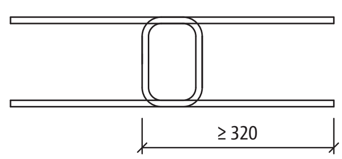
Cross-section

All dimensions in [mm]



	h ≤ 300 mm	h > 300 mm
s_1 [3]	36 mm	50 mm
$s_{2,3}$ [3]	50 mm	

Pos.①: 2 ∅ 8 U-bar



[3] If s_1, s_2, s_3 are exceeded, then the slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 31.

Table 6

[1] The selected U-bar A_{sx} and the longitudinal reinforcement A_{sy} are examples. Other U-bars and longitudinal reinforcement are permitted. If the specified reinforcement or the critical dowel spacings ($e_{h,crit}$, $e_{R,crit}$) are not met, then the punching shear ($V_{Rd,ct}$) and slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 30 - 31.
[2] SLD 80 plus: l_{c1} = 89 mm   SLD Q 80 plus: l_{c1} = 122 mm

Schöck dowel Type SLD 120 plus

Design/On-site reinforcement

The shear resistance of SLD plus is the smaller value of $V_{Rd,s}$ (table 1) and $V_{Rd,b}$ (table 4).

Design resistance steel $V_{Rd,s}$

Schöck dowel type	Joint width f [mm]	$V_{Rd,s}$ [kN]	
		C 20/25	≥ C 30/37
SLD 120 plus	≤ 40	176.7	197.6
	≤ 50	171.7	186.0
	≤ 60	160.4	
SLD Q 120 plus	≤ 40	176.7	197.6
	≤ 50	167.4	
	≤ 60	144.3	

Table 1

Minimum member dimensions and dowel spacings

Dimension in [mm]	SLD 120 plus	SLD Q 120 plus
Minimum slab thickness h_{min}	300	
Wall thickness b_w	≥ 460 + c_{nom}*	
Minimum horizontal dowel spacing $e_{h, min}$	450	
Minimum distance to edge $e_{R,min}$	225	
Beam width b_u	≥ 450	
Minimum vertical dowel spacing $e_{v, min}$	190	

Table 2

Geometrical minimum for dowel arrangement

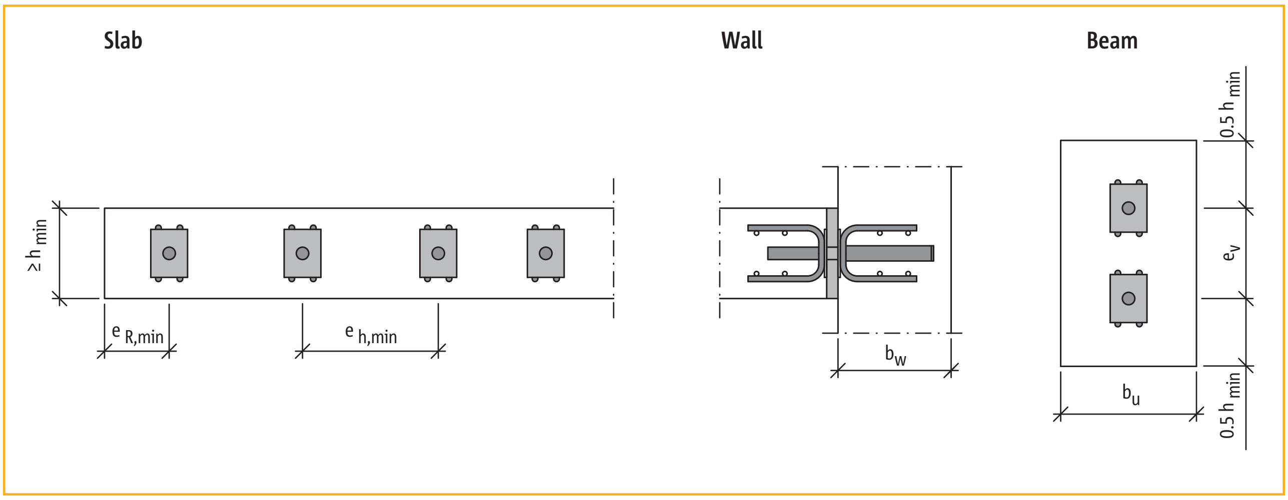


Table 3

*c_{nom} according to DIN 1045-1: 2008-08

Schöck dowel Type SLD 120 plus

Design/On-site reinforcement

Design resistance concrete $V_{Rd,b}$

Schöck dowel type	Slab depth h [mm]	$V_{Rd,b} = \min \begin{cases} V_{Rd,c} \\ V_{Rd,ct} \end{cases}$ [kN] C 20/25	C 30/37	A_{sx1} [1]	A_{sx2} [1]	A_{sy} [1]	Pos. 1
SLD 120 plus	300	154.1	176.4	8 Ø 16	2 Ø 16	4 Ø 16	2 Ø 10, e_1 = 150 mm
	350	207.7	238.4	8 Ø 20		4 Ø 20	
	400	243.3	278.5				
SLD Q 120 plus	300	167.4	191.6	6 Ø 16	2 Ø 16	4 Ø 16	2 Ø 10, e_1 = 150 mm
	350	187.6	229.8	8 Ø 20		4 Ø 20	
	400	234.8	282.6				

Table 4

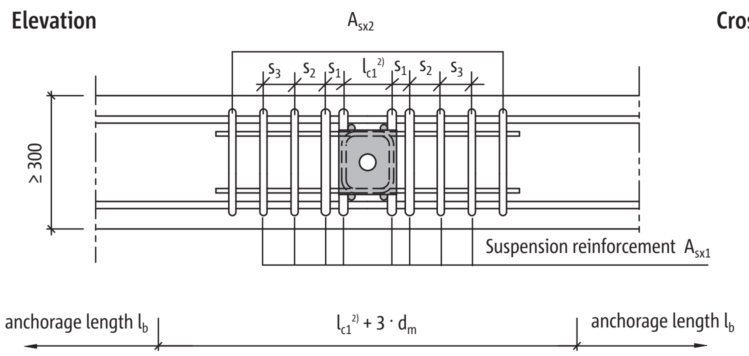
Required minimum dowel spacing for design resistance concrete $V_{Rd,b}$ from table 4

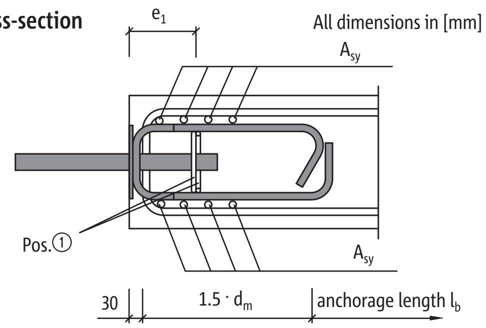
Dimension in [mm]	Slab thickness h in [mm]	SLD 120 plus	SLD Q 120 plus
Critical dowel spacing $e_{h,crit}$	300	825	860
	350	1015	1050
	400	1165	1200
Critical edge distance $e_{R,crit}$	300	645	665
	350	795	815
	400	910	930

Table 5

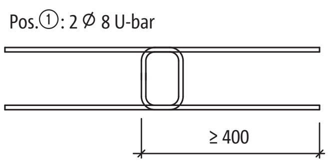
If smaller spacing is necessary the punching shear proof must be carried out in accordance with page 30.
The smallest possible dowel spacings are $e_{h,min}$ and $e_{R,min}$.

Position on-site reinforcement (by others)





	h ≤ 300 mm	h > 300 mm
s_1 [3]	40 mm	50 mm
$s_{2,3}$ [3]	50 mm	



[3] If s_1, s_2, s_3 are exceeded, then the slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 31.

Table 6

[1] The selected U-bar A_{sx} and the longitudinal reinforcement A_{sy} are examples. Other U-bars and longitudinal reinforcement are permitted. If the specified reinforcement or the critical dowel spacings ($e_{h,crit}$, $e_{R,crit}$) are not met, then the punching shear ($V_{Rd,ct}$) and slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 30 - 31.
[2] SLD 120 plus: l_{c1} = 114 mm SLD Q 120 plus: l_{c1} = 151 mm

Schöck dowel Type SLD 150 plus

Design/On-site reinforcement

The shear resistance of SLD plus is the smaller value of $V_{Rd,s}$ (table 1) and $V_{Rd,b}$ (table 4).

Design resistance steel $V_{Rd,s}$

Schöck dowel type	Joint width f [mm]	$V_{Rd,s}$ [kN] C 20/25	$V_{Rd,s}$ [kN] ≥ C 30/37
SLD 150 plus	≤ 40	235.7	263.5
	≤ 50	230.1	257.2
	≤ 60	224.7	
SLD Q 150 plus	≤ 40	235.7	260.2
	≤ 50	230.1	237.6
	≤ 60	206.4	

Table 1

Minimum member dimensions and dowel spacings

Dimension in [mm]	SLD 150 plus	SLD Q 150 plus
Minimum slab thickness h_{min}	350	
Wall thickness b_w	≥ 460 + c_{nom}*	≥ 540 + c_{nom}*
Minimum horizontal dowel spacing $e_{h, min}$	530	
Minimum distance to edge $e_{R,min}$	265	
Beam width b_u	≥ 530	
Minimum vertical dowel spacing $e_{v, min}$	235	

Table 2

Geometrical minimum for dowel arrangement

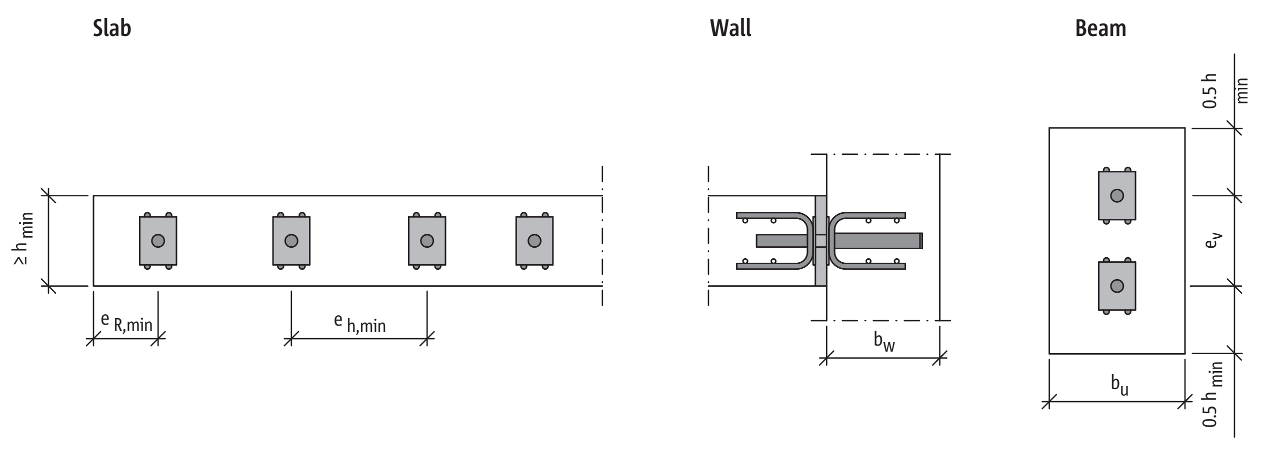


Table 3

*c_{nom} according to DIN 1045-1: 2008-08

Schöck dowel Type SLD 150 plus
Design/On-site reinforcement

Design resistance concrete $V_{Rd,b}$

Schöck dowel type	Slab depth h [mm]	$V_{Rd,b} = \min \begin{cases} V_{Rd,c} \\ V_{Rd,ct} \end{cases}$ [kN] C 20/25	C 30/37	A_{sx1} [1]	A_{sx2} [1]	A_{sy} [1]	Pos. 1
SLD 150 plus	350	209.9	240.3	8 ⌀ 20	2 ⌀ 16	4 ⌀ 20	2 ⌀ 12 e_1 = 185 mm
	400	277.7	317.9	8 ⌀ 25		4 ⌀ 25	
	450	318.4	364.5				
SLD Q 150 plus	350	193.1	236.5	8 ⌀ 20	2 ⌀ 16	4 ⌀ 20	2 ⌀ 12 e_1 = 185 mm
	400	248.4	304.2	8 ⌀ 25		4 ⌀ 25	
	450	323.0	369.7				

Table 4

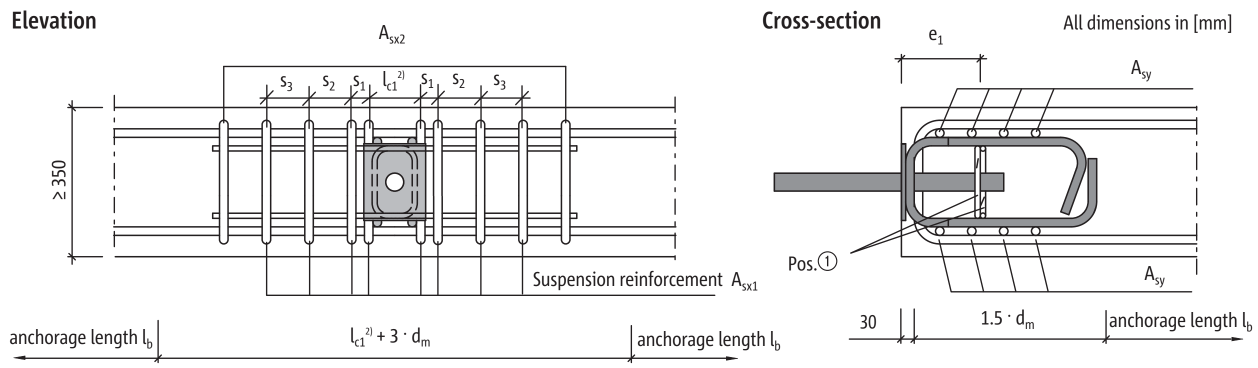
Required minimum dowel spacing for design resistance concrete $V_{Rd,b}$ from table 4

Dimension in [mm]	Slab thickness h in [mm]	SLD 150 plus	SLD Q 150 plus
Critical dowel spacing $e_{h, crit}$	350	1030	1075
	400	1165	1205
	450	1315	1355
Critical edge distance $e_{R, crit}$	350	805	825
	400	910	930
	450	1025	1045

Table 5

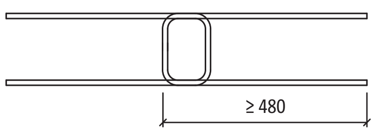
If smaller spacing is necessary the punching shear proof must be carried out in accordance with page 30.
The smallest possible dowel spacings are $e_{h, min}$ and $e_{R, min}$.

Position on-site reinforcement (by others)



	h ≤ 300 mm	h > 300 mm
s_1 [3]	50 mm	50 mm
$s_{2,3}$ [3]	50 mm	

Pos.①: 2 ⌀ 8 U-bar



[3] If s_1, s_2, s_3 are exceeded, then the slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 31.

Table 6

[1] The selected U-bar A_{sx} and the longitudinal reinforcement A_{sy} are examples. Other U-bars and longitudinal reinforcement are permitted. If the specified reinforcement or the critical dowel spacings ($e_{h,crit}$, $e_{R,crit}$) are not met, then the punching shear ($V_{Rd,ct}$) and slab bearing limit ($V_{Rd,c}$) must be calculated in accordance with page 30 - 31.
[2] SLD 150 plus: l_{c1} = 131 mm SLD Q 150 plus: l_{c1} = 171 mm

Schöck dowel Type SLD plus

Punching shear proof in accordance with BS 8110

SLD

Proof of punching shear resistance must be provided:

- if the amount of reinforcement is reduced in comparison with the suggestions on page 16 - 29
- if the critical dowel or edge conditions are not met while complying with the conditions $e_{h,min} \leq e_h < e_{h,crit}$ and $e_{R,min} \leq e_R \leq e_{R,crit}$

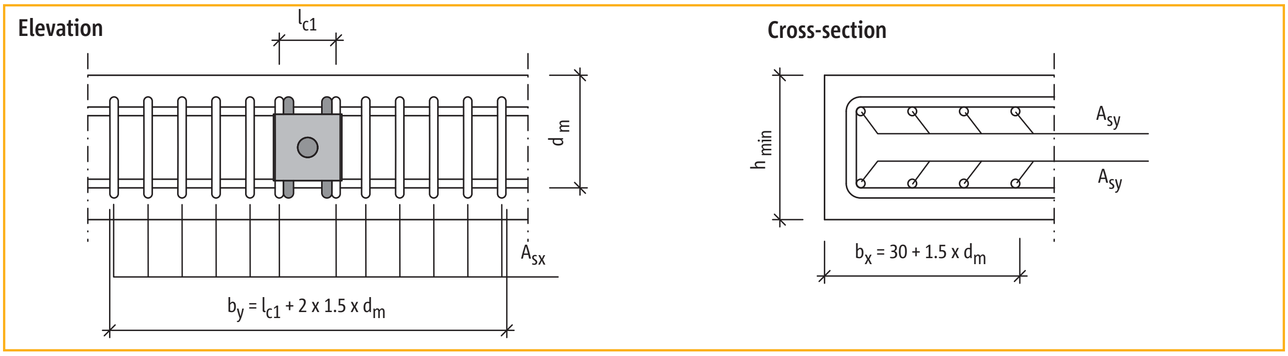


Figure 1: Effective lengths b_x and b_y and allowable reinforcement cross-section A_{sx} and A_{sy} for determination of the reinforcement grade ρ_l

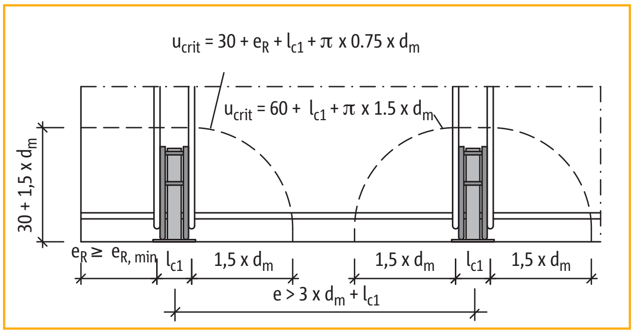


Figure 2: Critical circular section for dowel spacing $e > e_{crit}$

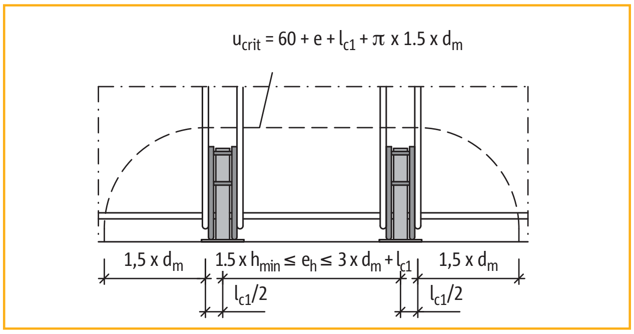


Figure 3: Critical circular section for reduced dowel spacing

$$V_c = 0.79 \times \left(\frac{100 \times A_s}{b_v \times d_m}\right)^{1/3} \times \left(\frac{400}{d_m}\right)^{1/4} \times \frac{U_{crit} \times d_m}{\gamma_m \times \beta} \geq V_{Ed}$$

$$V_c = 0.79 \times \left[\left(\frac{100 \times A_{sx}}{b_y \times d_m} + \frac{100 \times A_{sy}}{b_x \times d_m}\right)/2\right]^{1/3} \times \left(\frac{400}{d_m}\right)^{1/4} \times \frac{U_{crit} \times d_m}{\gamma_m \times \beta} \;*$$

Condition:

$$\left[\left(\frac{100 \times A_{sx}}{b_y \times d_m} + \frac{100 \times A_{sy}}{b_x \times d_m}\right)/2\right]^{1/3} \leq 3$$

$$\left(\frac{400}{d_m}\right)^{1/4} \geq 1$$

Legend:

b_v : width of section
γ_m : partial safety factor of strength of materials
b_x : area of the longitudinal reinforcement A_{sy}
b_y : area of the transverse reinforcement A_{sx}
d_m : effective depth $d_m = \frac{d_x + d_y}{2}$
U_{crit} : lenght of punching shear perimeter
β : load factor; here: $\beta = 1.4$
l_{c1} : spacing of the innermost U-bars in the transverse direction (see page 16 - 29)

* for concrete C > 25/30 and C ≤ 40/45: $V_c \cdot \left(\frac{f_{cu}}{25}\right)^{1/3}$

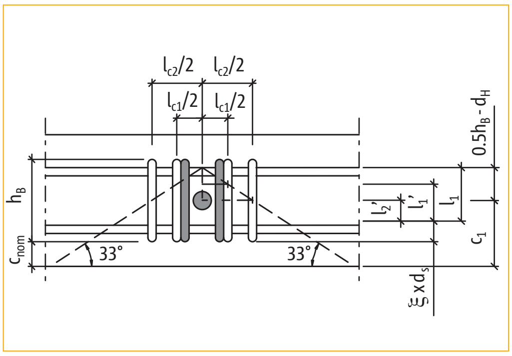
Schöck dowel Type SLD plus

Slab bearing limit according to method of Prof. Eligehausen[1)]

Proof of the slab bearing limit must be established:

- if the amount of reinforcement is reduced in comparison with the suggestions on page 16 - 29
- if the distances s_1, s_2, s_3 of the suspension reinforcement are exceeded, pages 16 - 29

The slab design resistance is given by:



$$V_{Rd,c} = \Sigma\, V_{Rd,1i} + \Sigma\, V_{Rd,2i} \leq \Sigma\ A_{sx1} \times f_{yd}$$

$V_{Rd,1i}$ transferable force from hook bearing effect

$$V_{Rd,1i} = 0.357 \times \psi_i \times A_{sx1,i} \times f_{yk} \times \sqrt{f_{ck}/30} \,/\, \gamma_{MC}$$

ψ_i : Coefficient for taking account of the distance of the suspended reinforcement from the dowel
ψ_i: $1 - 0{,}2 \times [(l_{ci}/2)/c_1]$
$l_{ci}/2$: Axis separation of the suspension reinforcement $A_{sx1,2}$ from the dowel
l_{c1}: see pages 16 - 29
c_1: Distance to edge measured from centre of dowel to the free edge

$A_{sx1,i}$: cross-section of a suspension reinforcement leg in the failure cone

f_{yk} : characteristic yield strength of the reinforcement: $f_{yk} = 500\ N/mm^2$

f_{ck} : characteristic cylindrical compressive strength of concrete

γ_{MC} : partial safety factor for concrete, $\gamma_{MC} = 1.5$

$V_{Rd,2i}$ transferable composite force

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

d_s : suspension reinforcement diameter [mm]

l_1 : suspension reinforcement leg lengths which can be applied
$l_1 = c_1 + (0.5 \times h_B - d_H) - \xi \times d_s - c_{nom}$
h_B, d_H: see pages 10 and 11
$c_1 = 0.5 \times h$
$\xi = 3.0$ for $d_s < 20$ mm
$\xi = 4.5$ for $d_s \geq 20$ mm
c_{nom}: concrete covering for suspension reinforcement ≥ 30 mm

l'_i : effective anchoring length in failure cone
$l'_i = l_1 - (l_{ci}/2) \times \tan 33°$

f_{bd} : Design value of bond stress for reinforcing steel

f_{yd} : Design value of suspension reinforcement yield strength
$f_{yd} = f_{yk}/\gamma_s$ using the partial safety factor for reinforcing steel $\gamma_s = 1.15$

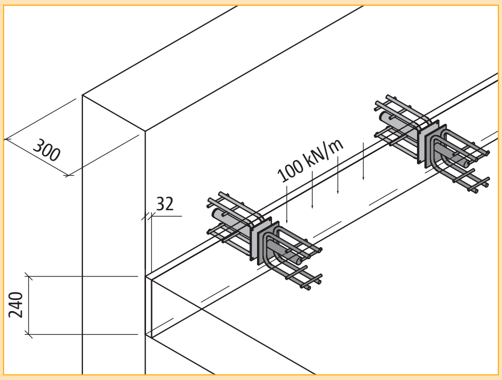
[1)] Professor of University of Stuttgart, Institute of Construction Materials, Departement of Fastening Technique

Schöck dowel Type SLD plus

Calculation example

SLD

Connection of a floor slab to a wall



Concrete	C 20/25
Slab thickness	$h = 240$ mm
Effective depth	$d_m = 194$ mm
Wall thickness	$b_W = 300$ mm
Concrete cover	$c_{nom,u} = c_{nom,o} = 30$ mm

Design value of shear force	$V_{Ed} = 100$ kN/m
Joint length	$l_f = 1.6$ m
Designed joint width	$f = 32$ mm
Start joint width	20 mm

Calculation for Schöck dowel SLD plus

Dowel type
Choice: Schöck dowel SLD 80 plus
$h_{min} = 240 \text{ mm} \leq 240 \text{ mm} = h_{exist}$
$V_{Rd,s} = 98.5$ kN for $f \leq 40$ mm and C20/25

On-site reinforcement
Choice: according to page 24
req. wall thickness $b_W = 270 \text{ mm} \leq 300 \text{ mm} = \text{exist. } b_W$

Required wall thickness see page 25.

Dowel spacing
Choice: $e = 400$ mm
$400 \text{ mm} > 360 \text{ mm} = e_{min}$ √
$400 \text{ mm} < 670 \text{ mm} = e_{crit}$!

Checking the dowel spacings see page 25.

Distance to edge
Choice: $e_R = 600$ mm
$600 \text{ mm} > 180 \text{ mm} = e_{R,min}$ √
$600 \text{ mm} > 535 \text{ mm} = e_{R,crit}$ √

A punching shear proof and verification of the slab bearing limit are necessary.

The maximum joint opening must be determined by a structural design engineer. This value can be determined by taking into account deformations due to shrinkage, load and temperature changes.

The deciding factor for the design is the maximum joint opening f = 32 mm.

Benefit:
The same high load-bearing strength with joints up to 40 mm

Schöck dowel Type SLD plus

Calculation example

Punching shear proof according to BS 8110

$$V_c = 0.79 \times \left(\frac{100 \times A_s}{b_v \times d_m}\right)^{1/3} \times \left(\frac{400}{d_m}\right)^{1/4} \times \frac{U_{crit} \times d_m}{\gamma_m \times \beta}$$

$$= 0.79 \times \left[\left(\frac{100 \times A_{sx}}{b_y \times d_m} + \frac{100 \times A_{sy}}{b_x \times d_m}\right)/2\right]^{1/3} \times \left(\frac{400}{d_m}\right)^{1/4} \times \frac{U_{crit} \times d_m}{\gamma_m \times \beta}$$

$\Sigma A_{sx} = 2 \times [6 \times 2.01] + 2 \times [2 \times 1.13] = 28.64\ cm^2$
[2 (6 ⌀ 16 + 2 ⌀ 12)]

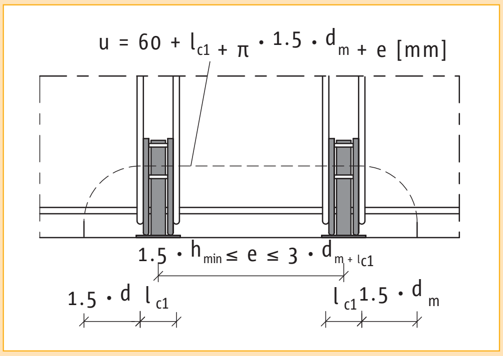
$A_{sy} = 3 \times 2.01 = 6.03\ cm^2$
(3 ⌀ 16)

$b_x = 30 + 1.5 \times d_m = 30 + 1.5 \times 194 = 321$ mm

$b_y = 2 \times 1.5 \times d_m + l_{c1} + e = 3 \times 194 + 89 + 400 = 1071$ mm

$u_{crit} = 60 + l_{c1} + \pi \times 1,5 \times d_m + e$
$= 60 + 89 + \pi \times 1,5 \times 194 + 400 = 1463.2$ mm

Allowable reinforcement cross-section A_{sx} and A_{sy} and effective lengths b_x and b_y see page 30.
Linear connection, so the punching shear proof must be carried out for two adjacent dowels.



l_{c1} = Spacing of the innermost U-bars in the transverse direction A_{sx1} see page 24

Condition:

$$\left[\left(\frac{100 \times A_{sx}}{b_y \times d_m} + \frac{100 \times A_{sy}}{b_x \times d_m}\right)/2\right]^{1/3} = 1.05 \le 3 \checkmark$$

$$\left(\frac{400}{d_m}\right)^{1/4} = 1.2 \ge 1 \checkmark$$

$$V_c = (0.79 \times 1.05 \times 1.2 \times \frac{1463.2 \times 194}{1.25 \times 1.4})/1000$$

$= 161.5$ kN

Calculation of slab bearing limit according to Prof. Eligehausen

$$V_{Rd,c} = \sum V_{Rd,1i} + \sum V_{Rd,2i} \le \sum A_{sx1} \times f_{yd}$$

$$V_{Rd,1i} = 0.357 \times \psi_i \times A_{sx1,i} \times f_{yk} \times \sqrt{f_{ck}/30}\,/\gamma_{MC}$$

$\psi_i = 1 - 0.2 \times [(l_{ci}/2)/c_1]$
$A_{sx1,i} = 2.01\ cm^2$
$f_{yk} = 500\ N/mm^2$
$f_{ck} = 20\ N/mm^2$
$c_1 = 0.5 \times 240 = 120$ mm

$l_{c1} = 89$ mm
$\psi_1 = 1 - 0.2 \times [(89/2)/120] = 0.93$
$V_{Rd,11} = 0.357 \times 0.93 \times 2.01 \times 50.0 \times \sqrt{20/30}\,/1.5 = 18.16$ kN
$l_{c2} = l_{c1} + 2 \times s_1 = 89 + 2 \times 36 = 161$ mm
$\psi_2 = 1 - 0.2 \times [(161/2)/120] = 0.87$
$V_{Rd,12} = 0.357 \times 0.87 \times 2.01 \times 50.0 \times \sqrt{20/30}\,/1.5 = 16.99$ kN

Schöck dowel Type SLD plus

Calculation example

SLD

$l_{c3} = l_{c2} + 2 \times s_2 = 161 + 2 \times 50 = 261$ mm

$\psi_3 = 1 - 0.2 \times [(261/2)/120] = 0.78$

$V_{Rd,13} = 0.357 \times 0.78 \times 2.01 \times 50.0 \times \sqrt{20/30} / 1.5 = 15.23$ kN

The fourth U-bars lies outside the calculated failure cone and is therefore not taken into account.

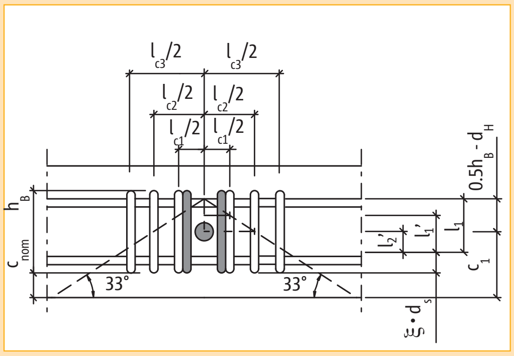
$V_{Rd,2i} = \pi \times d_s \times l'_i \times f_{bd}$

d_s = 16 mm
f_{bd} = 2.3 N/mm² for C20/25 in accordance with DIN 1045-1, Table 25
h_B = 180 mm (see page 12)
d_H = 14 mm (see page 12)
ξ = 3.0, da d_s = 16 mm < 20 mm
c_{nom} = 30 mm
$l_1 = c_1 + (0.5 \times h_B - d_H) - \xi \times d_s - c_{nom}$
$l_1 = 120 + (0.5 \times 180 - 14) - 3.0 \times 16 - 30 = 118$ mm
$l'_i = l_1 - (l_{c1}/2) \times \tan 33°$

$l'_1 = 118 - 89/2 \times \tan 33° = 89.1$ mm
$V_{Rd,21} = \pi \times 16 \times 89.1 \times 2.3 \times 10^{-3} = 10.30$ kN

$l'_2 = 118 - (161/2) \times \tan 33° = 65.72$ mm
$V_{Rd,22} = \pi \times 16 \times 65.72 \times 2.3 \times 10^{-3} = 7.60$ kN

$l'_3 = 118 - (261/2) \times \tan 33° = 33.25$ mm
$V_{Rd,23} = \pi \times 16 \times 33.25 \times 2.3 \times 10^{-3} = 3.84$ kN



f_{bd} : Design value for the bond stress in accordance with DIN 1045-1

d_s : Diameter of rear suspended reinforcement [mm]

l'_i : effective anchoring length

c_{nom}: Concrete covering of rear suspended reinforcement

h : Slab thickness

f_{ck} : characteristic cylindrical compressive strength of the concrete

f_{yk} : Yield strength of the rear suspended reinforcement

$V_{Rd,c} = \sum V_{Rd,1i} + \sum V_{Rd,2i} \leq \sum A_{sx1} \times f_{yd}$

$V_{Rd,c} = 2 \times (18.16 + 16.99 + 15.23 + 10.30 + 7.60 + 3.84) = 144.24 \text{ kN} \leq 6 \times 2.01 \times 43.5 = 524.6$ kN

Proofs:

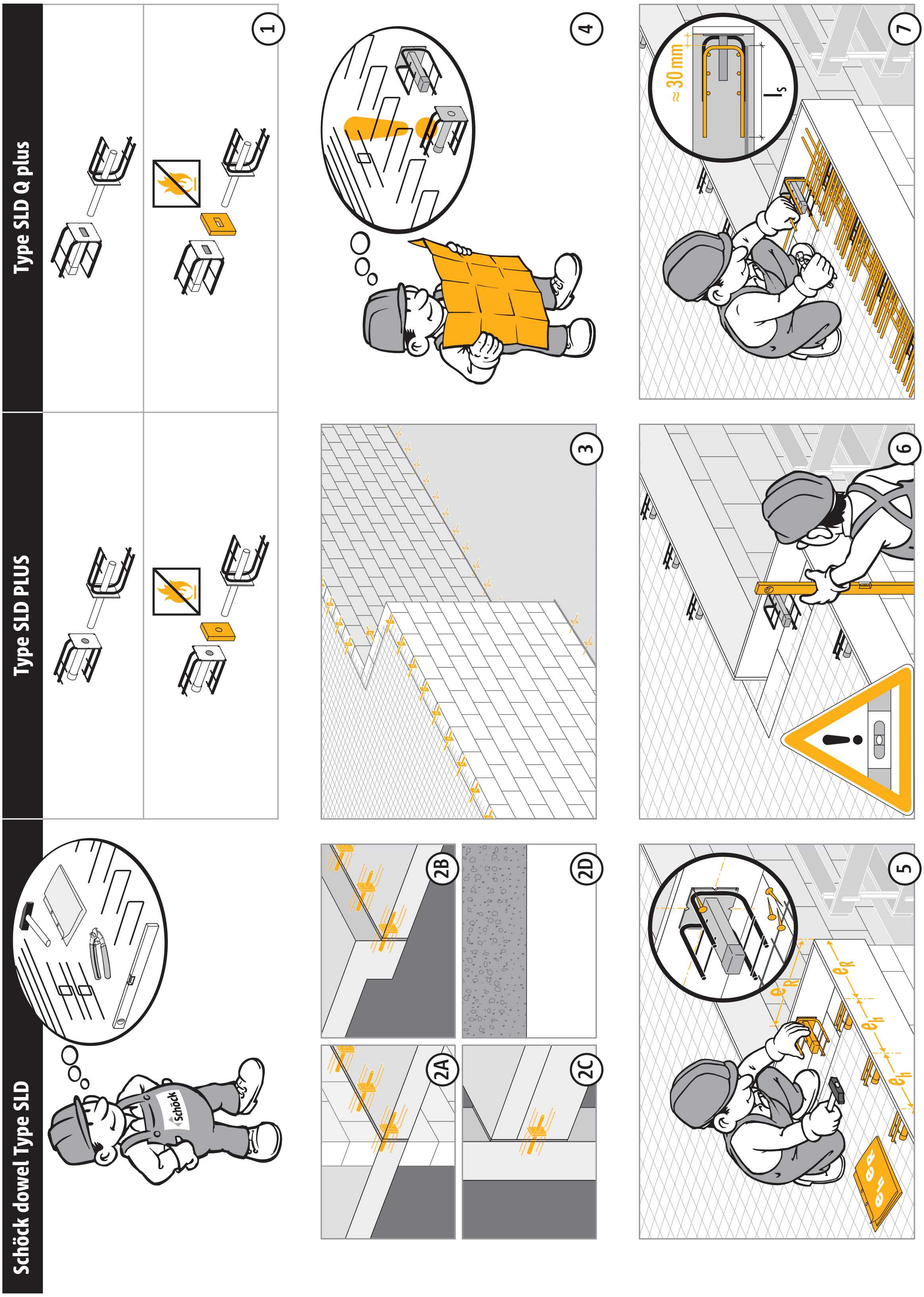
1) Punching shear
   $V_c = 161.5 \text{ kN} > V_{Ed} = 100 \text{ kN/m} \times 1.60 \text{ m} = 160$ kN

2) Slab bearing limit
   $V_{Rd,c} = 144.24 \text{ kN} > V_{ed} = (100 \text{ kN/m} \times 1.60 \text{ m}) : 2 = 80$ kN

3) Steel load-bearing capacity
   $V_{Rd,s} = 98.5 \text{ kN} > V_{ed} = (100 \text{ kN/m} \times 1.60 \text{ m}) : 2 = 80$ kN

Conclusion: The steel load-bearing capacity is the deciding factor for the maximum transferable shear force of the Schöck dowel SLD 80 plus.

Schöck dowel Type SLD plus
Installation instructions



Schöck dowel Type SLD plus

Installation instructions