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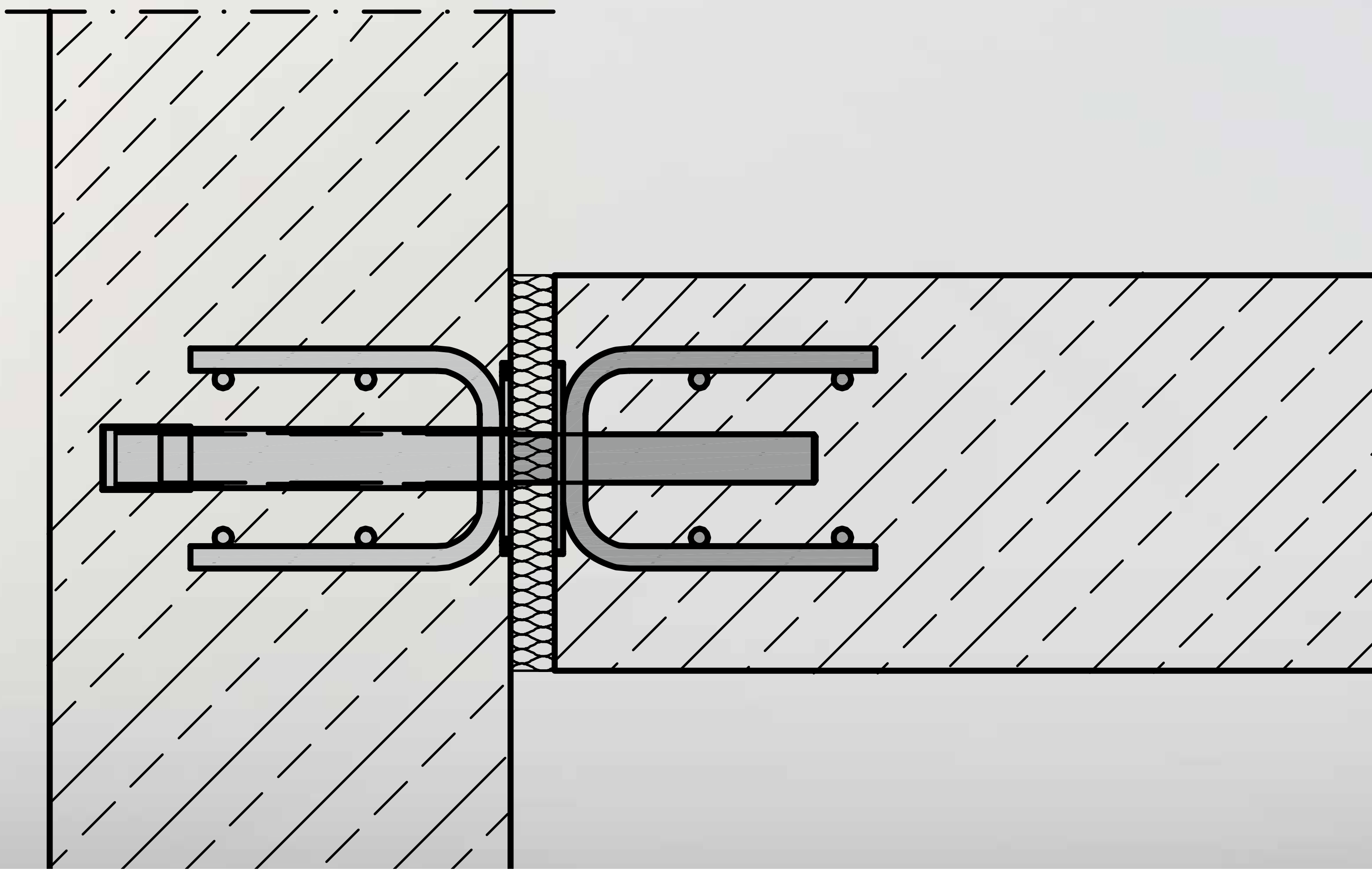
Dependable by design



TECHNICAL INFORMATION – AUGUST 2023

Stacon® – Shear force dowels for expansion joints

Shear force dowels for secure and constraint-free connection of reinforced concrete components in expansion joints.

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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Bicester
Oxfordshire
OX26 4UL

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Tel.: 01865 290 890
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E-Mail: design-uk@schoeck.com

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Scalix®

Comfortable planning with Schöck Scalix®
The new Schöck Scalix® design software is the first web application for the design of shear force dowels and runs on all common browsers. The modular software enables a simple design of the Schöck Stacon®. A desktop version of the previous design program is still available.

More information on Scalix® is available at:
scalix.schoeck.com

Notes | Symbols

Technical Information

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Notes Symbols

Hazard note

The triangle with exclamation mark indicates a hazard warning. This means there is a danger to life and limb if compliance is not observed.

Info

The square with an “i” indicates important information which, for example, must be read in conjunction with the design.

Check list

The square with a tick indicates the check list. Here, the essential points of the design are briefly summarised.

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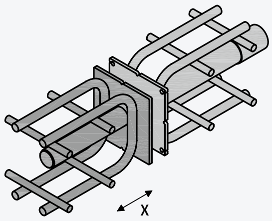
Summary

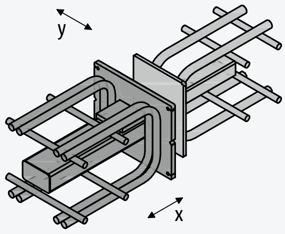
Summary of types

Schöck Stacon® type SLD — Page 19



SLD

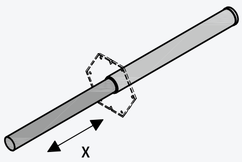
The heavy duty dowel serves the transmission of high shear forces in building joints and with this enables free movement in the direction of the dowel axis. Through the stiff anchoring body it is particularly suited for the connection of thin structural components.



SLD-Q

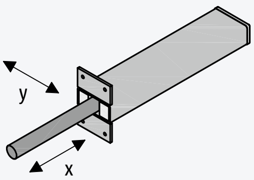
This heavy duty dowel serves the transmission of high shear forces in bulding joints and with this enables free movement in the longitudinal and transverse direction to the dowel axis. Through the stiff anchoring body it is particularly suited for the connection of thin structural components.

Schöck Stacon® type LD — Page 49



LD

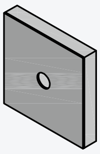
The load dowel serves the transmission of small to medium shear forces in building and structural component joints and with this enables free movement in the direction of the dowel axis.



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 flexibility in the direction of the longitudinal and traverse direction to the dowel axis.

Schöck fire protection collar BSM — Page 14



BSM

The fire protection collar is designed to protect the dowel from direct flame impingement and heat in the event of fire. The fire resistance of the shear force connection can therefore be classified as R 120. With an appropriate joint configuration the requirements on the fire resistance class REI 120 can be met.

Scheduled expansion joints | Schöck Stacon® solution

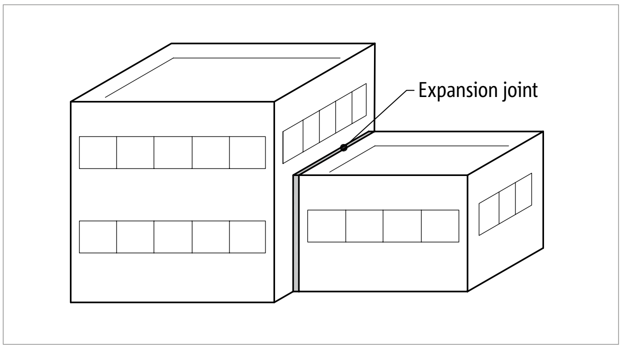


Fig. 1: Building joint - expansion joint divides the complete building

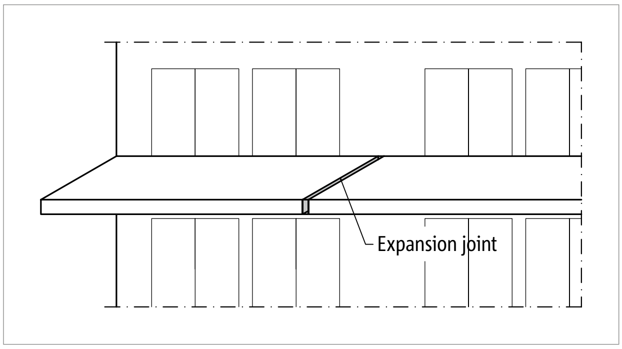


Fig. 2: Structural component joint - expansion joint divides individual structural components only

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 seperated by a joint.

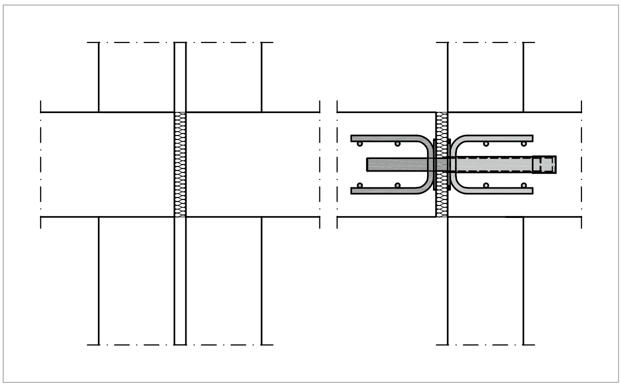


Fig. 3: Expansion joint using a Schöck Stacon® instead of a twin column or double wall

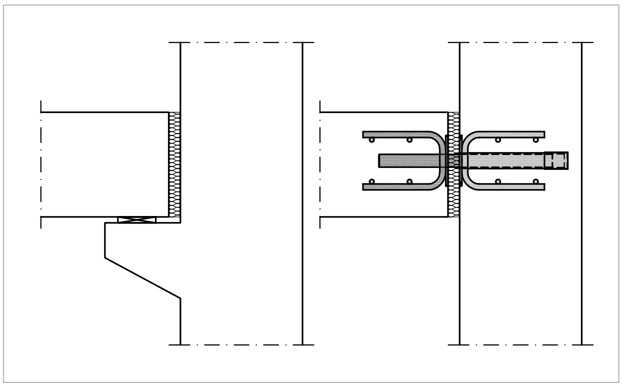


Fig. 4: Expansion joint using a Schöck Stacon® instead of a corbel

Schöck Stacon® solution

In the area of the joint the structural components separated by the joint must be supported. Furthermore, different vertical distortions of the building parts are also to be avoided. The conventional method for this has been to use corbels with sliding bearings or a double arrangement of load bearing walls and columns at the structural joint. Elaborate reinforcement and formwork is required to implement these solutions. They also take up more space, which limits the scope for redevelopment and repurposing of the space.

The Schöck Stacon® allows horizontal movement and supports vertical loads. This system offers many advantages:

- Simpler formwork and reinforcement layout
- Better use of space by doing away with double supports and brackets
- Production in one or in separate building phases possible
- Schöck Stacon® type SLD (heavy duty dowel) with United Kingdom Technical Assessment UKTA 23/6888
- Schöck Stacon® type LD (load dowel) with United Kingdom Technical Assessment UKTA 23/6892
- The Scalix® user-friendly design software is available at www.schoeck.com
- Joints can be configured to satisfy fire resistance class R 120 or REI 120
- Secure and maintenance-free connection through using high-grade stainless steels or galvanised steel

Connection situations

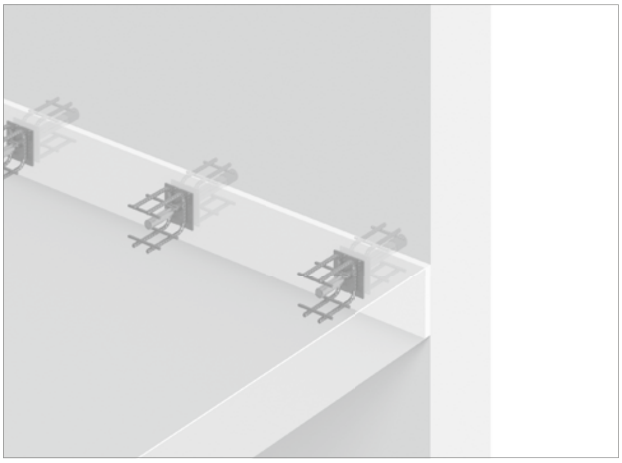


Fig. 5: Schöck Stacon® type SLD: slab-wall connection

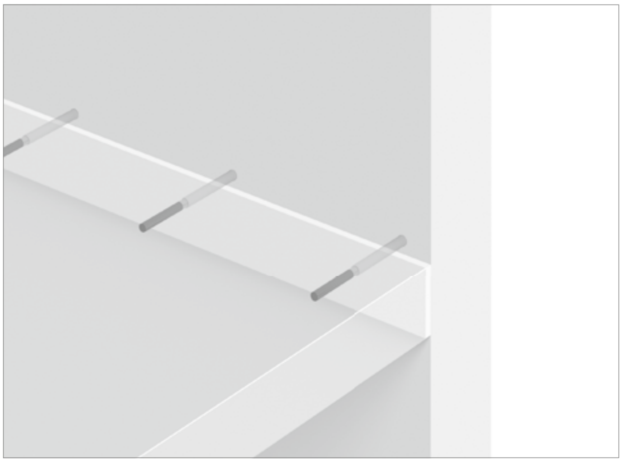


Fig. 6: Schöck Stacon® type LD: slab-wall connection

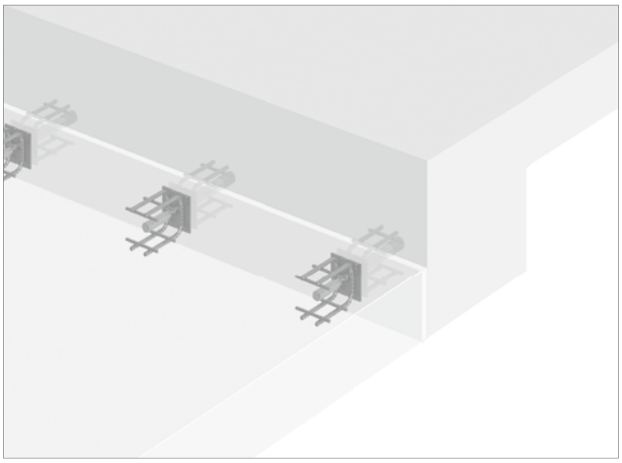


Fig. 7: Schöck Stacon® type SLD: slab-downstand beam connection

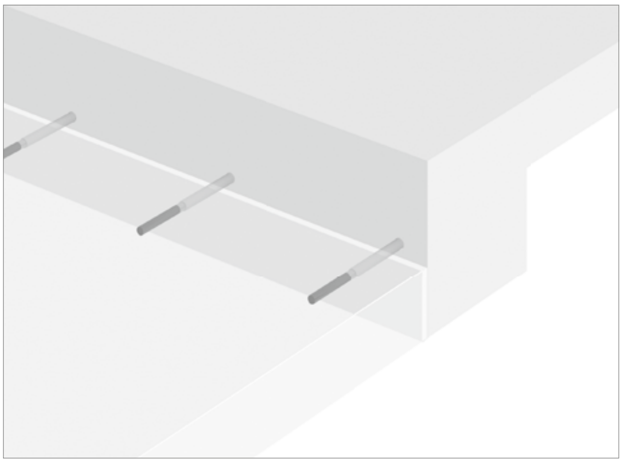


Fig. 8: Schöck Stacon® type LD: slab-downstand beam connection

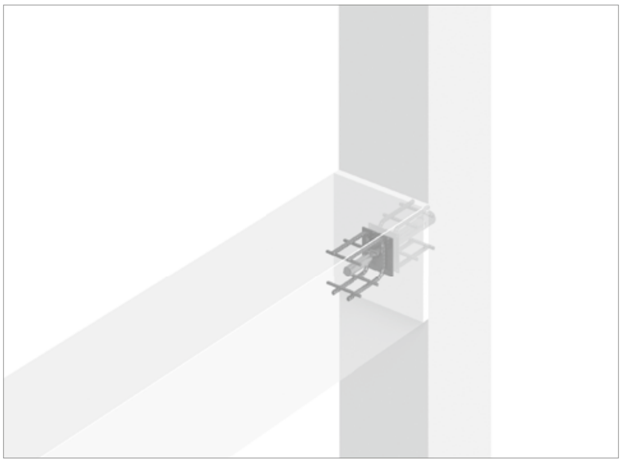


Fig. 9: Schöck Stacon®: balcony-column connection

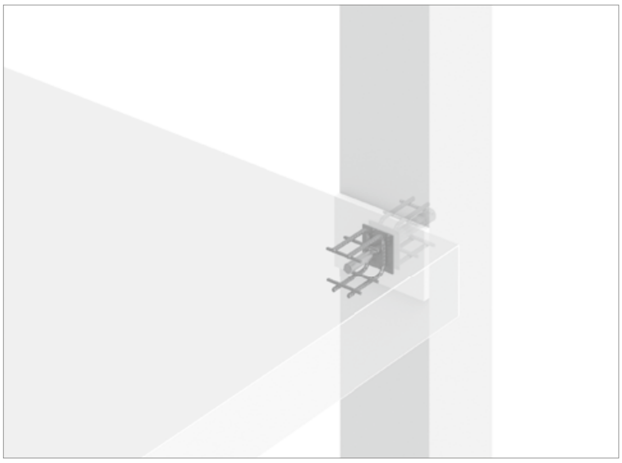


Fig. 10: Schöck Stacon®: slab-column connection

Connection situations

Fig. 11: Schöck Stacon®: wall-wall connection (front-flank)

Fig. 12: Schöck Stacon®: wall-wall connection (front-front)

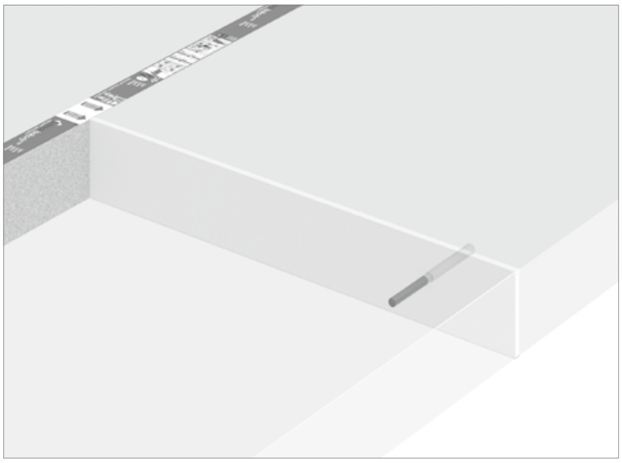


Fig. 13: Schöck Stacon®: Expansion joints in balcony slabs

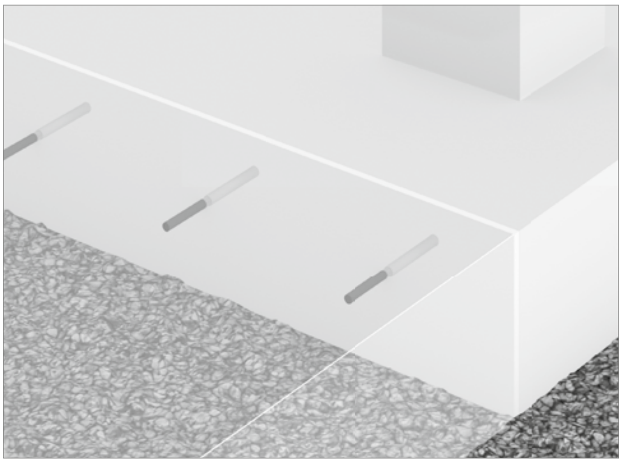


Fig. 14: Schöck Stacon®: Expansion joint in foundation slab

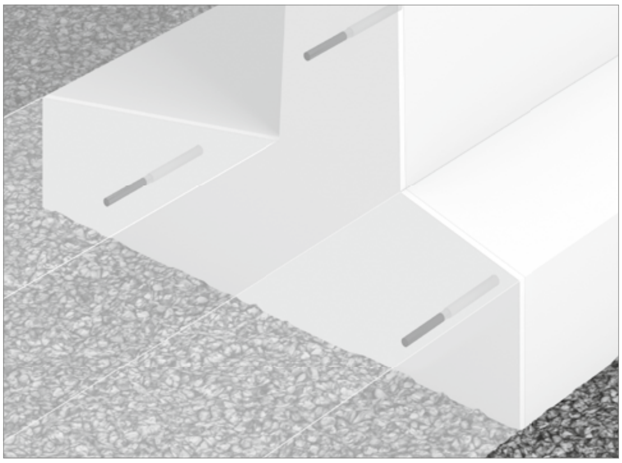


Fig. 15: Schöck Stacon®: expansion joint in cantilevered wall

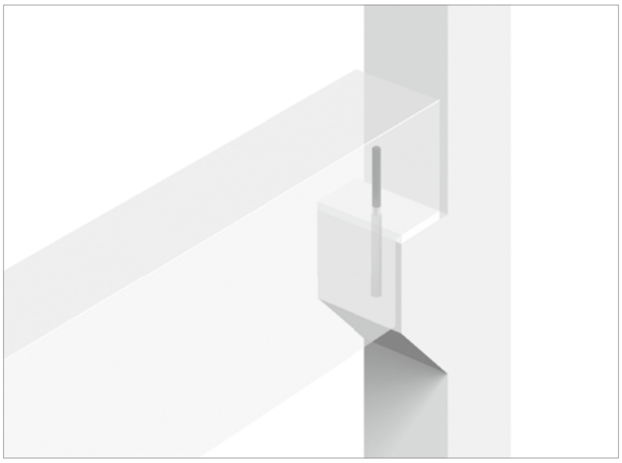
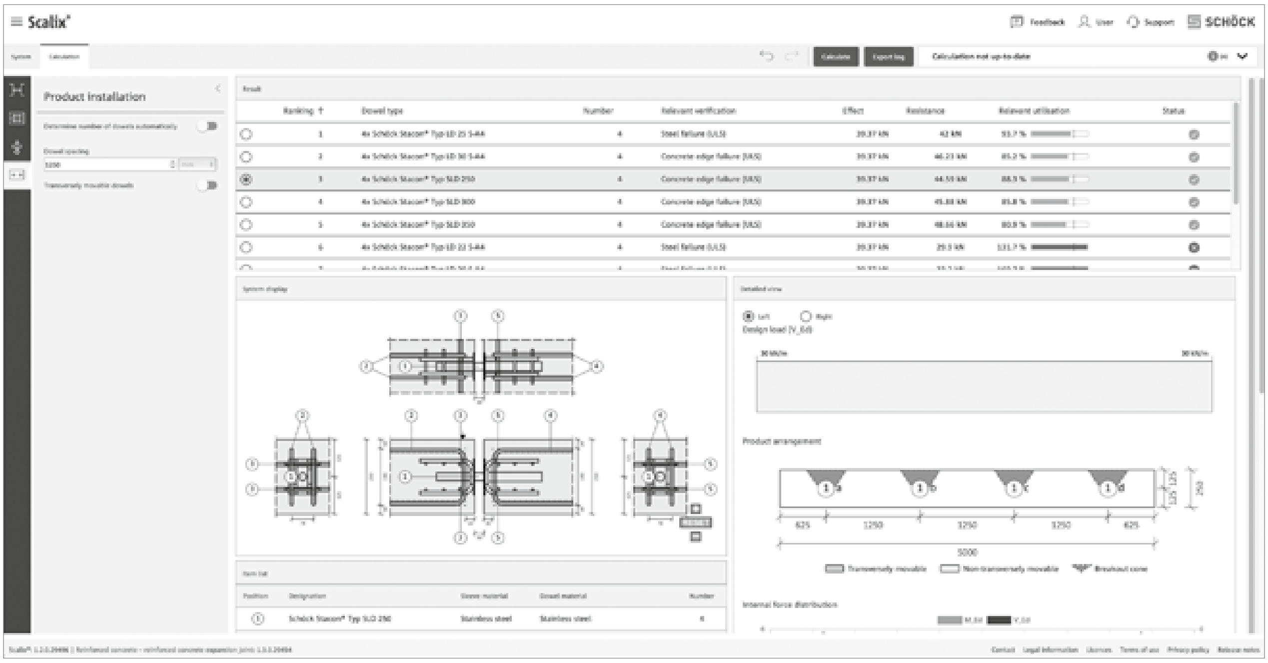


Fig. 16: Schöck Stacon®: securely locating a beam on a corbel

Scalix® design software

Expansion joints can be quickly and easily designed with the Schöck Scalix® software using the Schöck Stacon® types SLD and LD.

- Design takes place in accordance with the UKTA, the technical building regulation EOTA TR 065 and BS EN 1992-1-1 (EC2)
- Many different applications (slab-slab, slab-wall, slab-downstand beam, etc.) can be verified
- Automatic determination of the dowel spacings and dowel types
- Flexible load input with loads distributed over certain lengths, triangular loads or with free arrangement
- Automatic determination and graphic representation of the edge reinforcement
- Free access to the Scalix® design software at scalix.schoeck.com



Calculation of maximum joint width

Calculation of maximum joint width

The maximum joint width is always decisive for the design of the shear force dowels. 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 creep is only to be taken into account if a direct stress is acting continuously on the structural component, e.g. through prestressing. The maximum joint width can be estimated according to the following equation:

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

with:

- f_i: initial width of the joint when concreting [mm]
  f_i = L L L_w / 1200
- L_w: effectivestructuralcomponentlengthforexpansion
- ΔT: maximum temperature change of the structural component in accordance with BS EN 1991-1-5
- α_t: $1.0 \cdot 10^{-5}$ [1/K] in accordance with BS EN 1992-1-1, para 3.1.3 (5)
- ε_{cd}: Elongation on drying shrinkage in accordance with BS EN 1992-1-1, para 3.1.4 (6)
- ε_{ca}: Elongation on drying shrinkage in accordance with BS EN 1992-1-1, para 3.1.4 (6)

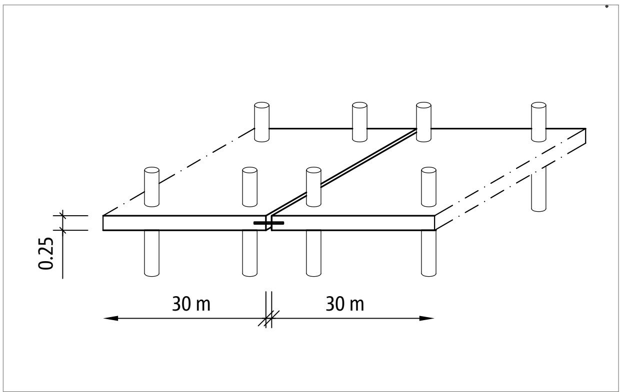


Fig. 17: Flat floor in an office building

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
Humidity 60 %
Temperature expansion can be disregarded as the building is heated later

Calculation according to BS EN 1992-1-1:

$f_i = 2 \cdot 15.000 / 1200 = 25$ mm – selected: 30 mm
ε_{cd} = 0.0368 % in accordance with BS EN 1992-1-1, para 3.1.4 (6)
ε_{ca} = 0.00375 % in accordance with BS EN 1992-1-1, para. 3.1.4 (6)

$f = 30 + 2 \cdot 15{,}000 \cdot (0.000368 + 0.0000375) =$ **43 mm**

The calculated shrinkage expansions are mean values with a variation coefficient of roughly 30 %. For this reason an additional safety margin of 5 mm should be taken into account.

Selection of Schöck Stacon® type | Design information

Selection of Schöck Stacon® type

The Schöck Stacon® types LD and SLD are approved for shear force connections relevant to structural systems and load-bearing structures. The correct type depends on the load-bearing capacity in each installation situation. The Schöck Stacon® type SLD has an anchoring body which also transmits high shear forces in thin structural components. This is clearly illustrated in the following diagram, which compares the maximum load-bearing capacity of the Schöck Stacon® types with certain slab thicknesses.

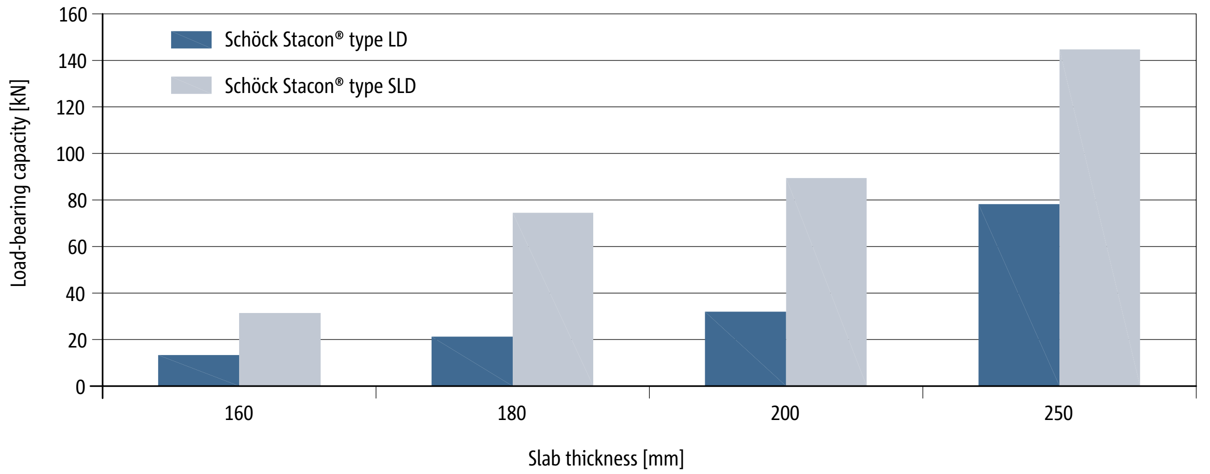


Fig. 18: Max. load-bearing capacity of the Schöck Stacon® types with selected slab thicknesses

Design information

Expansion joints are to be planned systematically to prevent imposed deformation in structural components. Thus the connected structural components must be investigated in the longitudinal and transverse direction for possible factors influencing movement such as temperature changes, shrinkage, creeping, swelling and settling of buildings. With long expansion joints upwards of 8 m or with expansion joints which do not run in a straight line, biaxial displaceable Stacon® type SLD-Q or LD-Q are to be used. Planned forces acting on the joint in a longitudinal and vertical direction are to be incorporated separately. For this, transversely movable Schöck Stacon® type SLD-Q or LD-Q are to be arranged along the complete joint. Dowels which systematically absorb the longitudinal force acting on the joint are installed at right angles to the joint axis. This ensures that these dowels are not unsystematically loaded due to vertical loads.

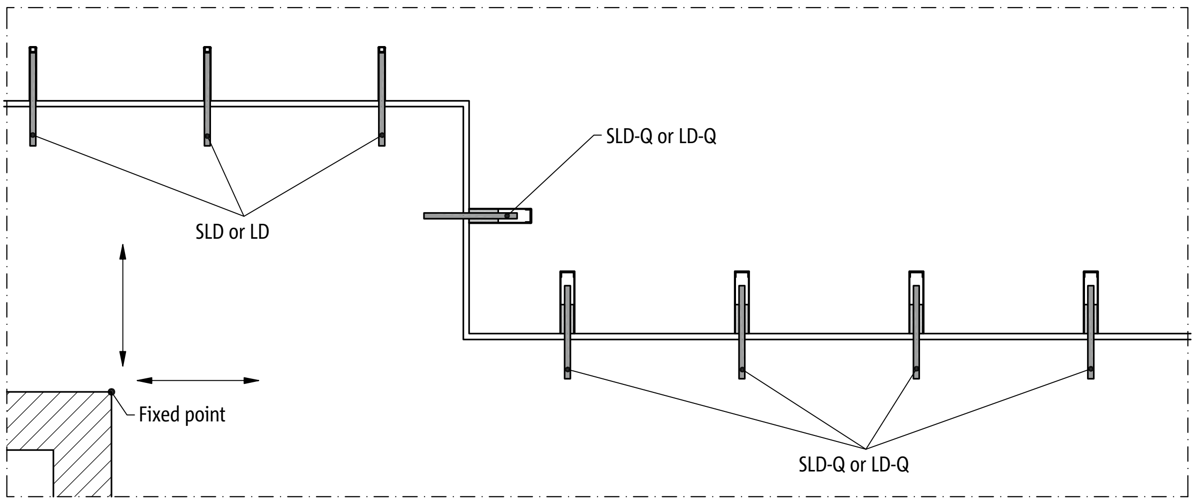


Fig. 19: Arrangement of axially and transversely movable dowels in building joints

Fire protection

Fire protection sleeve

Schöck Stacon® type BSM fire protection collar

The fire protection collars enable the joints to be constructed using the Schöck Stacon® types SLD and LD to fire resistance class R 120. This has been tested under the most unfavourable conditions and is regulated in the United Kingdom Technical Assessments UKTA 23/6892 (LD) and UKTA 23/6888 (SLD).

In order to achieve the fire resistance class R 120, the following boundary conditions are to be met:

- The shear force dowels and the associated on-site reinforcement has been designed for normal temperatures in accordance with the UKTA and the technical building regulation.
- The maximum reduction coefficient h_{fi} in accordance with BS EN 1992-1-2, para. 2.4.2 for the fire case as accidental design situation 0.7.
- The load-bearing capacity of the connected reinforced concrete structural components has been verified in accordance with BS EN 1992-1-1 for normal temperatures and BS EN 1992-1-2 for fire.
- The fire protection collars were arranged as shown in the following diagram.
- The concrete cover above and below the on-site reinforcement and welded on stirrup (type SLD) is at least 30 mm.
- The corresponding minimum slab thickness for load-bearing level of the Schöck Stacon® is met with a concrete cover of 30 mm.

The Stacon® type BSM fire protection collar consists of a non-combustible mineral fibre board and a 2 mm thick Promaseal® PL layer. In the event of fire, the Promaseal® foams up and seals an air gap of maximum 10 mm in the joint which protects the dowel. With the arrangement of two fire protection collars the permitted air gap increases to 20 mm. This means that no further cladding of the joint is necessary.

Depending on the planned joint width, the fire protection collar is available with a thickness of 20 or 30 mm. In addition, the fire protection collar BSM 0 with a thickness of 2.5 mm is available which can be combined with the fire protection collars BSM 20 and BSM 30. For larger joint widths several fire protection collars can be combined.

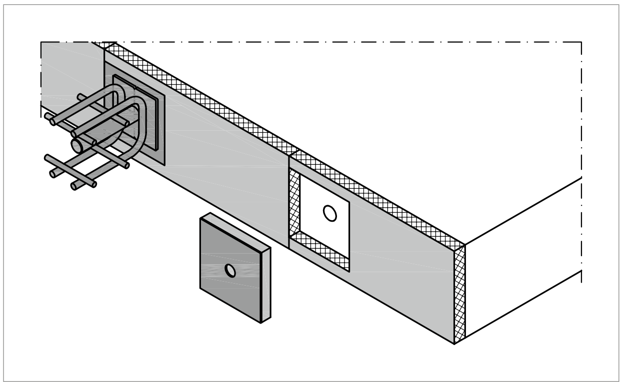


Fig. 20: Positioning of the Schöck Stacon® fire protection collar in the joint

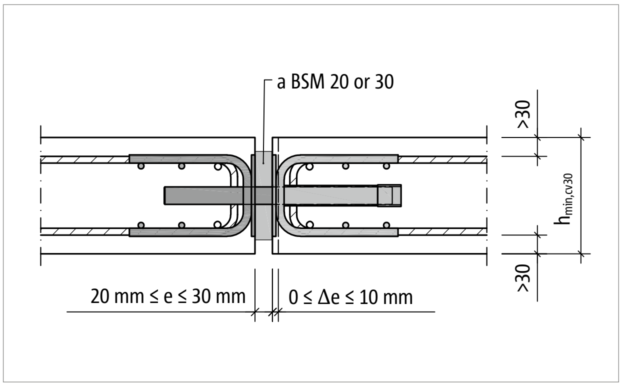


Fig. 21: Positioning of the fire protection collar with a joint width of 20 or 30 mm and a maximum joint opening of 10 mm

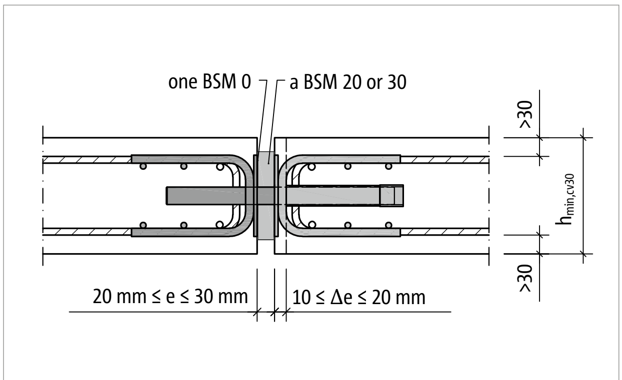


Fig. 22: Positioning of the fire protection collar with a joint width of 20 or 30 mm and a maximum joint opening of 20 mm

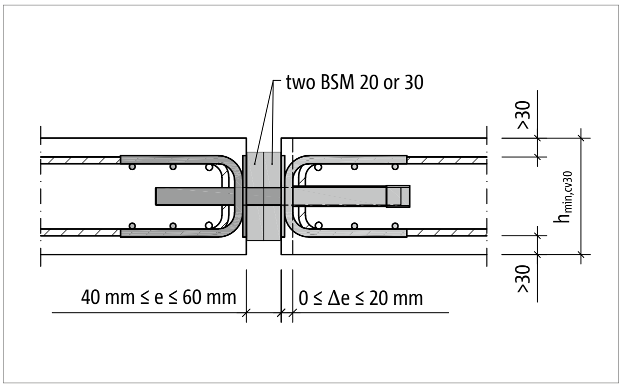


Fig. 23: Positioning of the fire protection collar with a joint width of 40 to 60 mm and a maximum joint opening of 20 mm

Fire protection

Fire protection sleeve

Fire protection collar for Schöck Stacon® type SLD and SLD-Q

Fire protection collar for Schöck Stacon® type BSM	Thickness [mm]	Height [mm]	Width [mm]
BSM 0 SLD 220–300	2.5	170	190
BSM 0 SLD 350-450	2.5	250	250
BSM 20 SLD 220	20	120	150
BSM 30 SLD 220	30	120	150
BSM 20 SLD 250	20	150	170
BSM 30 SLD 250	30	150	170
BSM 20 SLD 300	20	170	190
BSM 30 SLD 300	30	170	190
BSM 20 SLD 350-400	20	200	250
BSM 30 SLD 350-400	30	200	250
BSM 20 SLD 450	20	250	250
BSM 30 SLD 450	30	250	250

Fire protection collar for Schöck Stacon® type LD and LD-Q

Fire protection collar for Schöck Stacon® type BSM	Thickness [mm]	Height [mm]	Width [mm]
BSM 0 LD 16–30	2.5	170	190
BSM 20 LD 16-22	20	120	150
BSM 30 LD 16-22	30	120	150
BSM 20 LD 25-30	20	150	170
BSM 30 LD 25-30	30	150	170

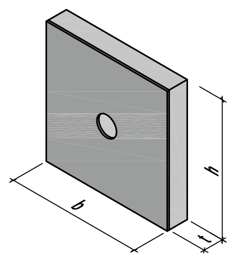


Fig. 24: Configuration of the Schöck Stacon® fire protection collar

Fire protection

Fire protection requirement REI 120

Joints with fire protection requirement REI 120

Many joints also have a function of preventing the spread of smoke and fire from one room to the next. This can also be achieved using the Promaseal® PL joint tape. This joint arrangement 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 REI 120 in accordance with BS EN 13501-2 could be achieved.

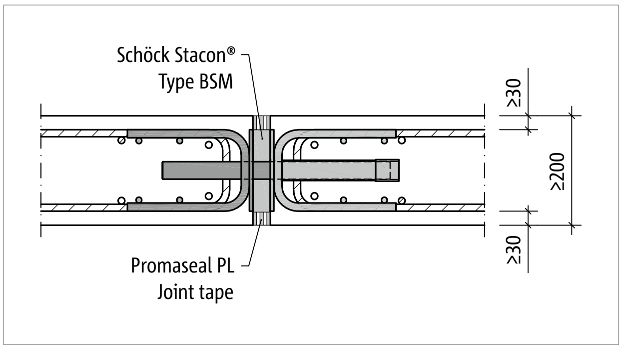
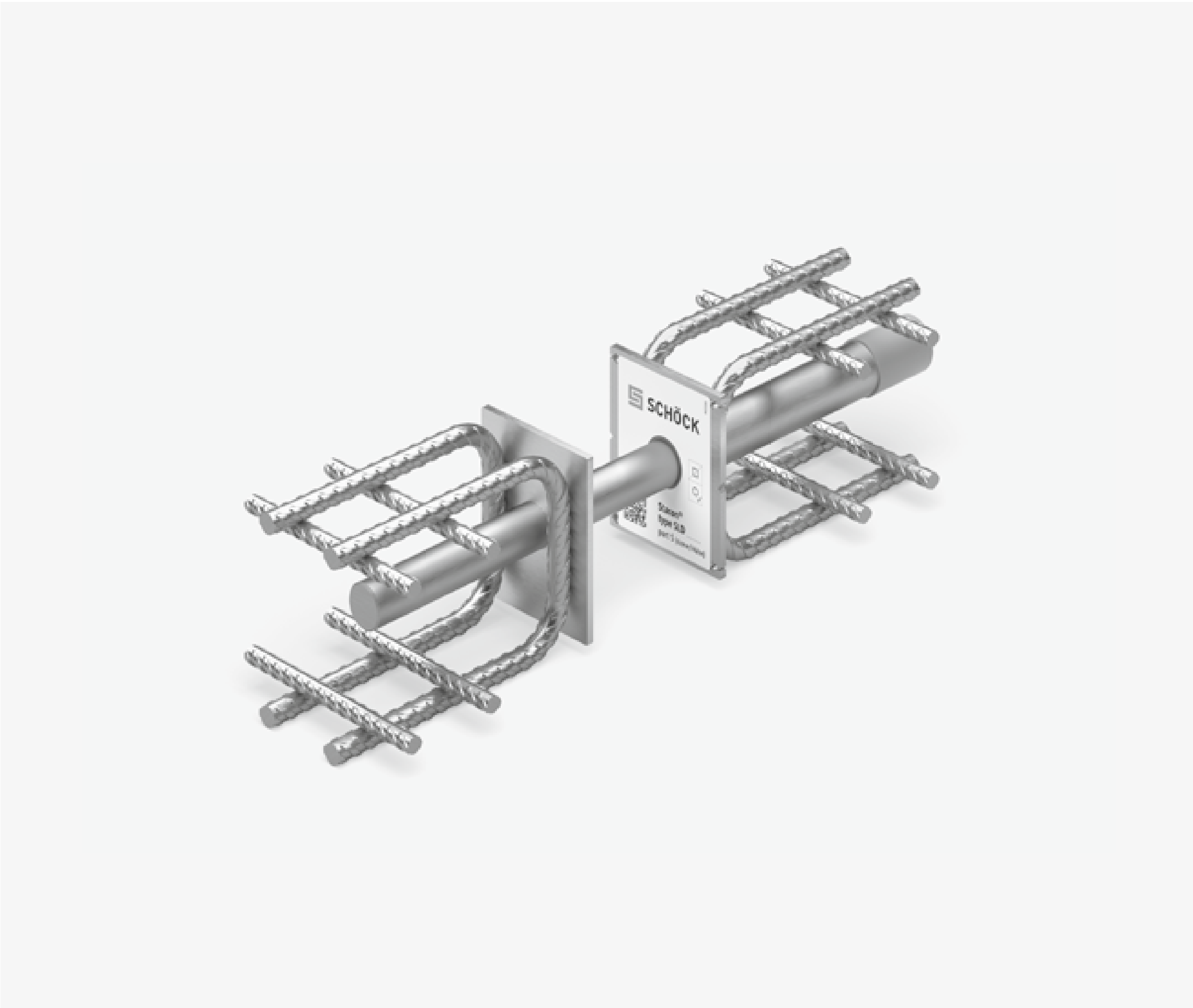


Fig. 25: Configuration of an expansion joint with REI 120 fire performance classification

Promaseal® is a registered brand of Etex Building Performance GmbH.

Structural Design

Schöck Stacon® type SLD, SLD-Q

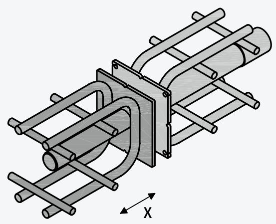


Schöck Stacon® type SLD
Heavy duty dowel for the transfer of high shear forces in expansion joints between thin concrete structural components with simultaneous freedom of movement in the direction of the dowel axis.

Schöck Stacon® type SLD-Q
Heavy-duty dowel for the transmission of high shear forces in expansion joints between thin concrete structural components with freedom of movement longitudinally and transversely to the dowel axis.

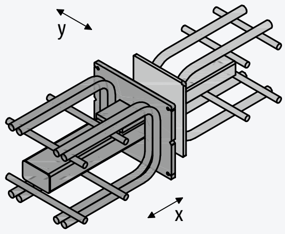
Product characteristics | Application areas

Schöck Stacon® 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-220

Product features

The Schöck Stacon® type SLD (heavy duty dowel) consists of a sleeve part and a dowel part, which are concreted into the respective building parts adjacent to the joint. The load is transferred from one structural component through the dowel into the sleeve then to the other structural component. With this, the welded-on stirrups and the face plate ensure optimum anchorage in the concrete.
The sleeve of the Schöck Stacon® type SLD is round and thus enables freedom of movement along 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 freedom of movement lateral to the dowel axis be required, the Schöck Stacon® dowel type SLD-Q can be used. The sleeve of this dowel is rectangular and thus enables displacement of ± 12 mm in the transversal direction. Furthermore, this type of dowel is also square in order to enable an optimum slippage in all directions.

Application areas

The Schöck Stacon® type SLD has undergone the United Kingdom Technical Assessment by the British Board of Agreement (BBA) for the transmission of mainly static, structurally relevant shear forces in expansion joints. The technical building regulation EOTA TR 065 in conjunction with the United Kingdom Technical Assessment UKTA 23/6888 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 mm. In addition, joint widths up to 80 mm with special types in accordance with the UKTA are also possible.
The dowel and sleeve consist of stainless steels with material numbers 1.4362, 1.4482, 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 listed below apply according to BS EN 1992-1-1 (EC2).

Product description

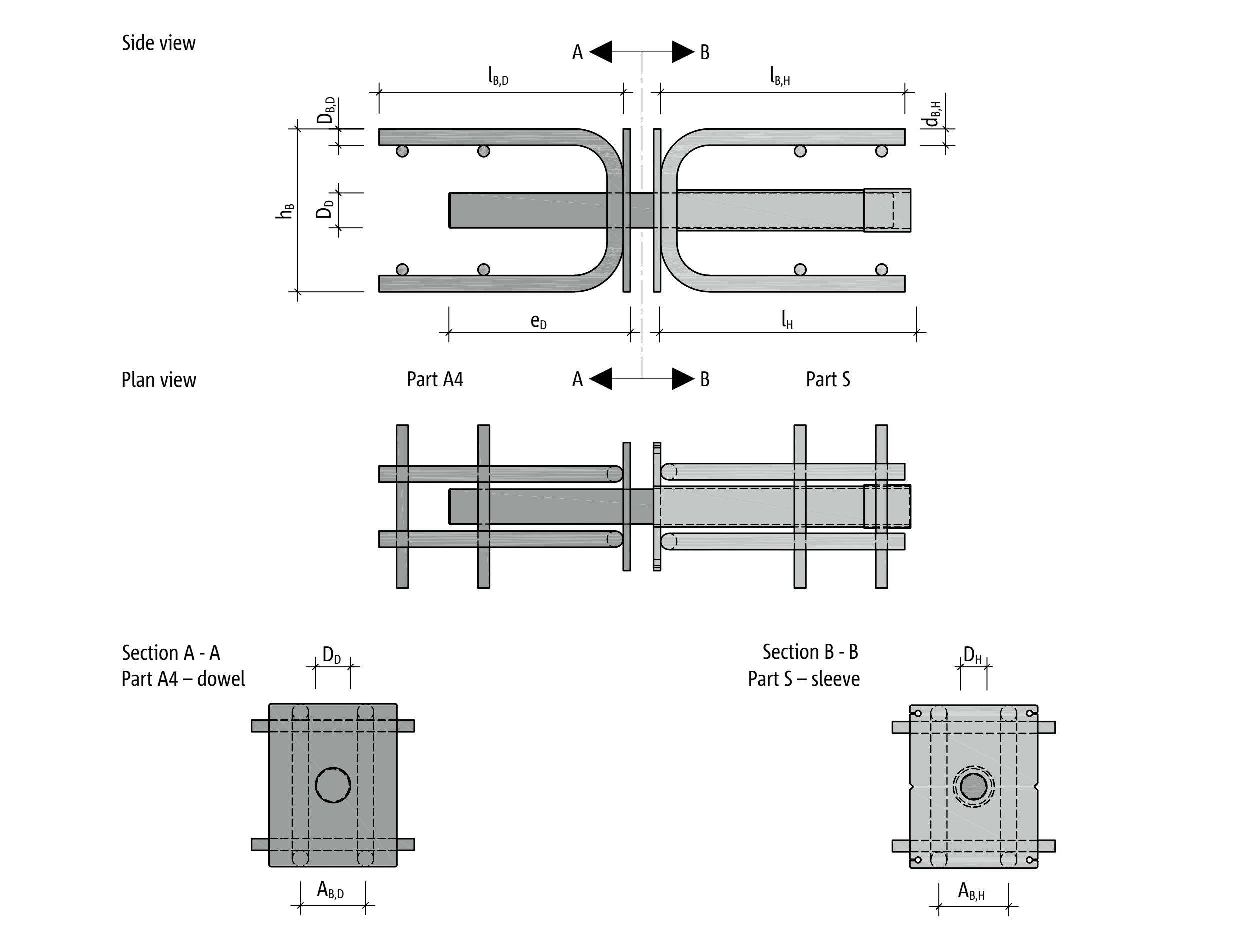


Fig. 26: Dimensions Schöck Stacon® type SLD 220 to SLD 450

Schöck Stacon® type SLD	220	250	300	350	400	450
Dowel element dimensions [mm]						
Dowel diameter D_D	22	25	30	35	40	45
Stirrup diameter $d_{B,D}$	10	12	14	12	14	14
Number of stirrups	2	2	2	4	2	4
Stirrup height h_B	100	120	140	170	200	230
Stirrup leg length $l_{B,D}$	154	184	216	258	348	400
Stirrup spacing $A_{B,D}$	46	49	56	97	70	113
Dowel embedment length e_D	114	129	156	183	208	235
Sleeve element dimensions [mm]						
Internal diameter D_H	23	26	31	36	41	46
Stirrup diameter $d_{B,H}$	10	12	14	12	14	14
Number of stirrups	2	2	2	4	2	4
Stirrup height h_B	100	120	140	170	200	230
Stirrup leg length $l_{B,H}$	154	184	216	258	348	400
Stirrup spacing $A_{B,H}$	49	53	60	97	70	113
Sleeve length l_H	180	195	220	245	270	295

Product description

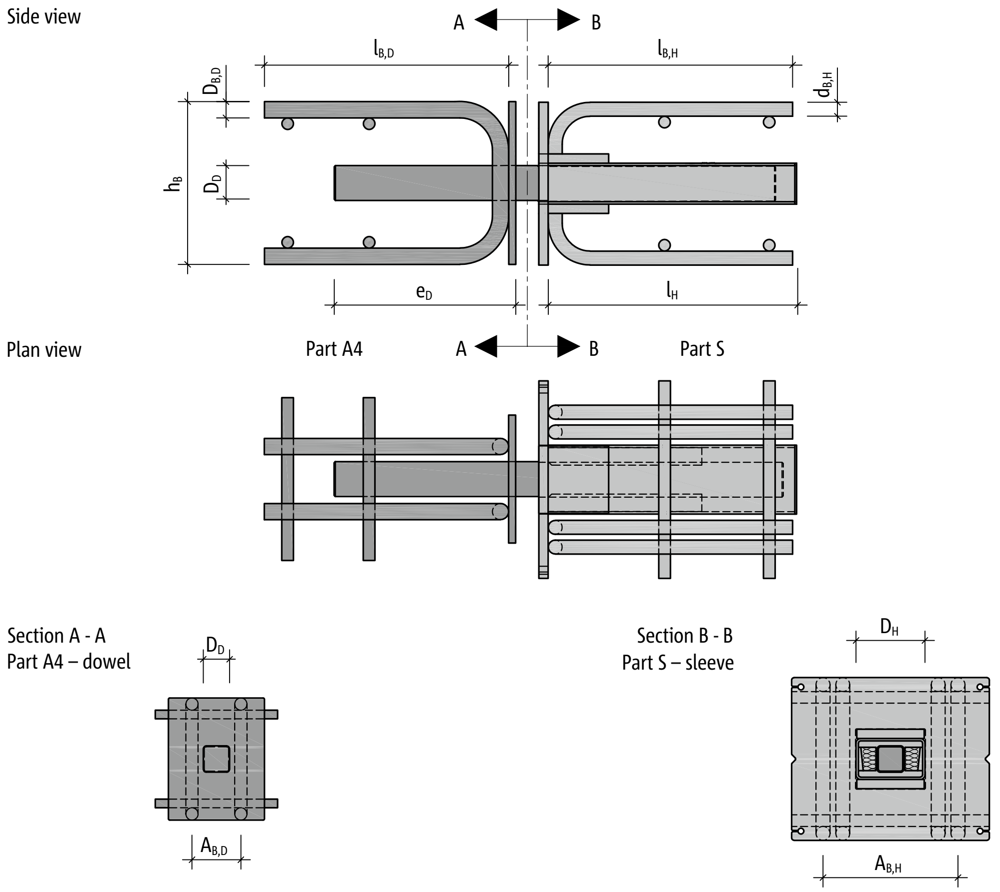


Fig. 27: Dimensions Schöck Stacon® type SLD-Q 220 to SLD-Q 400

Schöck Stacon® type SLD-Q	220	300	400
Dowel element dimensions [mm]			
Length of side of dowel D_D	22	30	40
Stirrup diameter $d_{B,D}$	10	14	14
Number of stirrups	2	2	4
Stirrup height h_B	100	140	200
Stirrup leg length $l_{B,D}$	154	216	350
Stirrup spacing $A_{B,D}$	46	56	102
Dowel embedment length e_D	114	156	210
Sleeve element dimensions [mm]			
Internal diameter D_H	47	55	65
Stirrup diameter $d_{B,H}$	10	12	14
Number of stirrups	2	4	4
Stirrup height h_B	100	140	200
Stirrup leg length $l_{B,H}$	156	218	350
Stirrup spacing $A_{B,H}$	72	116	132
Sleeve length l_H	180	220	270

Design process

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

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

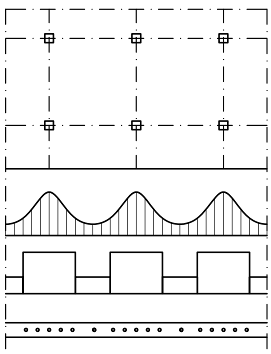
Determination of the expected maximum joint width.
See page 11

Examination of the minimum structural component dimensions and the applicable shear force dowels. See page 24

Examination of the shear force load-bearing capacity of the slab and determination of the required degree of reinforcement. See page 28

Reading of the maximum slab load-bearing capacity $V_{Rd,c,P}$ per dowel depending on slab thickness and degree of reinforcement.
See page 29

Are transversely movable dowels required?
See page 12



Transversely movable dowel not required

Selection of the matching load-bearing level of the Schöck Stacon® type SLD. Determination of the load-bearing capacity of the connection.
See design tables from page 30
$V_{Rd,dowel} = \min(V_{Rd,c,P}; V_{Rd,ce,s})$

Transversely movable dowel required

Selection of the matching load-bearing level of the Schöck Stacon® type SLD-Q. Determination of the load-bearing capacity of the connection.
See design tables from page 32
$V_{Rd,dowel} = \min(V_{Rd,c,P}; V_{Rd,ce,s})$

Are larger transverse displacements expected in the joint on a daily basis? See page 34
$V_{Rd,dowel} = V_{Rd,ce,SLS}$

Calculation of the required dowel spacing
$e_{req} = V_{Rd,dowel}$ [kN] / v'_{Ed} [kN/m]

Examination of the dowel spacing. See page 24
$1.5 \cdot h_{slab} \leq e \leq 8 \cdot h_{slab}$

Determination of the required edge reinforcement.
See page 35

You can find examples for the use of the design tables from page 39. Alternatively all Schöck Stacon® types can be designed using the Schöck Scalix® design software.

SLD

Structural design

Minimum dowel spacing/component dimensions

Schöck Stacon® type SLD	220	250	300	350	400	450
Minimum structural component dimension [mm]						
Minimum slab thickness h_{min} for c_v = 20 mm	150	160	180	210	240	270
Minimum slab thickness h_{min} for c_v = 30 mm	160	180	200	230	260	290
Minimum slab thickness h_{min} for c_v = 40 mm	180	200	220	250	280	310
Minimum wall thickness b_w	200	215	240	280	370	420
Beam width b_u	1.5 h_{min}					
Dowel spacing [mm]						
Minimum horizontal $e_{h,min}$	1.5 × slab thickness					
Maximum horizontal $e_{h,max}$	8 × slab thickness					
Minimum vertical $e_{v,min}$	150	160	180	210	240	270
Edge distances [mm]						
Minimum horizontal $e_{Rh,min}$	0.75 × slab thickness					

Schöck Stacon® type SLD-Q	220	300	400
Minimum structural component dimension [mm]			
Minimum slab thickness h_{min} for c_v = 20 mm	150	180	240
Minimum slab thickness h_{min} for c_v = 30 mm	160	200	260
Minimum slab thickness h_{min} for c_v = 40 mm	180	220	280
Minimum wall thickness b_w	200	240	370
Beam width b_u	1.5 h_{min}		
Dowel spacing [mm]			
Minimum horizontal $e_{h,min}$	1.5 × slab thickness		
Maximum horizontal $e_{h,max}$	8 × slab thickness		
Minimum vertical $e_{v,min}$	150	180	240
Edge distances [mm]			
Minimum horizontal $e_{Rh,min}$	0.75 × slab thickness		

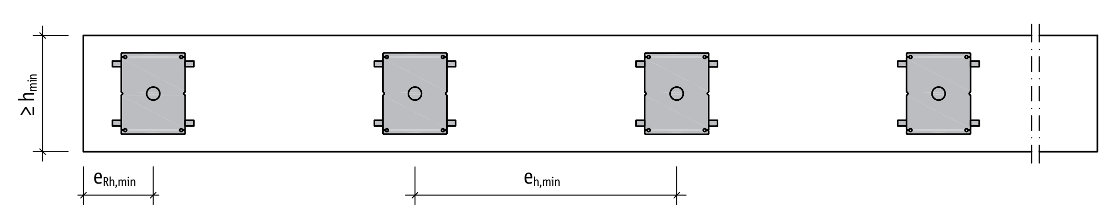


Fig. 1: Schöck Stacon® type SLD: Minimum structural component measurements and dowel spacings with one slab

SLD

Structural design

Minimum dowel spacing/component dimensions

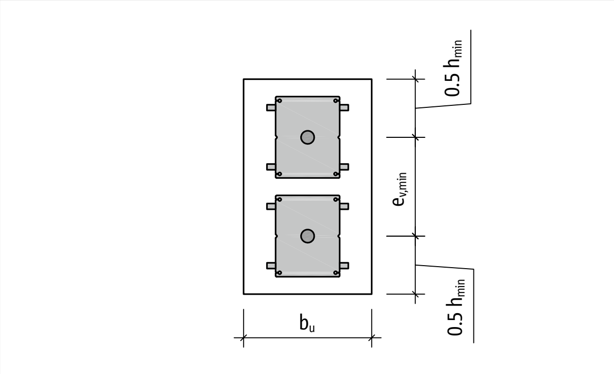


Fig. 29: Schöck Stacon® type SLD: Minimum structural component measurements and dowel spacings in the front face of a balcony or a wall

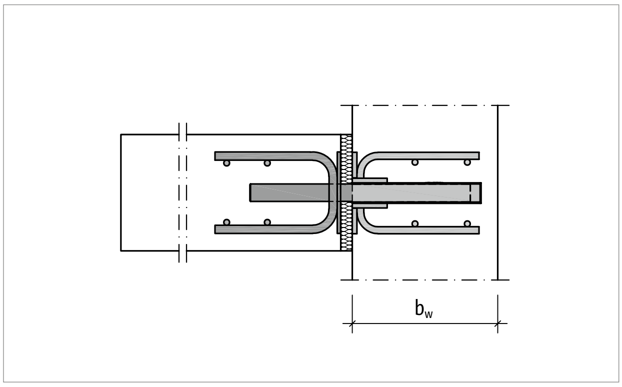


Fig. 30: Schöck Stacon® type SLD: Minimum structural component thickness of a wall or column

Shear force load-bearing capacity of slabs

Verification of the shear force load-bearing capacity
The shear force resistance of the slab is directed in accordance with BS EN 1992-1-1, para. 6.2. The following conditions must be met for slabs without shear force reinforcement:

$v_{Rd,c}$ [kN/m] ≥ v_{Ed} [kN/m]

with:

$v_{Rd,c}$: Design value of the shear force resistance of the slab in accordance with BS EN 1992-1-1, para. 6.2.2 (1)

v_{Ed}: Design value of the applied shear force without reduction in accordance with BS EN 1992-1-1, para. 6.2.2 (6)

Shear force dowels introduce the loads punctually into the slab. A linear support can be assumed for a dowel spacing of up to five times the static useful height. In this case the verification of the shear force load-bearing capacity, as shown in the diagram below, may be carried out across the complete slab width.
The load-bearing capacities $v_{Rd,c}$ for some slab thicknesses, concrete strength classes and degrees of reinforcement are listed in a table, see page 28. The required degree of reinforcement of the slab in the edge area can be determined and the maximum load-bearing capacity in accordance with BS EN 1992-1-1, para. 6.2 can be checked by referring to this table.

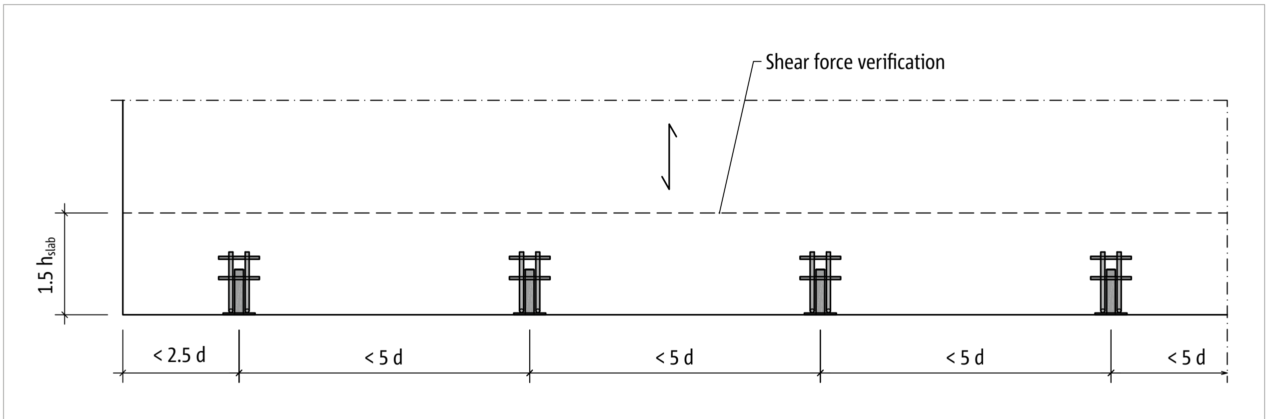


Fig. 31: Closed shear force verification of the slab with small dowel spacings

If the dowel spacing is more than five times the static useful height, the verification of the shear force load-bearing capacity must be carried out section by section in the area of the shear force dowels. This principle is presented in the diagram below. In this case every dowel, independent of the load-bearing level and joint width, can only introduce a certain maximum shear force into the slab.
The maximum shear forces $V_{Rd,c,P}$ for some slab thicknesses, concrete strength classes and degrees of reinforcement are listed in a table, see page 29.
This verification is not required for walls, columns and downstand beams.

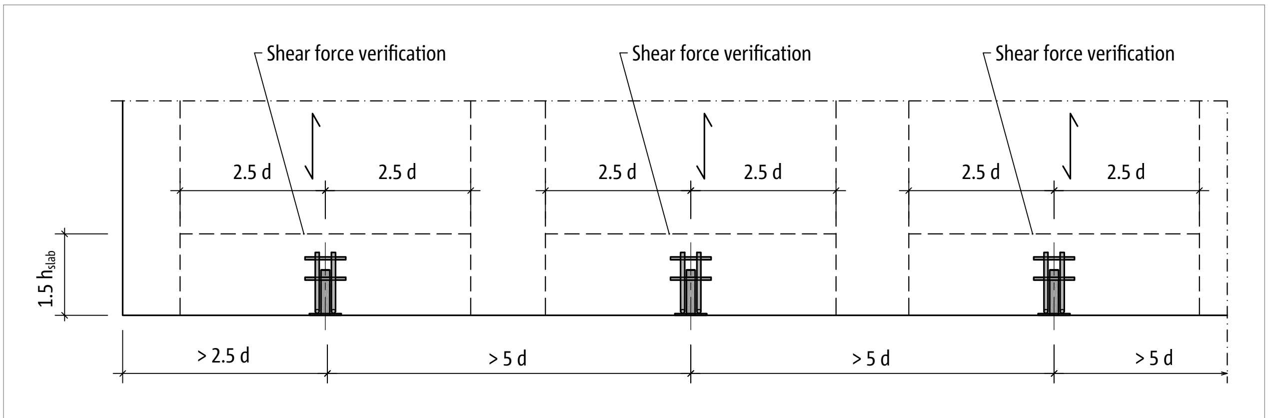


Fig. 32: Section-by-section shear force verification with large dowel spacings

SLD

Structural design

Shear force load-bearing capacity of slabs

Information on upper and lower slab reinforcement

- The degrees of reinforcement given in the tables on page28 and page 29 are to be installed at the top and bottom of the slab and anchored on the free edge of the slab. For this, the existing concrete reinforcement can be fully taken into account.
- In accordance with BS EN 1992-1-1, para. 9.3.1.2, at least 50 % of the required field reinforcement must be anchored in the support. As the support is indirect when connecting with shear force dowels, this reinforcement must be anchored in the edge beam as shown in the diagram below.
- If the length $l_{b,ind}$ for the anchorage of the reinforcement is not sufficient, the required anchorage length can be reduced by using angle hooks, welded-on cross bars or varying the ratio between existing and required reinforcement.

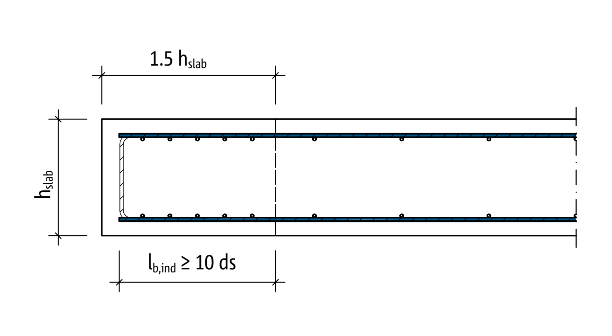


Fig. 33: Anchorage of the upper and lower reinforcement at the edge of the slab

Shear force load-bearing capacity of the slab

The design values of the shear force load-bearing capacity for selected concrete strengths, degrees of reinforcement and slab thicknesses in accordance with BS EN 1992-1-1, para. 6.2.2 (1) are specified in the following table. The minimum value of the shear force load-bearing capacity has already been taken into account here. These load-bearing capacities are independent of the selected shear force dowel and refer only to the slab.

Shear force resistance of the slab without shear force reinforcement for linear support									
Shear force resistance for		C28/35				C32/40			
		degree of reinforcement ρ_{ly} [%]							
Slab thickness [mm]		0.25	0.50	0.75	1.00	0.25	0.50	0.75	1.00
c_v = 20 mm	c_v = 30 mm	$v_{Rd,c}$ [kN/m]							
150	160	65.5	72.3	82.8	91.1	70.0	75.6	86.5	95.2
160	170	70.7	78.1	89.4	98.4	75.6	81.6	93.5	102.9
170	180	76.0	83.9	96.0	105.7	81.2	87.7	100.4	110.5
180	190	81.2	89.7	102.6	113.0	86.8	93.7	107.3	118.1
190	200	85.9	94.9	108.6	119.5	91.8	99.2	113.5	125.0
200	210	91.1	100.6	115.2	126.8	97.4	105.2	120.5	132.6
210	220	96.4	106.4	121.8	134.1	103.0	111.3	127.4	140.2
220	230	101.6	112.2	128.5	141.4	108.6	117.3	134.3	147.8
230	240	106.1	117.4	134.4	147.9	113.4	122.8	140.5	154.7
240	250	109.3	121.7	139.3	153.4	116.9	127.3	145.7	160.3
250	260	112.2	125.6	143.7	158.2	120.0	131.3	150.3	165.4
260	270	115.4	129.8	148.6	163.6	123.4	135.7	155.4	171.0
270	280	118.5	134.0	153.4	168.9	126.7	140.1	160.4	176.6
280	290	121.7	138.2	158.2	174.2	130.1	144.5	165.4	182.1
290	300	124.8	142.4	163.0	179.4	133.4	148.9	170.4	187.6
300	310	127.5	146.1	167.3	184.1	136.3	152.8	174.9	192.5
310	320	130.6	150.2	172.0	189.3	139.6	157.1	179.8	197.9
320	330	133.6	154.3	176.7	194.5	142.8	161.4	184.7	203.3
330	340	136.6	158.4	181.3	199.6	146.1	165.6	189.6	208.7
340	350	139.6	162.5	186.0	204.7	149.3	169.9	194.5	214.0
350	360	142.0	165.7	189.7	208.8	151.8	173.3	198.3	218.3
360	370	145.0	169.7	194.3	213.9	155.0	177.5	203.2	223.6
370	380	147.2	172.8	197.8	217.7	157.3	180.6	206.8	227.6
380	390	150.1	176.7	202.3	222.7	160.5	184.8	211.5	232.8
390	400	153.0	180.7	206.9	227.7	163.6	189.0	216.3	238.1
400	410	155.9	184.7	211.4	232.7	166.7	193.1	221.0	243.3
410	420	158.8	188.6	215.9	237.7	169.8	197.2	225.8	248.5
420	430	161.7	192.6	220.5	242.6	172.8	201.4	230.5	253.7
430	440	164.5	196.5	224.9	247.6	175.9	205.5	235.2	258.9
440	450	167.4	200.4	229.4	252.5	178.9	209.5	239.9	264.0
450	460	170.2	204.3	233.9	257.4	181.9	213.6	244.5	269.1
460	470	173.0	208.2	238.3	262.3	185.0	217.7	249.2	274.3
470	480	175.8	212.1	242.8	267.2	188.0	221.7	253.8	279.4
480	490	178.6	215.9	247.2	272.1	191.0	225.8	258.5	284.5
490	500	181.4	219.8	251.6	276.9	193.9	229.8	263.1	289.5
500	510	184.2	223.6	256.0	281.8	196.9	233.8	267.7	294.6

Shear force load-bearing capacity of the slab

Each shear force dowel has only one limited range of influence in which it can introduce the shear force into the slab. If the dowel spacing is greater than five times the static useful height, the load-bearing capacity of the connection is limited by the shear force load-bearing capacity of the slab within this range of influence.
The following table specifies the design values of the shear force load-bearing capacity for selected slab thicknesses, and degrees of reinforcement given. These values apply irrespective of the load-bearing level of the selected Schöck Stacon® type SLD.

Shear force load-bearing capacity of the slab with punctual support									
Shear force load-bearing capacity for		C28/35				C32/40			
		degree of reinforcement ρ_{ly} [%]							
Slab thickness [mm]		0.25	0.50	0.75	1.00	0.25	0.50	0.75	1.00
c_v = 20 mm	c_v = 30 mm	$V_{Rd,c,P}$ per dowel [kN]							
150	160	40.9	45.2	51.8	56.9	43.8	47.3	54.1	59.5
160	170	47.7	52.7	60.3	66.4	51.0	55.1	63.1	69.5
170	180	55.1	60.8	69.6	76.6	58.9	63.6	72.8	80.1
180	190	62.9	69.5	79.5	87.6	67.3	72.6	83.2	91.5
190	200	70.4	77.8	89.1	98.0	75.3	81.3	93.1	102.5
200	210	79.3	87.5	100.2	110.3	84.7	91.5	104.8	115.4
210	220	88.7	97.9	112.1	123.4	94.8	102.4	117.2	129.0
220	230	98.6	108.8	124.6	137.2	105.3	113.8	130.3	143.4
230	240	108.2	119.7	137.1	150.9	115.7	125.3	143.3	157.8
240	250	117.0	130.2	149.1	164.1	125.1	136.2	155.9	171.5
250	260	125.1	140.0	160.2	176.4	133.8	146.4	167.6	184.4
260	270	134.4	151.2	173.1	190.6	143.8	158.1	181.0	199.2
270	280	144.0	162.8	186.4	205.2	153.9	170.2	194.9	214.6
280	290	154.0	174.8	200.1	220.4	164.6	182.8	209.2	230.4
290	300	164.1	187.3	214.3	235.9	175.4	195.8	224.1	246.7
300	310	173.4	198.7	227.5	250.4	185.4	207.8	237.9	261.8
310	320	184.1	211.8	242.5	266.9	196.8	221.5	253.5	279.0
320	330	195.1	225.3	258.0	284.0	208.5	235.6	269.7	296.8
330	340	206.3	239.2	273.8	301.4	220.6	250.1	286.3	315.1
340	350	217.8	253.5	290.2	319.3	232.9	265.0	303.4	333.8
350	360	227.2	265.1	303.5	334.1	242.9	277.3	317.3	349.3
360	370	239.3	280.0	320.6	352.9	255.8	292.9	335.3	368.9
370	380	248.4	291.6	333.8	367.4	265.4	304.8	349.0	384.1
380	390	260.8	307.0	351.5	386.9	278.9	321.1	367.5	404.5
390	400	273.5	323.0	369.8	407.0	292.4	337.8	386.6	425.6
400	410	286.5	339.4	388.4	427.6	306.3	354.8	406.1	447.1
410	420	299.7	356.0	407.5	448.7	320.5	372.2	426.2	469.0
420	430	313.3	373.2	427.2	470.0	334.8	390.2	446.6	491.5
430	440	326.9	390.5	447.0	492.1	349.6	408.4	467.5	514.6
440	450	341.1	408.3	467.4	514.5	364.5	426.9	488.8	537.9
450	460	355.3	426.5	488.3	537.3	379.7	445.9	510.4	561.7
460	470	369.8	445.0	509.4	560.7	395.4	465.3	532.7	586.3
470	480	384.6	464.0	531.1	584.5	411.3	485.0	555.2	611.2
480	490	399.6	483.1	553.1	608.8	427.4	505.2	578.4	636.6
490	500	415.0	502.8	575.5	633.4	443.5	525.7	601.8	662.2
500	510	430.6	522.7	598.4	658.7	460.3	546.5	625.7	688.6

Load-bearing capacity of Stacon® type SLD

Design resistance $V_{Rd,ce,s}$ = min [resistance against steel failure $V_{Rd,s}$, concrete edge failure $V_{Rd,ce}$ and crack width limitation $V_{Rd,ce,SLS}$]
The following design values were determined on the basis of UKTA 23/6888, the technical regulation EOTA TR 065 and BS EN 1992-1-1. The values listed here apply only in connection with a reinforcement arrangement shown on page 35.

Schöck Stacon® type SLD			220	250	300	350	400	450
Design values with			$V_{Rd,ce,s}$ [kN] Check the shear force load-bearing capacity in advance (see design procedure on page23)					
Slab thickness [mm]		Joint width [mm]						
c_v = 20 mm	c_v = 30 mm							
150	160	20	56.8	-	-	-	-	-
		30	45.7	-	-	-	-	-
		40	38.1	-	-	-	-	-
		50	32.6	-	-	-	-	-
		60	28.5	-	-	-	-	-
160	180	20	56.8	74.7	-	-	-	-
		30	45.7	60.7	-	-	-	-
		40	38.1	50.9	-	-	-	-
		50	32.6	43.7	-	-	-	-
		60	28.5	38.2	-	-	-	-
180	200	20	56.8	74.7	123.3	-	-	-
		30	45.7	60.7	101.8	-	-	-
		40	38.1	50.9	86.0	-	-	-
		50	32.6	43.7	74.2	-	-	-
		60	28.5	38.2	65.2	-	-	-
200	220	20	56.8	74.7	123.3	-	-	-
		30	45.7	60.7	101.8	-	-	-
		40	38.1	50.9	86.0	-	-	-
		50	32.6	43.7	74.2	-	-	-
		60	28.5	38.2	65.2	-	-	-
220	240	20	56.7	74.7	118.5	171.5	-	-
		30	45.7	60.7	101.8	156.2	-	-
		40	38.1	50.9	86.0	133.3	-	-
		50	32.6	43.7	74.2	115.7	-	-
		60	28.5	38.2	65.2	102.0	-	-
230	250	20	56.8	74.7	121.3	176.0	-	-
		30	45.7	60.7	101.8	156.2	-	-
		40	38.1	50.9	86.0	133.3	-	-
		50	32.6	43.7	74.2	115.7	-	-
		60	28.5	38.2	65.2	102.0	-	-
250	270	20	56.8	74.7	123.3	184.9	243.6	-
		30	45.7	60.7	101.8	156.2	217.2	-
		40	38.1	50.9	86.0	133.3	187.0	-
		50	32.6	43.7	74.2	115.7	163.3	-
		60	28.5	38.2	65.2	102.0	144.5	-

Load-bearing capacity of Stacon® type SLD

Schöck Stacon® type SLD			220	250	300	350	400	450
Design values with			$V_{Rd,ce,s}$ [kN] Check the shear force load-bearing capacity in advance (see design procedure on page23)					
Slab thickness [mm]		Joint width [mm]						
c_v = 20 mm	c_v = 30 mm							
280	300	20	56.8	74.7	123.3	186.4	255.9	356.2
		30	45.7	60.7	101.8	156.2	217.2	307.9
		40	38.1	50.9	86.0	133.3	187.0	267.9
		50	32.6	43.7	74.2	115.7	163.3	235.7
		60	28.5	38.2	65.2	102.0	144.5	209.7
300	320	20	56.8	74.7	123.3	186.4	255.9	357.1
		30	45.7	60.7	101.8	156.2	217.2	307.9
		40	38.1	50.9	86.0	133.3	187.0	267.9
		50	32.6	43.7	74.2	115.7	163.3	235.7
		60	28.5	38.2	65.2	102.0	144.5	209.7
330	350	20	56.8	74.7	123.3	186.4	255.9	357.1
		30	45.7	60.7	101.8	156.2	217.2	307.9
		40	38.1	50.9	86.0	133.3	187.0	267.9
		50	32.6	43.7	74.2	115.7	163.3	235.7
		60	28.5	38.2	65.2	102.0	144.5	209.7
350	370	20	56.8	74.7	123.3	186.4	255.9	357.1
		30	45.7	60.7	101.8	156.2	217.2	307.9
		40	38.1	50.9	86.0	133.3	187.0	267.9
		50	32.6	43.7	74.2	115.7	163.3	235.7
		60	28.5	38.2	65.2	102.0	144.5	209.7
380	400	20	56.8	74.7	123.3	186.4	255.9	357.1
		30	45.7	60.7	101.8	156.2	217.2	307.9
		40	38.1	50.9	86.0	133.3	187.0	267.9
		50	32.6	43.7	74.2	115.7	163.3	235.7
		60	28.5	38.2	65.2	102.0	144.5	209.7
400	420	20	56.8	74.7	123.3	186.4	255.9	357.1
		30	45.7	60.7	101.8	156.2	217.2	307.9
		40	38.1	50.9	86.0	133.3	187.0	267.9
		50	32.6	43.7	74.2	115.7	163.3	235.7
		60	28.5	38.2	65.2	102.0	144.5	209.7
430	450	20	56.8	74.7	123.3	179.3	255.9	357.1
		30	45.7	60.7	101.8	156.2	217.2	307.9
		40	38.1	50.9	86.0	133.3	187.0	267.9
		50	32.6	43.7	74.2	115.7	163.3	235.7
		60	28.5	38.2	65.2	102.0	144.5	209.7
480	500	20	56.8	74.7	123.3	186.4	255.9	357.1
		30	45.7	60.7	101.8	156.2	217.2	307.9
		40	38.1	50.9	86.0	133.3	187.0	267.9
		50	32.6	43.7	74.2	115.7	163.3	235.7
		60	28.5	38.2	65.2	102.0	144.5	209.7

Load-bearing capacity of Stacon® type SLD-Q

Design resistance $V_{Rd,ce,s}$ = min [resistance against steel failure $V_{Rd,s}$, concrete edge failure $V_{Rd,ce}$ and crack width limitation $V_{Rd,ce,SLS}$]
The following design values were determined on the basis of UKTA 23/6888, the technical regulation EOTA TR 065 and BS EN 1992-1-1. The values listed here apply only in connection with a reinforcement arrangement shown on page 35.

Schöck Stacon® type SLD-Q			220	300	400
Design values with			$V_{Rd,ce,s}$ [kN] Check the shear force load-bearing capacity in advance (see design procedure on page23)		
Slab thickness [mm]		Joint width [mm]			
c_v = 20 mm	c_v = 30 mm				
150	160	20	55.4	-	-
		30	55.4	-	-
		40	50.7	-	-
		50	43.5	-	-
		60	38.1	-	-
160	180	20	59.9	-	-
		30	59.9	-	-
		40	50.7	-	-
		50	43.5	-	-
		60	38.1	-	-
180	200	20	74.1	138.8	-
		30	60.4	138.8	-
		40	50.7	122.9	-
		50	43.5	106.8	-
		60	38.1	94.2	-
200	220	20	74.1	148.9	-
		30	60.4	144.0	-
		40	50.7	122.9	-
		50	43.5	106.8	-
		60	38.1	94.2	-
220	240	20	72.6	158.5	-
		30	60.4	144.0	-
		40	50.7	122.9	-
		50	43.5	106.8	-
		60	38.1	94.2	-
230	250	20	74.1	163.2	-
		30	60.4	144.0	-
		40	50.7	122.9	-
		50	43.5	106.8	-
		60	38.1	94.2	-
250	270	20	74.1	171.7	310.4
		30	60.4	144.0	310.4
		40	50.7	122.9	272.6
		50	43.5	106.8	240.5
		60	38.1	94.2	214.4

Load-bearing capacity of Stacon® type SLD-Q

Schöck Stacon® type SLD-Q			220	300	400
Design values with			$V_{Rd,ce,s}$ [kN] Check the shear force load-bearing capacity in advance (see design procedure on page23)		
Slab thickness [mm]		Joint width [mm]			
c_v = 20 mm	c_v = 30 mm				
280	300	20	74.1	171.7	334.6
		30	60.4	144.0	312.1
		40	50.7	122.9	272.6
		50	43.5	106.8	240.5
		60	38.1	94.2	214.4
300	320	20	74.1	171.7	350.1
		30	60.4	144.0	312.1
		40	50.7	122.9	272.6
		50	43.5	106.8	240.5
		60	38.1	94.2	214.4
330	350	20	73.4	171.7	359.6
		30	60.4	144.0	312.1
		40	50.7	122.9	272.6
		50	43.5	106.8	240.5
		60	38.1	94.2	214.4
350	370	20	74.1	171.7	359.6
		30	60.4	144.0	312.1
		40	50.7	122.9	272.6
		50	43.5	106.8	240.5
		60	38.1	94.2	214.4
380	400	20	74.1	171.7	359.6
		30	60.4	144.0	312.1
		40	50.7	122.9	272.6
		50	43.5	106.8	240.5
		60	38.1	94.2	214.4
400	420	20	74.1	171.7	359.6
		30	60.4	144.0	312.1
		40	50.7	122.9	272.6
		50	43.5	106.8	240.5
		60	38.1	94.2	214.4
430	450	20	74.1	171.4	359.6
		30	60.4	144.0	312.1
		40	50.7	122.9	272.6
		50	43.5	106.8	240.5
		60	38.1	94.2	214.4
480	500	20	74.1	171.7	359.6
		30	60.4	144.0	312.1
		40	50.7	122.9	272.6
		50	43.5	106.8	240.5
		60	38.1	94.2	214.4

Operating strength of Stacon® type SLD-Q | On-site reinforcement

Operational strength of transversely movable dowels

With larger transverse displacements every day of more than 2 mm, the dowel can rub against the inside of the sleeve which increases wear. These frequent displacements occur when external members such as, for example, balcony slabs or façade components, are connected. In these cases the load must be limited.
The load-bearing capacities of the Schöck Stacon® type SLD-Q for the ultimate limit state are listed in the bottom table. As these values are smaller than the load-bearing capacities without regular displacement with the respective minimum slab thickness, these values apply irrespective of the slab thickness.

Schöck Stacon® type SLD-Q		220	300	400
Design values with		$V_{Rd,ce,SLS}$ [kN]		
Joint width [mm]	10–50	40.9	94.7	198.3
	60	38.1	94.2	198.3

On-site reinforcement

The on-site reinforcement specified here was designed for the following requirements:

- Slab edge reinforcement to avoid concrete edge failure (Pos. 1)
- Bending moments and shear forces of the flush edge beam as continuous support for a maximum dowel spacing of 8 • h_{slab} (Pos. 2)
- Transverse reinforcement for anchorage of the slab flexible reinforcement in the flush downstand beam in accordance with BS EN 1992-1-1

The first slip-in stirrup of the Position 1 right and left of the shear force dowel must be directly in contact with the welded-on dowel bracket.

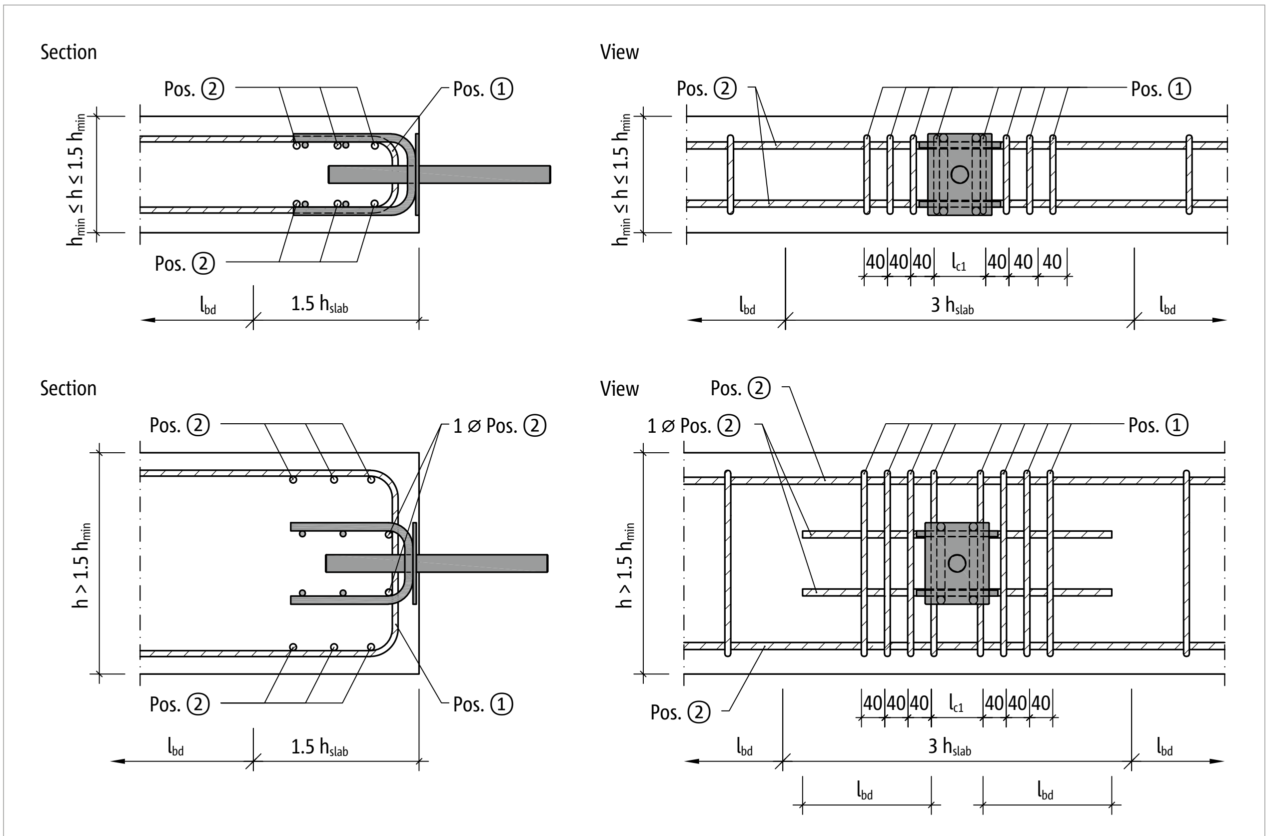


Fig. 34: On-site reinforcement with Schöck Stacon® type SLD

On-site reinforcement

Schöck Stacon® type SLD		220	250	300	350	400	450
On-site reinforcement for		Number and diameter					
Slab thickness [mm]							
c_v = 20 mm	c_v = 30 mm						
Pos. 1: U-stirrup							
150–200	160-220	2 x 2 ⌀ 12	2 x 3 ⌀ 12	2 x 3 ⌀ 16	-	-	-
210–300	230-320	2 x 2 ⌀ 10	2 x 2 ⌀ 12	2 x 2 ⌀ 16	2 x 3 ⌀ 16	2 x 4 ⌀ 16	2 x 4 ⌀ 20
310–400	330–420	2 x 2 ⌀ 10	2 x 2 ⌀ 10	2 x 3 ⌀ 12	2 x 3 ⌀ 16	2 x 4 ⌀ 16	2 x 4 ⌀ 20
410–500	430–520	2 x 2 ⌀ 10	2 x 2 ⌀ 10	2 x 3 ⌀ 10	2 x 2 ⌀ 16	2 x 3 ⌀ 16	2 x 4 ⌀ 20
Pos. 2: Joint longitudinal reinforcement for the degree of reinforcement of the slab ≤ 0.5 %							
150–200	160-220	2 x 3 ⌀ 12	2 x 3 ⌀ 12	2 x 3 ⌀ 16	-	-	-
210–300	230-320	2 x 4 ⌀ 16	2 x 4 ⌀ 16	2 x 4 ⌀ 16	2 x 4 ⌀ 16	2 x 5 ⌀ 16	2 x 4 ⌀ 20
310–400	330–420	2 x 3 ⌀ 16	2 x 5 ⌀ 16	2 x 4 ⌀ 20	2 x 4 ⌀ 20	2 x 4 ⌀ 20	2 x 4 ⌀ 20
410–500	430–520	2 x 2 ⌀ 16	2 x 4 ⌀ 16	2 x 5 ⌀ 20	2 x 6 ⌀ 20	2 x 6 ⌀ 20	2 x 6 ⌀ 20
Pos. 2: Joint longitudinal reinforcement for the degree of reinforcement of the slab ≤ 1.0 %							
150–200	160-220	2 x 5 ⌀ 12	2 x 5 ⌀ 12	2 x 3 ⌀ 16	-	-	-
210–300	230-320	2 x 5 ⌀ 16	2 x 6 ⌀ 16	2 x 7 ⌀ 16	2 x 7 ⌀ 16	2 x 5 ⌀ 20	2 x 5 ⌀ 20
310–400	330–420	2 x 3 ⌀ 16	2 x 6 ⌀ 16	2 x 7 ⌀ 20	2 x 7 ⌀ 20	2 x 7 ⌀ 20	2 x 7 ⌀ 20
410–500	430–520	2 x 2 ⌀ 16	2 x 4 ⌀ 16	2 x 6 ⌀ 20	2 x 7 ⌀ 20	2 x 8 ⌀ 20	2 x 8 ⌀ 20

Schöck Stacon® type SLD-Q		220	300	400
On-site reinforcement for		Number and diameter		
Slab thickness [mm]				
c_v = 20 mm	c_v = 30 mm			
Pos. 1: U-stirrup				
150–200	160-220	2 x 3 ⌀ 12	2 x 3 ⌀ 16	-
210–300	230-320	2 x 2 ⌀ 12	2 x 3 ⌀ 16	2 x 4 ⌀ 20
310–400	330–420	2 x 2 ⌀ 10	2 x 3 ⌀ 16	2 x 3 ⌀ 20
410–500	430–520	2 x 2 ⌀ 10	2 x 2 ⌀ 16	2 x 3 ⌀ 20
Pos. 2: Joint longitudinal reinforcement for the degree of reinforcement of the slab ≤ 0.5 %				
150–200	160-220	2 x 3 ⌀ 12	2 x 3 ⌀ 16	-
210–300	230-320	2 x 3 ⌀ 16	2 x 3 ⌀ 16	2 x 4 ⌀ 20
310–400	330–420	2 x 5 ⌀ 16	2 x 4 ⌀ 20	2 x 5 ⌀ 20
410–500	430–520	2 x 2 ⌀ 16	2 x 6 ⌀ 20	2 x 6 ⌀ 20
Pos. 2: Joint longitudinal reinforcement for the degree of reinforcement of the slab ≤ 1.0 %				
150–200	160-220	2 x 5 ⌀ 12	2 x 3 ⌀ 16	-
210–300	230-320	2 x 6 ⌀ 16	2 x 6 ⌀ 16	2 x 4 ⌀ 20
310–400	330–420	2 x 6 ⌀ 16	2 x 7 ⌀ 20	2 x 7 ⌀ 20
410–500	430–520	2 x 4 ⌀ 12	2 x 7 ⌀ 25	2 x 8 ⌀ 25

Distance of the first U-stirrup laterally from the dowel

$l_{c1} = A_{B,D/H} + d_{b,D/H} + ⌀$ Pos. 1

l_{c1}: Centre distance of the first U-stirrup next to the Schöck Stacon® type SLD

$A_{B,D/H}$: Centre distance of the welded-on stirrup on the sleeve and/or dowel element (see page 21 or 22)

$d_{b,D/H}$: Diameter of the welded-on stirrup on the sleeve and/or dowel element (see page 21 or 22)

⌀ Pos. 1: Diameter of the on-site reinforcement of Pos. 1

SLD

Structural design

Precast construction | Joint tapes

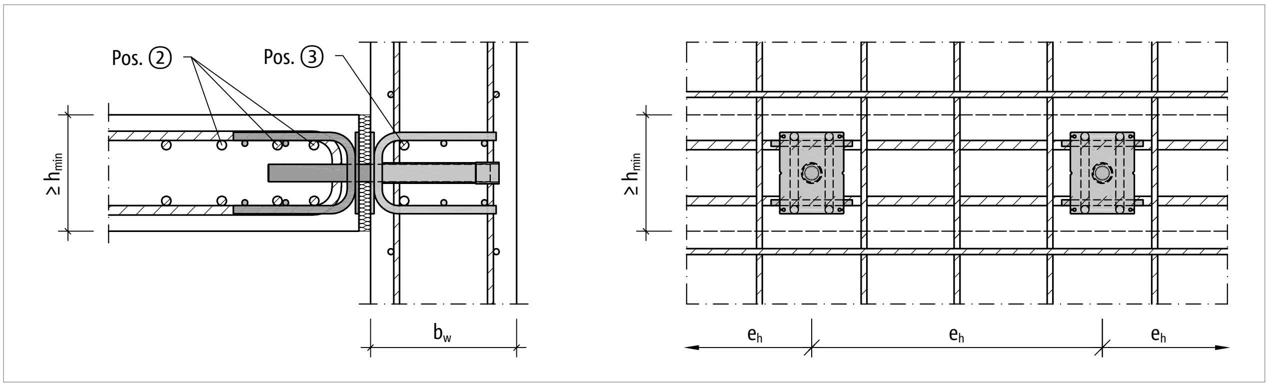


Fig. 35: Schöck Stacon® type SLD: on-site reinforcement with floor-wall connection

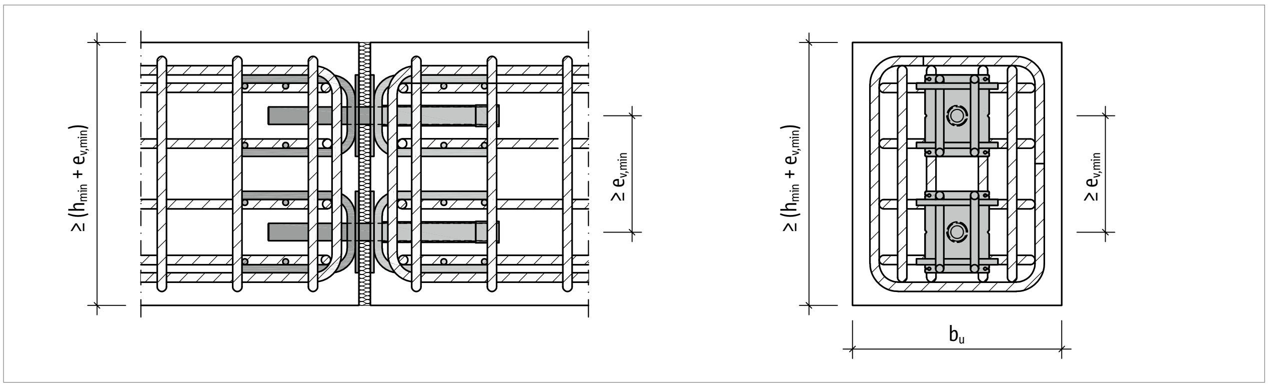


Fig. 36: Schöck Stacon® type SLD: on-site reinforcement with beam connection

Schöck Stacon®	220	250	300	350	400	450
On-site reinforcement for	Number and diameter					
Pos. 3: Longitudinal bar within the dowel for walls and downstand beams						
Type SLD	2 x 1 ⌀ 8	2 x 1 ⌀ 10	2 x 1 ⌀ 12	2 x 1 ⌀ 16	2 x 1 ⌀ 16	2 x 1 ⌀ 20

Schöck Stacon®	220	300	400
On-site reinforcement for	Number and diameter		
Pos. 3: Longitudinal bar within the dowel for walls and downstand beams			
Type SLD-Q	2 x 1 ⌀ 10	2 x 1 ⌀ 16	2 x 1 ⌀ 20

Prefabricated construction and joint tapes

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

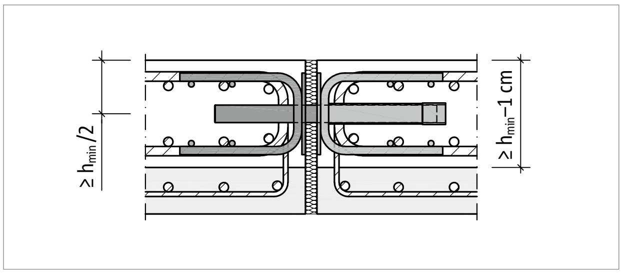


Fig. 37: Schöck Stacon® type SLD: on-site reinforcement with semi precast floor slab units

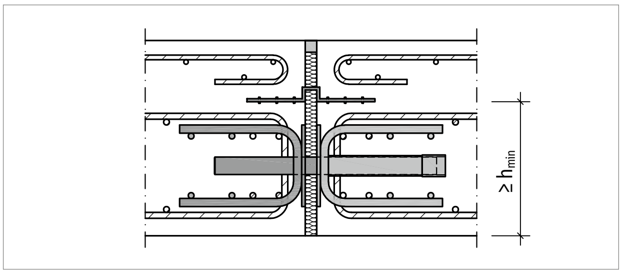


Fig. 38: Schöck Stacon® type SLD: Expansion joint with joint tape

Verification of the load-bearing capacity

Verification of the load-bearing capacity in accordance with technical building regulation EOTA TR 065
The load-bearing capacity of an expansion joint connection with the Schöck Stacon® type SLD results from the minimum of the verifications against shear force load-bearing capacity of the slab, concrete edge failure and steel load-bearing capacity.

Ultimate limit state:

	V_{Ed}	$\leq V_{Rd,c}$	Shear force load-bearing capacity of the complete slab and in the area of the dowels
	V_{Ed}	$\leq V_{Rd,ce,s}$	Load-bearing capacity of the shear force dowel
	$V_{Rd,ce,s}$	$= \min (V_{Rd,ce}; V_{Rd,s})$	

Serviceability limit state:

	$V_{Ed,SLD}$	$\leq V_{Rd,ce,SLS}$	Limitation of the crack widths (≤ 0.3 mm)
	$V_{Ed,SLS}$	$\leq V_{Rd,s,20,SLS}$	Operating strength of the transversely movable shear force dowels SLD-Q

with:	V_{Ed}:	Design value of the applied shear force in the ultimate limit state
	$V_{Ed,SLS}$:	Design value of the applied shear force in the serviceability limit state as quasi-permanent load combination
	$V_{Rd,c}$:	Design value of the shear force load-bearing capacity of the concrete structural component
	$V_{Rd,dowel}$:	Design value of the shear force load-bearing capacity of the dowel connection
	$V_{Rd,ce}$:	Design value of the resistance to concrete edge failure
	$V_{Rd,s}$:	Design value of the resistance to steel failure
	$V_{Rd,ce,SLS}$:	Design value for the limitation of the crack widths in the concrete
	$V_{Rd,s,20,SLS}$:	Design value for the wear resistance of transversely movable dowels

These verifications are fulfilled in compliance with the previous design tables. In the case of downstand beams, columns and walls, the verification of the shear force load-bearing capacity can be dispensed with.

Steel load-bearing capacity

Steel load-bearing capacity in accordance with technical building regulation EOTA TR 065 and UKTA 23/6888

Steel load-bearing capacity of the Schöck Stacon® type SLD was determined by means of the load-deformation curve from tests. Until this load-bearing capacity is reached, all deformations from concrete and steel are elastic and reversible. This load-bearing capacity is always relevant in structural components in which concrete failure due to concrete edge failure or shear force failure can be excluded. This is the case, for example, in walls or columns.

Schöck Stacon® type SLD		220	250	300	350	400	450
Steel load-bearing capacity for		$V_{Rd,s}$ [kN]					
Joint width [mm]	10	73.6	95.3	153.1	225.8	303.7	414.8
	20	56.8	74.7	123.3	186.4	255.9	357.1
	30	45.7	60.7	101.8	156.2	217.2	307.9
	40	38.1	50.9	86.0	133.3	187.0	267.9
	50	32.6	43.7	74.2	115.7	163.3	235.7
	60	28.5	38.2	65.2	102.0	144.5	209.7

Schöck Stacon® type SLD-Q		220	300	400
Steel load-bearing capacity for		$V_{Rd,s}$ [kN]		
Joint width [mm]	10	94.0	205.9	359.6
	20	74.1	171.7	359.6
	30	60.4	144.0	312.1
	40	50.7	122.9	272.6
	50	43.5	106.8	240.5
	60	38.1	94.2	214.4

Design example

Connection of a floor plate to a wall

Boundary conditions:

Slab:	Concrete:	C32/40	
	Slab thickness:	h_{slab}	= 250 mm
	Concrete cover:	c_v	= 30 mm
	Reinforcement in slab:	⌀16/200 = a_s	= 1005 mm²/m
Wall:	Concrete:	C32/40	
	Wall thickness:	b_w	= 250 mm
	Concrete cover:	c_v	= 30 mm
Joint:	Joint length:	l_f	= 5 m
	Joint width on installation:	f_E	= 20 mm
	Maximum joint width:	f	= 28 mm
	No transverse displacements expected		Schöck Stacon® type SLD
Load:	Simplified load:	v'_{Ed}	= 100 kN/m

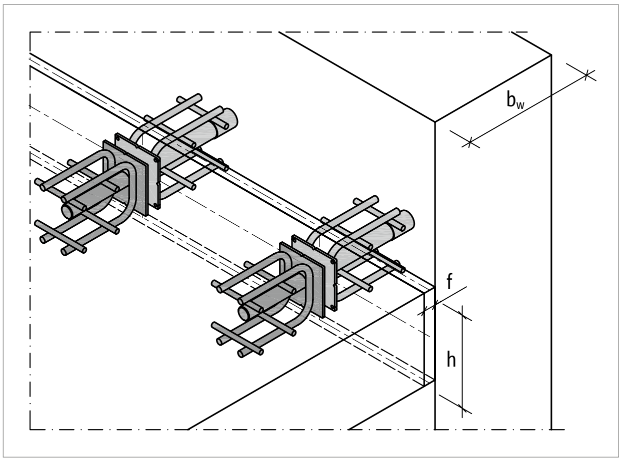


Fig. 39: Design example of floor-wall connection

Degree of reinforcement of the slab which is anchored in the edge beam (see diagram page 27):

Anchorage length ⌀16:	$l_{b,eq}$	= 570 mm
Minimum anchorage length:	$l_{min} = 10 \cdot 16$	= 160 mm
Existing anchorage length:	$l_{b,ind} = 1.5 \cdot h - c_v$	= 345 mm ≥ 160 mm
Degree of anchored reinforcement:	$\rho_{ly} = l_{b,ind}/l_{b,eq} \cdot a_s/d$	= 0.29 %

Examination of the minimum structural component dimensions:

Read off from the table on page 24

SLD 300 selected

Minimum slab thickness	$h_{min} = 200\text{ mm} \leq h_{slab} = 250\text{ mm}$
Minimum wall thickness	$b_{w,min} = 240\text{ mm} \leq b_w = 250\text{ mm}$

Schöck Stacon® type SLD	220	250	300	350
Minimum structural component dimension [mm]				
Minimum slab thickness h_{min} for c_v = 20 mm	150	160	180	210
Minimum slab thickness h_{min} for c_v = 30 mm	~~160~~	~~180~~	→ 200	230
Minimum slab thickness h_{min} for c_v = 40 mm	180	200	220	250
Minimum wall thickness b_w	~~200~~	~~215~~	→ 240	280

Design example

Verification of the shear force load-bearing capacity of the slab:
Verification by means of the table on page 28
v'_{Ed} = 100 kN/m ≤ $v_{Rd,c}$ = 116.9 kN/m
The degree of reinforcement of the slab is sufficient.

Shear force resistance of the slab without shear force reinforcement for linear support						
Shear force resistance for		C28/35		C32/40		
		Degree of reinforcement ρ_{ly} [%]				
Slab thickness [mm]		0.75	1.0	0.25	0.5	0.75
c_v = 20 mm	c_v = 30 mm	$v_{Rd,c}$ [kN/m]				
230	240	134.4	147.9	113.4	122.8	140.5
240	250	139.3	153.4	116.9	127.3	145.7
250	260	143.7	158.2	120.0	131.3	150.3

Maximum shear force load-bearing capacity of the slab per dowel:
Read off from the table on page 29
The slab can accept no more than 125.1 kN/dowel.

Shear force load-bearing capacity of the slab with punctual support						
Shear force resistance for		C28/35		C32/40		
		Degree of reinforcement ρ_{ly} [%]				
Slab thickness [mm]		0.75	1.0	0.25	0.5	0.75
c_v = 20 mm	c_v = 30 mm	$v_{Rd,c,P}$ per dowel [kN/m]				
230	240	137.1	150.9	115.7	125.3	143.3
240	250	149.1	164.1	125.1	136.2	155.9
250	260	160.2	176.4	133.8	146.4	167.6

Selection of the matching load-bearing level:
Read off from the table on page 30
SLD 300 selected
$V_{Rd,ce,s}$ = 101.8 kN ≤ $V_{Rd,c,P}$ = 125.1 kN
Thus the load-bearing capacity of the dowel $V_{Rd,ce,s}$ is decisive for the design.
$V_{Rd,dowel}$ = 101.8 kN

Schöck Stacon® type SLD			250	300	350
Design values with			$V_{Rd,ce,s}$ [kN]		
Slab thickness [mm]		Joint width [mm]			
c_v = 20 mm	c_v = 30 mm				
230	250	20	74.7	123.3	178.4
		30	60.7	101.8	156.2
		40	50.9	86.0	133.3
		50	43.7	74.2	115.7
		60	38.2	65.2	102.0

Calculation of the required dowel spacing:
$e_{req} = V_{Rd,dowel} / v'_{Ed}$ = 101.8 kN / 100 kN/m
e_{req} = 1.02 m

Selection of the dowel spacing and number of dowels:
$n_{dowel} = l_f / e_{req}$ = 5 m / 1.02 m = 4.9 ≈ 5 dowels
$e_{sel} = l_f / n_{dowel}$ = 5 m / 5 dowels = 1.0 m

Examination of the dowel spacing:
Details in the table on page 24
Minimum dowel spacing $e_{h,min} = 1.5 \cdot h_{slab}$ = 1.5 · 250 mm = 375 mm ≤ 1000 mm
Maximum dowel spacing $e_{h,max} = 8 \cdot h_{slab}$ = 8 · 250 mm = 2000 mm ≥ 1000 mm

Determination of the required edge reinforcement:

Slab:
Read off from the table on page 35
Pos. 1: 2 ⌀ 16 right and left of the dowel
Pos. 2: 4 ⌀ 16 at upper and lower slab edge

Schöck Stacon® type SLD		250	300	350
On-site reinforcement for		Number and diameter		
Slab thickness [mm]				
c_v = 20 mm	c_v = 30 mm			
Pos. 1: U-stirrup				
150–200	160–220	2 x 3 ⌀ 12	2 x 3 ⌀ 16	-
210–300	230–320	2 x 2 ⌀ 12	2 x 2 ⌀ 16	2 x 3 ⌀ 16
Pos. 2: Joint longitudinal reinforcement for the degree of reinforcement of the slab ≤ 0.5 %				
150–200	160–220	2 x 3 ⌀ 12	2 x 3 ⌀ 16	-
210–300	230–320	2 x 4 ⌀ 16	2 x 4 ⌀ 16	2 x 4 ⌀ 16

Design example

Wall:
Read off from the table on page 36
Pos. 3: 1 ⌀ 12 in the dowel stirrup top and bottom
In the wall only one longitudinal bar is required at the top and bottom to absorb the splitting tensile force.

Schöck Stacon®	250	300	350
On-site reinforcement for	Number and diameter		
Pos. 3: Longitudinal bar within the dowel for walls and downstand beams			
Type SLD	2 x 1 ⌀ 10	2 x 1 ⌀ 12	2 x 1 ⌀ 16

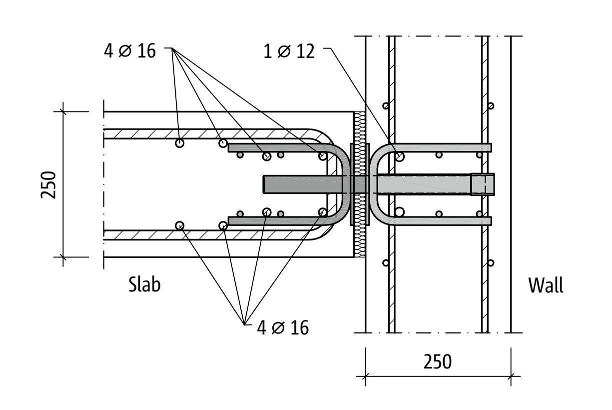


Fig. 40: Section through floor-wall connection showing reinforcement set-up

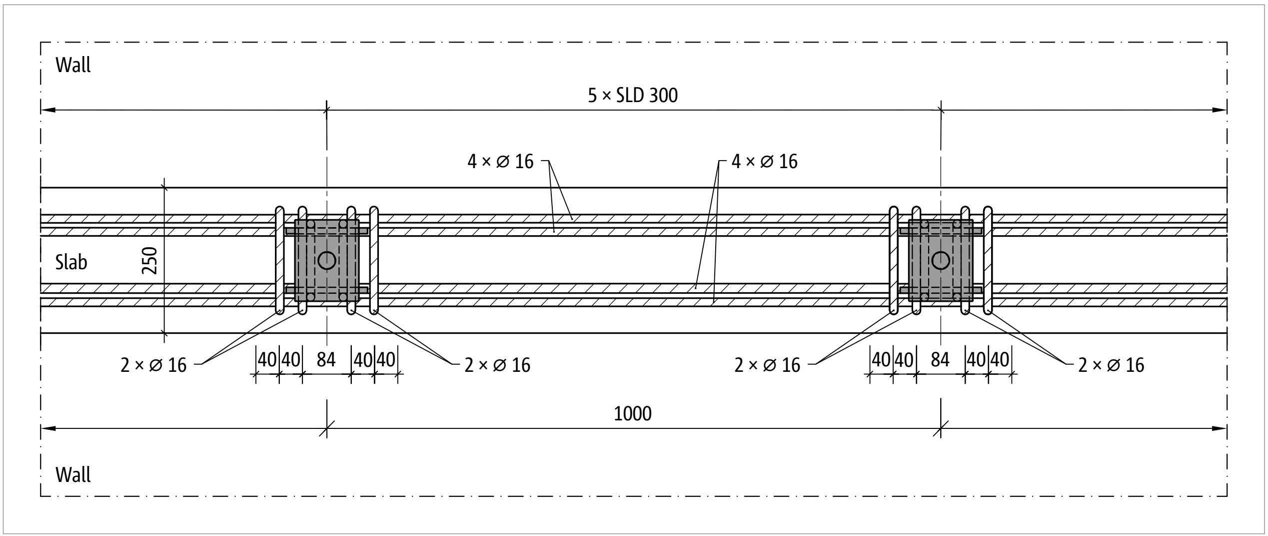


Fig. 41: View of the floor showing reinforcement set-up

Design example

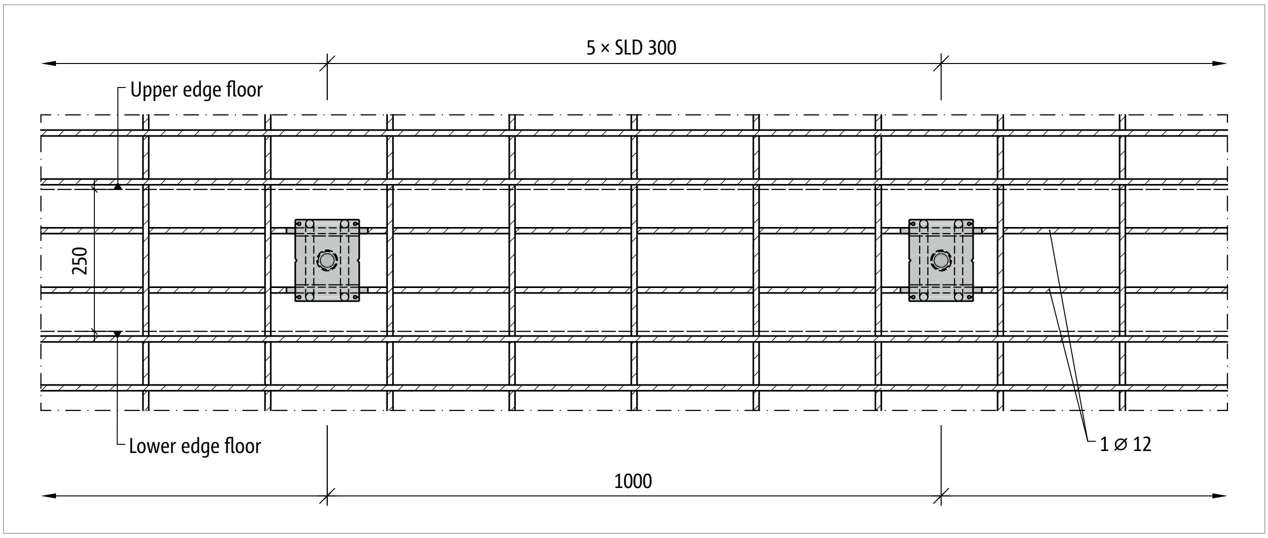


Fig. 42: View of the wall showing reinforcement set-up

Design example

Connection of a floor plate to a downstand beam

Boundary conditions:

Slab:	Concrete:	C32/40	
	Slab thickness:	h_{slab}	= 300 mm
	Concrete cover:	c_v	= 30 mm
	Reinforcement in slab:	$\varnothing 16 / 100 = a_s$	= 2011 mm²/m
Downstand beam:	Concrete:	C32/40	
	Height:	h_u	= 500 mm
	Width:	b_w	= 300 mm
	Concrete cover:	c_v	= 30 mm
Joint:	Joint length:	l_f	= 20 m
	Joint width on installation:	f_E	= 20 mm
	Maximum joint width:	f	= 28 mm
	Transverse displacements expected		Schöck Stacon® type SLD-Q
	The expected daily transverse displacements are smaller than 2 mm.		
	Offset slab downstand beam	v_u	= 100 mm
Load:	Simplified load:	v'_{Ed}	= 100 kN/m

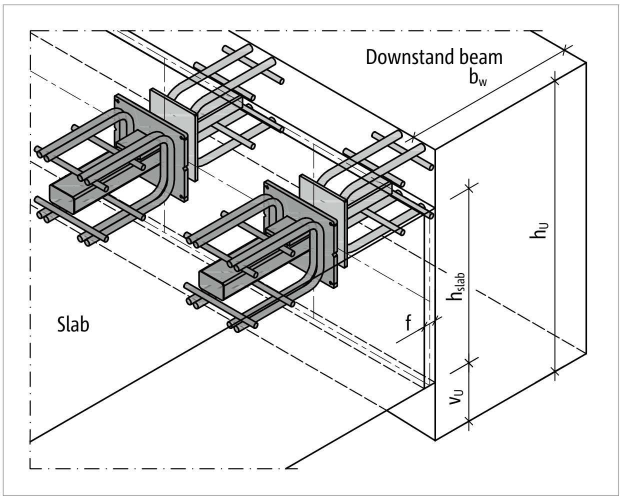


Fig. 43: Design example of floor-wall connection

Degree of reinforcement of the slab which is anchored in the edge beam (see diagram page 27):

Anchorage length ⌀16:	$l_{b,eq}$	= 570 mm
Minimum anchorage length:	$l_{min} = 10 \cdot 16$	= 160 mm
Existing anchorage length:	$l_{b,ind} = 1.5 \cdot h - c_v$	= 420 mm ≥ 160 mm
Degree of anchored reinforcement:	$\rho_{ly} = l_{b,ind}/l_{b,eq} \cdot a_s/d$	= 0.57 %

Examination of the minimum structural component dimensions:

Read off from the table on page 24

SLD-Q 300 selected

Minimum slab thickness	$h_{min} = 200\text{ mm} \leq h_{slab} = 300\text{ mm}$
Minimum wall thickness / downstand beam width	$b_{w,min} = 240\text{ mm} \leq b_w = 300\text{ mm}$

SLD

Structural design

Design example

Verification of the shear force load-bearing capacity of the slab:
Verification by means of the table on page 28
$v'_{Ed} = 100$ kN/m $\leq v_{Rd,c} = 148.9$ kN/m
The degree of reinforcement of the slab is sufficient.

Shear force resistance of the slab without shear force reinforcement for linear support						
Shear force resistance for		C28/35	C32/40			
		Degree of reinforcement ρ_{ly} [%]				
Slab thickness [mm]		1.0	0.25	0.5	0.75	1.0
c_v = 20 mm	c_v = 30 mm	$v_{Rd,c}$ [kN/m]				
280	290	174.2	130.1	144.5	165.4	182.1
290	300	179.4	133.4	148.9	170.4	187.6
300	310	184.1	136.3	152.8	174.9	192.5

Maximum shear force load-bearing capacity of the slab per dowel:
Read off from the table on page 29
The slab can accept no more than 195.8 kN/dowel.

Shear force load-bearing capacity of the slab with punctual support						
Shear force resistance for		C28/35	C32/40			
		Degree of reinforcement ρ_{ly} [%]				
Slab thickness [mm]		1.0	0.25	0.5	0.75	1.0
c_v = 20 mm	c_v = 30 mm	$v_{Rd,c,P}$ per dowel [kN/m]				
280	290	220.4	164.6	182.8	209.2	230.4
290	300	235.9	175.4	195.8	224.1	246.7
300	310	250.4	185.4	207.8	237.9	261.8

Selection of the matching load-bearing level:
Read off from the table on page 32
SLD-Q 300 selected
$V_{Rd,ce,s} = 144.0$ kN $\leq V_{Rd,c,P} = 195.8$ kN/dowel
Thus the load-bearing capacity of the dowel $V_{Rd,ce,s}$ is decisive for the design.
As no daily transverse displacements larger than 2 mm are to be expected, the load-bearing capacity does not have to be reduced in accordance with page 34.
$V_{Rd,dowel} = 144.0$ kN

Schöck Stacon® type SLD-Q			220	300	400
Design values with		Joint width [mm]	$V_{Rd,ce,s}$ [kN]		
Slab thickness [mm]					
c_v = 20 mm	c_v = 30 mm				
		20	74.1	171.7	334.6
280	300	30	60.4	144.0	312.1
		40	50.7	122.9	268.7
		50	43.5	106.8	240.5
		60	38.1	94.2	214.4

Calculation of the required dowel spacing:
$e_{req} = V_{Rd,dowel} / v'_{Ed} = 144.0$ kN / 100 kN/m
$e_{req} = 1.44$ m

Selection of the dowel spacing and number of dowels:
$n_{dowel} = l_f / e_{req} = 20$ m / 1.44 m = 13.9 ≈ 14 dowels
$e_{sel} = l_f / n_{dowel} = 20$ m / 14 dowels ≈ 1.4 m

Examination of the dowel spacing:
Details in the table on page 24
Minimum dowel spacing $e_{h,min} = 1.5 \cdot h_{slab} = 1.5 \cdot 300$ mm $= 450$ mm ≤ 1400 mm
Maximum dowel spacing $e_{h,max} = 8 \cdot h_{slab} = 8 \cdot 300$ mm $= 2400$ mm ≥ 1400 mm

Design example

Determination of the required edge reinforcement:

Slab:
Read off from the table on page 35
Pos. 1: 3 ⌀ 16 right and left of the dowel
Pos. 2: 6 ⌀ 16 at upper and lower slab edge

Schöck Stacon® type SLD-Q		220	300	400
On-site reinforcement for		Number and diameter		
Slab thickness [mm]				
c_v = 20 mm	c_v = 30 mm			
Pos. 1: U-stirrup				
150–200	160–220	2 x 3 ⌀ 12	2 x 3 ⌀ 16	-
210–300	230–320	~~2 x 2 ⌀ 12~~	2 x 3 ⌀ 16	2 x 4 ⌀ 20
310–400	330–420	2 x 2 ⌀ 10	2 x 3 ⌀ 16	2 x 3 ⌀ 20
Pos. 2: Joint longitudinal reinforcement for the degree of reinforcement of the slab ≤ 1.0 %				
150–200	160–220	2 x 5 ⌀ 12	2 x 3 ⌀ 16	-
210–300	230–320	~~2 x 6 ⌀ 16~~	2 x 6 ⌀ 16	2 x 4 ⌀ 20

Downstand beam:
Read off from the table on page 35
Pos. 1: 3 ⌀ 16 right and left of the dowel

Schöck Stacon® type SLD-Q		220	300	400
On-site reinforcement for		Number and diameter		
Slab thickness [mm]				
c_v = 20 mm	c_v = 30 mm			
Pos. 1: U-stirrup				
150–200	160–220	2 x 3 ⌀ 12	2 x 3 ⌀ 16	-
210–300	230–320	2 x 2 ⌀ 12	2 x 3 ⌀ 16	2 x 4 ⌀ 20
310–400	330–420	~~2 x 2 ⌀ 10~~	2 x 3 ⌀ 16	2 x 3 ⌀ 20

Read off from the table on page 36
Pos. 3: 1 ⌀ 16 in the dowel stirrup top and bottom
In the wall only one longitudinal bar is required at the top and bottom to absorb the splitting tensile force.

Schöck Stacon®	220	300	400
On-site reinforcement for	Number and diameter		
Pos. 3: Longitudinal bar within the dowel for walls and downstand beams			
Type SLD-Q	2 x 1 ⌀ 10	2 x 1 ⌀ 16	2 x 1 ⌀ 20

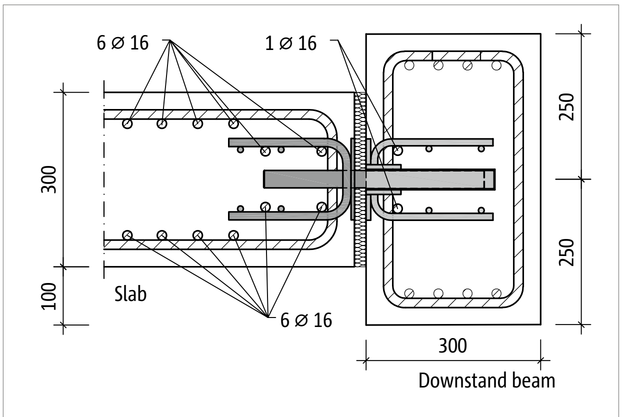


Fig. 44: Section through floor-downstand beam connection showing reinforcement set-up

Design example

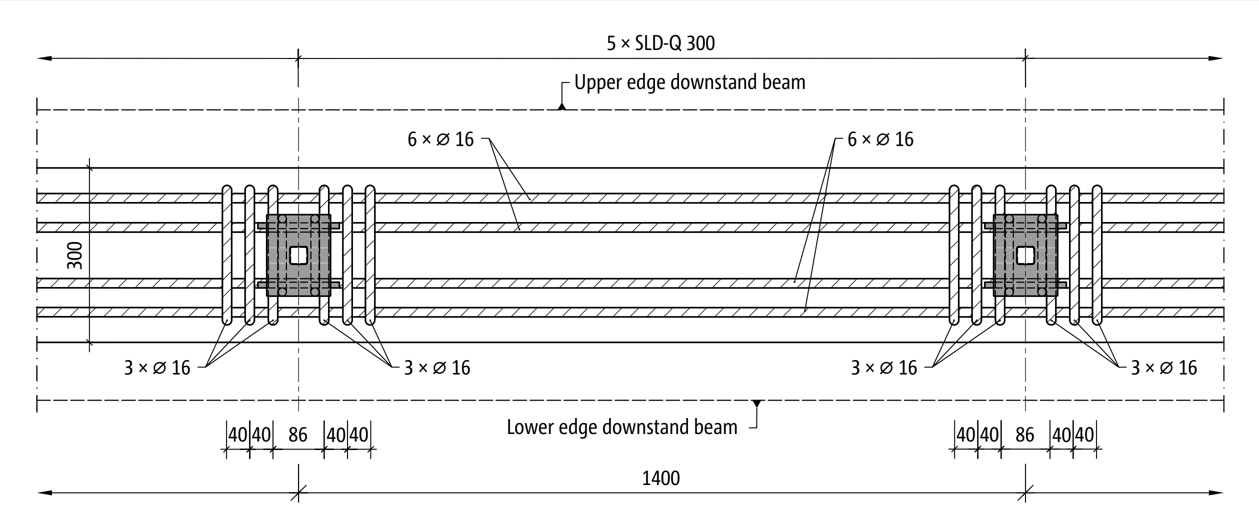


Fig. 45: View of the floor showing reinforcement set-up

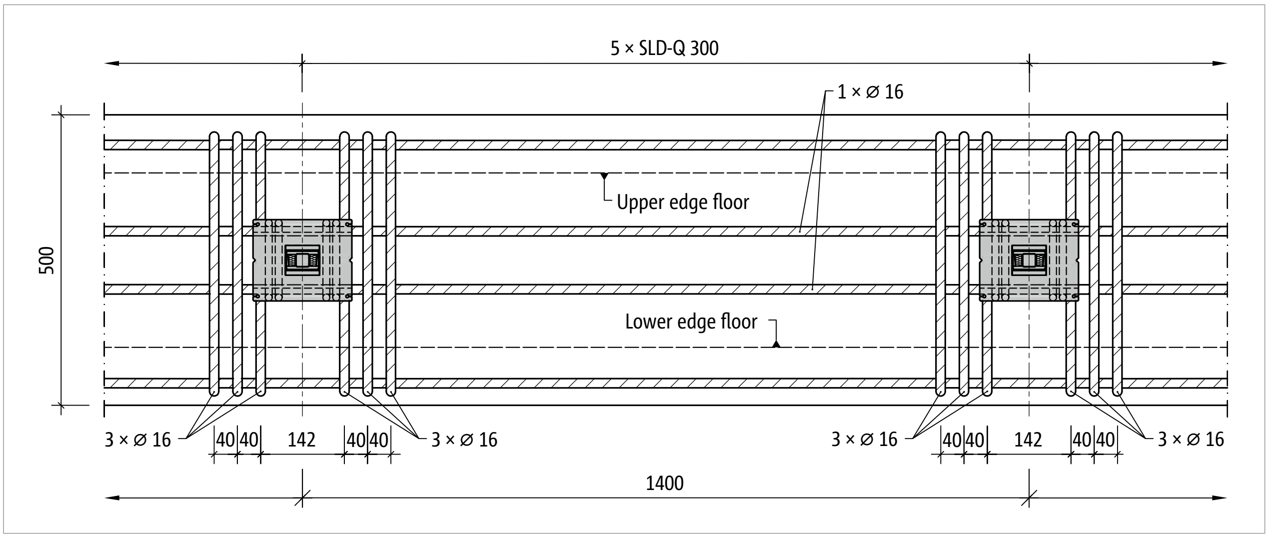


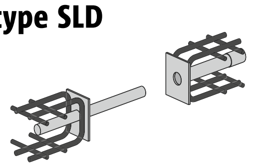
Fig. 46: View of the downstand beam showing reinforcement set-up

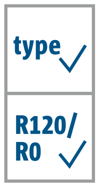
SLD

Structural design

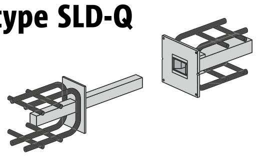
Installation instructions

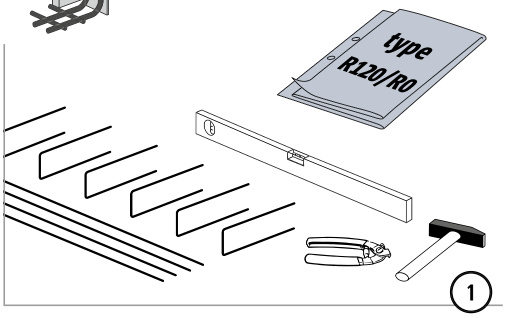
type SLD

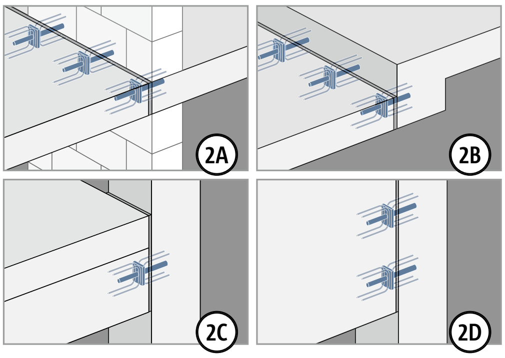


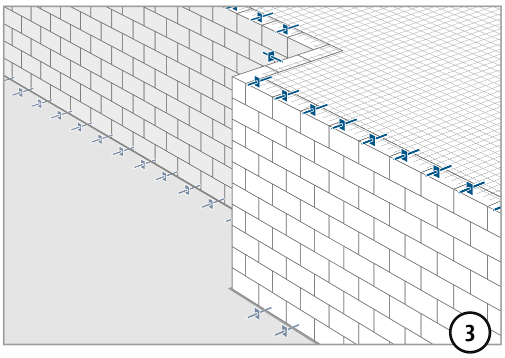


type SLD-Q



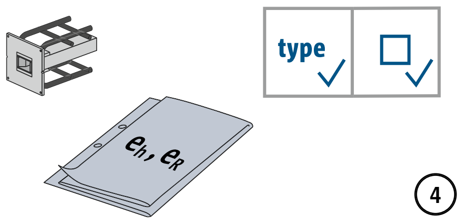


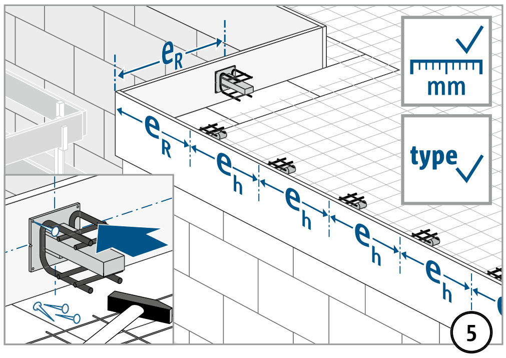


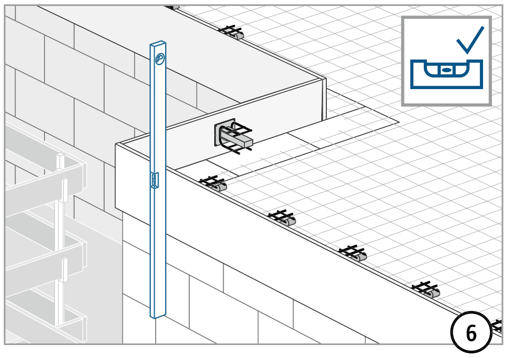


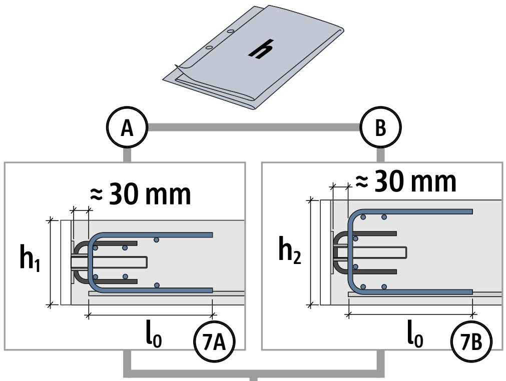
type SLD part S

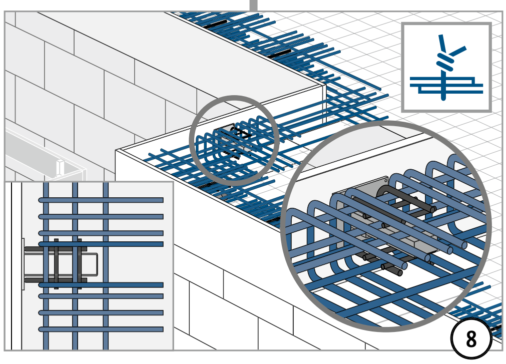
type SLD-Q part S

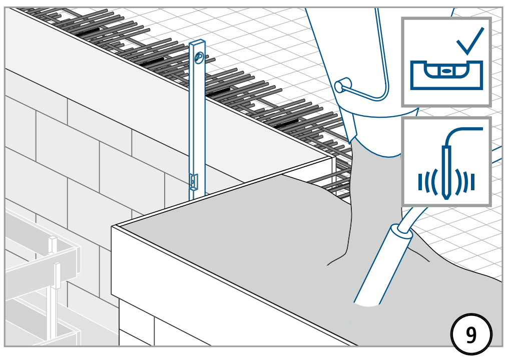








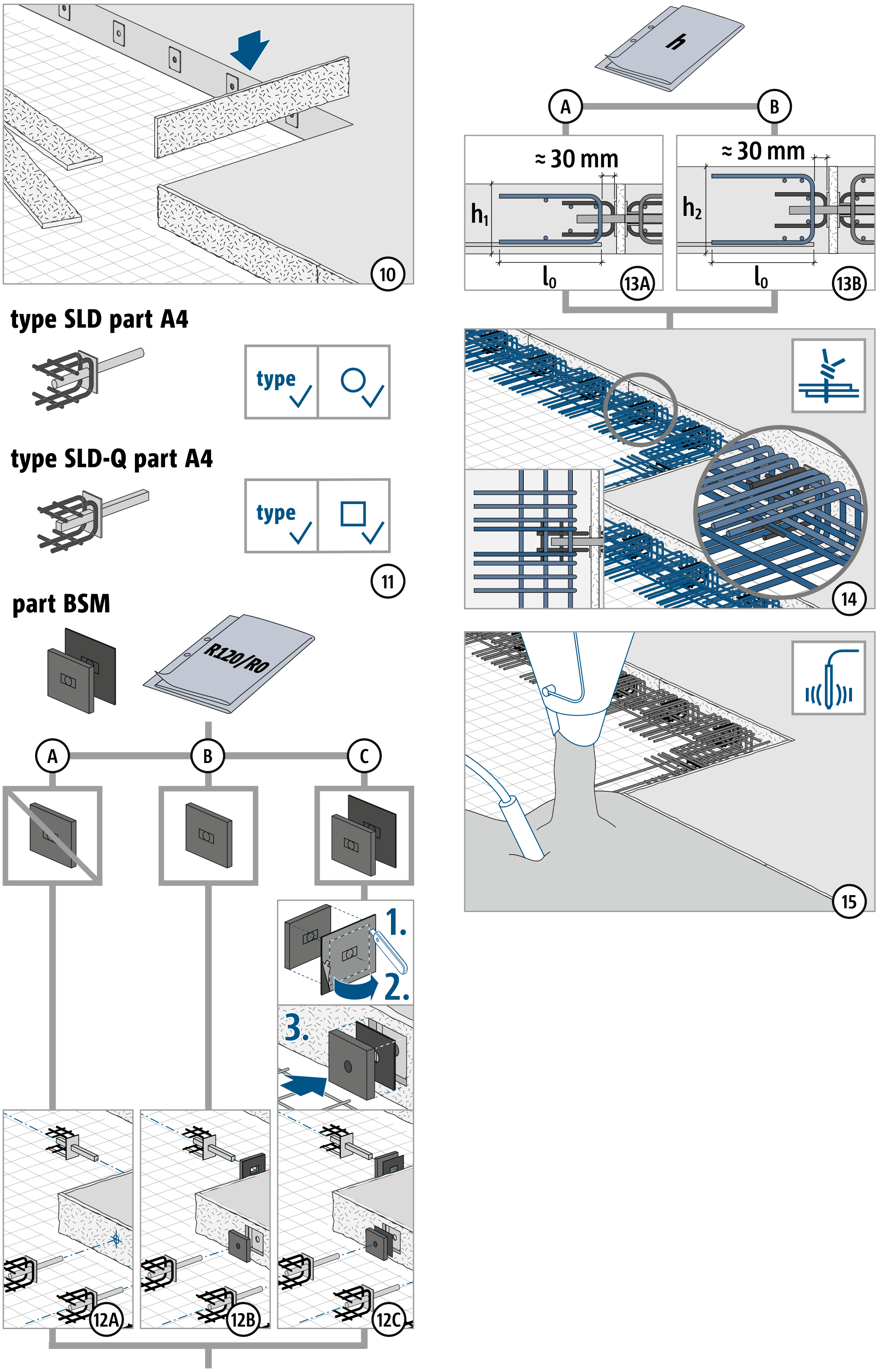




SLD

Structural design

Installation instructions



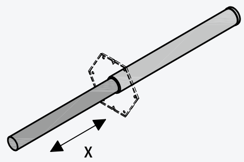
Schöck Stacon® type LD, LD-Q

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

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

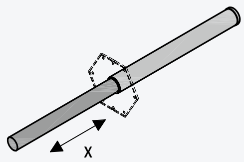
Summary of types | Type designations

Schöck Stacon® type LD



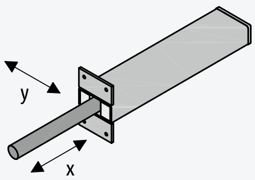
LD ⌀ S-A4

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



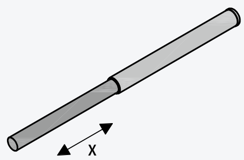
LD ⌀ P-A4 or LD ⌀ P-Zn

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



LD-Q ⌀ S-A4

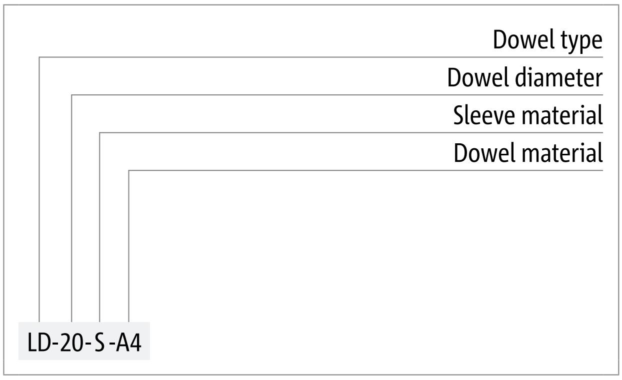
The dowel and the transversely movable sleeve are made of stainless steel of corrosion protection class 3 This dowel system allows displacement of structural components longitudinally and transversely to the dowel axis and can be used in interior and exterior areas.



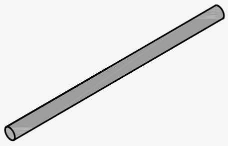
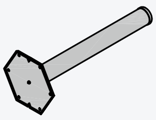
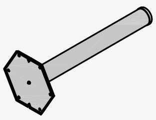
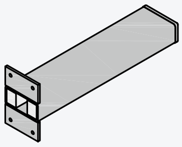
LD ⌀ F-A4 or LD ⌀ F-Zn

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

Type designations in planning documents



Summary of types | Product selection

Schöck Stacon® type LD components	
	**LD ⌀ Part A4 or LD ⌀ Part Zn** The dowel is available in stainless steel (A4) or hot galvanised carbon steel (Zn). The hot galvanised dowel should be employed in dry interior areas of buildings only.
	**LD ⌀ Part S** The sleeve is made of stainless steel with a mounting nail plate for fixing to the formwork. This sleeve can be combined with the stainless steel Dowel LD Part A4 only and is particularly suitable for structural component joints with frequent movement such as, for example, in the exterior area.
	**LD ⌀ Part P** The sleeve and the mounting plate are made of plastic. The sleeve can be fixed simply to the formwork using the mounting plate. The sleeve can be combined with a stainless steel (A4) dowel or hot galvanised carbon steel (Zn) dowel and is particularly suitable for the joints of structural components with less movements in the interior area of buildings.
	**LD-Q ⌀ Part S** The rectangular sleeve is made of stainless steel and can be combined with the stainless steel (A4) dowel. It can be used in structural component joints in interior and exterior areas, if movements axially and transverse to the dowel axis are to be expected.

Schöck Stacon® type LD variants
The configuration of the Schöck Stacon® type LD can be varied as follows:
- Dowel diameter ⌀:
  16, 20, 22, 25 and 30
- Sleeve material:
  S: Stainless steel of corrosion protection class 3
  P: Plastic
- Dowel material:
  A4: Stainless steel S690 of corrosion protection class 3
  Zn: Structural steel S690 hot-dip galvanized

Product characteristics | Corrosion protection/materials | Application areas

Product features

The Schöck Stacon® type LD (heavy duty dowel) consists of a sleeve part and a dowel part, which are concreted into the respective concrete components adjacent to the joint. The load is transferred from one structural component through the dowel into the sleeve then to the other structural component. Within the concrete structural components, the load is taken up by the on-site reinforcement in the area of the dowel.
The sleeve of the Schöck Stacon® type LD is round and thus enables freedom of movement in the direction of the dowel axis, in order to prevent induced stresses due to structural component elongation. The forces can be transmitted perpendicularly and transversely to the dowel axis.
The LD-Q can be used to allow movement transversely to the dowel axis. The sleeve of this dowel is rectangular and thus enables a displacement of ± 12 mm.

Corrosion protection and materials

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

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

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

Application areas

The Schöck Stacon® type LD is technically approved primarily for the transmission of static loadings in expansion joints. The United Kingdom Technical Assessment UKTA 23/6892 regulates the dimensioning according to the harmonised product standard ETAG 030 for the concrete strength classes C20/25 to C50/60. The joint widths can vary between 10 mm and 60 mm. In accordance with harmonised European product standard ETAG 030 only the Schöck Stacon® Type LD ⌀ S-A4 can be used as bracing component between two building parts as only this dowel can transmit horizontal forces. Use of the Schöck Stacon® type LD under earthquake or fatigue loads, is not addressed in the assessment.
All of the following design and reinforcement tables have been determined with a concrete cover of 20 mm.

Product description

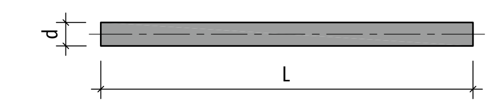


Fig. 47: Schöck Stacon® Type LD part A4, LD part Zn: Dimensions of the dowel

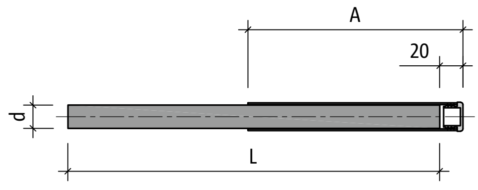


Fig. 48: Schöck Stacon® type LD F-A4, LD F-Zn: Dimensions of the dowel with plastic sleeve

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

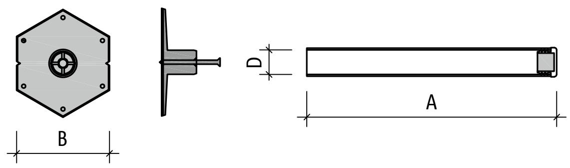


Fig. 49: Schöck Stacon® type LD part S, LD part P: Dimensions of the sleeves made of stainless steel and plastic

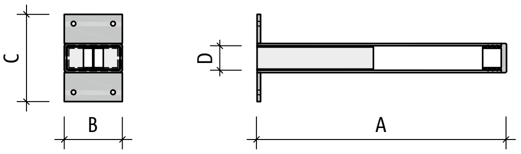


Fig. 50: Schöck Stacon® type LD-Q part S: Dimensions of the transversely movable sleeve

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

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

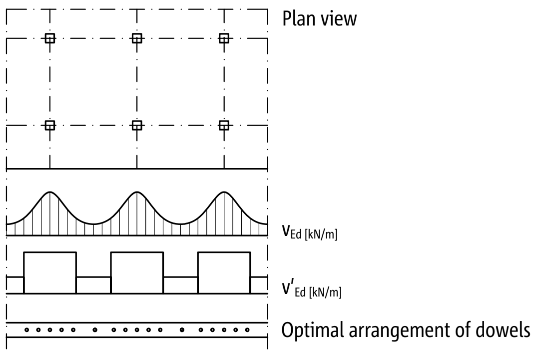
Design process

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

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

Determination of the expected maximum joint width.
See page 11

Are transversely movable dowels required?
See page 12



Design using tables

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

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

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

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

Determination of the required edge reinforcement.
See page 60

Design using Schöck Scalix® design software

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

Input of the boundary conditions and the load.

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

Saving of the project and the position.

Input of further positions.

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

LD

Structural design

Minimum dowel spacing/component dimensions

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

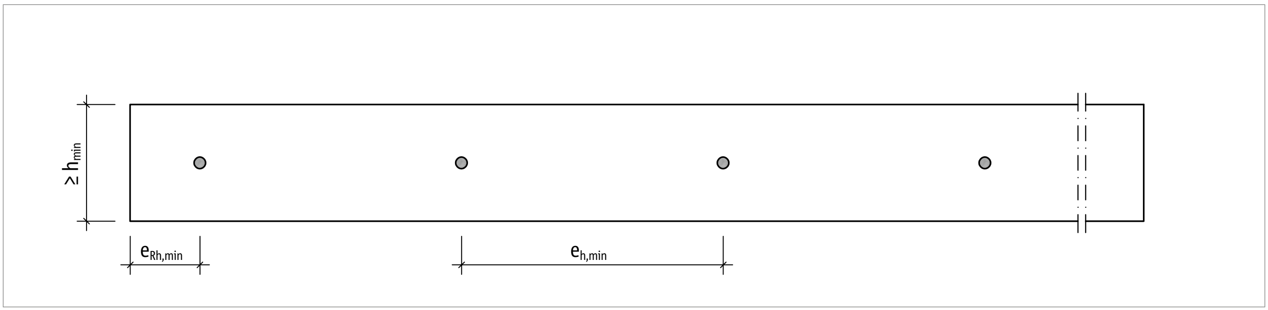


Fig. 51: Schöck Stacon® type LD: Minimum structural component measurements and dowel spacings with one slab

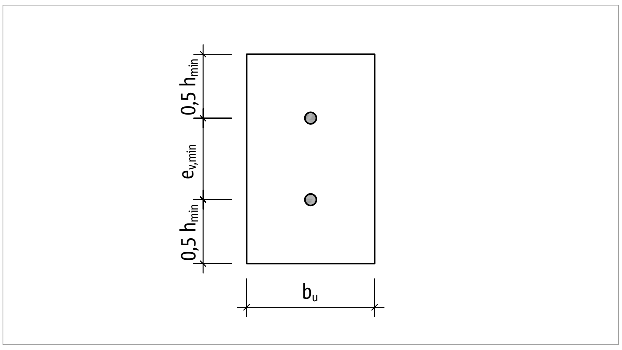


Fig. 52: Schöck Stacon® type LD: Minimum structural component measurements and dowel spacings in the front face of a balcony or a wall

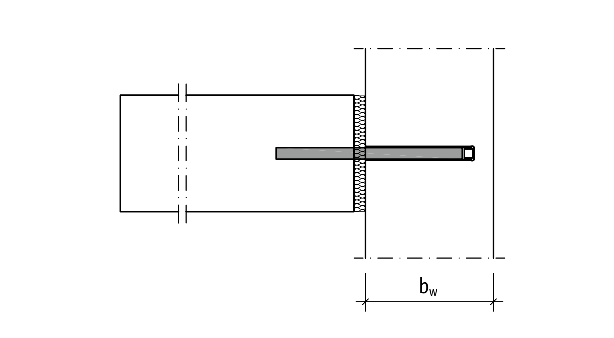


Fig. 53: Schöck Stacon® type LD: Minimum structural component thickness of a wall or column

LD

Structural design

Critical dowel spacings/edge distances

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

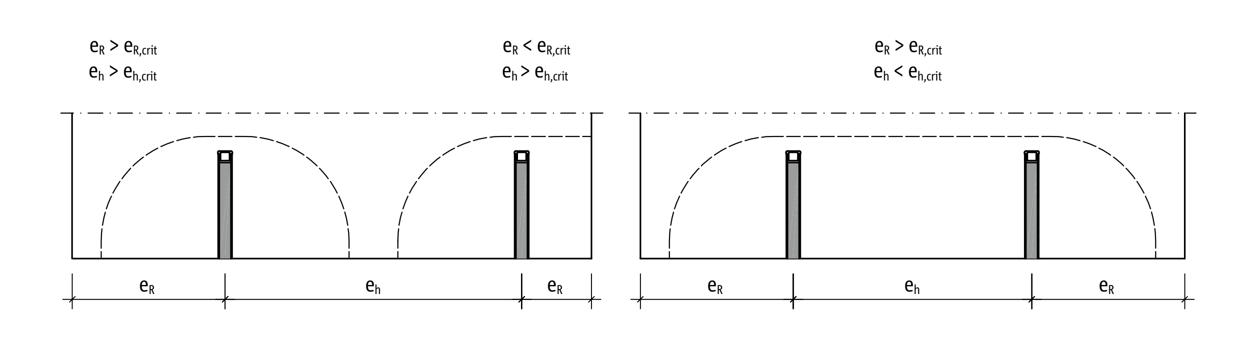


Fig. 54: Schöck Stacon® type LD: Round cuts dependent on the critical dowel spacing and edge distance

Schöck Stacon® type LD		16	20	22	25	30
Critical dowel spacings for		$e_{h,crit}$ [mm]				
Slab thickness [mm]	160	400	400	400	-	-
	180	500	500	500	490	-
	200	510	570	570	580	-
	220	550	630	630	640	650
	250	630	670	720	720	730
	280	700	710	810	810	820
	300	750	750	860	870	880
	350	880	880	880	1020	1030

Schöck Stacon® type LD		16	20	22	25	30
Critical edge distances for		$e_{R,crit}$ [mm]				
Slab thickness [mm]	160	200	200	200	-	-
	180	270	270	270	260	-
	200	270	350	350	340	-
	220	280	350	420	420	410
	250	320	360	440	500	570
	280	350	380	450	520	590
	300	380	390	470	530	610
	350	440	440	460	560	640

Critical dowel spacings/edge distances

Schöck Stacon® type LD-Q		16	20	22	25	30
Critical dowel spacings for		$e_{h,crit}$ [mm]				
Slab thickness [mm]	160	400	400	400	-	-
	180	450	500	500	480	-
	200	500	510	570	590	-
	220	550	550	580	650	650
	250	630	630	630	680	730
	280	700	700	700	700	820
	300	750	750	750	750	880
	350	880	880	880	880	890

Schöck Stacon® type LD-Q		16	20	22	25	30
Critical edge distances for		$e_{R,crit}$ [mm]				
Slab thickness [mm]	160	200	200	200	-	-
	180	230	270	270	260	-
	200	250	270	330	330	-
	220	280	280	310	380	410
	250	320	320	320	370	500
	280	350	350	350	360	500
	300	380	380	380	380	490
	350	440	440	440	440	480

Design LD C20/25 – C50/60

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

The following design values were determined according to BS EN 1992-1-1 (EC2) using a concrete cover of 20 mm. With high concrete cover the load-bearing capacity for an appropriately reduced slab thickness must be used. The maximum load-bearing capacities listed here apply only in connection with a reinforcement arrangement in accordance with page 60 and only if the critical dowel spacing or edge distances in accordance with page 56 are adhered to.

Schöck Stacon® type LD		16	20	22	25	30
Design values with		V_{Rd} [kN/dowel]				
Slab thickness [mm]	Joint width [mm]					
160	20	11.8	11.8	11.8	-	-
	30	11.8	11.8	11.8	-	-
	40	11.8	11.8	11.8	-	-
	50	10.9	11.8	11.8	-	-
180	20	18.8	20.6	20.6	20.1	-
	30	15.1	20.6	20.6	20.1	-
	40	12.6	20.6	20.6	20.1	-
	50	10.9	20.1	20.6	20.1	-
200	20	18.8	32.1	32.1	31.3	-
	30	15.1	27.4	32.1	31.3	-
	40	12.6	23.2	29.9	31.3	-
	50	10.9	20.1	26.0	31.3	-
220	20	18.8	33.5	42.6	45.1	44.1
	30	15.1	27.4	35.2	45.1	44.1
	40	12.6	23.2	29.9	42.0	44.1
	50	10.9	20.1	26.0	36.8	44.1
250	20	18.8	33.5	42.6	58.8	77.6
	30	15.1	27.4	35.2	49.0	77.6
	40	12.6	23.2	29.9	42.0	67.7
	50	10.9	20.1	26.0	36.8	59.8
280	20	18.8	33.5	42.6	58.8	81.7
	30	15.1	27.4	35.2	49.0	78.2
	40	12.6	23.2	29.9	42.0	67.7
	50	10.9	20.1	26.0	36.8	59.8
300	20	18.8	33.5	42.6	58.8	84.3
	30	15.1	27.4	35.2	49.0	78.2
	40	12.6	23.2	29.9	42.0	67.7
	50	10.9	20.1	26.0	36.8	59.8
350	20	18.8	33.5	42.6	58.8	90.7
	30	15.1	27.4	35.2	49.0	78.2
	40	12.6	23.2	29.9	42.0	67.7
	50	10.9	20.1	26.0	36.8	59.8

Design LD-Q C20/25 – C50/60

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

The following design values were determined according to BS EN 1992-1-1 (EC2) using a concrete cover of 20 mm. With high concrete cover the load-bearing capacity for an appropriately reduced slab thickness must be used. The maximum load-bearing capacities listed here apply only in connection with a reinforcement arrangement in accordance with page 60 and only if the critical dowel spacing or edge distances in accordance with page 57 have been adhered to.

Schöck Stacon® type LD-Q		16	20	22	25	30
Design values with		V_{Rd} [kN/dowel]				
Slab thickness [mm]	Joint width [mm]					
160	20	10.4	11.8	11.8	-	-
	30	8.4	11.8	11.8	-	-
	40	7.0	11.8	11.8	-	-
	50	6.0	11.2	11.8	-	-
180	20	10.4	18.6	20.6	19.5	-
	30	8.4	15.2	19.5	19.5	-
	40	7.0	12.9	16.6	19.5	-
	50	6.0	11.2	14.5	19.5	-
200	20	10.4	18.6	23.7	30.5	-
	30	8.4	15.2	19.5	27.2	-
	40	7.0	12.9	16.6	23.3	-
	50	6.0	11.2	14.5	20.4	-
220	20	10.4	18.6	23.7	32.7	44.1
	30	8.4	15.2	19.5	27.2	43.4
	40	7.0	12.9	16.6	23.3	37.6
	50	6.0	11.2	14.5	20.4	33.2
250	20	10.4	18.6	23.7	32.7	51.3
	30	8.4	15.2	19.5	27.2	43.4
	40	7.0	12.9	16.6	23.3	37.6
	50	6.0	11.2	14.5	20.4	33.2
280	20	10.4	18.6	23.7	32.7	51.3
	30	8.4	15.2	19.5	27.2	43.4
	40	7.0	12.9	16.6	23.3	37.6
	50	6.0	11.2	14.5	20.4	33.2
300	20	10.4	18.6	23.7	32.7	51.3
	30	8.4	15.2	19.5	27.2	43.4
	40	7.0	12.9	16.6	23.3	37.6
	50	6.0	11.2	14.5	20.4	33.2
350	20	10.4	18.6	23.7	32.7	51.3
	30	8.4	15.2	19.5	27.2	43.4
	40	7.0	12.9	16.6	23.3	37.6
	50	6.0	11.2	14.5	20.4	33.2

On-site reinforcement | Precast construction

On-site reinforcement

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

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

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

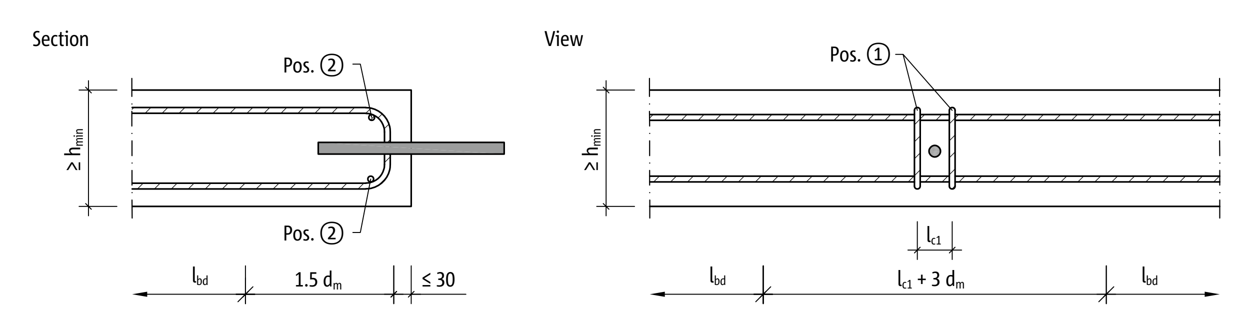


Fig. 55: On-site reinforcement with Schöck Stacon® type LD

Precast construction

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

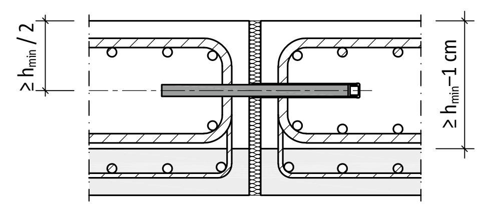


Fig. 56: Schöck Stacon® type LD: Arrangement of on-site reinforcement in half-precast slabs

On-site reinforcement

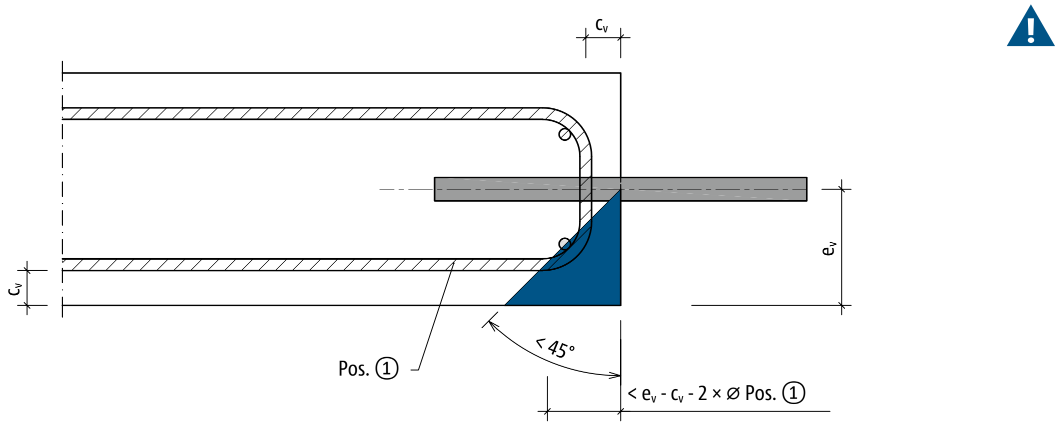


Fig. 57: Schöck Stacon® type LD: Position of the longitudinal reinforcement in relation to the front face of the slab

Do not modify on-site reinforcement

The distance between the longitudinal reinforcement and the front edge of the concrete slab is very important for the load-bearing capacity of the reinforcement. If this distance is too large the lateral stirrups alongside the dowel cannot contribute to the resistance. If stirrup diameters larger than those specified in the table on page 60 are used, the longitudinal reinforcement is displaced. For this reason the reinforcement diameters stated in the table must be used, or the concrete cover at the front face of the slab reduced.

Hazard note – separation longitudinal reinforcement to front face too large

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

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

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

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

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

with:

V_{Ed}: Design value for the applied shear force
V_{Rd}: Design resistance of the dowel connection
$V_{Rd,ct}$: Design resistance against punching shear failure
$V_{Rd,c}$: Design resistance against concrete edge failure
$V_{Rd,s}$: Design resistance against steel failures of the dowel

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

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

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

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

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

Punching shear design

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

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

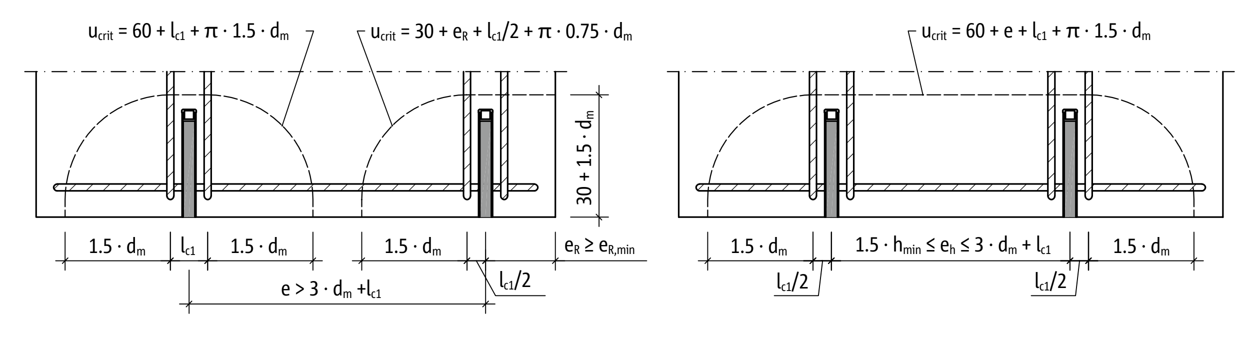


Fig. 58: Schöck Stacon® type LD: Lengths of the round cuts for the punching verification depending on the dowel spacings

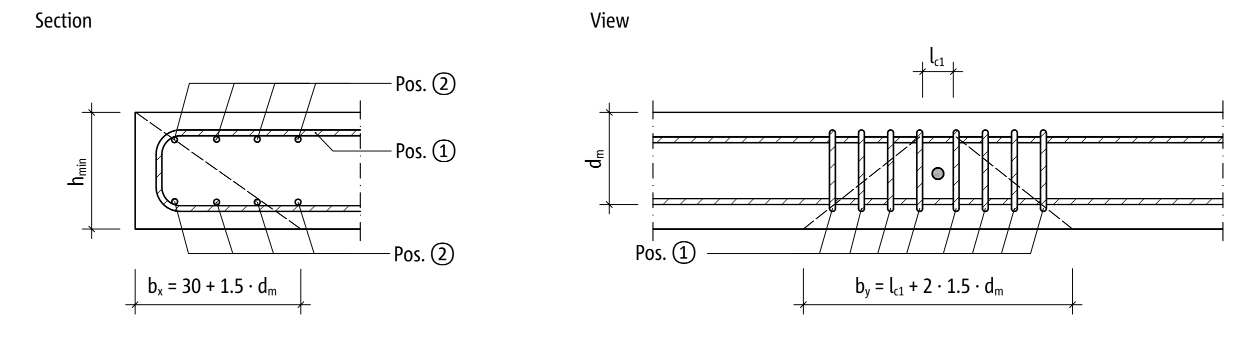


Fig. 59: Schöck Stacon® type LD: Dimensions of the punching area

Punching shear resistance:

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

with:

η_1 = 1.0 for standard concrete

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

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

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

f_{ck}: Characteristic concrete cylinder compressive strength

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

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

Concrete edge failure

Verification against concrete edge failure in accordance with UKTA 23/6892
The verification against concrete edge failure is a product-specific verification and is based trial evaluations. For the verification, the load-bearing capacity is calculated with the aid of the suspended reinforcement on both sides of the dowel. However, only the legs of the suspended reinforcement, whose effective anchorage length (l'_i) in the breakout cone is greater than 0, may be taken into account. Otherwise these legs are too far from the dowel and are thus ineffective.

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

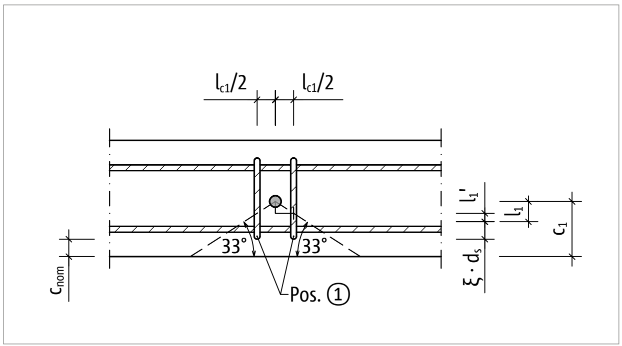


Fig. 60: Schöck Stacon® type LD: Dimensions of the breakout cone of the concrete edge

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

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

with:

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

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

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

with:

- d_s: Diameter of the suspended reinforcement in [mm]
- l'_i: Effective anchorage length of the suspended reinforcement in the break out cone
  $l'_i = l_1 - (l_{ci} / 2) \cdot \tan 33°$
  $l_{ci}/2$: Centre distance of the considered suspended reinforcement $A_{Pos.\,1,i}$ from the dowel
  $l_1 = h / 2 - \xi \cdot d_s - c_{nom}$
  $\xi = 3$ for $d_s \leq 16$ mm
  $\xi = 4.5$ for $d_s > 16$ mm
  c_{nom}: Concrete cover of the suspended reinforcement
- f_{bd}: Design value of the composite stress between reinforcing steel and concrete

Design example

Connection of a floor plate to a wall

Concrete:	C28/35	
Slab thickness:	h	= 200 mm
Wall thickness:	b_w	= 300 mm
Concrete cover:	$c_{nom,u} = c_{nom,o}$	= 20 mm
Design value of the shear force:	v_{Ed}	= 35 kN/m
Joint length:	l_f	= 5.0 m
Joint width on installation:	f_E	= 20 mm
Maximum joint opening:	f	= 32 mm
Environmental conditions:	Joint inside a heated building - category C1	

The maximum joint opening to be expected is decisive for the design of the Schöck Stacon® type LD. This dimension can be determined by superimposing the deformations occurring as a result of the shrinkage, loading and temperature changes. Further information on the calculation of maximum joint width is provided on page 11.
In accordance with UKTA 23/6892, for design purposes the maximum joint opening to be expected must be rounded up to a full 10 mm. For this reason in the following design a maximum joint width of 40 mm is assumed.

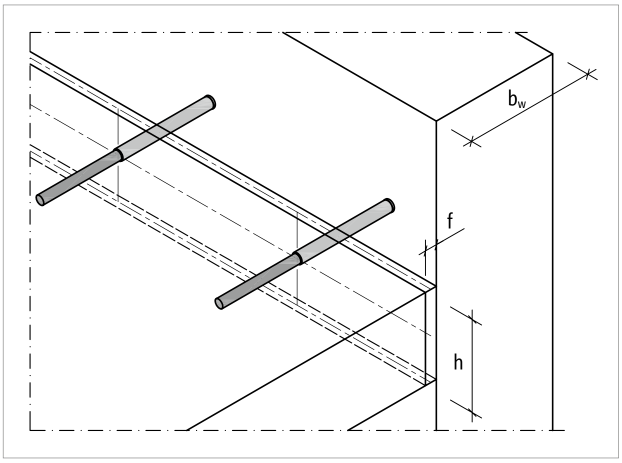


Fig. 61: Design example of floor-wall connection

Selection of the suitable materials for the dowel and the sleeve

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

Design Schöck Stacon® type LD

Determination of the design load for the dowel:

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

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

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

LD

Structural design

Design example

Determination of the optimum dowel spacings:

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

Checking of the minimum structural component measurements in accordance with page 55:

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

Checking of the critical dowel spacings and edge distances in accordance with page 56:

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

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

Longitudinal reinforcement:	$A_{Pos.\ 2}$	= 1 ⌀ 10 (at top and bottom edge of structural component)
Suspended reinforcement:	$A_{Pos.\ 1}$	= 1 ⌀ 0 (right and left of dowel)

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

Steel load-bearing capacity

Load-bearing capacity:	$V_{Rd,s}$	= in accordance with table page 62 for LD 25 with a joint width of 40 mm
	$V_{Rd,s}$	= 42.0 kN

Punching shear failure verification

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

with:

η_1 = 1.0 for standard concrete

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

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

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

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

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

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

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

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

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

l_{c1} = 70 mm see page 60

f_{ck} = 28 N/mm²

β = 1.4 - Dowel in the edge area

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

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

$= 0.14 \cdot 1.0 \cdot 2.0 \cdot (100 \cdot 0.0016 \cdot 28)^{1/3} \cdot 170 \cdot 931 / 1{,}4 = 50.2$ kN

LD

Structural design

Design example

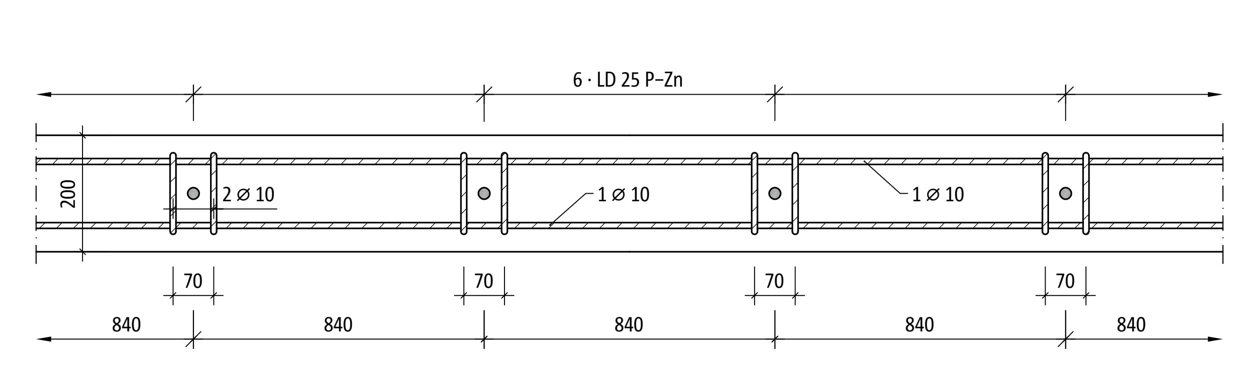


Fig. 62: Arrangement of reinforcement in the slab

Concrete edge failure

Load-bearing capacity:	$V_{Rd,ce}$	$= \Sigma V_{Rd,1,i} + \Sigma V_{Rd,2,i} \leq \Sigma A_{Pos.\,1,i} \cdot f_{yd}$
Hook load-bearing effect:	$V_{Rd,1,i}$	$= 0.61 \cdot 0.92 \cdot \psi_i \cdot A_{Pos.\,1,i} \cdot f_{yk} \cdot (f_{ck} / 30)^{1/2} / \gamma_c$
with:	$A_{Pos.\,1,i}$	$= 78.5$ mm² (⌀ 10)
	f_{yk}	$= 550$ N/mm² (B550)
	f_{ck}	$= 30$ N/mm² (for all concrete classes in accordance with UKTA 23/6892)
	γ_c	$= 1.5$
	c_1	$= h / 2 = 200 / 2 = 100$ mm
	ψ_i	$= 1 - 0.2 \cdot (l_{ci} / 2) / c_1$
	l_{c1}	= 70 mm (see page 60)
	ψ_1	$= 1 - 0.2 \cdot (70 / 2) / 100$ mm $= 0.93$
	$V_{Rd,1,1}$	$= 0.61 \cdot 0.92 \cdot 0.93 \cdot 78.5 \cdot 550 \cdot (30 / 30)^{1/2} / 1.5 = 15.0$ kN
Composite load-bearing effect:	$V_{Rd,2,i}$	$= \pi \cdot d_s \cdot l'_i \cdot f_{bd}$
with:	d_s	$= 10$ mm
	ξ	$= 3$ for d_s
	c_{nom}	$= 20$ mm
	f_{bd}	$= 2.9$ N/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 60)
	l'_1	$= 50 - (70 / 2) \cdot \tan 33° = 27.3$ mm
	$V_{Rd,2.1}$	$= \pi \cdot 10 \cdot 27.3 \cdot 2.9 = 2.32$ kN
Load-bearing capacity:	$V_{Rd,ce}$	$= \Sigma V_{Rd,1,i} + \Sigma V_{Rd,2,i} \leq \Sigma A_{Pos.\,1,i} \cdot f_{yd}$
		$= 2 \cdot 15.0 + 2 \cdot 2.32$
		$= 34.64$ KN $\leq 2 \cdot 0.785 \cdot 43.5 = 68.3$ kN.

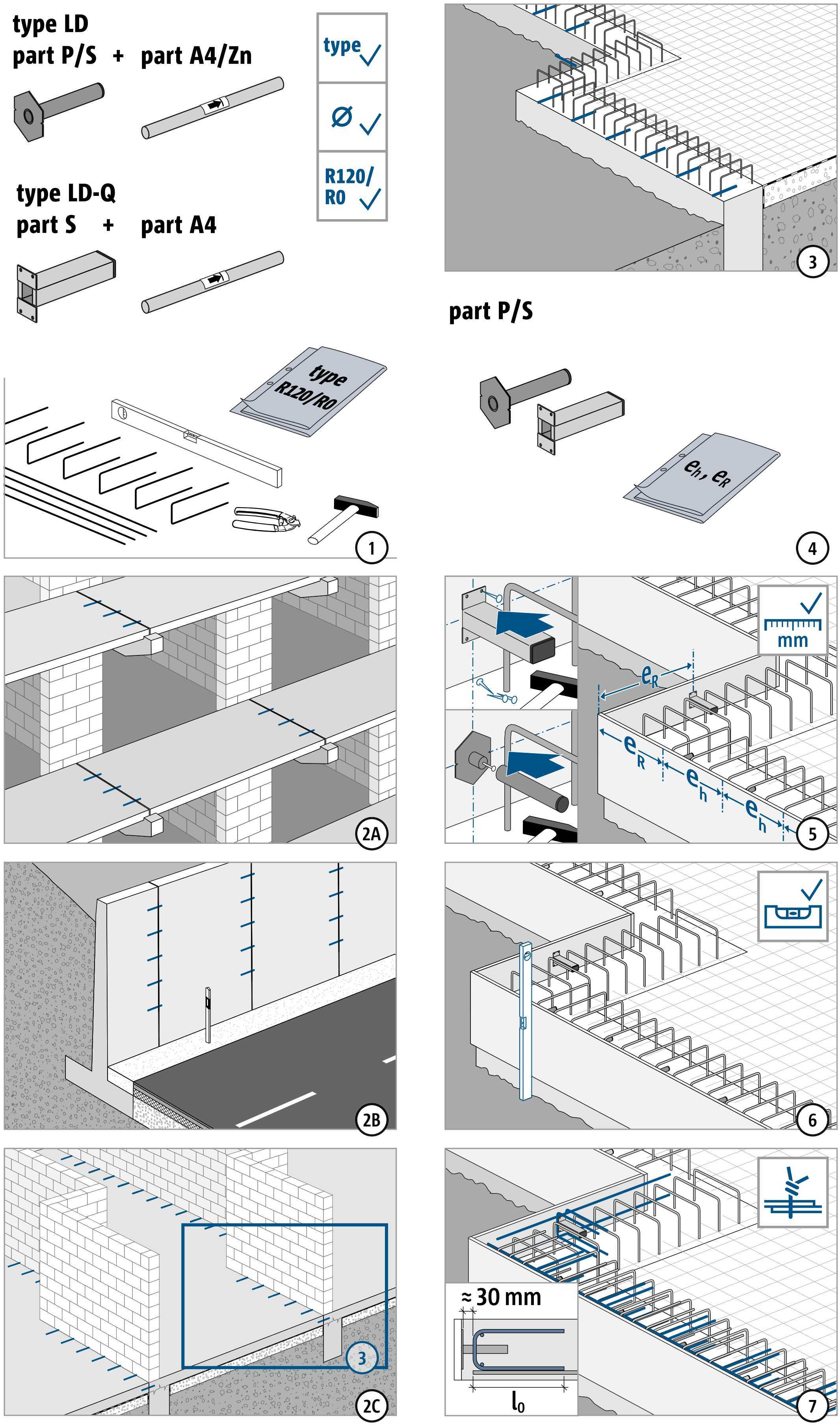
Verifications

Punching shear failure:	$V_{Rd,ct} = 50.2$ kN	$\geq V_{Ed,LD\,25} = 29.4$ kN
Concrete edge failure:	$V_{Rd,ce} = 34.64$ kN	$\geq V_{Ed,LD\,25} = 29.4$ kN
Steel failure:	$V_{Rd,s} = 42.0$ kN	$\geq V_{Ed,LD\,25} = 29.4$ kN

LD

Structural design

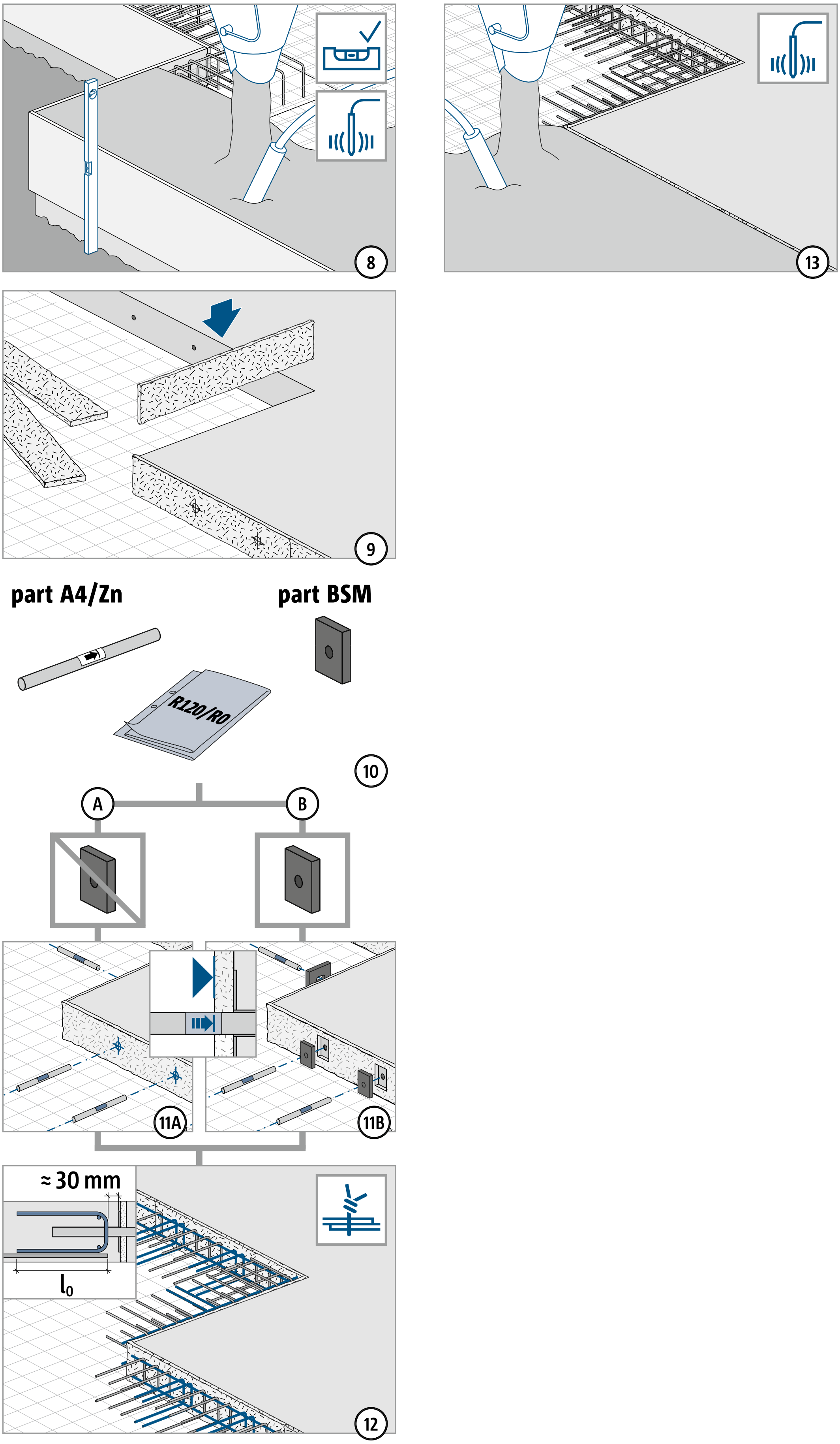
Installation instructions



LD

Structural design

Installation instructions



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