HALFEN HSD SHEAR DOWEL SYSTEMS
TECHNICAL PRODUCT INFORMATION

HALFEN SHEAR DOWEL SYSTEMS

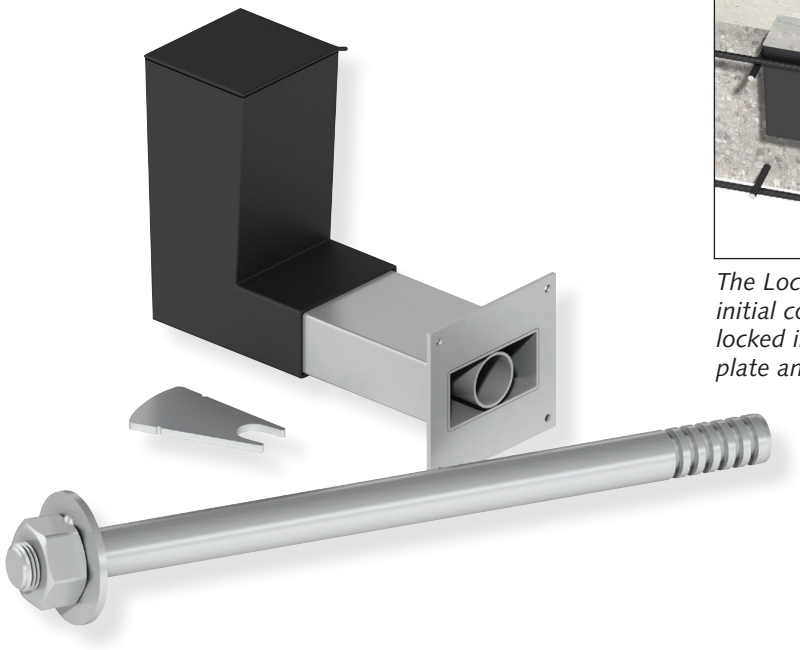
CONCRETE

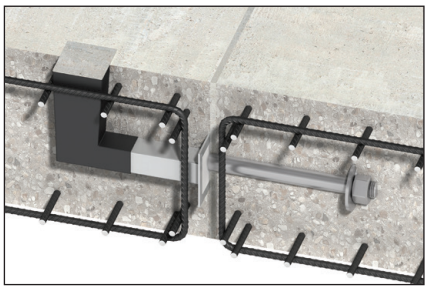
HSD 13.1-US

HALFEN
A CRH COMPANY

HALFEN HSD-LD Lockable Dowels.

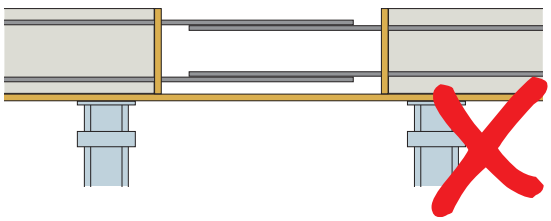
For temporary movement joints in post tensioned slabs.





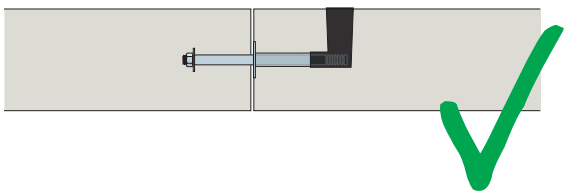
The Lockable Dowel accommodates initial concrete shrinkage and is then locked in position with a mechanical plate and epoxy resin.

Traditional "pour strips"



- Additional formwork
- Trip hazard
- Restricted access
- Slabs propped for several weeks

HALFEN HSD-LD Lockable Dowel



- Minimal formwork
- Improved site access
- Reduced propping time

Many advantages with one result: HALFEN provides safety, reliability and efficiency for you and your customers.

Read more about the advantages of the HALFEN HSD-LD Lockable Dowels on the pages 18 to 25.

HALFEN

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HALFEN HSD SHEAR DOWEL SYSTEMS

Table of content

Public Health Facility

Product Range

HALFEN Shear Dowels

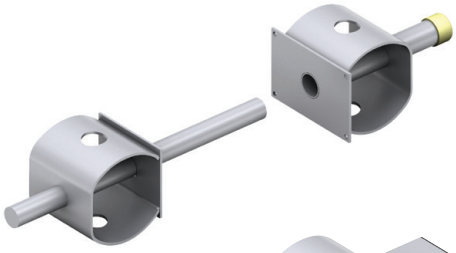
The HALFEN range of shear dowels provides solutions for a wide range of applications, loads, slab depths and joint thicknesses. Each connector is a two-part assembly comprising of a sleeve and a dowel component. The sleeve is nailed to the formwork ensuring subsequent alignment with the dowel. This alignment is essential for effective movement. The complete installation procedure is shown on page 14. HALFEN Shear Dowels are manufactured from stainless steel to ensure a high degree of corrosion resistance with no requirements for additional protection.

HALFEN HSD-ULTRA and HSD-ULTRA-V

The HALFEN HSD-ULTRA Shear Dowel is a two part, high capacity system. Additional steel plates around the dowel and associated sleeve engage more concrete to allow higher load resistance within the system. HALFEN HSD-ULTRA allows for longitudinal movement only, while the HALFEN HSD-ULTRA-V also permits movement perpendicular to the dowel.

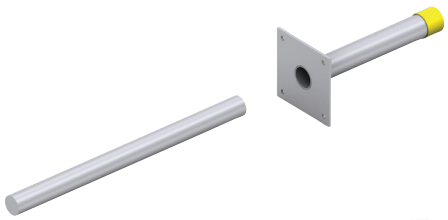
HALFEN HSD and HSD-V

HALFEN HSD Shear Dowels are used in joints with relatively small loads. The HALFEN HSD-V Shear Dowel uses the same dowel as the HSD, but the cylindrical sleeve is contained within a rectangular box section to allow lateral movement in addition to longitudinal movement.

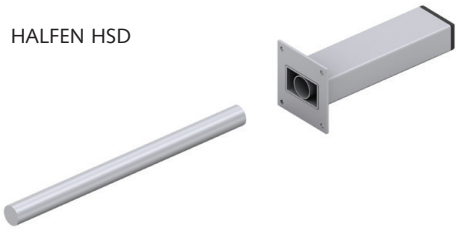


HALFEN HSD-ULTRA

HALFEN HSD-ULTRA-V

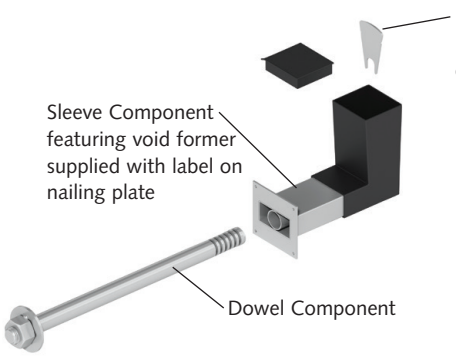


HALFEN HSD

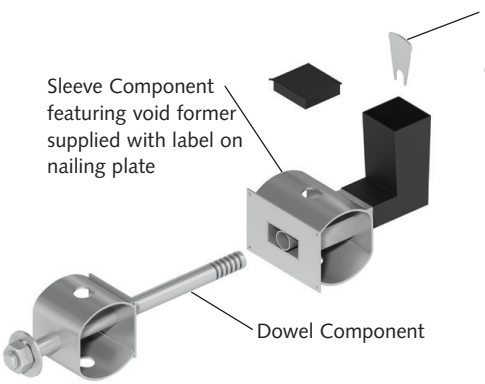


HALFEN HSD-V

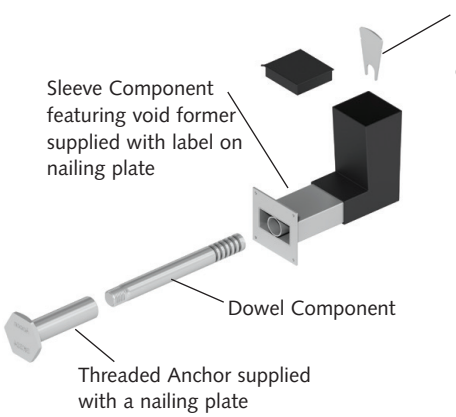
Product Range



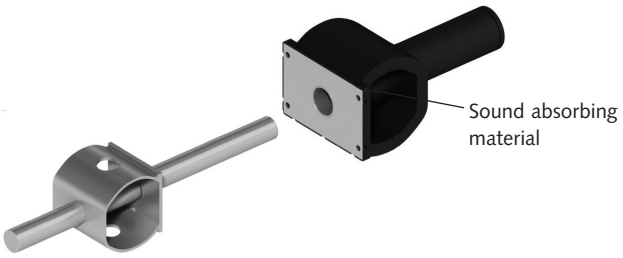
HALFEN HSD-LD 20
Slab-to-Slab



HALFEN-LD 30
Slab-to-Slab



HALFEN HSD-LD 20W
Slab-to-Wall



HALFEN HSD-ULTRA-AD

HALFEN HSD-LD 20 Lockable Dowel*
The dowel component is manufactured from $1^{3}/_{16}$" diameter stainless steel; one end is threaded with a fixed nut and washer, and the other features a series of grooves to accept a Locking Plate. The cylindrical sleeve which accepts the dowel component is contained within a box-section to allow lateral, longitudinal, and rotational movement. The epoxy resin is poured into the L-shaped void former. This product has a maximum design shear strength of over 15 kip. See pages 18-25 for full technical details.

HALFEN HSD-LD 30 Lockable Dowel*
The HSD-LD 30 is a high capacity Lockable Dowel with a design shear strength of up to 30.6 kip. See pages 18-25 for full technical details.

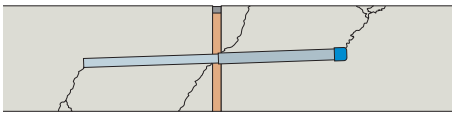
HALFEN HSD-LD 20W Lockable Dowel*
The dowel component is manufactured from $1^{3}/_{16}$" diameter stainless steel, but is shorter than the HSD-LD dowel. One end of the dowel is designed to fit into the stainless steel Threaded Anchor cast into the face of the concrete and the other end features a series of grooves to accept a Locking Plate. The sleeve component is the same as used in the HSD-LD. See pages 18-25 for full technical details.

HALFEN HSD-ULTRA-AD Acoustic Dowels
The HALFEN HSD-ULTRA-AD Acoustic Dowels feature a 22mm diameter stainless steel dowel, located in a sound absorbing sleeve. It is designed to reduce oscillation of impact sound through a building by isolating concrete components, such as stair landings from the main structural frame. A decoupled concrete configuration, utilizing the HSD-ULTRA-AD, offers an 18 dB impact sound reduction over a rigid concrete floor connection, verified by third party testing. See pages 26 and 27 for further technical details.

Introduction

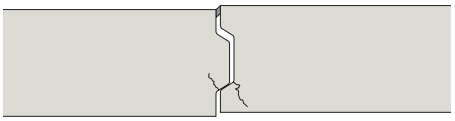
Dowelled Joints

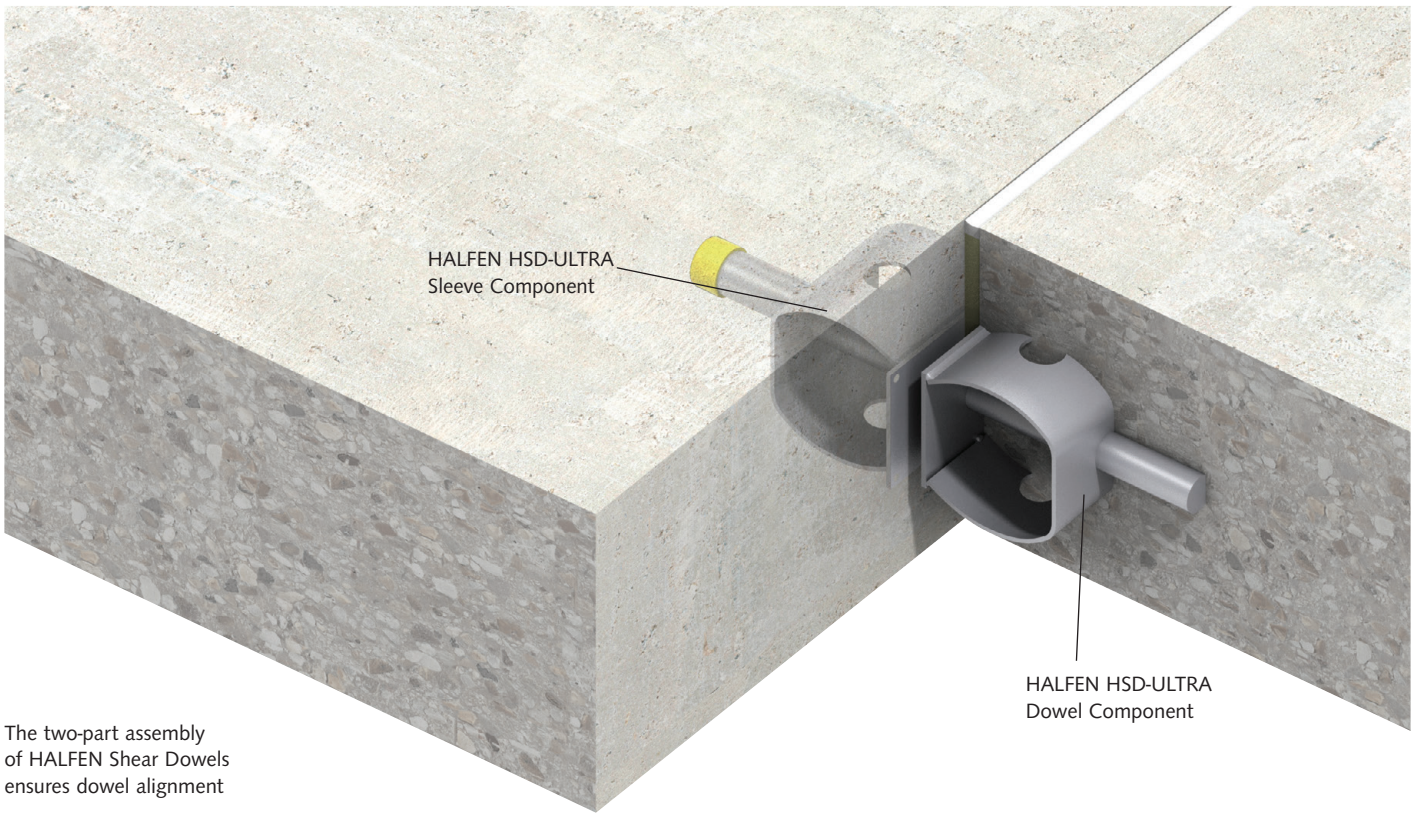
Dowels are used to transfer shear across construction and movement joints in concrete. They are often either cast or drilled into the concrete. A single row of short thicker dowels provides reasonable shear transfer but demands additional accuracy during construction. Skewed installation of dowels can lead to stress concentrations, resulting in subsequent spalling of the concrete. Where dowels are used across expansion and contraction joints, half the length of the bar is debonded to allow movement to take place. Dowelled joints either require formwork to be drilled to allow the dowels to pass through, or concrete to be drilled for dowels to be resin fixed in one side. At movement joints, dowels will need to be accurately aligned in both directions to ensure movement can actually take place, otherwise cracking is likely to occur. Plain dowels are not very effective when used across joints wider than $^{3}/_{8}$".



Keyed Joints

Keyed joints require complicated formwork to create the tongue and groove. If the joint is not formed correctly, differential movement can take place. Load is transferred through the locally reduced section of the joint which can result in cracking.





The two-part assembly of HALFEN Shear Dowels ensures dowel alignment

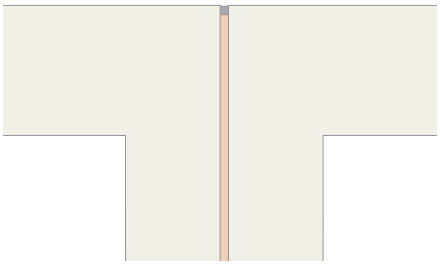
HALFEN Solutions to Joints

In most cases conventional dowelled or keyed joints can be replaced by joints incorporating HALFEN Shear Dowels. These connectors are more effective at transferring load and allowing movement to take place, easier to fix on site, and can prove to be a more cost-effective solution.

HALFEN connectors can be used for movement joints in floor slabs, suspended slabs, and for replacing double columns and beams at structural movement joints. Applications in civil engineering include joints in bridge parapets, bridge abutments and diaphragm wall constructions.

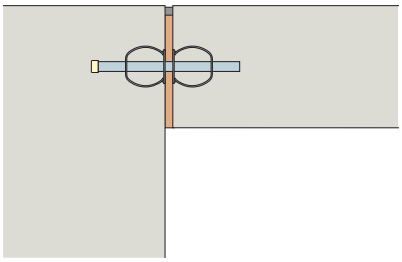
Traditional solution

Floor-to-floor connection with columns



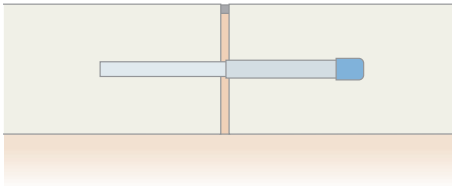
Double Columns

HALFEN solution

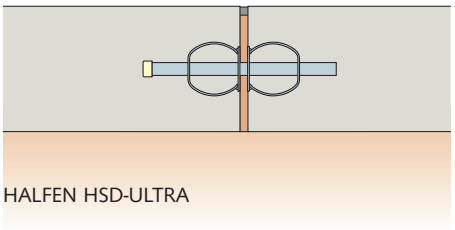


Single Column with
HALFEN HSD-ULTRA

Floor Slab

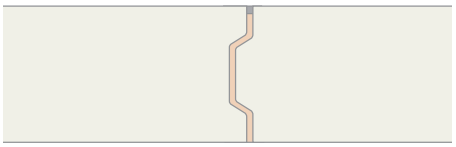


Dowel Bar

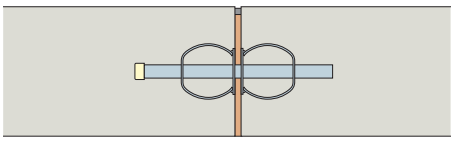


HALFEN HSD-ULTRA

Wall

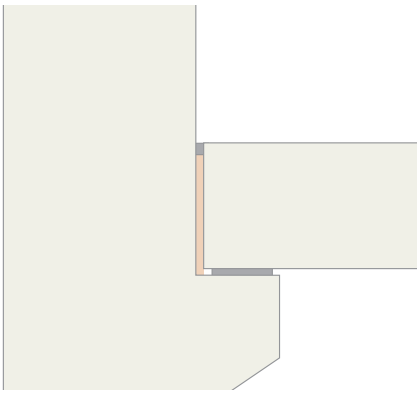


Keyed Joint

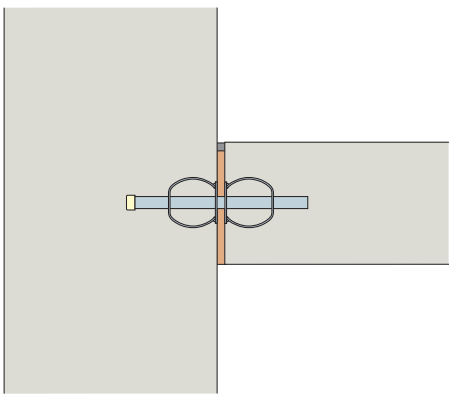


HALFEN HSD-ULTRA

Slab/wall connection



Corbel Support



HALFEN HSD-ULTRA

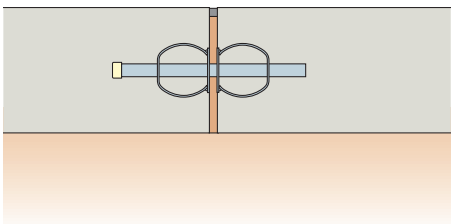
Applications

There are many applications for HALFEN HSD Shear Dowels in all types of reinforced concrete constructions – both building and civil engineering projects.

Building Applications

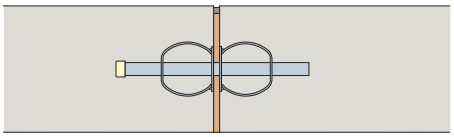
Ground Floor Slabs

Movement joints are usually required to divide a reinforced concrete ground slab into bays. HALFEN HSD Shear Dowels are used to transfer shear load from slab to slab and to prevent differential settlement. Where adjoining bays are different sizes, movement in two directions will occur, HALFEN HSD-V Shear Dowels should be used in this situation.



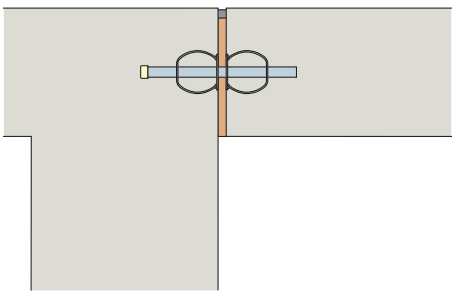
Suspended Floor Slabs

In suspended slabs, connectors should be placed at points of contraflexure where there is little or no bending moment and maximum shear force.



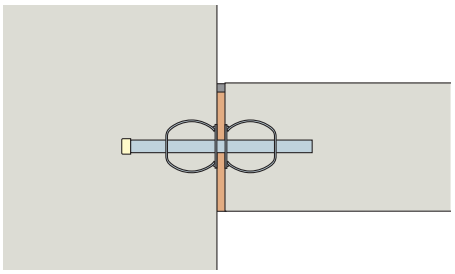
Structural Movement Joints in Frames

A common requirement in framed buildings is a structural movement joint to isolate one part of the building from another. Traditional practice is to provide a line of double columns. The use of HALFEN Shear Dowels eliminates the need for a double column thus reduces costs, speeds construction, and increases the useable floor area.



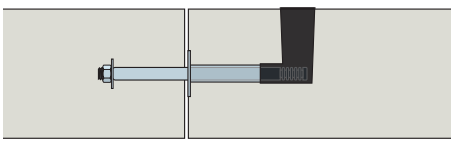
Beam to Wall or Slab Connections

Corbel and half lap joints are a problem to design and difficult and expensive to construct. The use of HALFEN HSD Shear Dowels simplifies design and construction, producing a more efficient connection.



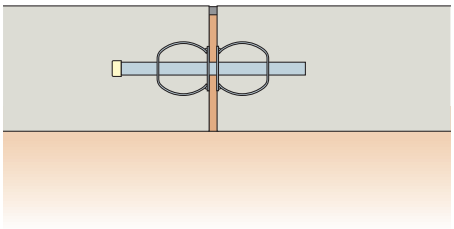
Post-Tensioned Building Frames

The HALFEN range includes Lockable Dowels which replace pour strips in post-tensioned concrete frames. See page 18 to 25 for more information.



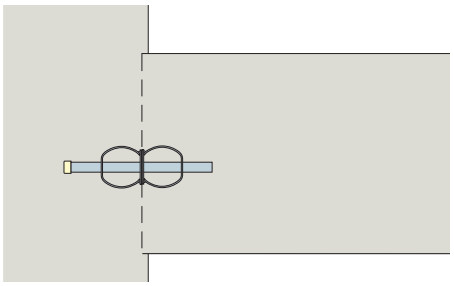
Civil Engineering Applications

Movement Joints in Carriageways
HALFEN HSD Shear Dowels are used in carriageway joints to transfer high shear loads caused by traffic loading and for eliminating differential settlement.

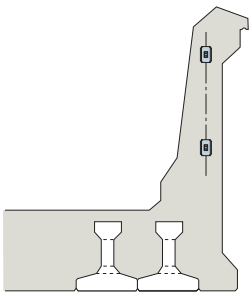


Bridge Abutments
HALFEN HSD Shear Dowels are used vertically at bridge abutments to fix the bridge deck to the abutment. In addition to ease of installation, the use of HALFEN HSD Shear Dowels allows for the bridge deck to be jacked up for bearings to be replaced.

Diaphragm Wall/Slab Connections
Connecting road slabs to diaphragm walls can be a difficult and expensive operation. Forming recesses or using post fixed dowels into site drilled holes presents many problems on site. HALFEN HSD Shear Dowels provide a cost effective solution. The sleeve components are nailed to plywood formwork which is rigidly fixed to the reinforcement cage. After excavation the plywood is removed to reveal the faces of the sleeves. The dowel components can now be inserted ready to support the slab.

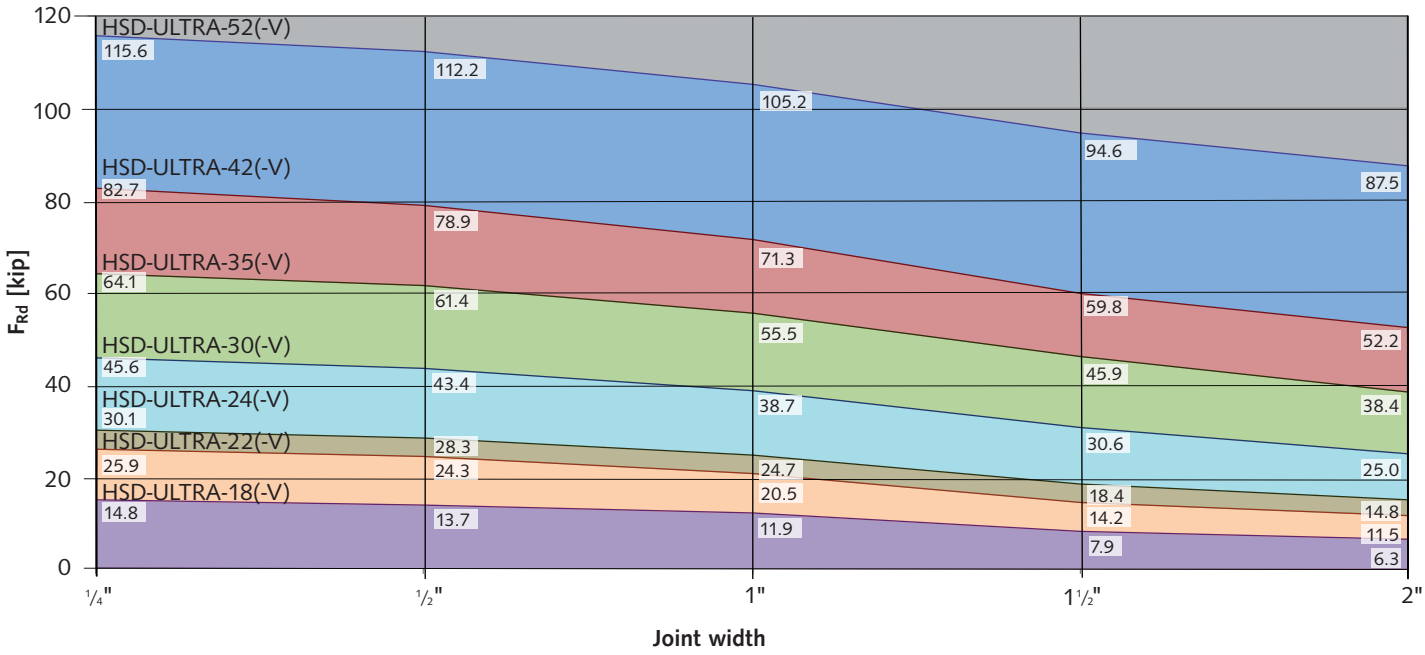


Joints in Parapets
The use of HALFEN Shear Dowels in the vertical joints in parapets is a simple and cost effective way of connecting the sections. The HALFEN HSD-V facilitates significant rotation at the joint without reducing the horizontal shear capacity.



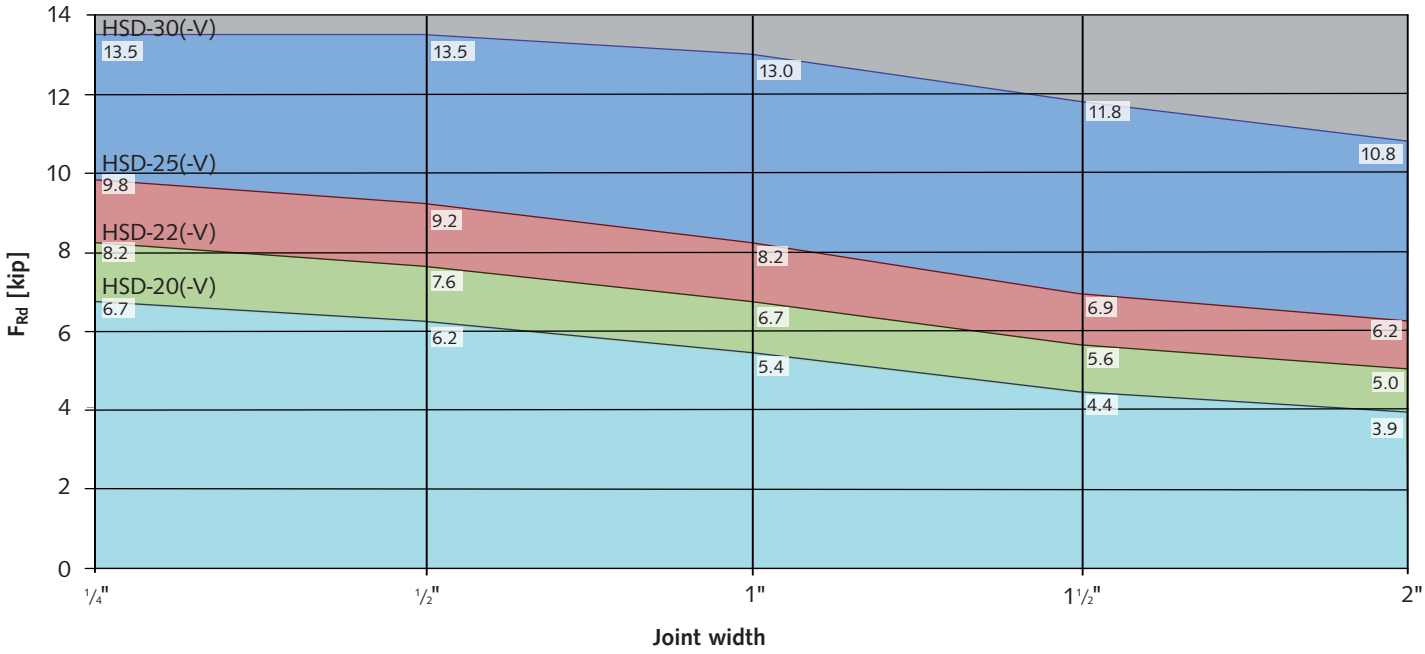
Design strength HALFEN HSD-ULTRA Shear Dowels

HALFEN HSD-ULTRA/HSD-ULTRA-V design strength F_{Rd} [kip] for various joint widths at a maximum slab thickness in 4000 psi concrete.



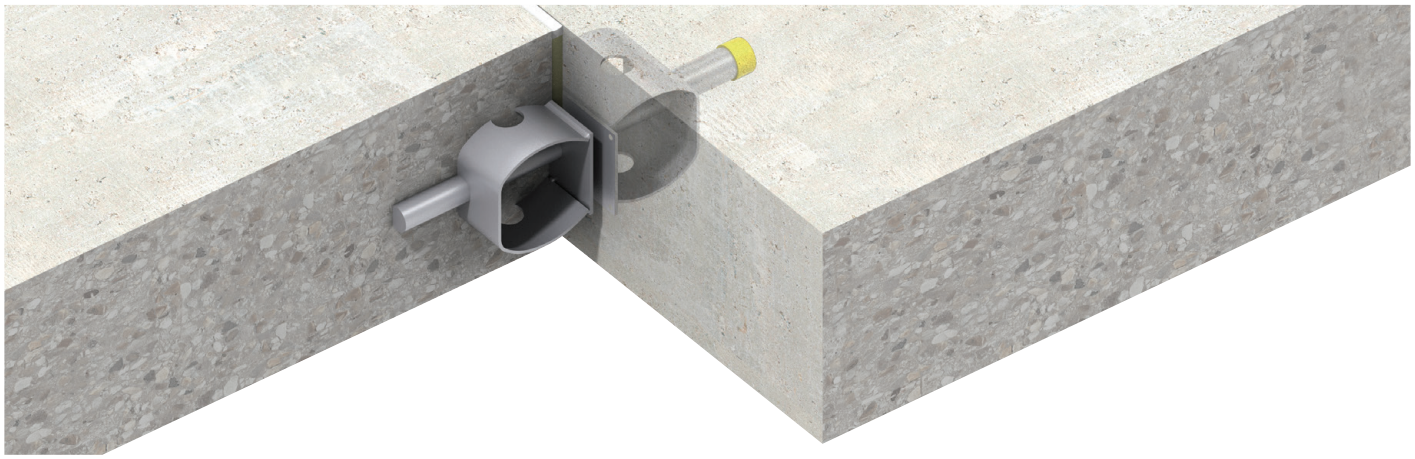
Design strength HALFEN HSD Shear Dowels

HALFEN HSD/HSD-V design strength F_{Rd} [kip] for various joint widths at a maximum slab thickness in 4000 psi concrete.



HALFEN HSD-ULTRA SHEAR DOWEL SYSTEM

Introduction HSD-ULTRA/HSD-ULTRA-V

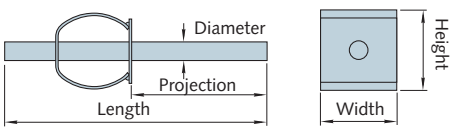


The HALFEN HSD-ULTRA is a shear dowel system for high loads. The steel plates in the area around the dowel and the sleeve distribute the load in the concrete and allow higher loads than conventional shear dowels.

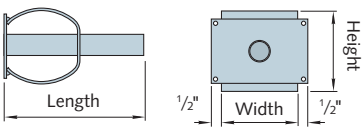
HALFEN HSD-ULTRA shear dowels come in two parts. The set always consists of the dowel (HSD-ULTRA-D) and the corresponding sleeve (HSD-ULTRA-S and HSD-ULTRA-SV, respectively). The HSD-ULTRA does not allow any movement perpendicular to the dowel. The HSD-ULTRA-V allows lateral movement in one direction. Both, HSD-ULTRA and HSD-ULTRA-V allow movement in longitudinal direction.

Dimensions of the dowels and sleeves can be found on this page. Additional information like design strength and required supplementary reinforcement can be found on pages 12-13.

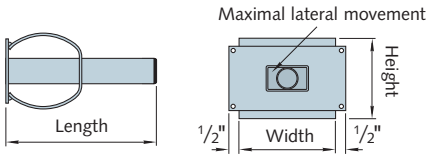
HSD-ULTRA-D Dowel



HSD-ULTRA-S Sleeve



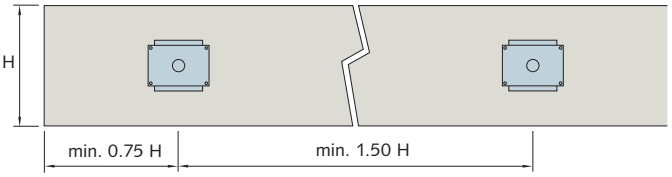
HSD-ULTRA-SV Sleeve



HALFEN HSD-ULTRA and HSD-ULTRA-V – Dimensions												
	Dowel HSD-ULTRA-D					Sleeve HSD-ULTRA-S			Sleeve HSD-ULTRA-SV			
	Diameter [Inch]	Length [Inch]	Projection [Inch]	Height [Inch]	Width [Inch]	Length [Inch]	Height [Inch]	Width [Inch]	Length [Inch]	Height [Inch]	Width [Inch]	lat. movement [Inch]
HSD-ULTRA18(-V)	11/16	10 5/8	5 7/8	3	2 3/4	6 1/8	3	2 3/4	6 3/4	3	3 7/8	1
HSD-ULTRA22(-V)	7/8	12 1/4	6 1/4	3 3/4	3 1/2	6 1/2	3 3/4	3 1/2	6 7/8	3 3/4	4 1/2	7/8
HSD-ULTRA24(-V)	15/16	13	6 3/4	4 3/8	3 7/8	6 7/8	4 3/8	3 7/8	7 1/8	4 3/8	4 3/4	7/8
HSD-ULTRA30(-V)	1 3/16	14 3/8	7 1/4	5 1/2	4 1/2	7 1/2	5 1/2	4 1/2	8 1/4	5 1/2	6 3/8	1 5/8
HSD-ULTRA35(-V)	1 3/8	16 1/2	8 1/4	6 1/4	5 1/4	8 1/2	6 1/4	5 1/4	9 1/4	6 1/4	6 3/4	1 1/4
HSD-ULTRA42(-V)	1 5/8	18 1/2	9	7 1/8	6 7/8	9 5/8	7 1/8	6 7/8	9 5/8	7 1/8	8	1 7/8
HSD-ULTRA52(-V)	2 1/16	22 1/2	11	8 5/8	8 1/4	11 5/8	8 5/8	8 1/4	11 5/8	8 5/8	9 5/8	1 1/2

Edge Distance and Spacing

The minimum edge distance and spacing of the HALFEN HSD-ULTRA shear dowels is determined by the depth of slab and is illustrated in the adjacent drawing.

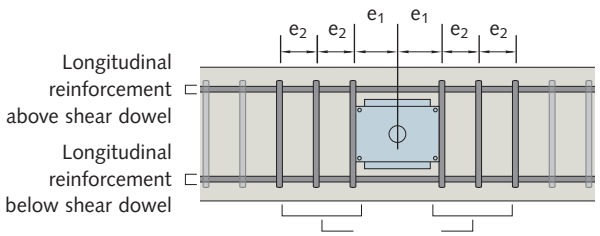


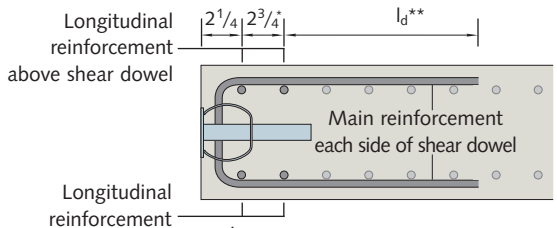
Design strength

Dowel	Slab thickness [Inch]	Design strength F_{Rd} [kip] for various joint widths [Inch] in 3000/4000 psi concrete									
		1/4		1/2		1		1 1/2		2	
HSD-ULTRA-18(-V)	6 1/2	7.9	9.4	7.9	9.0	7.9	8.1	7.9	7.9	6.3	6.3
	7	8.7	10.6	8.3	10.1	7.9	9.2	7.9	7.9	6.3	6.3
	7 1/2	9.9	11.9	9.6	11.5	9.0	10.3	7.9	7.9	6.3	6.3
	8	10.4	12.6	10.1	12.1	10.2	11.0	7.9	7.9	6.3	6.3
	9	11.2	13.5	10.7	12.8	10.8	11.7	7.9	7.9	6.3	6.3
	10	11.9	14.2	11.9	13.7	11.9	11.9	7.9	7.9	6.3	6.3
	11	13.1	14.8	12.3	13.7	11.9	11.9	7.9	7.9	6.3	6.3
HSD-ULTRA-22(-V)	7 1/2	13.5	16.4	13.2	16.0	12.2	14.8	11.7	14.2	11.5	11.5
	8	15.7	20.2	15.8	19.3	15.7	18.2	14.2	14.2	11.5	11.5
	9	18.1	21.8	18.1	21.1	18.0	19.8	14.2	14.2	11.5	11.5
	10	20.6	23.4	20.7	22.9	20.2	20.5	14.2	14.2	11.5	11.5
	11	23.9	25.2	23.8	24.3	20.2	20.5	14.2	14.2	11.5	11.5
	12	25.2	25.9	23.8	24.3	20.2	20.5	14.2	14.2	11.5	11.5
HSD-ULTRA-24(-V)	8	16.3	19.8	16.0	19.3	15.1	18.2	14.8	15.3	14.8	14.8
	9	19.4	23.6	19.1	23.2	19.1	21.8	18.4	18.4	14.8	14.8
	10	25.0	27.9	25.0	27.2	24.5	24.7	18.4	18.4	14.8	14.8
	11	28.8	29.9	27.7	28.3	24.5	24.7	18.4	18.4	14.8	14.8
	12	29.3	30.1	27.7	28.3	24.5	24.7	18.4	18.4	14.8	14.8

Reinforcement details

Local reinforcement is required around each connector to guarantee that the forces are transferred between the connectors and the concrete. Correct detailing in accordance with appropriate design codes and the recommendations provided here in will ensure HALFEN HSD-ULTRA and HSD-ULTRA-V shear dowels achieve their full capacity. The tables below show proposals for the type and spacing of the main reinforcement, together with details of reinforcement above and below the shear dowels.





* $2\,^1/_4$ for HSD Ultra – 18(-V)
** l_d calculated in accordance with latest edition of ACI 318

Dowel	Local reinforcement around the dowels in 3000/4000 psi concrete			
	Main reinforcement [total per shear dowel]			Longitudinal bars top and bottom
	U-bars each side of the dowel	distance e_1 (Inches)	distance e_2 (Inches)	
HSD-ULTRA-18 [-V]	(2) No. 4 [(2) No. 4]	1 3/4 [2]	4 1/4 [4 1/4]	(2) No. 4 [(2) No. 4]
HSD-ULTRA-22 [-V]	(3) No. 4 [(3) No. 4]	2 1/4 [2 3/4]	2 1/4 [2 1/4]	(2) No. 4 [(2) No. 4]
HSD-ULTRA-24 [-V]	(5) No. 4 [(5) No. 4]	2 1/4 [2 3/4]	1 3/4 [1 3/4]	(2) No. 4 [(2) No. 4]

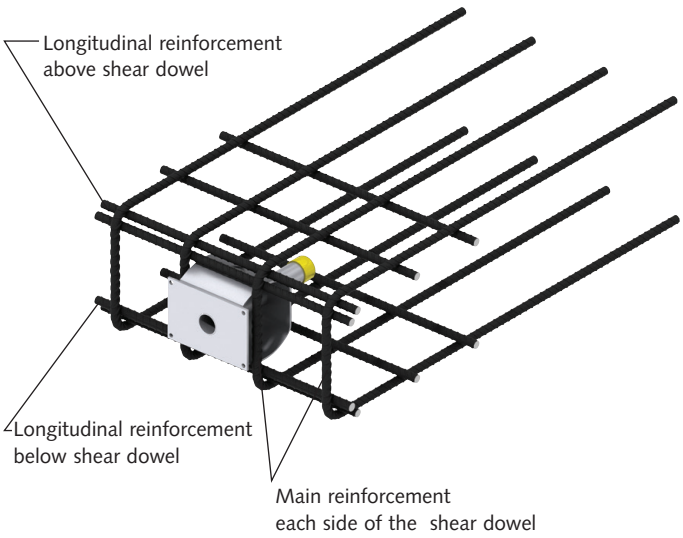
Minimum longitudinal bars are based on minimum dowel centres (1.5 * h_{min}). If spacing greater than this is adopted, the longitudinal bars are to be designed assuming slab edge acts as a beam spanning between the dowels.

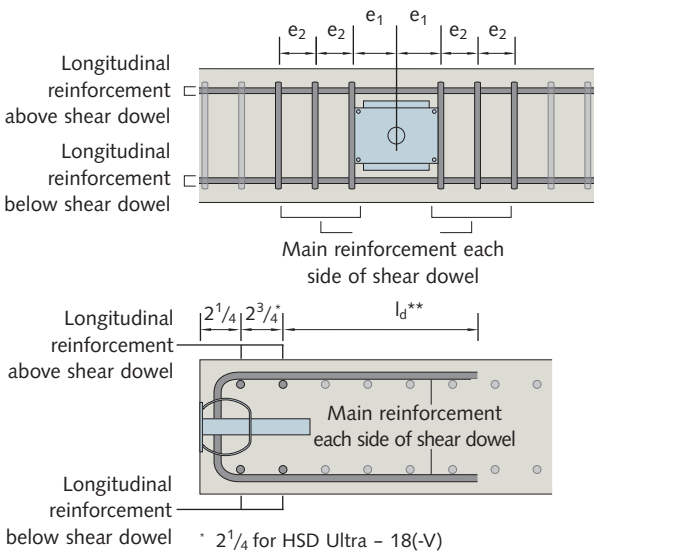
Design strength

Dowel	Slab thickness [Inch]	Design strength F_{Rd} [kip] for various joint widths [Inch] in 3000/4000 psi concrete									
		1/4		1/2		1		1 1/2		2	
HSD-ULTRA-30(-V)	10	30.0	33.9	30.0	33.9	29.7	33.5	29.7	30.1	25.0	25.0
	11	32.3	36.6	32.3	36.6	32.4	36.6	30.6	30.6	25.0	25.0
	12	35.2	39.8	35.3	39.8	35.3	38.7	30.6	30.6	25.0	25.0
	13	38.8	42.7	38.9	42.7	38.0	38.7	30.6	30.6	25.0	25.0
	14	44.3	45.6	42.3	43.4	38.0	38.7	30.6	30.6	25.0	25.0
HSD-ULTRA-35(-V)	12	50.4	57.1	50.4	57.1	50.4	55.5	45.6	45.9	38.4	38.4
	14	62.3	64.1	60.1	61.4	54.6	55.5	45.6	45.9	38.4	38.4
HSD-ULTRA-42(-V)	14	66.1	74.0	66.1	74.0	66.1	71.3	59.8	59.8	52.2	52.2
	16	82.7	82.7	78.9	78.9	71.3	71.3	59.8	59.8	52.2	52.2
HSD-ULTRA-52(-V)	16	87.9	99.6	87.9	99.6	87.9	99.6	87.9	94.6	86.3	87.5
	18	103.8	111.5	103.8	111.5	102.4	105.2	92.9	94.6	86.3	87.5
	20	111.4	115.6	108.5	112.2	102.4	105.2	92.9	94.6	86.3	87.5

All values in the tables on page 12 and 13 are design load capacities (LRFD) and have to be compared to factored loads.

Reinforcement details





* $2^1/_4$ for HSD Ultra – 18(-V)
** l_d calculated in accordance with latest edition of ACI 318

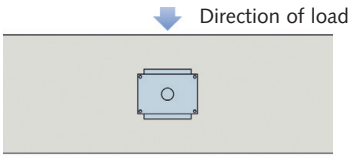
Dowel	Local reinforcement around the dowels in 3000/4000 psi concrete			
	Main reinforcement [total per shear dowel]			Longitudinal bars top and bottom
	U-bars each side of the dowel	distance e_1 (Inches)	distance e_2 (Inches)	
HSD-ULTRA-30 [-V]	(5) No. 4 [(5) No. 4]	2 3/4 [3 3/4]	2 [2]	(3) No. 4 [(3) No. 4]
HSD-ULTRA-35 [-V]	(4) No. 4 [(4) No. 5]	3 [4]	4 1/2 [4 1/2]	(2) No. 5 [(2) No. 5]
HSD-ULTRA-42 [-V]	(5) No. 5 [(5) No. 5]	3 3/4 [4 1/2]	3 1/2 [3 1/2]	(3) No. 5 [(3) No. 5]
HSD-ULTRA-52 [-V]	(7) No. 5 [(7) No. 5]	4 1/2 [5]	2 1/2 [2 1/4]	(4) No. 5 [(4) No. 5]

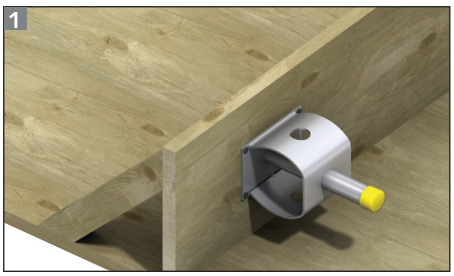
Minimum longitudinal bars are based on minimum dowel centres (1.5 * h_{min}). If spacing greater than this is adopted, the longitudinal bars are to be designed assuming slab edge acts as a beam spanning between the dowels.

Installation Procedure

The two-part assembly of all HALFEN Shear Dowels removes the need for drilling formwork on site, supporting dowel bars and fitting debonding sleeves and end caps. The installation is a fast and accurate process.

HSD and HSD-ULTRA Shear Dowels normally transfer vertical loads across a joint. The face marked 'Top' on both the sleeve and the dowel should be uppermost. For applications where the load is not vertical, the face marked 'Top' will need to be in the same direction as the load.





Nail the sleeve component to the formwork ensuring that the sleeve is correctly orientated for the direction of the load. Check that the minimum spacing and edge distances are not exceeded. The label prevents debris from entering into the sleeve aperture and should not be removed at this stage.

Fix the local reinforcement in position around the sleeve component together with any other reinforcement that is required, ensuring that the correct cover to the reinforcement is maintained. Pour the concrete to complete the installation of the sleeve component.

When the concrete has achieved sufficient strength, strike the shuttering. Peel off or puncture the label to reveal the hole for the dowel. Where HSD-V or HSD-ULTRA-V are being used, the label should only be punctured enough to allow the dowel into the cylindrical sleeve.

Position the compressible joint filler of the appropriate width for applications where movement is expected between the two sections of concrete.

Push the dowel component through the joint filler (if applicable) until it is fully located in the sleeve component. It may be necessary to tap the dowel component to overcome the dimple which pinch holds the dowel in the sleeve and prevents dislocation when the concrete is vibrated.

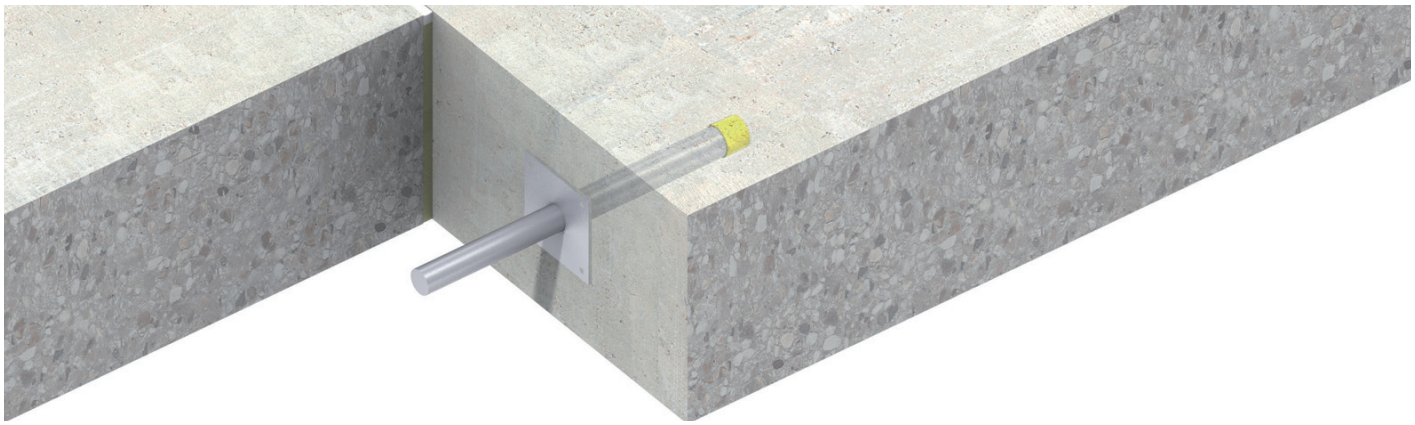
Fix the local reinforcement in position around the dowel component together with any other reinforcement that is required, ensuring that the correct cover to the reinforcement is maintained. Pour the concrete to complete the installation of the shear connector.

Notes: *(i)* Although installation is shown for HALFEN HSD-ULTRA, the procedure is the same for all HALFEN HSD Shear Dowels.

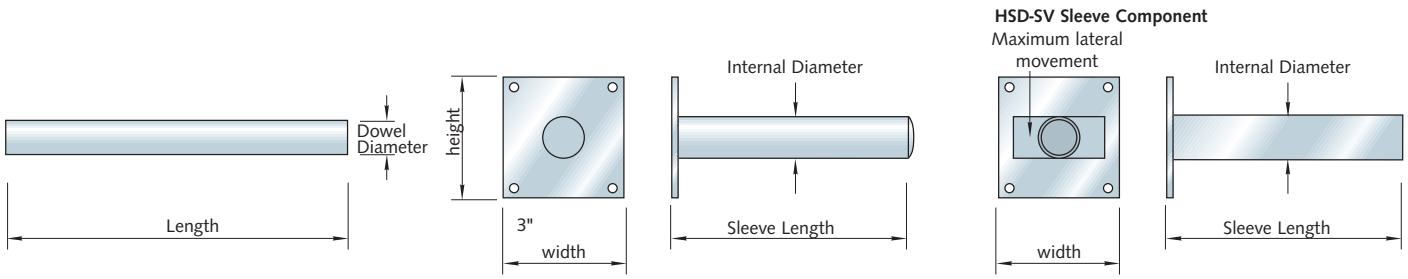
(ii) Where deep concrete pours are proposed, the installation will require further consideration. More robust fixing of the sleeve and dowel components will be necessary, to avoid displacement during pouring of the concrete.

HALFEN HSD SHEAR DOWEL SYSTEM

Introduction HSD/HSD-V



The HALFEN HSD is a shear dowel system for applications with smaller loads where the alignment of the dowels is critical. HALFEN HSD Shear Dowels come in two parts. The set always consists of the dowel (HSD-D) and the corresponding sleeve (HSD-S and HSD-SV) respectively. The HSD does not allow any movement perpendicular to the dowel. The HSD-V allows lateral movement in one direction. Both, HSD and HSD-V allow movement in longitudinal direction. Dimensions of the dowels and sleeves can be found on this page. Additional information such as design capacities and required reinforcement can be found on page 16 and 17.



HALFEN HSD- and HSD-V – Dimensions									
	Dowel HSD-D		Sleeve HSD-S			Sleeve HSD-SV			
	Diameter [Inch]	Length [Inch]	Length [Inch]	Height [Inch]	Width [Inch]	Length [Inch]	Height [Inch]	Width [Inch]	lat. movement [Inch]
HSD 20(-V)	13/16	11 3/4 *	6 3/4	3	3	6 3/4	3	3	3/4
HSD 22(-V)	7/8	11 3/4 *	6 3/4	3	3	6 3/4	3	3	3/4
HSD 25(-V)	1	11 3/4 *	6 3/4	3	3	6 3/4	3	3	5/8
HSD 30(-V)	1 3/16	13 3/4 *	7 5/8	3 7/8	3 7/8	7 5/8	3 7/8	4 3/8	1 5/8

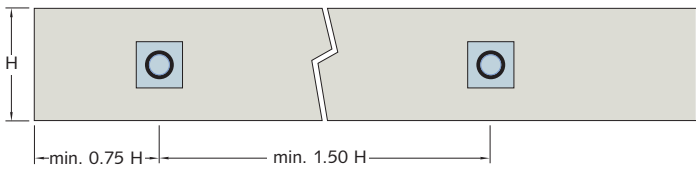
* Different dowel lengths are available on request

Performance data HSD 20, 22, 25, 30 / HSD-20V, 22V, 25V, 30V

Design strength

Dowel	Slab thickness [Inch]	Design strength F_{Rd} [kip] for various joint widths [Inch] in 3000/4000 psi concrete									
		1/4		1/2		1		1 1/2		2	
HSD-20(-V)	7	4.9	5.6	4.9	5.6	4.9	5.4	4.4	4.4	3.9	3.9
	7 1/2	5.1	5.8	5.1	5.8	5.1	5.4	4.4	4.4	3.9	3.9
	8	6.7	6.7	6.2	6.2	5.4	5.4	4.4	4.4	3.9	3.9
	9	6.7	6.7	6.2	6.2	5.4	5.4	4.4	4.4	3.9	3.9
	10	6.7	6.7	6.2	6.2	5.4	5.4	4.4	4.4	3.9	3.9
HSD-22(-V)	7	5.5	6.3	5.5	6.3	5.5	6.3	5.5	5.6	5.0	5.0
	7 1/2	5.7	6.5	5.7	6.5	5.7	6.5	5.6	5.6	5.0	5.0
	8	7.4	7.8	7.4	7.6	6.7	6.7	5.6	5.6	5.0	5.0
	9	8.2	8.2	7.6	7.6	6.7	6.7	5.6	5.6	5.0	5.0
	10	8.2	8.2	7.6	7.6	6.7	6.7	5.6	5.6	5.0	5.0
HSD-25(-V)	8	7.0	7.9	7.0	7.9	7.0	7.9	6.9	6.9	6.2	6.2
	9	8.8	9.3	8.8	9.2	8.2	8.2	6.9	6.9	6.2	6.2
	10	9.8	9.8	9.2	9.2	8.2	8.2	6.9	6.9	6.2	6.2
	11	9.8	9.8	9.2	9.2	8.2	8.2	6.9	6.9	6.2	6.2
	12	9.8	9.8	9.2	9.2	8.2	8.2	6.9	6.9	6.2	6.2
HSD-30(-V)	8	8.0	9.1	8.0	9.1	8.0	9.1	8.0	9.1	8.0	9.1
	9	9.4	10.6	9.4	10.6	9.4	10.6	9.4	10.6	9.4	10.6
	10	10.9	12.3	10.9	12.3	10.9	12.3	10.9	11.8	10.8	10.8
	11	11.6	13.5	11.6	13.5	11.6	13.0	11.6	11.8	10.8	10.8
	12	11.6	13.5	11.6	13.5	11.6	13.0	11.6	11.8	10.8	10.8

All values in the table above are design strengths (LRFD) and have to be compared to factored loads.

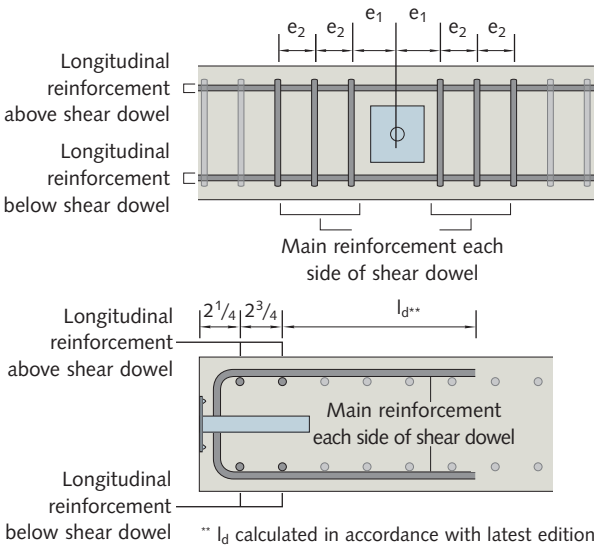


Edge Distances and Spacing

The minimum edge distance and spacing of the HALFEN HSD shear dowels is determined by the depth of the slab and illustrated in the adjacent drawing.

Reinforcement details

Local reinforcement is required around each connector to guarantee that the forces are transferred between the connectors and the concrete. Correct detailing in accordance with appropriate design codes and the recommendations provided here in will ensure HALFEN HSD and HSD-V shear dowels attain their full capacity. The tables below show proposals for the type and spacing of the main reinforcement, together with details of reinforcement above and below the shear dowels.



** l_d calculated in accordance with latest edition of ACI 318

Dowel	Design capacities F_{Rd} [kip] for various joint widths [Inch] in 3000/4000 psi concrete							
	Main reinforcement [total per shear dowel]						Longitudinal bars top and bottom	
	U-bars each side of the dowel		distance e_1 [Inches]		distance e_2 [Inches]			
HSD-20(-V)	(2) No. 3	(2) No. 3	1 1/2	2	2	2	(2) No. 3	(2) No. 3
HSD-22(-V)	(2) No. 4	(2) No. 4	2	2	1 1/2	2	(2) No. 3	(2) No. 3
HSD-25(-V)	(2) No. 4	(2) No. 4	1 1/2	2	1 1/4	2	(2) No. 3	(2) No. 3
HSD-30(-V)	(2) No. 5	(2) No. 5	2	2 1/4	2	2 1/4	(2) No. 3	(2) No. 3

The minimum longitudinal bars are based on a dowel distance of 1.5 times the slab thickness h. If the spacing is greater than this, the longitudinal bars are to be designed assuming the slab edge acts as a beam spanning between the dowels.

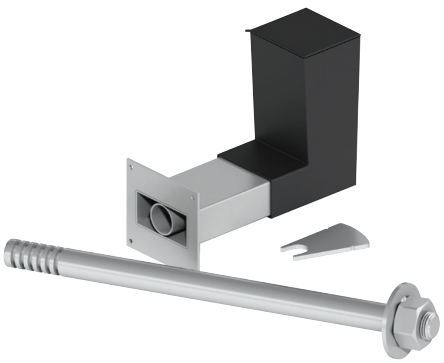
Lockable Dowels
HALFEN HSD-LD Lockable Dowels have been designed for use at temporary movement joints, most commonly found in post-tensioned concrete frames. These dowels allow initial shrinkage of the concrete to take place and are then locked in position with a mechanical plate and a controlled amount of epoxy resin. The locked dowels continue to transfer shear, but prevent further movement taking place.

Advantages
The use of HALFEN HSD Lockable Dowels can save a significant amount of time and materials over other construction methods. Concrete shrinkage has traditionally been accommodated by leaving gaps in the slabs called 'pour strips' or 'closure strips'. These strips are filled once movement has stabilized, however until they are filled the slabs must be propped, restricting site access and delaying site progress. Gaps in the slab also create a trip hazard for site workers, require additional formwork and can leave the soffit face marked. Lockable Dowels improve site access, minimize formwork requirements, and accelerate the rate of construction. With a Lockable Dowel, there is less requirement for the slabs to be propped or a support corbel to be constructed, as shear load is transferred by the dowel. The time saved by early removal of slab props can be significant.

In addition, engineers have found the HALFEN HSD Lockable Dowel to be the preferred design solution for pin-ended joints. Although it is customary for practical reasons to use U-bars or other rebar continuity systems at these connections, these options do not truly act as hinges and so rotation of the slab under load can induce cracking at the wall-to-slab interface with potential integrity issues.

The Lockable Dowel is closer to a true pin-ended joint and, being manufactured from stainless steel, provides additional corrosion protection over systems using carbon steel reinforcement. The design capacities shown on page 24 are backed by independent test data and the unique void former allows inspection of the dowel before the joint is locked. Standard HALFEN systems are available for use at slab joints and retaining/core walls, requiring permanent movement.


Pour Strips restrict site access, cause a trip hazard and delay progress on site

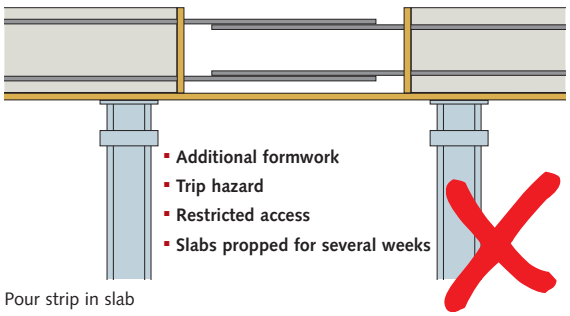


Applications

In most cases, HALFEN Lockable Dowels can be used to replace pour strips at temporary movement joints in post-tensioned concrete structures. Standard HALFEN systems are available for use at slab joints and retaining/core walls, requiring permanent movement.

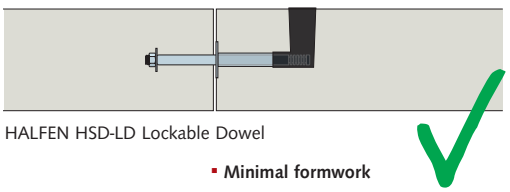
Slab-to-Slab

Traditional solution



Pour strip in slab

HALFEN solution

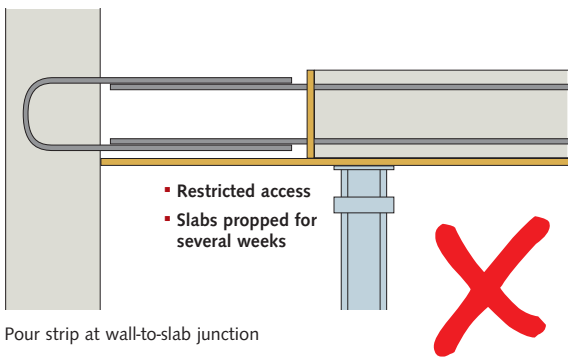


HALFEN HSD-LD Lockable Dowel

▪ Minimal formwork
▪ Improved site access
▪ Reduced propping time

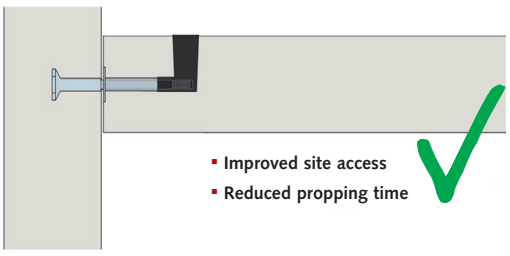
Slab-to-Wall

Traditional solution



Pour strip at wall-to-slab junction

HALFEN solution



HALFEN HSD-LD-W Lockable Wall Dowel

Range of Lockable Dowels

HALFEN HSD-LD Lockable Dowels allow initial shrinkage of the concrete to take place and then, after a pre-determined time period (generally 28-120 days), the dowels are locked in position with a mechanical plate and a controlled amount of epoxy resin. The range comprises three products; HSD-LD 20 Lockable Dowel, HSD-LD 30 Lockable High Capacity Dowel, and HSD-LD 20W Lockable Wall Dowel.

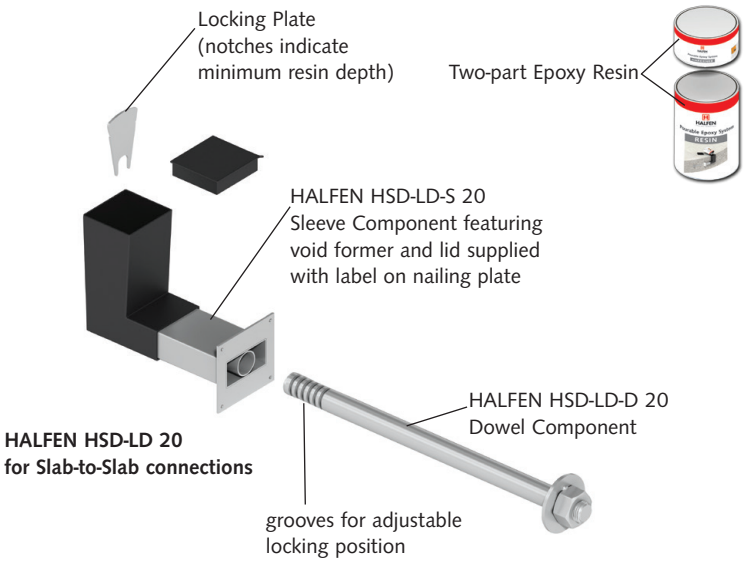
Slab-to-Slab Lockable Dowels

HSD-LD* Lockable Dowel
The dowel component is manufactured from 1 3/16" diameter stainless steel; one end is threaded with a fixed nut and washer, and the other features a series of grooves to accept the Locking Plate. The cylindrical sleeve which accepts the dowel component is contained within a box-section to allow lateral, longitudinal, and rotational movement. The epoxy resin is poured into the L-shaped void former. This product has a maximum design strength of over 15 kip. See pages 22 to 24 for full technical details.

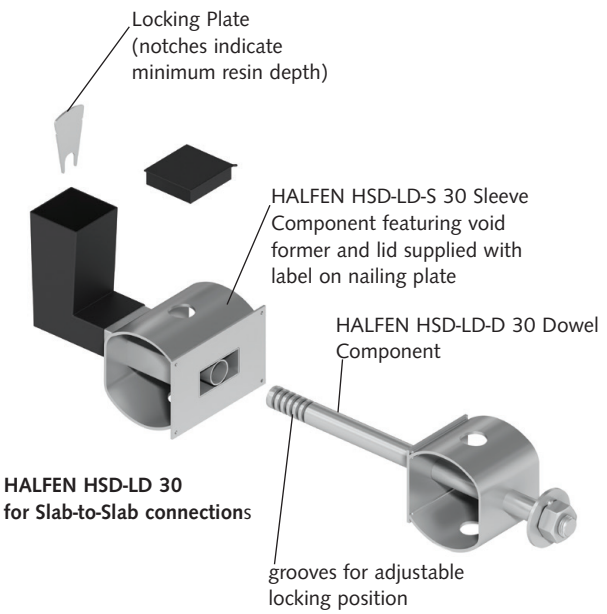
HSD-LD 30* Lockable High Capacity Dowel
The HSD-LD 30 is a high load Lock-able Dowel with a design capacity of up to 30.6 kip.


Reinforcement around HSD-LD-S 20 Sleeves


HSD-LD-S 30 Sleeve nailed to formwork



HALFEN HSD-LD 20 for Slab-to-Slab connections



HALFEN HSD-LD 30 for Slab-to-Slab connections

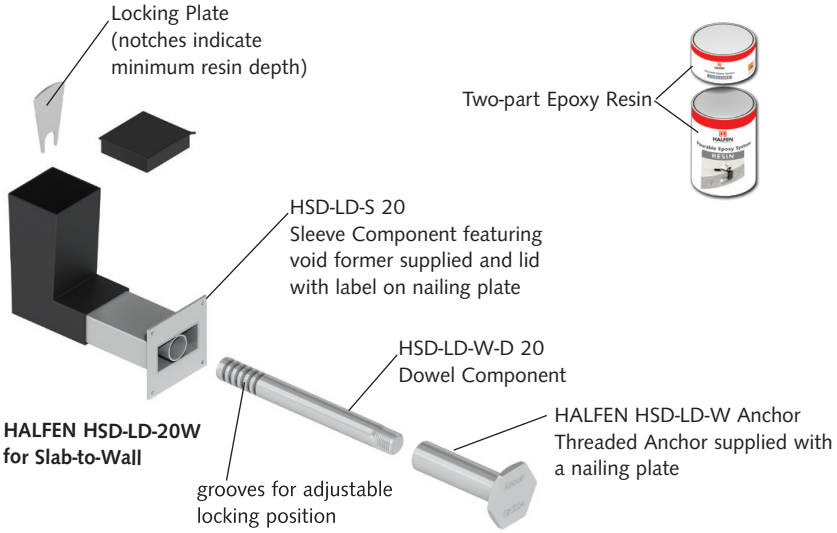
Example Specification Clause
Delete/Amend blue text as appropriate
<HALFEN HSD-LD 20 or HALFEN HSD-LD 30> lockable shear load connector comprising dowel, sleeve and locking components to be installed at the temporary movement joint between two slabs. Product to be positioned at <insert centers> inch horizontal centers at <the center line of the slab or XXX inch from the top of the slab>. The dowel is to be locked in position after <insert time period> using the locking plate and resin supplied. System should be installed in accordance with HALFEN's instructions and engineer's drawings.

* US Patent No. 8209933

Slab-to-Wall Lockable Dowel

HSD-LD-20W* Lockable Wall Dowel

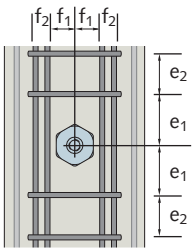
The HSD-LD-20W dowel component is also manufactured from 1 $^{3}/_{16}$" diameter stainless steel, but is shorter than the HSD-HSD-LD-D 20 dowel. One end of the dowel is designed to screw into the stainless steel HALFEN HSD-LD-W Anchor cast into the face of the concrete and the other end features a series of grooves to accept the Locking Plate. The sleeve component is the same as used in the HALFEN HSD-LD 20. See pages 22 to 24 for full technical details.



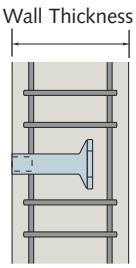
HALFEN HSD-LD-20W for Slab-to-Wall

Reinforcement Details

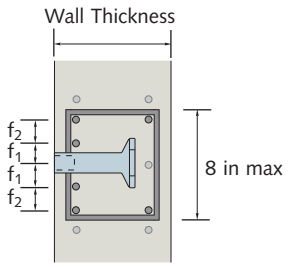
Local reinforcement is required around each HALFEN Lockable Dowel to guarantee that the forces are transferred between the connectors and the concrete. Correct detailing in accordance with the latest edition of ACI 318 and the recommendations provided here will ensure the dowels attain their full capacity. The tables show the main reinforcement required, together with details of reinforcement above and below the connectors. Only requirements for wall dowel are provided below. Reference pg 24 for HSD-LD 20 Sleeve reinforcement requirements.



Wall Elevation



Wall Section View



Wall Plan View

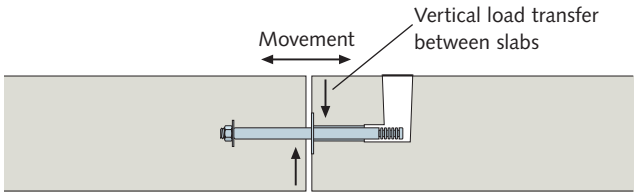
Spacing of Main Reinforcement						
Dowel	**No. Stirr-ups top and bottom of dowel**	**No. Vertical Bars each side of Dowel**	**Position e_1**	**Position e_2**	**Position f_1**	**Position f_2**
HSD-LD-20W (Wall >9 in)	2#4	2#4	2"	1 ½"	1 ½"	1 ½"
HSD-LD-20W (Wall >11 in)	2#5	2#5	2"	1 ½"	1 ½"	1 ½"

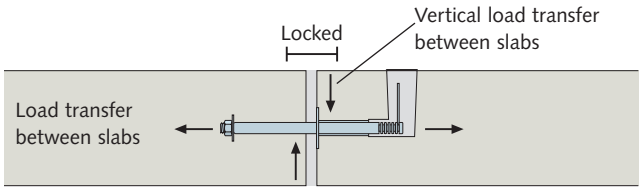
Example Specification Clause

Delete/Amend blue text as appropriate HALFEN HSD-LD-20W Lockable Wall Dowel comprising dowel, sleeve, threaded anchor and locking components to be installed at the temporary movement joint between slab and wall. Product to be po-sitioned at <insert centers> inch horizontal centers at <the center line of the slab or XXX inch from the top of the slab>. The dowel is to be locked in position after <insert time period> using the locking plate and resin supplied. System should be installed in accordance with HALFEN's instructions and engineer's drawings.

* US Patent No. 8209933

Performance Data





Performance Data

HSD-LD 20 Lockable Dowel [slab-to-slab]

Slab Thickness	Design Strength Longitudinal Load [kip]	Vertical Design Strength [kip] for Various Design Joint Widths in 4000 psi Concrete						
		¼ "	½ "	¾ "	1 "	1¼ "	1½ "	2 "
6¼ "	10.0	2.7	2.7	2.7	2.7	2.7	2.7	2.7
6½ "	10.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4
7 "	14.6	5.1	5.1	5.1	5.1	5.1	5.1	5.1
7½ "	14.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
8"	18.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
8⅝ "	22.5	12.0	12.0	12.0	12.0	12.0	12.0	10.8
9"	22.5	13.0	13.0	13.0	12.8	12.2	11.8	10.8
10 "	22.5	14.0	14.0	14.0	14.0	13.6	13.0	12.4
11 " and above	22.5	15.7	15.7	14.9	14.2	13.6	13.0	12.5

HSD-LD 30 Lockable Dowel [slab-to-slab]

Slab Thickness	Design Strength Longitudinal Load [kip]	Vertical Design Strength [kip] for Various Design Joint Widths in 4000 psi Concrete						
		¼ "	½ "	¾ "	1 "	1¼ "	1½ "	2 "
9½ " and above	22.5	30.6	30.6	30.6	30.6	30.6	30.6	30.6

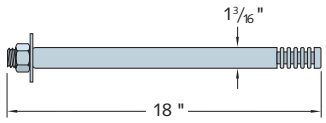
HSD-LD-20W Lockable Dowel [slab-to-wall]

Slab Thickness	Design Strength Longitudinal Load [kip]	Vertical Design Strength [kip] for Various Design Joint Widths in 4000 psi Concrete						
		¼ "	½ "	¾ "	1 "	1¼ "	1½ "	2 "
6¼ "	10.0	2.7	2.7	2.7	2.7	2.7	2.7	2.7
6½ "	10.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4
7 "	14.6	5.1	5.1	5.1	5.1	5.1	5.1	5.1
7½ "	14.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
8"	18.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
8⅝ "	18.0	12.0	12.0	12.0	12.0	12.0	12.0	10.8
9"	18.0	13.0	13.0	13.0	12.8	12.2	11.8	10.8
10 "	18.0	14.0	14.0	14.0	14.0	13.6	13.0	12.4
11 " and above	18.0	15.7	15.7	14.9	14.2	13.6	13.0	12.5

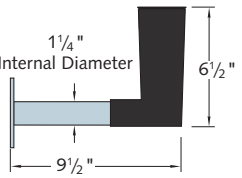
All values in the table above are based on strength design (LRFD) and have to be compared to factored loads.

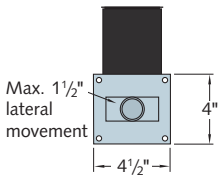
Dimensions

HSD-LD 20 Lockable Shear Dowel Components:
HSD-LD-D 20 Dowel

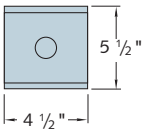


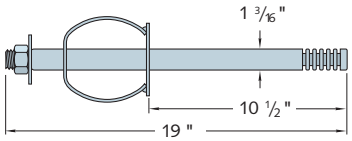
HSD-LD-S 20 Sleeve



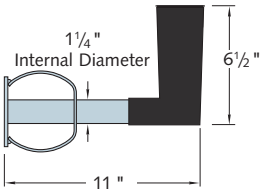


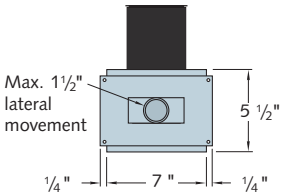
HSD-LD 30 Lockable Shear Dowel Components:
HSD-LD-D 30 Dowel



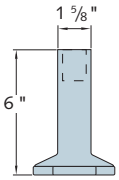


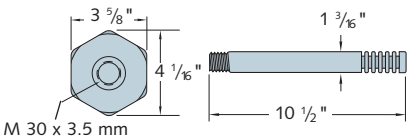
HSD-LD-S 30 Sleeve





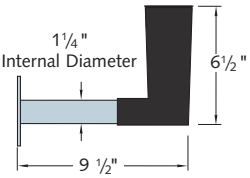
HSD-LD-20W Lockable Wall Dowel Components:
HSD-LD-W-Anchor Threaded Anchor

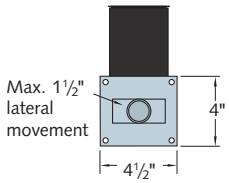




HSD-LD-W-D 20 wall dowel

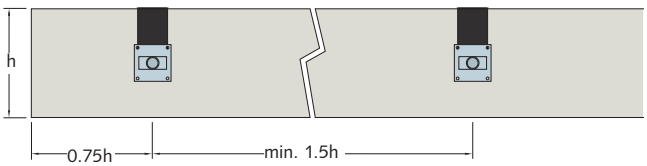
HSD-LD-S 20 Sleeve



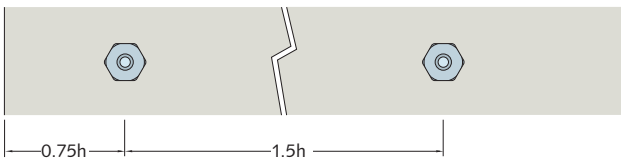


Edge Distance and Spacings

For connectors working at or near their maximum capacity, the minimum spacing should be 1.5 times the slab thickness. Where the allowable load of the connector could be used in a thinner slab, a spacing of 1.5 times the thinner slab thickness can be used. The minimum end distance is always 0.5 times the spacing.



HSD-LD 20 Minimum Edge Distance and Spacings



HSD-LD-20W Minimum Edge Distance and Spacings. h = depth of adjoining slab

HALFEN HSD-LD 20 Lockable Dowel sample calculation

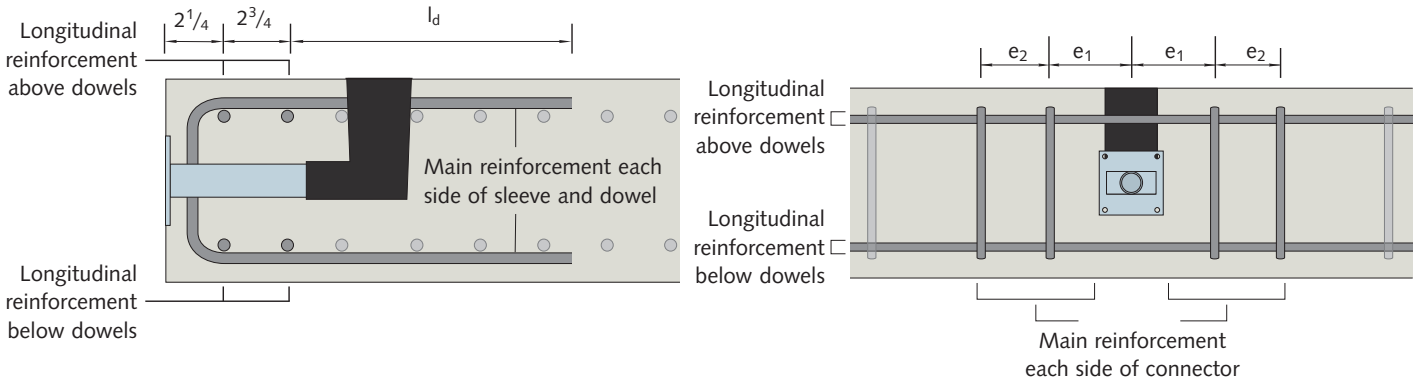
Slab thickness	= 10"	
Joint width	= 3/4"	
Concrete strength	= 4,000 psi	
Service dead load	= 1.5 kip/ft	factor = 1.2
Service live load	= 2.0 kip/ft	factor = 1.6
Factored load	= 1.5 x 1.2 + 2.0 x 1.6 = 5.0 kip/ft	
Design strength	= 14 kip (10" slab 3/4" joint)	
Therefore centers for vertical load	= 14 / 5.0 = 2.8 ft use 2'-9" centers	

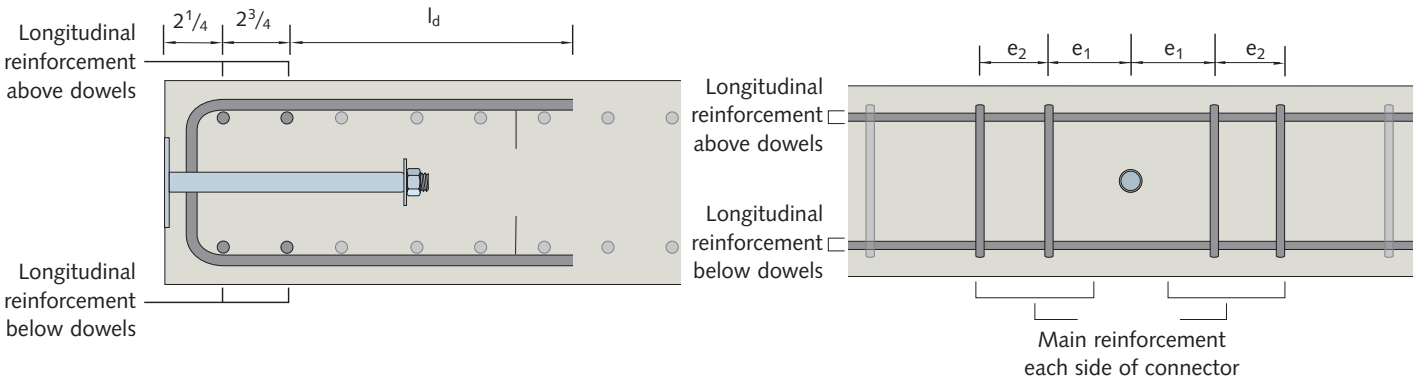
Once it is locked, this dowel will provide a design longitudinal capacity of 22.5 kip / 2.8 ft = 8.0 kip/ft.

Reinforcement Details

Local reinforcement is required around each HALFEN Lockable Dowel to guarantee that the forces are transferred between the connectors and the concrete. Correct detailing in accordance with appropriate design codes and the recommendations provided here will ensure the dowels attain their full capacity. The tables show the main reinforcement required, together with details of reinforcement above and below the connectors. The reinforcement configuration for the HSD-LD Ultra and HSD-LD 30 (Slab <8 ½") for the dowels and sleeves are the same. The reinforcement configuration for the HSD-LD 30 for slabs ≥ than 8 ½ inches differ as shown below.

HSD-LD 30 & HSD-LD 20



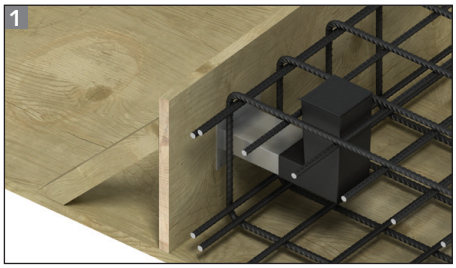


Dowel	No. U-bars Dowel Side (Sleeve Side)	No. Longitudinal Bars top and bottom Dowel Side (Sleeve Side)	Position e_1 Dowel side (Sleeve Side)	Position e_2 Dowel Side (Sleeve side)
HSD-LD 20 (Slabs <8 ½")	2 # 4 (2 #4)	2 #4 (2 #4)	1 ¼" (2")	1 ½" (1 ½")
HSD-LD 30	2 # 5 (2 #5)	2 #5 (2 #5)	2 ¾" (3 ¾")	1 ½" (1 ¼")

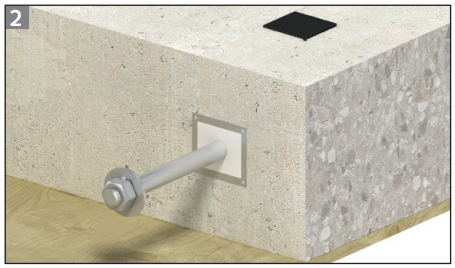
Minimum longitudinal bars are based on Minimum dowel centers of (1.5*h). If spacing greater than this is adopted, the longitudinal bars are to be designed assuming slab edge acts as a beam spanning between the dowels.

Installation HSD-LD 20 and HSD-LD 30 (slab-to-slab)

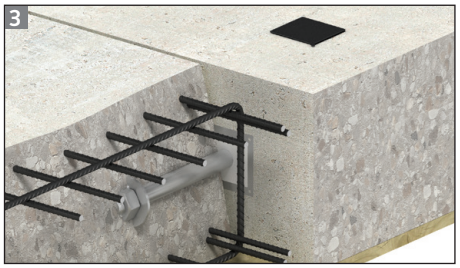
Although installation is shown for the HSD-LD 20, the procedure is the same for the HLD-LD 30.



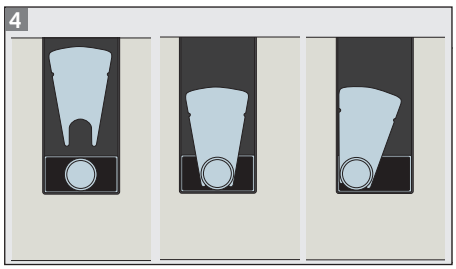
Nail the sleeve to the formwork either central in the slab or for slab depths over 12" so the top of the void former is level with the top of the slab. Do not remove the label over the nailing plate as this prevents ingress of concrete into the sleeve. Place the local reinforcement, as specified on engineer's drawings.



Pour the concrete, and when the required strength is attained, remove the formwork. Puncture the label to reveal the cylindrical sleeve only and insert the dowel until it is approximately ¾" from the back of the void former.



Place the local reinforcement around the dowel component and pour the concrete.

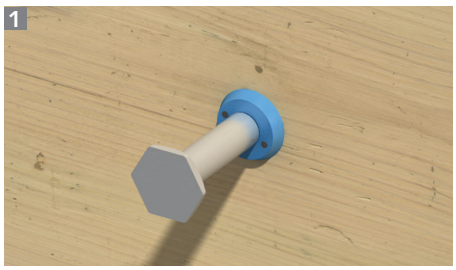


After a predetermined time period (generally 28-120 days), when movement between the slabs has stabilized, the dowel is ready to be locked. Fit the Locking Plate on a groove in the center of the void former. The fan-shaped Locking Plate allows the dowel to be locked in any position.

Mix the two-part epoxy resin and pour into the void former. It is essential the resin flows along the stainless steel box section towards the joint and reaches the notches on the locking plate, which indicate minimum resin depth.

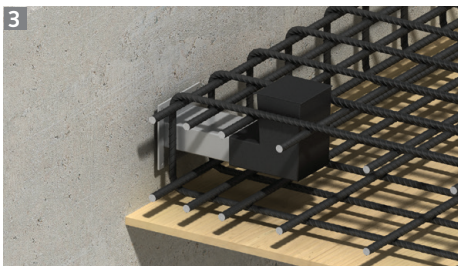
After 24 hours the void former can be filled with cementitious material, level with the top of the slab, to complete the installation. The locked dowel continues to transfer vertical load between the slabs, but movement can no longer take place.

Installation HSD-LD 20 (slab-to-wall)



Nail the threaded anchor to the formwork so the dowel will be central in the adjoining slab or within 6" of the top of slabs over 12". Place the local reinforcement as specified on engineer's drawings and cast the concrete.

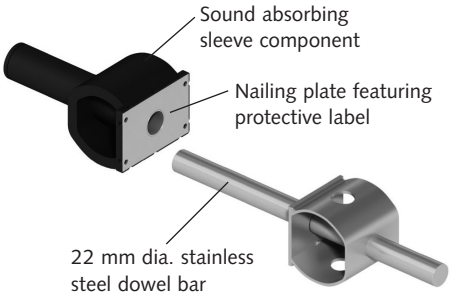
When concrete reaches sufficient strength, remove the formwork and remove nailing plate. Screw the dowel into the anchor.



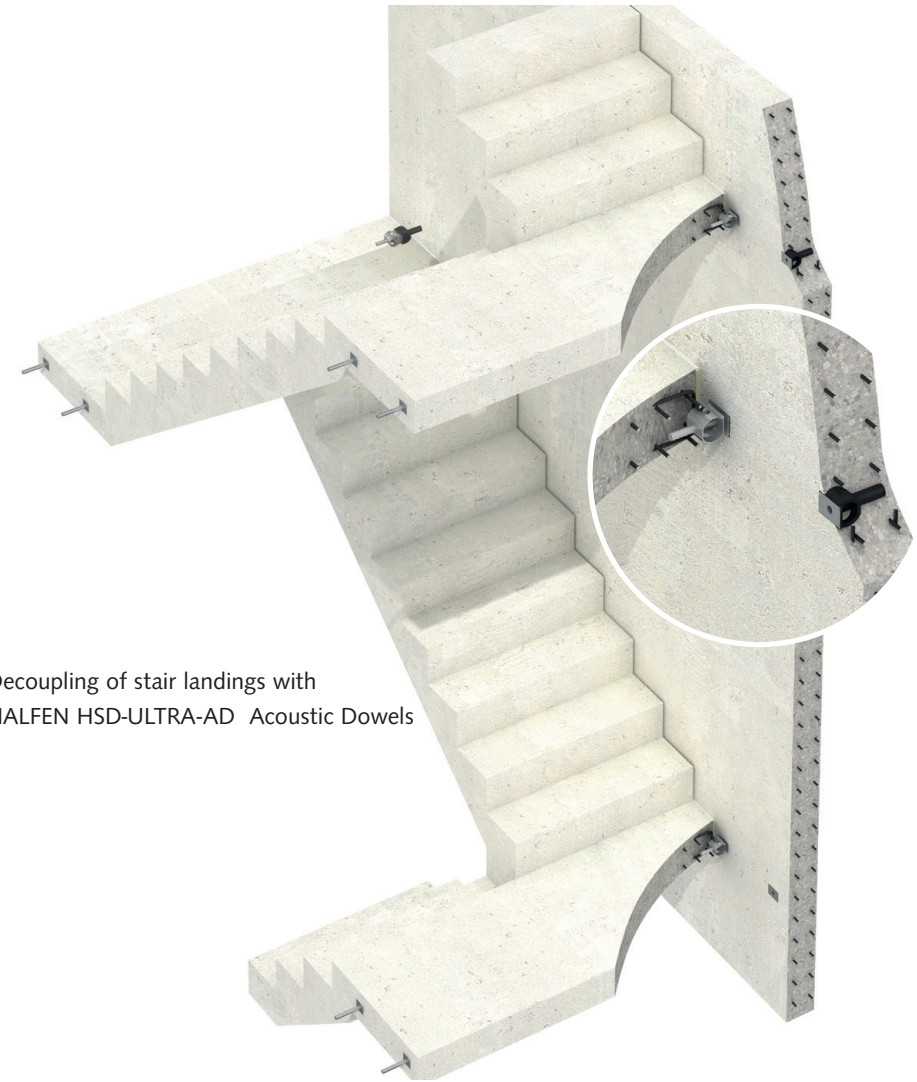
Puncture the label of the sleeve to reveal the cylindrical sleeve only. Push the sleeve over the dowel until it is flush with the concrete. Tie sleeve to reinforcement and pour concrete. See steps 4 to 6 above to complete installation.

Notes: Where deep concrete pours are proposed, the installation will require further consideration. More robust anchoring of the sleeve and dowel components will be necessary, to avoid displacement during casting of the concrete.

HALFEN HSD-ULTRA-AD acoustic Dowel
HALFEN HSD-ULTRA-AD is designed to transfer shear load and allow essential movement at joints in concrete frames, while also reducing the oscillation of impact sound through a building, by isolating adjacent concrete elements. The stainless steel dowel bar is located in a sound absorbing sleeve that decouples concrete components, such as stair landings from the main structural frame. Typical applications include multi-occupancy buildings, like hotels, apartments and hospitals, where noise can adversely affect concentration, relaxation and sleep, and has historically been a major source of complaints. Impact noise in these structures tends to originate in areas of high pedestrian traffic, and often where hard floor coverings are used to facilitate effective cleaning, such as stairways.



HALFEN HSD-ULTRA-AD Acoustic Dowel



Decoupling of stair landings with HALFEN HSD-ULTRA-AD Acoustic Dowels

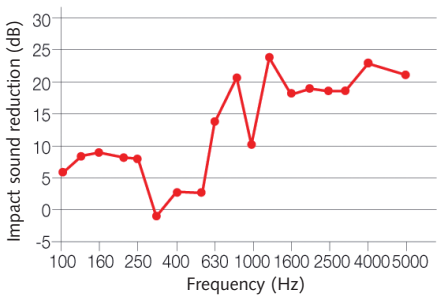
Acoustic Performance Testing
The HALFEN HSD-ULTRA-AD has been independently tested by the Fraunhofer Institute for Building Physics in Stuttgart, a leading research authority on acoustics. Tests were conducted in accordance with EN ISO 10140: 3: 2010: Acoustics: Laboratory measurement of sound insulation of building elements: Measurement of impact sound insulation, with additional calculations to EN ISO 717-2: 2013.
A decoupled concrete configuration, featuring HALFEN HSD-ULTRA-AD Acoustic Shear Dowels, offers an 18dB impact sound reduction over a rigid concrete floor connection.

Impact Sound Reduction

Control Specimen*	Test Specimen*	Impact Sound Reduction of Staisil-HLD Acoustic Dowel
67 dB	49 dB	**18 dB**

*Weighted normalised impact sound pressure level

Impact sound reduction at one-third octave bands

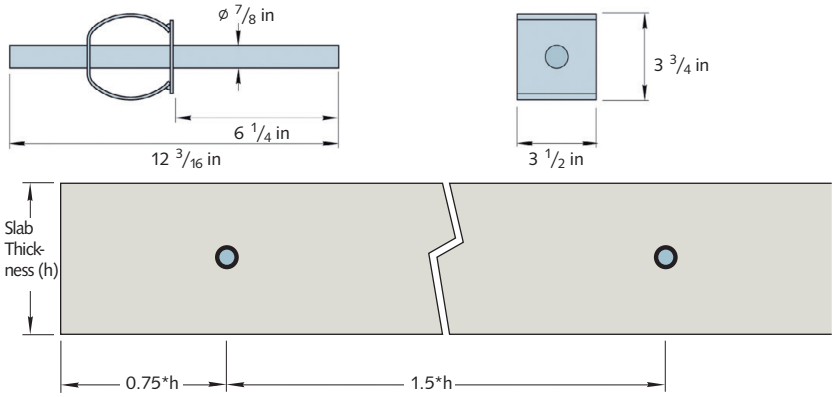


Design strength

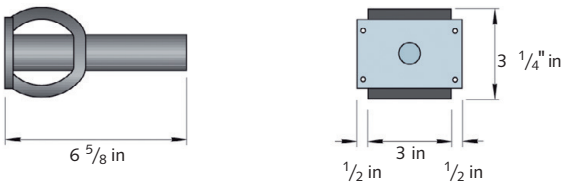
Design strength F_{Rd} [kip] for various joint widths [Inch] in 4000 psi concrete					
Slab thickness [Inch]	1/4	1/2	1	1 1/2	2
7	7.8	7.8	7.8	7.6	7.4
7 1/2	8.3	8.3	8.3	8.3	8.3
8	8.7	8.7	8.7	8.7	8.7
9	8.7	8.7	8.7	8.7	8.7
10	8.7	8.7	8.7	8.7	8.7
10 1/2	8.7	8.7	8.7	8.7	8.7
11	8.7	8.7	8.7	8.7	8.7
11 1/2	8.7	8.7	8.7	8.7	8.7
12	8.7	8.7	8.7	8.7	8.7
12 1/2	8.7	8.7	8.7	8.7	8.7

All values in the table above are based on Strength Design (LRFD) and have to be compared to factored loads.

Dimensions and Spacings



Sleeve

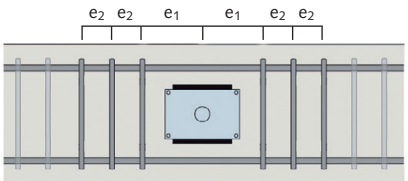


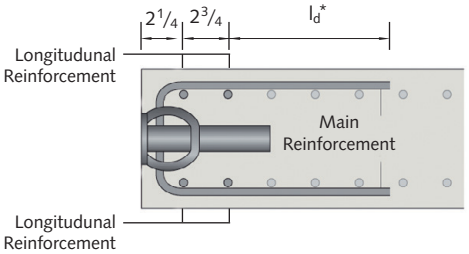
Edge Distances and Spacing

The edge distances and connector spacing required, as shown in the drawing on the left, are defined by the slab thickness.

Reinforcement Details

Local reinforcement is required to guarantee that the forces are transferred between the connectors and the concrete. The tables show proposals for the type and spacing of the main reinforcement, together with details of reinforcement above and below the connectors.





Spacing of Main Reinforcement

Dowel	No. U-bars each side	No. Longitudinal Bars top and bottom each side	Position e_1 each side	Position e_2 each side
HSD-AD Acoustic Dowel	3 #3 or 2 #4	2 #3	2-3/4"	2-3/4"

* l_d is calculated in accordance with the latest edition of ACI 318

Minimum longitudinal bars are based on Minimum dowel centers of (1.5*h). If spacing greater than this is adopted, the longitudinal bars are to be designed assuming slab edge acts as a beam spanning between the dowels.

CONTACT HALFEN WORLDWIDE

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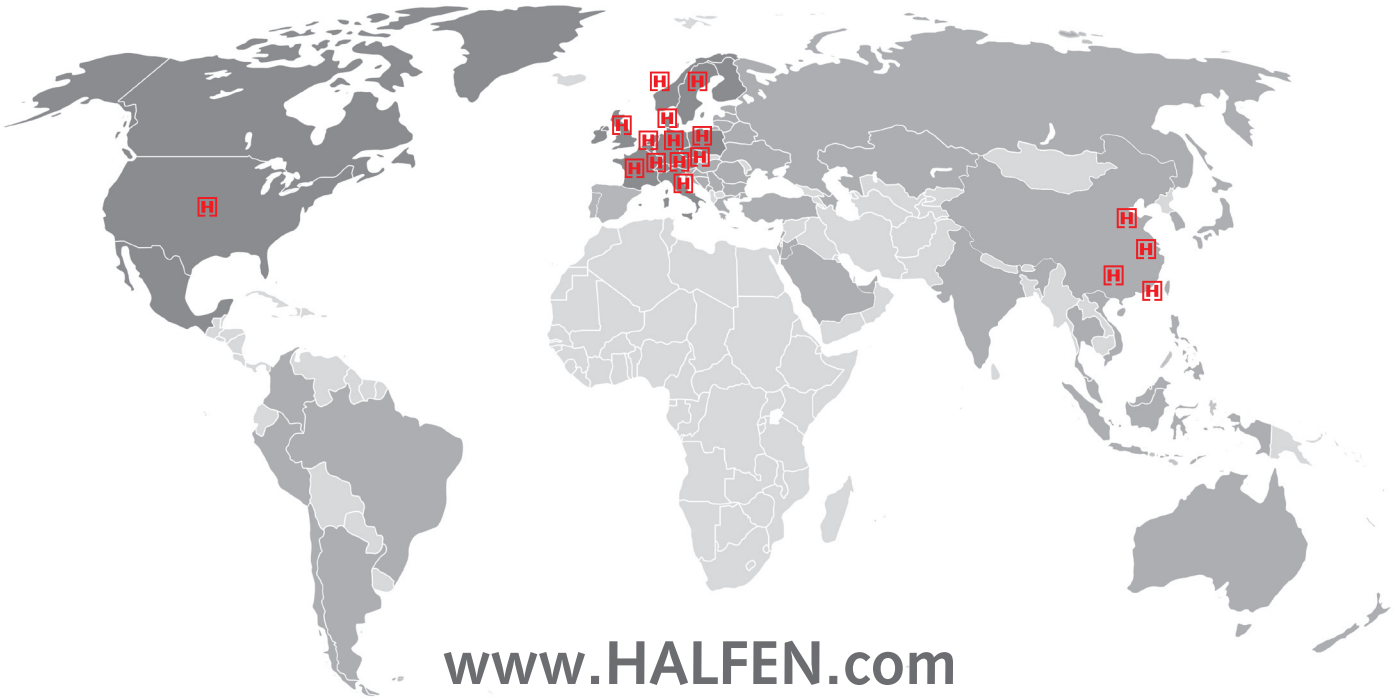

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