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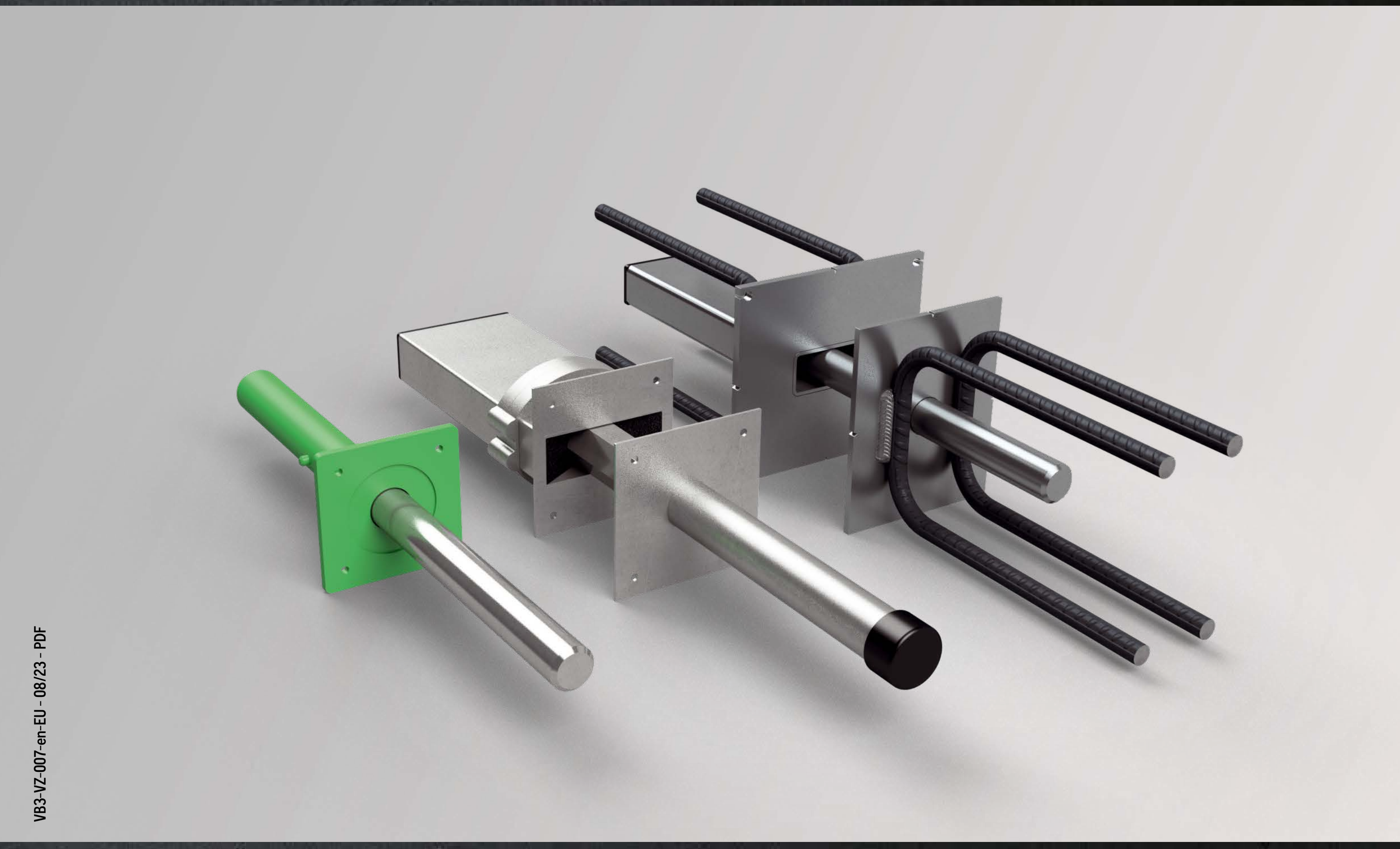
Pakon Shear dowel systems ESD / DB / Nursid



VB3-VZ-007-en-EU - 08/23 - PDF

European Technical Assessment (ETA-23/0180)

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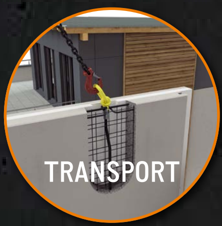

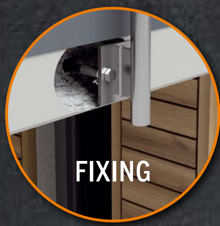

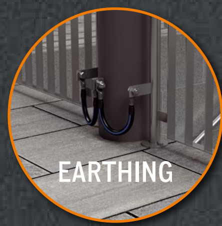

ETA-Danmark A/S
Göteborg Plads 1 DK-2150 Nordhavn Tel. +45 72 24 59 00
Fax +45 72 24 59 04
Internet www.etadanmark.dk

Authorised and notified according to Article 29 of the Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011

MEMBER OF EOTA

European Technical Assessment ETA-23/0180 of 2023/03/28

I General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: ETA-Danmark A/S

Trade name of the construction product:	ESD, DB and NURSID
Product family to which the above construction product belongs:	Dowels for structural joints under static and quasi-static loading
Manufacturer:	Pakon AG Bahnhofstrasse 33 CH 8867 Niederurnen Internet www.pakonag.com
Manufacturing plant:	Pakon AG M 20 Areal, Wasterkingerweg CH 8193 Eglisau-Hüntwangen
This European Technical Assessment contains:	34 pages including 28 annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	EAD 050019-00-0301, Dowels for structural joints under static and quasi-static loading
This version replaces:	

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II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of the product

The ESD, DB and NURSID dowel systems transmit shear loads across an expansion joint between structural concrete elements made of reinforced normal weight concrete of strength classes C20/25 to C50/60 acc. to EN 206. The concrete elements are subjected to static and quasi-static actions only and they must have a minimum slab thickness of 150 mm. Further the concrete elements are subjected to fire exposure and designed acc. to EN 1992-1-1 and EN 1992-1-2.

The **ESD dowel system** consists of a circular bar and a sleeve into which the bar is inserted. ESD belongs to the dowel family with a single bar and a sleeve without anchor plate or ancillary reinforcement steel. There are two dowel types with regard to the degrees of freedom of movement. The dowel type **ESD-N** allows axial movements only with bars made of stainless steel or galvanized steel and sleeves made of plastic or stainless steel. The dowel type **ESD-Q** allows axial and non-cyclic lateral movements with bars made of stainless steel or galvanized steel and sleeves with strengthening rings made of stainless steel.

The **DB dowel system** consists of a circular bar and a sleeve into which the bar is inserted. DB belongs to the dowel family with a single bar and a sleeve with anchor plate and ancillary reinforcement. There are two dowel types with regard to the degrees of freedom of movement. The dowel type **DB-N** allows axial movements only with bars made of stainless steel or galvanized steel and sleeves made of stainless steel. The dowel type **DB-Q** allows axial and non-cyclic lateral movements with bars made of stainless steel or galvanized steel and sleeves made of stainless steel. For both dowel types DB-N and DB-Q the anchor plate and the ancillary reinforcement steel are made of stainless steel, whereas the ancillary reinforcement steel can also be a normal reinforcment steel.

The **NURSID dowel system** consists of a dowel bar and two sleeves. The dowel bar is made of one steel bar whereas the shape changes from circular to hexagon. So the bar section with the circular shape can be inserted into a circular sleeve of the ESD-N or DB-N dowel types at one side and the hexagon shaped part is inserted into a rectangular sleeve of the ESD-Q or DB-Q dowel types at the other side. So NURSID belongs to the ESD and DB dowel types with a single bar and a sleeve with or without anchor plate and ancillary reinforcement steel. The NURSID dowel system allows axial movements at the circular sleeve and non-cyclic lateral movements at the rectangular sleeve as well as compensation of structural tolerances.

See further descriptions in Annex A.

2 Specification of the intended use in accordance with the applicable EAD 330046-01-0602 (hereinafter referred to as EAD)

The dowel systems transmit shear loads across an expansion joint between structural concrete elements made of reinforced normal weight concrete of strength class C20/25 to C50/60 according to EN 206. The concrete elements are subjected to static and quasi-static actions only. They are subjected to fire exposure and have to be designed acc. to EN 1992-1-1 and EN 1992-1-2. The minimum concrete slab thickness is equal to h_{slab} = max (6 · d_{bar}; 150 mm).

The ESD-N and DB-N dowel types allow axial movements only which take place at the circular sleeve. The ESD-Q and DB-Q dowel types allow lateral movements up to ± 15 mm in addition which take place at the rectangular sleeve, whereas these lateral movements are not supposed to be cyclic movements. That means that the ESD-Q and DB-Q dowel types should not be supposed to external environmental conditions with daily temperature cycles causing lateral movements of the dowel bar. On the other hand the ESD-Q and DB-Q dowel types can be used at internal environmental conditions with mainly one-directional lateral movements of the dowel bar due to e.g. concrete creeping or shrinkage.

Bars made of galvanized steel will be subjected to dry internal environment. Bars, anchor plates and sleeves made of stainless steel or sleeves made of plastic can be subjected to environmental conditions acc. to EN 1993-1-4, table A.1 depending on the corrosion resistance class.

The performances given in Section 3 are only valid if the products are used in compliance with the specifications and conditions given in Annex A.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the product of 50 years.

The indications given on the intended working life cannot be interpreted as a guarantee given by the producer or the Technical Assessment Body, but are to be regarded only as a means for selecting the appropriate products in relation to the expected economically reasonable working life of the works.

The real working life might be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for construction works.

3 Performance of the product and references to the methods used for its assessment

Performances of the dowel systems, related to the basic requirements for construction works (hereinafter BWR), were determined according to EAD 050019-00-0301.

These performances, given in the following paragraphs, are valid as long as the components are the ones described in Annex A of this ETA.

	Characteristic	Assessment of characteristic
3.1	**Mechanical resistance and stability (BWR 1)**	
	Resistance to steel failure at ULS for ESD and NURSID with ESD	$e = 0.5 \cdot d_{bar}$ See Annex B1 to B4
	Resistance to steel failure at ULS for DB and NURSID with DB	$e = 0$ See Annex B5 to B6
	Resistance to steel failure at ULS for NURSID with crossed combinations	$e = 0.25 \cdot d_{bar}$ See Annex B7 to B9
	Resistance to concrete edge failure at ULS for ESD and NURSID with ESD	$X_{1,1} = X_{1,2} = 0.60$
		$B_{spec,1} = 0$; $B_{spec,2}$ acc. to Annex B12
		$H_{spec,1} = H_{spec,2} = c_1$ acc. to Annex B12
		$k_{1,1} = k_{1,2} = 0.5$
	Resistance to concrete edge failure at ULS for DB and NURSID with DB	$X_{1,1} = X_{1,2} = 0.37$
		$B_{spec,1}$ and $B_{spec,2}$ acc. to Annex B13
		$H_{spec,1}$ and $H_{spec,2}$ acc. to Annex B13
		$k_{1,1} = k_{1,2} = 0.5$
	Resistance to concrete edge failure at SLS for ESD and NURSID with ESD	$X_2 = 0.41$
	Resistance to concrete edge failure at SLS for DB and NURSID with DB	$X_2 = 0.57$
3.2	**Safety in case of fire (BWR2)**	
	Reaction to fire	The dowels are made from steel classified as Euroclass A1 in accordance with EN 13501-1 and Commission Delegated Regulation 2016/364
	Resistance to fire	See Annex C1

4 Attestation and verification of constancy of performance (AVCP)

4.1 AVCP system

According to the decision 1998/214/EC of the European Commission 1, as amended by 2003/639/EC, the system of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) is:

2+

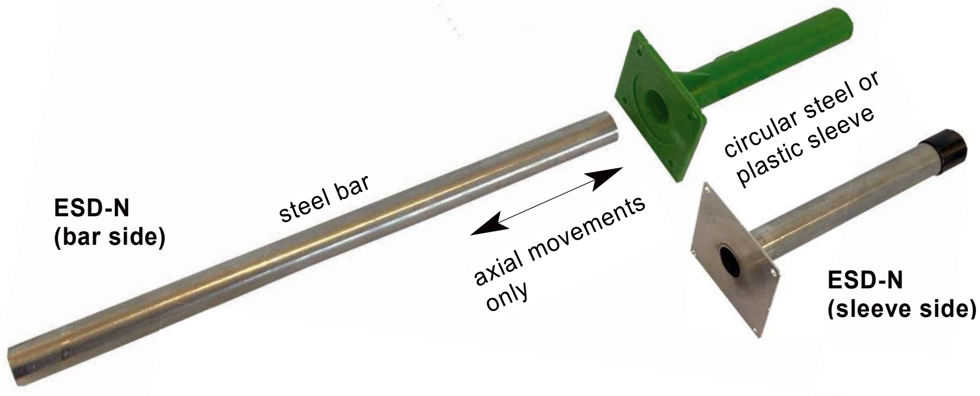
5 Technical details necessary for the implementation of the AVCP system, as foreseen in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at ETA-Danmark prior to CE marking.

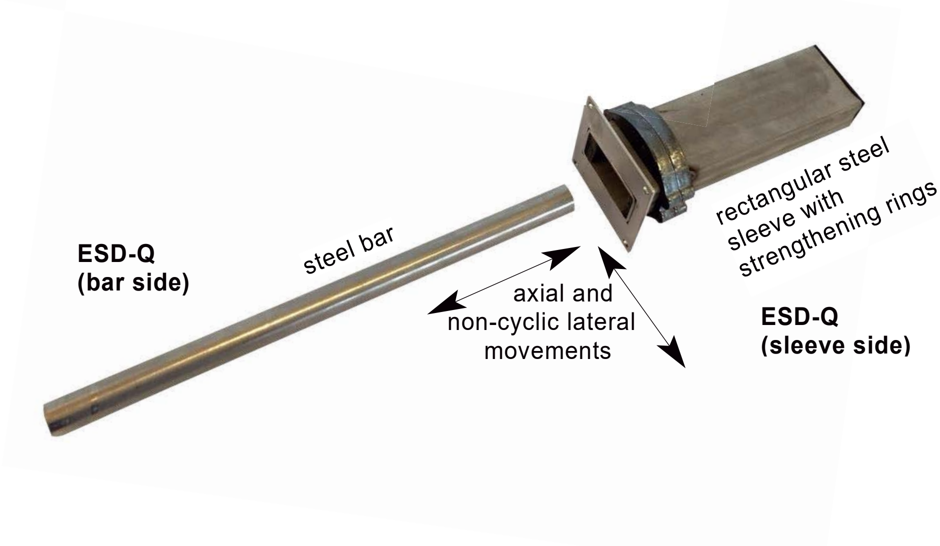
Issued in Copenhagen on
2023-03-28 by

Thomas Bruun
Managing Director, ETA-Danmark

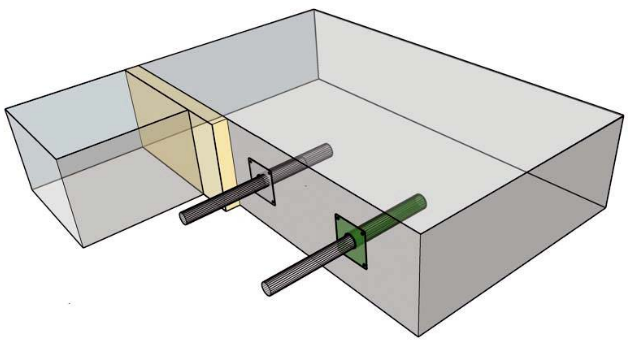
ESD-N



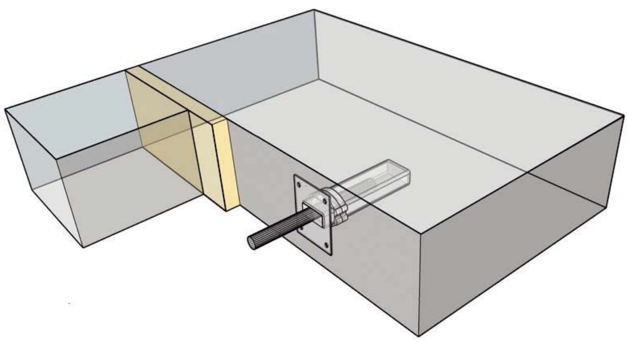
ESD-Q



with ESD-N for the connection of concrete elements which allows axial movements only



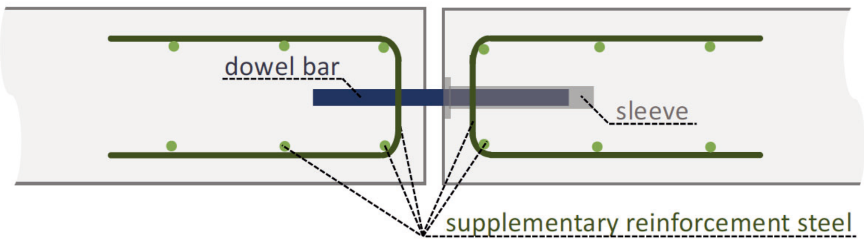
with ESD-Q for the connection of concrete elements which allows axial and non-cyclic lateral movements



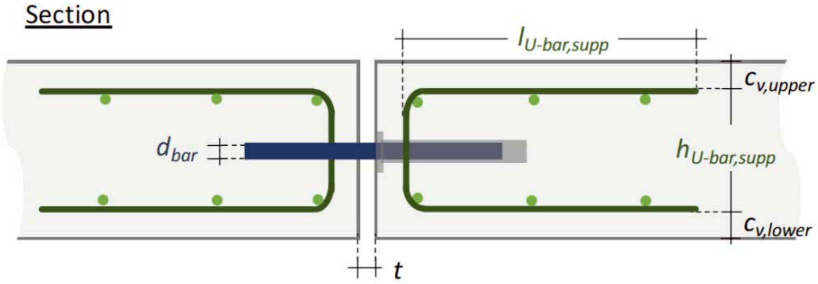
ESD Dowels – ESD-N and ESD-Q with Intended Use	Annex A1
Product description	

ESD-N – Geometrical Parameters

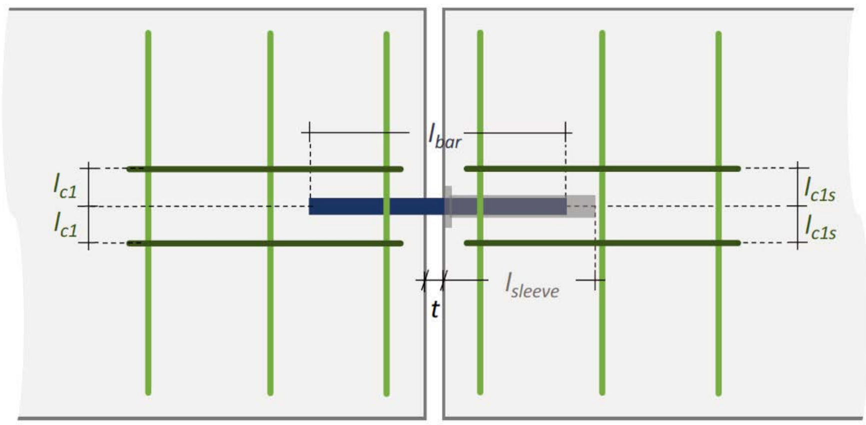
ESD-N components



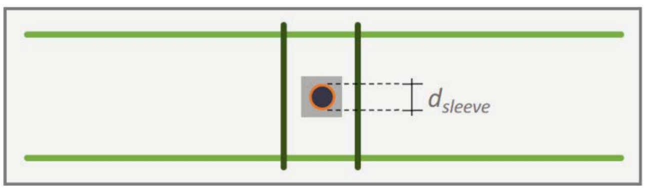
Section



Top view



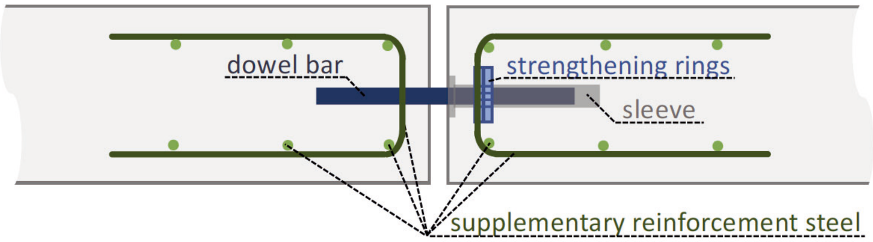
Front view



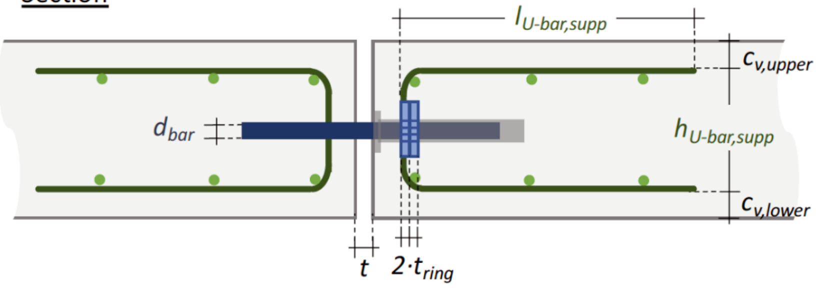
ESD Dowels – Geometrical Parameters ESD-N	**Annex A2**
Product description	

ESD-Q – Geometrical Parameters

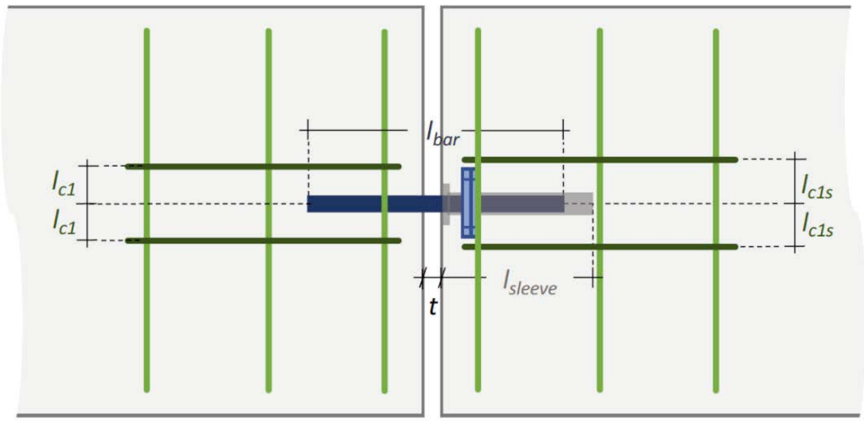
ESD-Q components



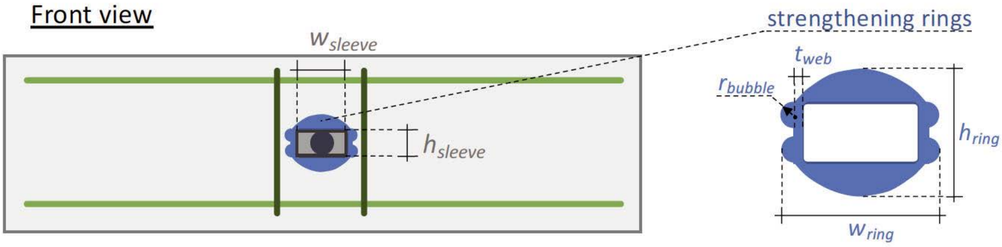
Section



Top view



Front view



ESD Dowels – Geometrical Parameters ESD-Q	Annex A3
Product description	

ESD Components		Dimensions	Material and Grades
ESD-N and ESD-Q	Bar	d_{bar} = 16 mm, 20 mm, 22 mm, 24 mm, 25 mm, 27 mm, 30 mm, 35 mm; $l_{bar} = 2 \times 5 \cdot d_{bar}$ + up to 60 mm for joint widths 10-60 mm	Galvanized steel 1.7225, 1.7227 or stainless steel 1.4571, 1.4482, 1.4462, 1.4404, 1.4362 or 1.4301; all $R_{p0,2} \geq 235$ N/mm^2
ESD-N and ESD-Q	Supplementary reinforcement steel (in each con-crete element)	2 x 1 U-bar: Ø 6 mm, Ø 8 mm, Ø 10 mm, Ø 12 mm, Ø 14 mm, Ø 16 mm or Ø 20 mm $l_{U\text{-bar,supp}} = 0{,}6 \cdot \alpha_1 \cdot \alpha_4 \cdot l_{b,rqd} + 3 \cdot \varnothing_{U\text{-bar,supp}}$ *1) $h_{U\text{-bar,supp}} = h_{slab} - c_{v,upper} - c_{v,lower}$	B 500 A/B or B 550 A/B
ESD-N	Sleeve (circular)	$d_{sleeve,in} = d_{bar}$ + 1 mm, $t_{sleeve} \geq$ 1,5 mm, $l_{sleeve} = 5 \cdot d_{bar}$ + up to 65 mm	Plastic PP, PE, PVC or stainless steel acc. to EN 1993-1-4; $R_{p0,2} \geq 235$ N/mm^2
ESD-Q	Sleeve (rectangular) with	$h_{sleeve,in} = d_{bar}$ + 1 mm, $w_{sleeve,in} \geq d_{bar}$ + 30 mm, $t_{sleeve} \geq$ 1,5 mm, $l_{sleeve} = 5 \cdot d_{bar}$ + up to 65 mm	Stainless steel acc. to EN 1993-1-4; $R_{p0,2} \geq 235$ N/mm^2
ESD-Q	2 strengthening rings	$h_{ring} = h_{sleeve,out} + 2 \cdot 0{,}35 \cdot d_{bar}^{6/5}$ $w_{ring} = w_{sleeve,out} + 2 \cdot (t_{web} + r_{bubble})$ $t_{web} = 0{,}005 \cdot d_{bar}^{2}$ $r_{bubble} = d_{bar} / 4$ t_{ring} = 10 mm each	Steel S 690, $R_{p0,2} \geq 690$ N/mm^2 acc. to EN 10149-2

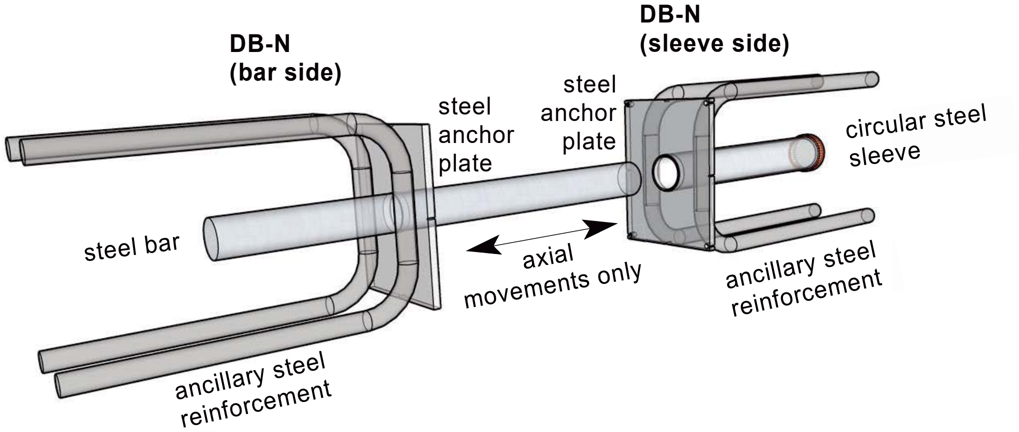
*1) The coefficient α_1 is set to 1.0 for straight legs of the supplementary reinforcement U-bars. The coefficient α_1 is set to 0.7 for standard bends, standard hooks or standard loops at the end of the supplementary reinforcement U-bars.

The coefficient α_4 is usually set to 1.0. If there is a confinement by a transverse reinforcement bar with $\varnothing_t \geq 0.6 \cdot \varnothing_{U\text{-bar,supp}}$ welded to each leg of the supplementary reinforcement U-bars, the coefficient α_4 can be set to 0.7.

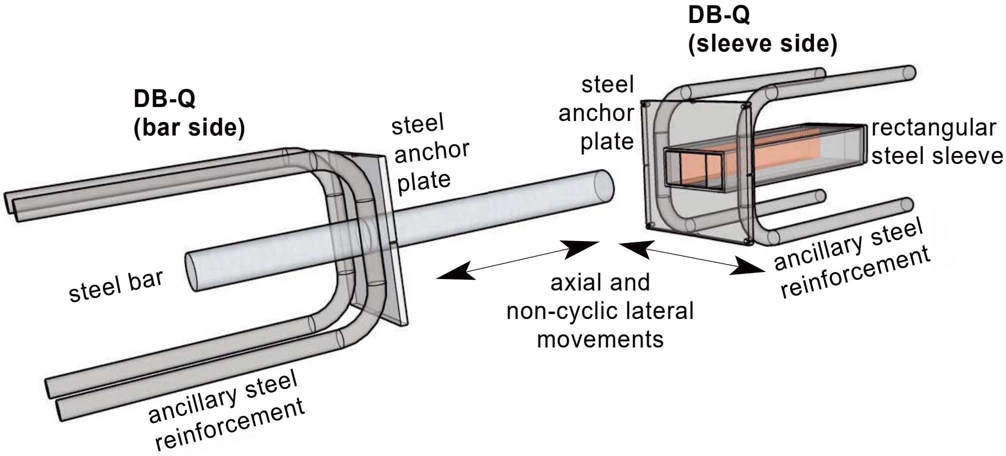
For the calculation of $l_{b,rqd}$ the coefficient α_{ct} is set to 1.0.

ESD Dowels – Components with Dimensions, Materials and Grades	Annex A4
Product description	

DB-N

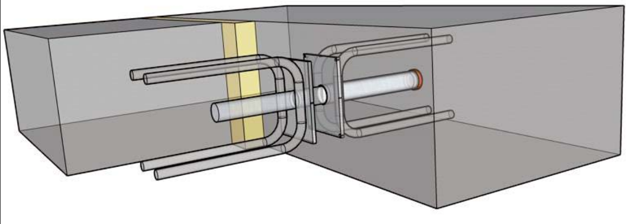


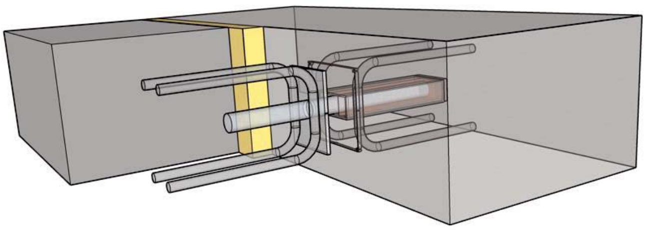
DB-Q



with DB-N for the connection of concrete elements which allows axial movements only

with DB-Q for the connection of concrete elements which allows axial and non-cyclic lateral movements

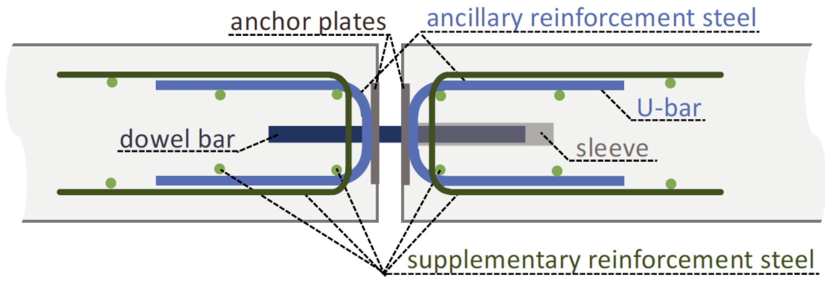




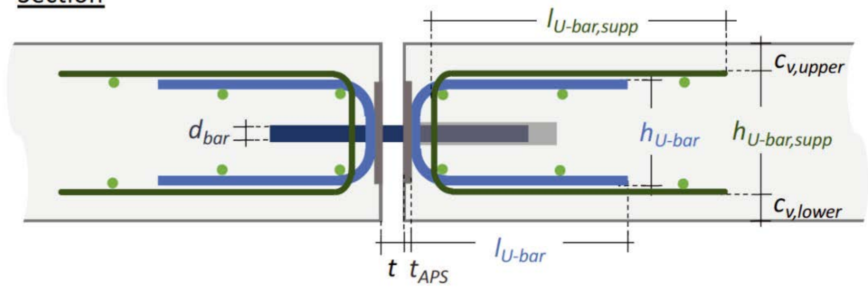
DB Dowels – DB-N and DB-Q with Intended Use	**Annex A5**
Product description	

DB – Geometrical Parameters

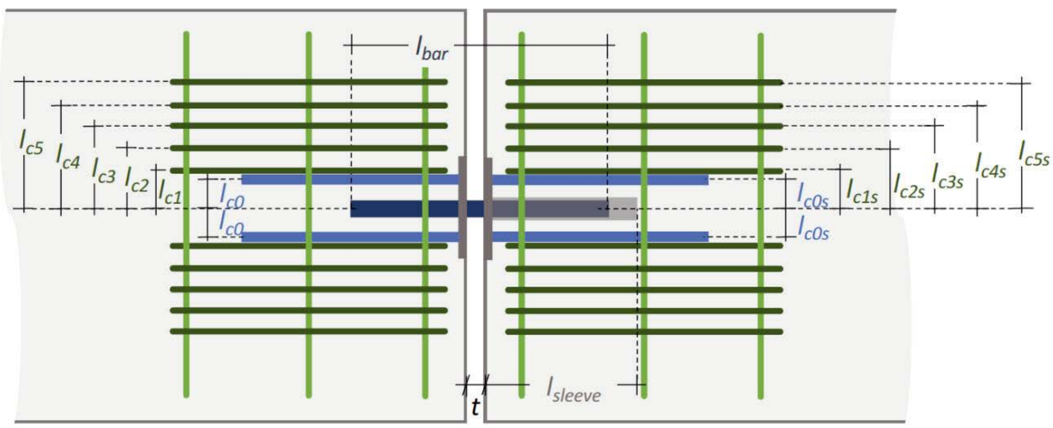
DB components



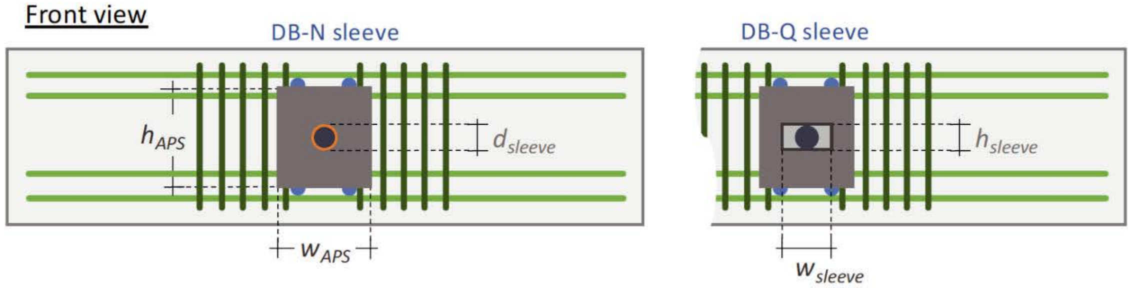
Section



Top view



Front view



DB Dowels – Geometrical Parameters DB-N and DB-Q	Annex A6
Product description	

DB Components		**Dimensions**	**Material and Grades**
DB-N and DB-Q	Bar	d_{bar} = 20 mm, 22 mm, 24 mm, 25 mm, 27 mm, 30 mm, 35 mm, 40 mm; $l_{bar} = 2 \times 5 \cdot d_{bar}$ + up to 60 mm for joint widths 10-60 mm and $l_{bar} = 2 \times 5 \cdot d_{bar}$ + 61 mm up to 120 mm for joint widths 61-120 mm	Galvanized steel 1.7225, 1.7227 or stainless steel 1.4571, 1.4482, 1.4462, 1.4404, 1.4362 or 1.4301; all $R_{p0,2} \geq 460$ N/mm^2
	Anchor plate*1)	w_{APS} = 65 mm up to 200 mm h_{APS} = 85 mm up to 210 mm t_{APS} = 4 mm up to 10 mm	Stainless steel 1.4571, 1.4482, 1.4462, 1.4404, 1.4307 or 1.4301; all $R_{p0,2} \geq 235$ N/mm^2
	Ancillary reinforcement steel *2) (welded on the anchor plate)	2 x 1 U-bar: Ø 10 mm, Ø 12 mm, Ø 14 mm, Ø 16 mm, Ø 20 mm or Ø 25 mm $l_{U\text{-}bar} \approx 0{,}3 \cdot \alpha_1 \cdot \alpha_4 \cdot l_{b,rqd} + 3\ Ø_{U\text{-}bar}$ *3) $h_{U\text{-}bar} \approx 5 \cdot d_{bar}$	B 500 A/B NR, B 500 A/B or B 550 A/B up to Ø 25 mm; Stainless steel 1.4571, 1.4482, 1.4462, 1.4404, 1.4362, 1.4301 up to Ø 25 mm; all $R_{p0,2} \geq 450$ N/mm^2
	Supplementary reinforcement steel (in each concrete element)	2 x 1 up to 2 x 5 U-bars: Ø 10 mm, Ø 12 mm, Ø 14 mm, Ø 16 mm, Ø 20 mm, Ø 25 mm or Ø 26 mm $l_{U\text{-}bar,supp} \approx 0{,}6 \cdot \alpha_1 \cdot \alpha_4 \cdot l_{b,rqd} + 3\ Ø_{U\text{-}bar,supp}$ *3) $h_{U\text{-}bar,supp} = h_{slab} - c_{v,upper} - c_{v,lower}$	B 500 A/B or B 550 A/B
DB-N	Sleeve (circular)	$d_{sleeve,in} = d_{bar}$ + 1 mm, $t_{sleeve} \geq$ 1,5 mm, $l_{sleeve} = 5 \cdot d_{bar}$ + up to 65 mm	Stainless steel acc. to EN 1993-1-4; all $R_{p0,2} \geq 235$ N/mm^2
DB-Q	Sleeve (rectangular)	$h_{sleeve,in} = d_{bar}$ + 1 mm, $t_{sleeve} \geq$ 1,5 mm, $w_{sleeve,in} \geq d_{bar}$ + 30 mm, $l_{sleeve} = 5 \cdot d_{bar}$ + up to 65 mm	Stainless steel acc. to EN 1993-1-4; all $R_{p0,2} \geq 235$ N/mm^2

*1) The height and width of the anchor plate can be increased slightly to meet the required thickness of concrete cover for the ancillary reinforcement steel.

*2) A normal reinforcing steel B 500 A/B can be used, if the thickness of the concrete cover in accordance with EN 1992-1-1 is fulfilled, which can be controlled, for example, by the dimensions of the anchor plate.

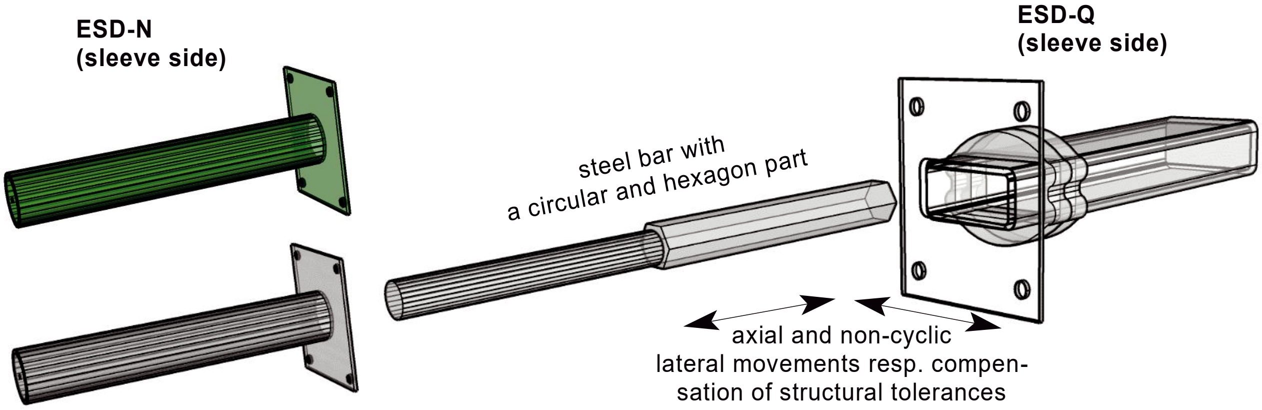
*3) The coefficient α_1 is set to 1.0 for straight legs of the supplementary reinforcement U-bars. The coefficient α_1 is set to 0.7 for standard bends, standard hooks or standard loops at the end of the supplementary reinforcement U-bars.

The coefficient α_4 is usually set to 1.0. If there is a confinement by a transverse reinforcement bar with $Ø_t \geq 0.6 \cdot Ø_{U\text{-}bar,supp}$ welded to each leg of the supplementary reinforcement U-bars, the coefficient α_4 can be set to 0.7.

For the calculation of $l_{b,rqd}$ the coefficient α_{ct} is set to 1.0.

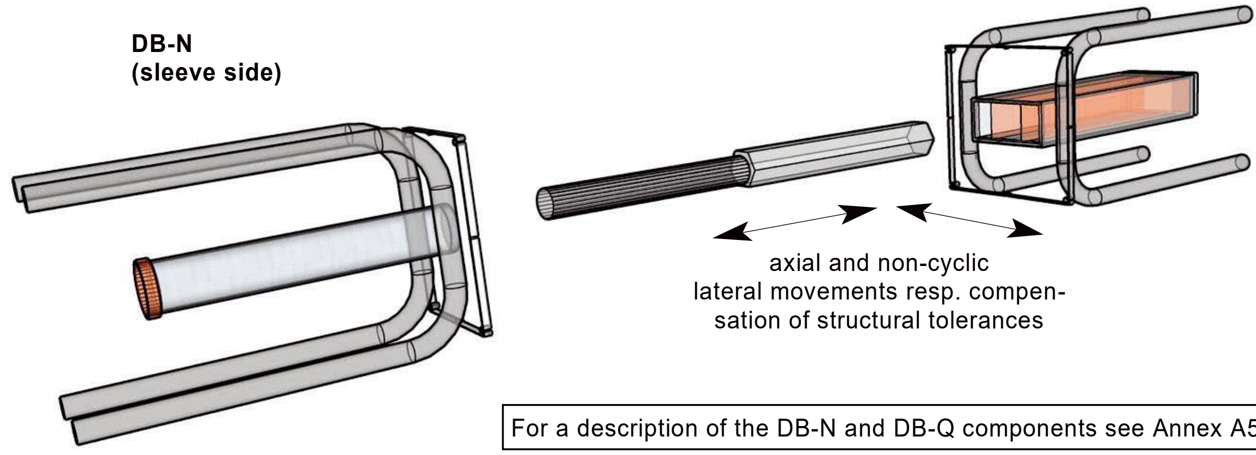
DB Dowels – Components with Dimensions, Materials and Grades	**Annex A7**
Product description	

NURSID with ESD



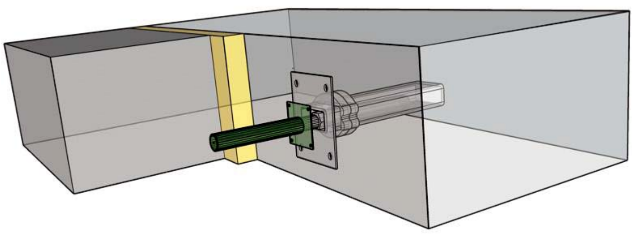
For a description of the ESD-N and ESD-Q components see Annex A1

NURSID with DB

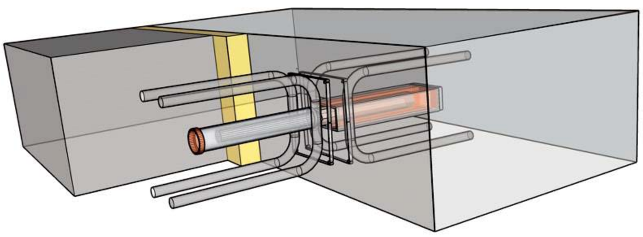


For a description of the DB-N and DB-Q components see Annex A5

NURSID with ESD for the connection of concrete elements which allows axial and non-cyclic lateral movements respectively compensates structural tolerances

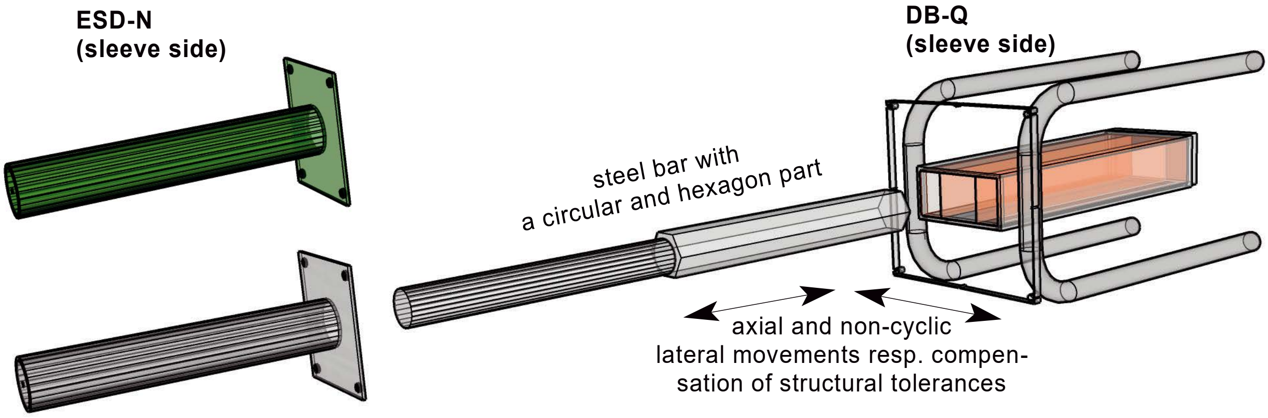


NURSID with DB for the connection of concrete elements which allows axial and non-cyclic lateral movements respectively compensates structural tolerances



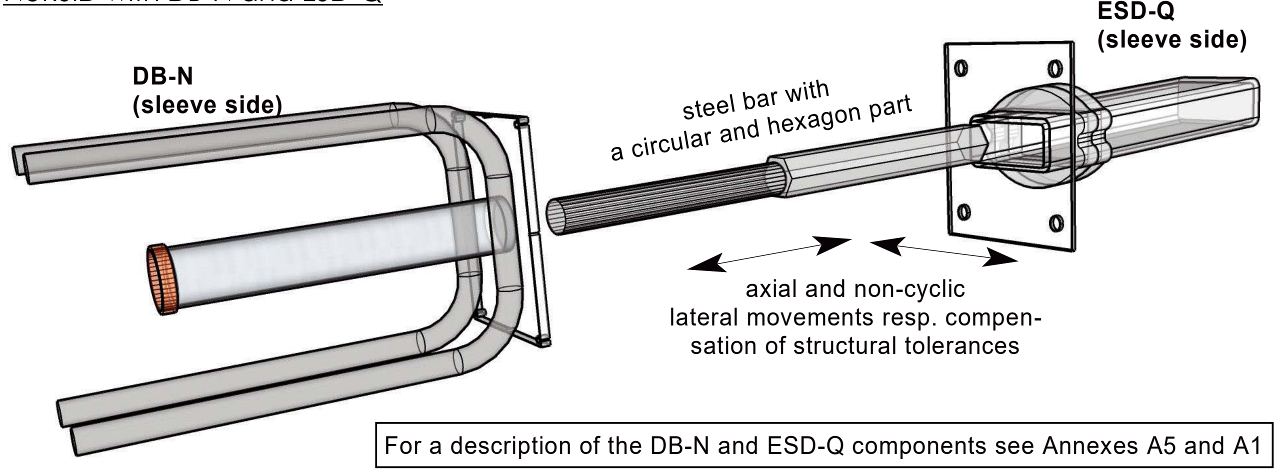
NURSID Dowels – NURSID Combinations with Intended Use	**Annex A8**
Product description	

NURSID with ESD-N and DB-Q



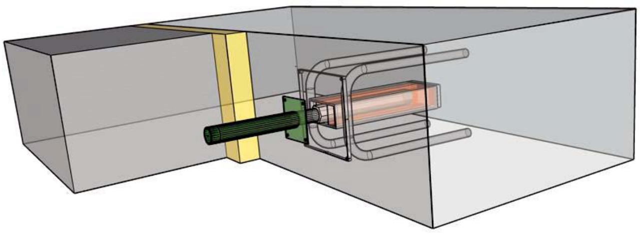
For a description of the ESD-N and DB-Q components see Annexes A1 and A5

NURSID with DB-N and ESD-Q

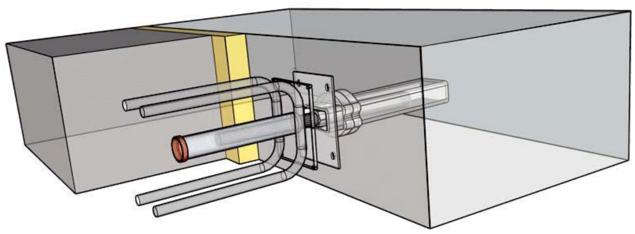


For a description of the DB-N and ESD-Q components see Annexes A5 and A1

NURSID with ESD-N and DB-Q for the connec tion of concrete elements which allows axial and non-cyclic lateral movements respectively compensates structural tolerances



NURSID with DB-N and ESD-Q for the connec tion of concrete elements which allows axial and non-cyclic lateral movements respectively compensates structural tolerances



NURSID Dowels – NURSID Combinations with Intended Use	**Annex A9**
Product description	

NURSID Components		Dimensions	Material and Grades
NURSID	Bar (with a circular and hexagon part)	$d_{bar,circ/hexa}$ = 20 / 24 mm, 20 / 30 mm, 22 / 27 mm, 22 / 30 mm, 25 / 36 mm, 30 / 41 mm*1); $l_{bar,circ} = l_{bar,hexa} = 5 \cdot d_{bar,circ}$ + 30 mm; $l_{bar} = 10 \cdot d_{bar,circ}$ + 60 mm for joint widths 10-30 mm*2)	Galvanized steel 1.7225, 1.7227 or stainless steel 1.4571, 1.4482, 1.4462, 1.4404, 1.4362 or 1.4301; all $R_{p0,2} \geq 355$ N/mm²
ESD-N and ESD-Q	Sleeve (circular)	$d_{sleeve,in} = d_{bar,circ}$ + 1 mm, $t_{sleeve} \geq 1{,}5$ mm, $l_{sleeve} = 5 \cdot d_{bar,circ}$ + 35 mm*2)	Plastic PP, PE, PVC or stainless steel acc. to EN 1993-1-4; $R_{p0,2} \geq 235$ N/mm²
	Sleeve (rectangular) with 2 strengthening rings	$h_{sleeve,in} = d_{bar,hexa}$ + 1 mm, $w_{sleeve,in} \geq d_{bar,hexa}$ + 30 mm, $t_{sleeve} \geq 1{,}5$ mm, $l_{sleeve} = 5 \cdot d_{bar,circ}$ + 35 mm*2) $h_{ring} = h_{sleeve,out} + 2 \cdot 0{,}35 \cdot d_{bar,hexa}^{6/5}$ $w_{ring} = w_{sleeve,out} + 2 \cdot (t_{web} + r_{bubble})$ $t_{web} = 0{,}005 \cdot d_{bar,hexa}^{2}$ $r_{bubble} = d_{bar,hexa} / 4$ t_{ring} = 10 mm each	Stainless steel acc. to EN 1993-1-4, $R_{p0,2} \geq 235$ N/mm² Steel S 690, $R_{p0,2} \geq 690$ N/mm² acc. to EN 10149-2
	Supplementary reinforcement steel (in each concrete element)	2 x 1 U-bar: Ø 6 mm, Ø 8 mm, Ø 10 mm, Ø 12 mm, Ø 14 mm, Ø 16 mm or Ø 20 mm $l_{U\text{-}bar,supp} = 0{,}6 \cdot \alpha_1 \cdot \alpha_4 \cdot l_{b,rqd} + 3 \cdot Ø_{U\text{-}bar,supp}$*3) $h_{U\text{-}bar,supp} = h_{slab} - c_{v,upper} - c_{v,lower}$	B 500 A or B or B 550 A/B

Continuation of the table on the next page, see Annex A11

*1) The diameter of the hexagon part of the dowel bar $d_{bar,hexa}$ corresponds to the size of an open-ended wrench. The diameter of the hexagon part is always greater than the diameter of the circular part and the hexagon section covers fully the circular section. So the circular part of the dowel bar is always decisive with regard to steel failure. Other combinations of circular and hexagon diameters are also possible in the range of the ESD and DB dowel bar sizes.

*2) The dowel bar length and the sleeve lengths on both sides are chosen in a way, that the axial movement can take place on each side, whereas the minimum dowel bar length inside the concrete slab is still $5 \cdot d_{bar,circ}$ on each side.

*3) The coefficient α_1 is set to 1.0 for straight legs of the supplementary reinforcement U-bars. The coefficient α_1 is set to 0.7 for standard bends, standard hooks or standard loops at the end of the supplementary reinforcement U-bars.

The coefficient α_4 is usually set to 1.0. If there is a confinement by a transverse reinforcement bar with $Ø_t \geq 0.6 \cdot Ø_{U\text{-}bar,supp}$ welded to each leg of the supplementary reinforcement U-bars, the coefficient α_4 can be set to 0.7.

For the calculation of $l_{b,rqd}$ the coefficient α_{ct} is set to 1.0.

NURSID Dowels – Components with Dimensions, Materials and Grades (Pt. 1)	**Annex A10**
Product description	

Continuation of the table from the previous page, see Annex A10

NURSID Components		**Dimensions**	**Material and Grades**
DB-N and DB-Q	Sleeve (circular)	$d_{\text{sleeve,in}} = d_{\text{bar,circ}} + 1$ mm, $t_{\text{sleeve}} \geq 1{,}5$ mm, $l_{\text{sleeve}} = 5 \cdot d_{\text{bar,circ}} + 35$ mm*2)	Stainless steel acc. to EN 1993-1-4; all $R_{p0,2} \geq 235$ N/mm^2
	Sleeve (rectangular)	$h_{\text{sleeve,in}} = d_{\text{bar,hexa}} + 1$ mm, $t_{\text{sleeve}} \geq 1{,}5$ mm, $w_{\text{sleeve,in}} \geq d_{\text{bar,hexa}} + 30$ mm, $l_{\text{sleeve}} = 5 \cdot d_{\text{bar,circ}} + 35$ mm*2)	Stainless steel acc. to EN 1993-1-4; all $R_{p0,2} \geq 235$ N/mm^2
	Anchor plate*4)	w_{APS} = 65 mm up to 200 mm h_{APS} = 85 mm up to 210 mm t_{APS} = 4 mm up to 10 mm	Stainless steel 1.4571, 1.4482, 1.4462, 1.4404, 1.4307 or 1.4301; all $R_{p0,2} \geq 235$ N/mm^2
	Ancillary reinforcement steel *5) (welded on the anchor plate)	2 x 1 U-bar: Ø 10 mm, Ø 12 mm, Ø 14 mm, Ø 16 mm, Ø 20 mm or Ø 25 mm $l_{\text{U-bar}} \approx 0{,}3 \cdot \alpha_1 \cdot \alpha_4 \cdot l_{\text{b,rqd}} + 3\ Ø_{\text{U-bar}}$ *3) $h_{\text{U-bar}} \approx 5 \cdot d_{\text{bar}}$	B 500 A/B NR, B 500 A/B or B 550 A/B up to Ø 25 mm; Stainless steel 1.4571, 1.4482, 1.4462, 1.4404, 1.4362, 1.4301 up to Ø 25 mm; all $R_{p0,2} \geq 450$ N/mm^2
	Supplementary reinforcement steel (in each concrete element)	2 x 1 up to 2 x 5 U-bars: Ø 10 mm, Ø 12 mm, Ø 14 mm, Ø 16 mm, Ø 20 mm, Ø 25 mm or Ø 26 mm $l_{\text{U-bar,supp}} \approx 0{,}6 \cdot \alpha_1 \cdot \alpha_4 \cdot l_{\text{b,rqd}} + 3\ Ø_{\text{U-bar,supp}}$ *3) $h_{\text{U-bar,supp}} = h_{\text{slab}} - c_{\text{v,upper}} - c_{\text{v,lower}}$	B 500 A/B or B 550 A/B

*2) The dowel bar length and the sleeve lengths on both sides are chosen in a way, that the axial movement can take place on each side, whereas the minimum dowel bar length inside the concrete slab is still $5 \cdot d_{\text{bar,circ}}$ on each side.

*3) The coefficient α_1 is set to 1.0 for straight legs of the supplementary reinforcement U-bars. The coefficient α_1 is set to 0.7 for standard bends, standard hooks or standard loops at the end of the supplementary reinforcement U-bars.

The coefficient α_4 is usually set to 1.0. If there is a confinement by a transverse reinforcement bar with $Ø_t \geq 0.6 \cdot Ø_{\text{U-bar,supp}}$ welded to each leg of the supplementary reinforcement U-bars, the coefficient α_4 can be set to 0.7.

For the calculation of $l_{\text{b,rqd}}$ the coefficient α_{ct} is set to 1.0.

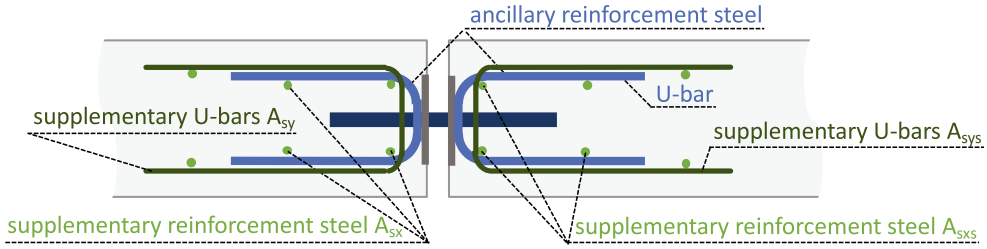
*4) The height and width of the anchor plate can be increased slightly to meet the required thickness of concrete cover for the ancillary reinforcement steel.

*5) A normal reinforcing steel B 500 A/B can be used, if the thickness of the concrete cover in accordance with EN 1992-1-1 is fulfilled, which can be controlled, for example, by the dimensions of the anchor plate.

NURSID Dowels – Components with Dimensions, Materials and Grades (Pt. 2)	**Annex A11**
Product description	

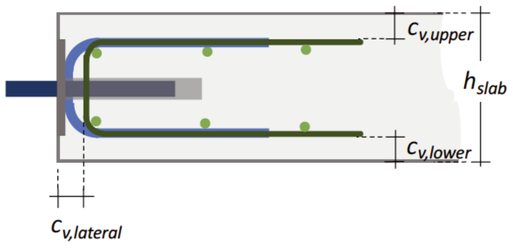
DB – Arrangement of Supplementary Reinforcement Steel

Designation of components



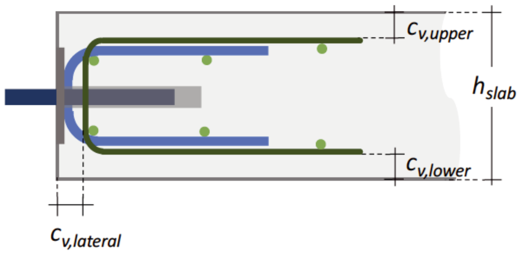
$A_{sx} \geq 2x\ 3ØA_{sy}$ and $A_{sxs} \geq 2x\ 3ØA_{sys}$ with A_{sy} and A_{sys} acc. to Annex B10

Arrangement of supplementary reinforcement steel at small slab thicknesses

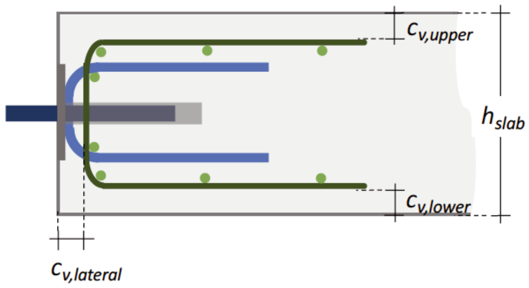


The minimum slab thickness is:
min $h_{slab} = h_{U\text{-}bar} + c_{v,upper} + c_{v,lower}$
$\geq \max(6 \cdot d_{bar}\ ;\ 150\ mm)$
with $h_{U\text{-}bar}$ acc. to Annex B13

Arrangement of supplementary reinforcement steel at average slab thicknesses



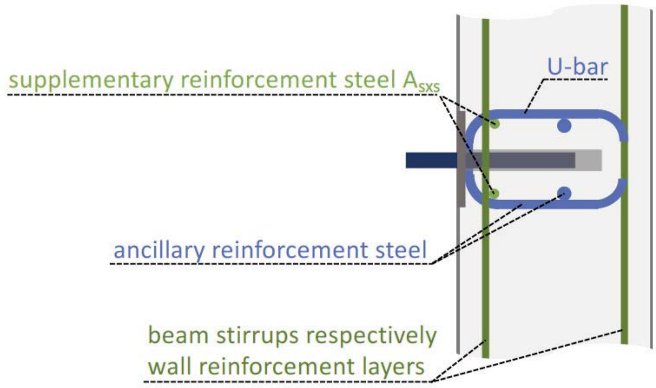
Arrangement of supplementary reinforcement steel at greater slab thicknesses



DB Dowels – Arrangement of Reinforcement Steel	**Annex A12**
Product description	

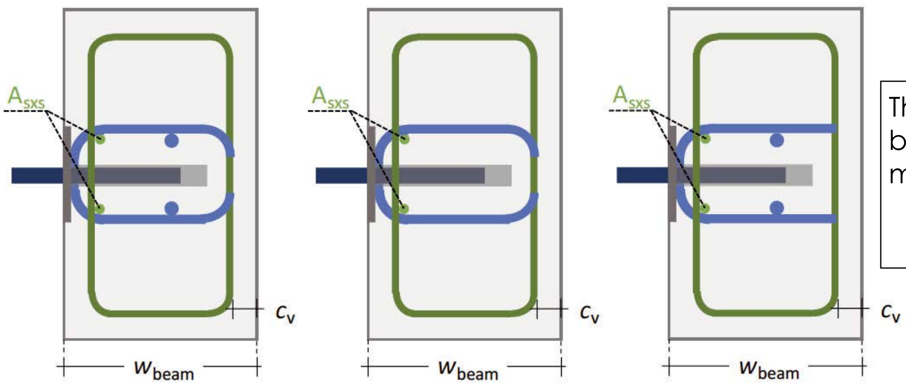
DB – Arrangement of Reinforcement Steel Bars

Designation of components



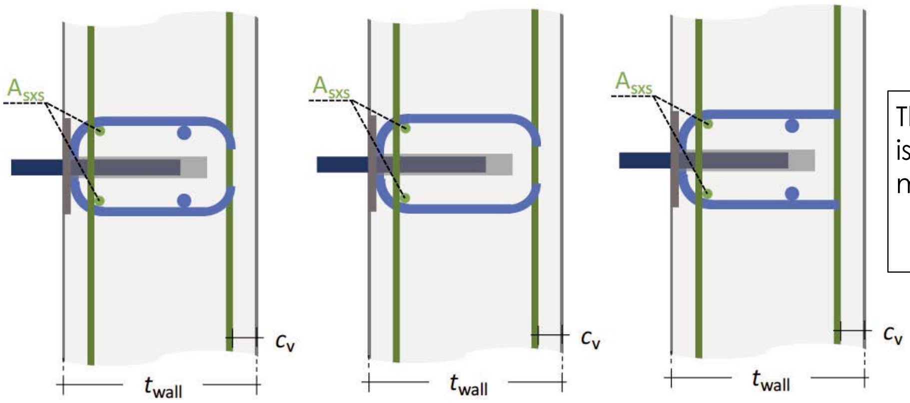
$A_{sx} = A_{sxs} = 2Ø_{U\text{-}bar}$

Arrangement of ancillary and supplementary reinforcement steel bars at beams



The minimum width of the beam is:
min $w_{beam} = t_{APS} + l_{U\text{-}bar} + c_v$
with t_{APS} and $l_{U\text{-}bar}$ acc. to Annexes A7 and A11

Arrangement of ancillary and supplementary reinforcement steel bars at walls



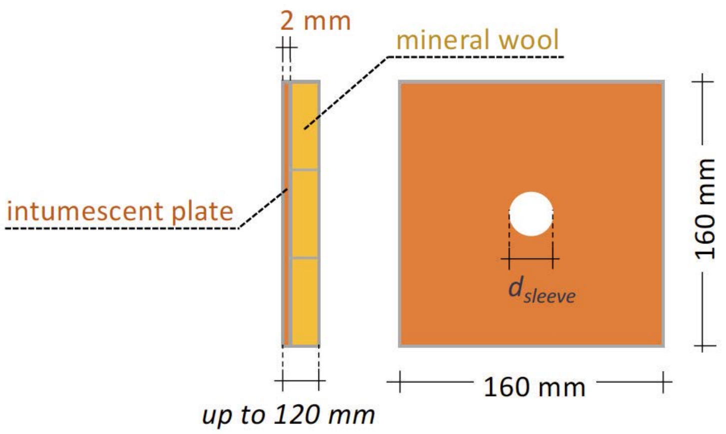
The minimum wall thickness is:
min $t_{wall} = t_{APS} + l_{U\text{-}bar} + c_v$
with t_{APS} and $l_{U\text{-}bar}$ acc. to Annexes A7 and A11

DB Dowels – Arrangement of Reinforcement Steel	**Annex A13**
Product description	

Fire Protection Collars for ESD and DB

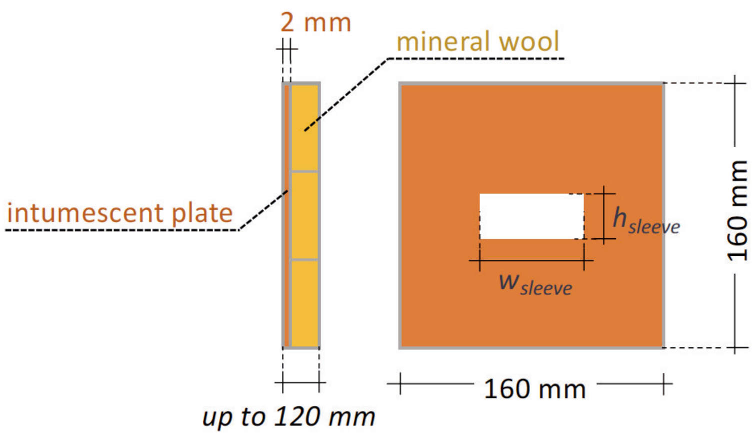
Material and dimensions

for ESD-N and DB-N



with d_{sleeve} acc. to Annexes A4 and A7

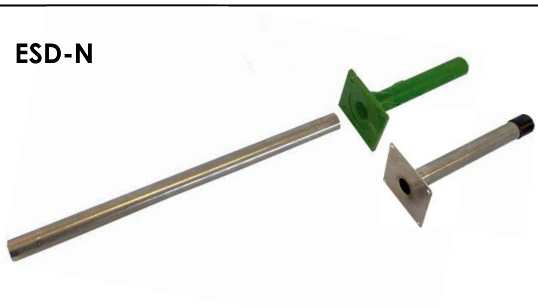
for ESD-Q and DB-Q

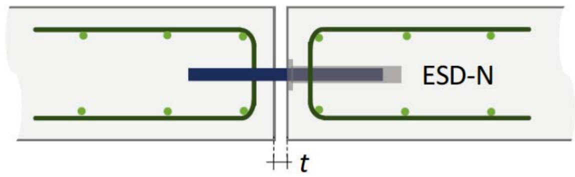


with h_{sleeve} and w_{sleeve} acc. to Annexes A4 and A7

Fire Protection Collars	Annex A14
Product description	

ESD-N





Note: In case of two-directional forces acting perpendicular to the dowel axis the shear force $V_{Ed,s}$ has to be determined as resultant force.

ESD-N, dowel bar $R_{p0,2}$ = 750 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]					
		10	20	30	40	50	60
d bar [mm]	Ø 16	32,2	23,3	18,2	15,0	12,7	11,0
	Ø 20	54,5	40,9	32,7	27,3	23,4	20,5
	Ø 22	68,1	51,9	41,9	35,1	30,3	26,6
	Ø 24	83,1	64,3	52,4	44,2	38,2	33,7
	Ø 25	91,1	71,0	58,1	49,2	42,6	37,6
	Ø 27	108,3	85,7	70,6	60,1	52,3	46,3
	Ø 30	136,9	110,5	92,0	78,9	69,0	61,4
	Ø 35	191,8	159,5	134,9	116,9	103,2	92,3

ESD-N, dowel bar $R_{p0,2}$ = 690 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]					
		10	20	30	40	50	60
d bar [mm]	Ø 16	29,6	21,4	16,8	13,8	11,7	10,1
	Ø 20	50,2	37,6	30,1	25,1	21,5	18,8
	Ø 22	62,6	47,7	38,5	32,3	27,8	24,4
	Ø 24	76,4	59,1	48,2	40,6	35,2	31,0
	Ø 25	83,8	65,3	53,5	45,2	39,2	34,6
	Ø 27	99,6	78,8	65,0	55,3	48,1	42,6
	Ø 30	125,9	101,6	84,7	72,6	63,5	56,5
	Ø 35	176,5	146,7	124,1	107,6	94,9	84,9

ESD-N, dowel bar $R_{p0,2}$ = 460 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]					
		10	20	30	40	50	60
d bar [mm]	Ø 16	19,8	14,3	11,2	9,2	7,8	6,8
	Ø 20	33,5	25,1	20,1	16,7	14,3	12,5
	Ø 22	41,7	31,8	25,7	21,5	18,6	16,3
	Ø 24	50,9	39,4	32,1	27,1	23,4	20,6
	Ø 25	55,9	43,6	35,6	30,2	26,1	23,1
	Ø 27	66,4	52,5	43,3	36,9	32,1	28,4
	Ø 30	83,9	67,7	56,5	48,4	42,3	37,6
	Ø 35	117,6	97,8	82,8	71,7	63,3	56,6

ESD-N – Resistances to Steel Failure

Performances

Annex B1

ESD-N (continued)

ESD-N, dowel bar $R_{p0,2}$ = 355 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width t [mm]					
		10	20	30	40	50	60
d_{bar} [mm]	Ø 16	15,3	11,0	8,6	7,1	6,0	5,2
	Ø 20	25,8	19,4	15,5	12,9	11,1	9,7
	Ø 22	32,2	24,5	19,8	16,6	14,3	12,6
	Ø 24	39,3	30,4	24,8	20,9	18,1	15,9
	Ø 25	43,1	33,6	27,5	23,3	20,2	17,8
	Ø 27	51,3	40,5	33,4	28,4	24,7	21,9
	Ø 30	64,8	52,3	43,6	37,3	32,7	29,0
	Ø 35	90,8	75,5	63,9	55,3	48,8	43,7

ESD-N, dowel bar $R_{p0,2}$ = 275 N/mm²

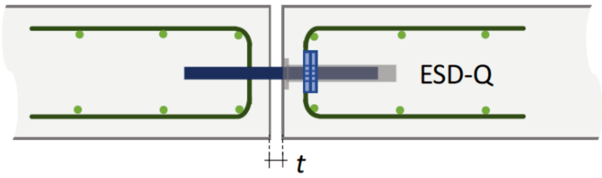
$V_{Rd,s,ULS}$ [kN]		joint width t [mm]					
		10	20	30	40	50	60
d_{bar} [mm]	Ø 16	11,8	8,5	6,7	5,5	4,7	4,0
	Ø 20	20,0	15,0	12,0	10,0	8,6	7,5
	Ø 22	25,0	19,0	15,4	12,9	11,1	9,7
	Ø 24	30,5	23,6	19,2	16,2	14,0	12,3
	Ø 25	33,4	26,0	21,3	18,0	15,6	13,8
	Ø 27	39,7	31,4	25,9	22,0	19,2	17,0
	Ø 30	50,2	40,5	33,8	28,9	25,3	22,5
	Ø 35	70,3	58,5	49,5	42,9	37,8	33,8

ESD-N, dowel bar $R_{p0,2}$ = 235 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width t [mm]					
		10	20	30	40	50	60
d_{bar} [mm]	Ø 16	10,1	7,3	5,7	4,7	4,0	3,5
	Ø 20	17,1	12,8	10,3	8,5	7,3	6,4
	Ø 22	21,3	16,2	13,1	11,0	9,5	8,3
	Ø 24	26,0	20,1	16,4	13,8	12,0	10,5
	Ø 25	28,5	22,3	18,2	15,4	13,4	11,8
	Ø 27	33,9	26,8	22,1	18,8	16,4	14,5
	Ø 30	42,9	34,6	28,8	24,7	21,6	19,2
	Ø 35	60,1	50,0	42,3	36,6	32,3	28,9

ESD-N – Resistances to Steel Failure	**Annex B2**
Performances	

ESD-Q



ESD-Q, dowel bar $R_{p0,2}$ = 750 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]					
		10	20	30	40	50	60
d_{bar} [mm]	Ø 16	29,0	20,9	16,4	13,5	11,4	9,9
	Ø 20	49,1	36,8	29,5	24,5	21,0	18,4
	Ø 22	61,2	46,7	37,7	31,6	27,2	23,9
	Ø 24	74,7	57,8	47,1	39,8	34,4	30,3
	Ø 25	82,0	63,9	52,3	44,3	38,4	33,8
	Ø 27	97,5	77,1	63,6	54,1	47,1	41,6
	Ø 30	123,2	99,4	82,8	71,0	62,1	55,2
	Ø 35	172,6	143,5	121,4	105,2	92,9	83,1

ESD-Q, dowel bar $R_{p0,2}$ = 690 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]					
		10	20	30	40	50	60
d_{bar} [mm]	Ø 16	26,7	19,3	15,1	12,4	10,5	9,1
	Ø 20	45,2	33,9	27,1	22,6	19,4	16,9
	Ø 22	56,3	42,9	34,7	29,1	25,0	22,0
	Ø 24	68,8	53,2	43,4	36,6	31,6	27,9
	Ø 25	75,4	58,8	48,1	40,7	35,3	31,1
	Ø 27	89,7	70,9	58,5	49,8	43,3	38,3
	Ø 30	113,3	91,5	76,2	65,3	57,2	50,8
	Ø 35	158,8	132,0	111,7	96,8	85,4	76,4

ESD-Q, dowel bar $R_{p0,2}$ = 460 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]					
		10	20	30	40	50	60
d_{bar} [mm]	Ø 16	17,8	12,8	10,1	8,3	7,0	6,1
	Ø 20	30,1	22,6	18,1	15,1	12,9	11,3
	Ø 22	37,6	28,6	23,1	19,4	16,7	14,7
	Ø 24	45,8	35,5	28,9	24,4	21,1	18,6
	Ø 25	50,3	39,2	32,1	27,1	23,5	20,8
	Ø 27	59,8	47,3	39,0	33,2	28,9	25,5
	Ø 30	75,6	61,0	50,8	43,6	38,1	33,9
	Ø 35	105,9	88,0	74,5	64,5	57,0	51,0

ESD-Q – Resistances to Steel Failure	**Annex B3**
Performances	

ESD-Q (continued)

ESD-Q, dowel bar $R_{p0,2}$ = 355 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]					
		10	20	30	40	50	60
d_{bar} [mm]	Ø 16	13,7	9,9	7,8	6,4	5,4	4,7
	Ø 20	23,2	17,4	13,9	11,6	10,0	8,7
	Ø 22	29,0	22,1	17,8	15,0	12,9	11,3
	Ø 24	35,4	27,4	22,3	18,8	16,3	14,3
	Ø 25	38,8	30,3	24,8	20,9	18,2	16,0
	Ø 27	46,1	36,5	30,1	25,6	22,3	19,7
	Ø 30	58,3	47,1	39,2	33,6	29,4	26,1
	Ø 35	81,7	67,9	57,5	49,8	44,0	39,3

ESD-Q, dowel bar $R_{p0,2}$ = 275 N/mm²

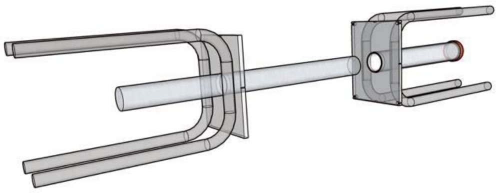
$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]					
		10	20	30	40	50	60
d_{bar} [mm]	Ø 16	10,6	7,7	6,0	4,9	4,2	3,6
	Ø 20	18,0	13,5	10,8	9,0	7,7	6,8
	Ø 22	22,5	17,1	13,8	11,6	10,0	8,8
	Ø 24	27,4	21,2	17,3	14,6	12,6	11,1
	Ø 25	30,1	23,4	19,2	16,2	14,1	12,4
	Ø 27	35,7	28,3	23,3	19,8	17,3	15,3
	Ø 30	45,2	36,5	30,4	26,0	22,8	20,3
	Ø 35	63,3	52,6	44,5	38,6	34,0	30,5

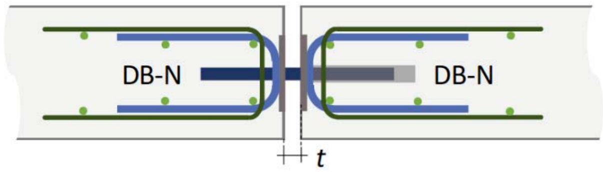
ESD-Q, dowel bar $R_{p0,2}$ = 235 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]					
		10	20	30	40	50	60
d_{bar} [mm]	Ø 16	9,1	6,6	5,1	4,2	3,6	3,1
	Ø 20	15,4	11,5	9,2	7,7	6,6	5,8
	Ø 22	19,2	14,6	11,8	9,9	8,5	7,5
	Ø 24	23,4	18,1	14,8	12,5	10,8	9,5
	Ø 25	25,7	20,0	16,4	13,9	12,0	10,6
	Ø 27	30,5	24,2	19,9	16,9	14,7	13,1
	Ø 30	38,6	31,1	26,0	22,2	19,5	17,3
	Ø 35	54,1	45,0	38,0	33,0	29,1	26,0

ESD-Q – Resistances to Steel Failure (continued)	**Annex B4**
Performances	

DB-N





Note: In case of two-directional forces acting perpendicular to the dowel axis the shear force $V_{Ed,s}$ has to be determined as resultant force.

DB-N, dowel bar $R_{p0,2}$ = 750 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width t [mm]											
		10	20	30	40	50	60	70	80	90	100	110	120
d_{bar} [mm]	Ø 20	92,4	73,4	54,5	40,9	32,7	27,3	23,4	20,5	18,2	16,4	14,9	13,6
	Ø 22	113,9	93,0	72,2	54,5	43,6	36,3	31,1	27,2	24,2	21,8	19,8	18,2
	Ø 24	137,6	114,9	92,1	70,7	56,6	47,1	40,4	35,3	31,4	28,3	25,7	23,6
	Ø 25	150,3	126,6	102,9	79,9	63,9	53,3	45,7	40,0	35,5	32,0	29,1	26,6
	Ø 27	177,3	151,7	126,2	100,7	80,5	67,1	57,5	50,3	44,7	40,3	36,6	33,6
	Ø 30	222,0	193,6	165,3	136,9	110,5	92,0	78,9	69,0	61,4	55,2	50,2	46,0
	Ø 35	307,7	274,6	241,5	208,4	175,3	146,2	125,3	109,6	97,4	87,7	79,7	73,1
	Ø 40	407,4	369,5	331,6	293,8	255,9	218,2	187,0	163,6	145,5	130,9	119,0	109,1

DB-N, dowel bar $R_{p0,2}$ = 690 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width t [mm]											
		10	20	30	40	50	60	70	80	90	100	110	120
d_{bar} [mm]	Ø 20	85,0	67,6	50,2	37,6	30,1	25,1	21,5	18,8	16,7	15,1	13,7	12,5
	Ø 22	104,7	85,6	66,4	50,1	40,1	33,4	28,6	25,0	22,3	20,0	18,2	16,7
	Ø 24	126,6	105,7	84,8	65,0	52,0	43,4	37,2	32,5	28,9	26,0	23,6	21,7
	Ø 25	138,2	116,5	94,7	73,5	58,8	49,0	42,0	36,8	32,7	29,4	26,7	24,5
	Ø 27	163,1	139,6	116,1	92,6	74,1	61,7	52,9	46,3	41,2	37,0	33,7	30,9
	Ø 30	204,3	178,2	152,0	125,9	101,6	84,7	72,6	63,5	56,5	50,8	46,2	42,3
	Ø 35	283,1	252,6	222,2	191,7	161,2	134,5	115,3	100,9	89,6	80,7	73,3	67,2
	Ø 40	374,8	339,9	305,1	270,3	235,5	200,7	172,1	150,5	133,8	120,4	109,5	100,4

DB-N, dowel bar $R_{p0,2}$ = 460 N/mm²

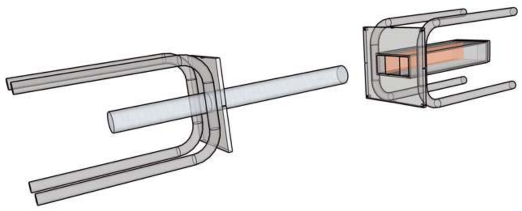
$V_{Rd,s,ULS}$ [kN]		joint width t [mm]											
		10	20	30	40	50	60	70	80	90	100	110	120
d_{bar} [mm]	Ø 20	56,7	45,0	33,5	25,1	20,1	16,7	14,3	12,5	11,2	10,0	9,1	8,4
	Ø 22	69,8	57,1	44,3	33,4	26,7	22,3	19,1	16,7	14,8	13,4	12,1	11,1
	Ø 24	84,4	70,4	56,5	43,4	34,7	28,9	24,8	21,7	19,3	17,3	15,8	14,5
	Ø 25	92,2	77,6	63,1	49,0	39,2	32,7	28,0	24,5	21,8	19,6	17,8	16,3
	Ø 27	108,7	93,1	77,4	61,7	49,4	41,2	35,3	30,9	27,4	24,7	22,4	20,6
	Ø 30	136,2	118,8	101,4	83,9	67,7	56,5	48,4	42,3	37,6	33,9	30,8	28,2
	Ø 35	188,7	168,4	148,1	127,8	107,5	89,6	76,8	67,2	59,8	53,8	48,9	44,8
	Ø 40	249,8	226,6	203,4	180,2	157,0	133,8	114,7	100,4	89,2	80,3	73,0	66,9

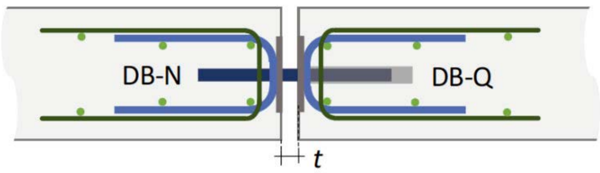
DB-N – Resistances to Steel Failure

Performances

Annex B5

DB-Q





DB-Q, dowel bar $R_{p0,2}$ = 750 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]											
		10	20	30	40	50	60	70	80	90	100	110	120
d_{bar} [mm]	Ø 20	83,1	66,1	49,1	36,8	29,5	24,5	21,0	18,4	16,4	14,7	13,4	12,3
	Ø 22	102,5	83,7	65,0	49,0	39,2	32,7	28,0	24,5	21,8	19,6	17,8	16,3
	Ø 24	123,8	103,4	82,9	63,6	50,9	42,4	36,4	31,8	28,3	25,4	23,1	21,2
	Ø 25	135,2	113,9	92,6	71,9	57,5	47,9	41,1	36,0	32,0	28,8	26,1	24,0
	Ø 27	159,6	136,6	113,6	90,6	72,5	60,4	51,8	45,3	40,3	36,2	32,9	30,2
	Ø 30	199,8	174,3	148,7	123,2	99,4	82,8	71,0	62,1	55,2	49,7	45,2	41,4
	Ø 35	277,0	247,2	217,3	187,5	157,7	131,5	112,8	98,7	87,7	78,9	71,8	65,8
	Ø 40	366,6	332,6	298,5	264,4	230,3	196,4	168,3	147,3	130,9	117,8	107,1	98,2

DB-Q, dowel bar $R_{p0,2}$ = 690 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]											
		10	20	30	40	50	60	70	80	90	100	110	120
d_{bar} [mm]	Ø 20	76,5	60,8	45,2	33,9	27,1	22,6	19,4	16,9	15,1	13,5	12,3	11,3
	Ø 22	94,3	77,0	59,8	45,1	36,1	30,1	25,8	22,5	20,0	18,0	16,4	15,0
	Ø 24	113,9	95,1	76,3	58,5	46,8	39,0	33,4	29,3	26,0	23,4	21,3	19,5
	Ø 25	124,4	104,8	85,2	66,2	52,9	44,1	37,8	33,1	29,4	26,5	24,1	22,1
	Ø 27	146,8	125,6	104,5	83,3	66,7	55,6	47,6	41,7	37,0	33,3	30,3	27,8
	Ø 30	183,8	160,3	136,8	113,3	91,5	76,2	65,3	57,2	50,8	45,7	41,6	38,1
	Ø 35	254,8	227,4	200,0	172,5	145,1	121,0	103,7	90,8	80,7	72,6	66,0	60,5
	Ø 40	337,3	305,9	274,6	243,3	211,9	180,7	154,8	135,5	120,4	108,4	98,5	90,3

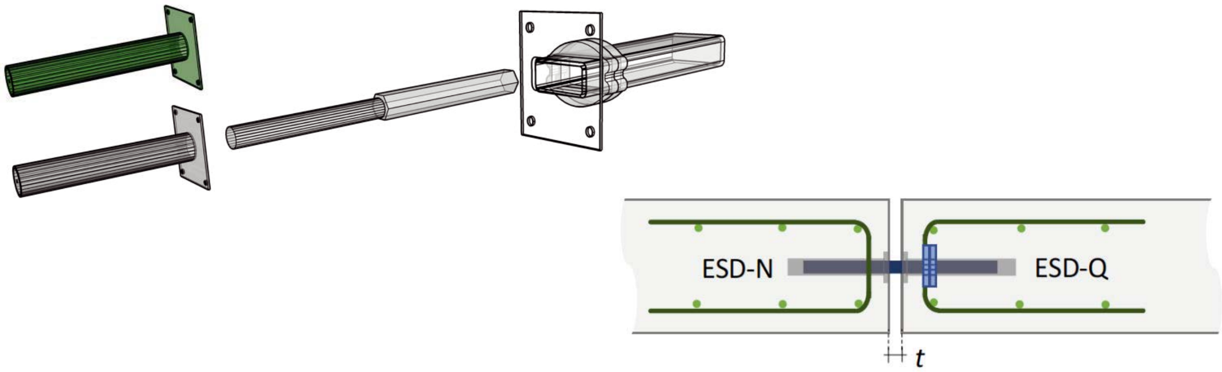
DB-Q, dowel bar $R_{p0,2}$ = 460 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]											
		10	20	30	40	50	60	70	80	90	100	110	120
d_{bar} [mm]	Ø 20	51,0	40,5	30,1	22,6	18,1	15,1	12,9	11,3	10,0	9,0	8,2	7,5
	Ø 22	62,8	51,4	39,9	30,1	24,0	20,0	17,2	15,0	13,4	12,0	10,9	10,0
	Ø 24	75,9	63,4	50,9	39,0	31,2	26,0	22,3	19,5	17,3	15,6	14,2	13,0
	Ø 25	82,9	69,9	56,8	44,1	35,3	29,4	25,2	22,1	19,6	17,6	16,0	14,7
	Ø 27	97,9	83,8	69,7	55,6	44,4	37,0	31,7	27,8	24,7	22,2	20,2	18,5
	Ø 30	122,6	106,9	91,2	75,6	61,0	50,8	43,6	38,1	33,9	30,5	27,7	25,4
	Ø 35	169,9	151,6	133,3	115,0	96,7	80,7	69,2	60,5	53,8	48,4	44,0	40,3
	Ø 40	224,9	204,0	183,1	162,2	141,3	120,4	103,2	90,3	80,3	72,3	65,7	60,2

DB-Q – Resistances to Steel Failure	**Annex B6**
Performances	

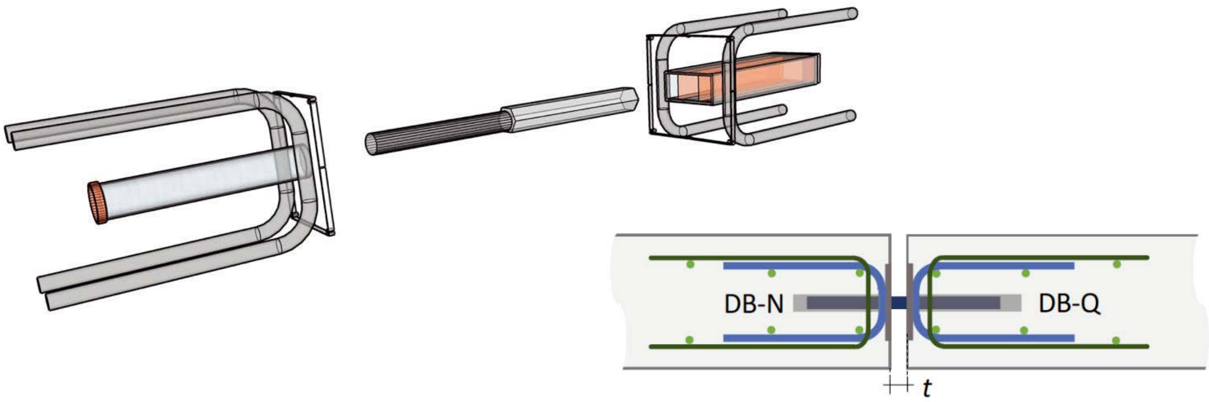
NURSID

a) NURSID combination ESD-N with ESD-Q



➥ For the NURSID combination ESD-N with ESD-Q the resistances to steel failure of ESD-Q are valid, see Annexes B3 and B4.

b) NURSID combination DB-N with DB-Q



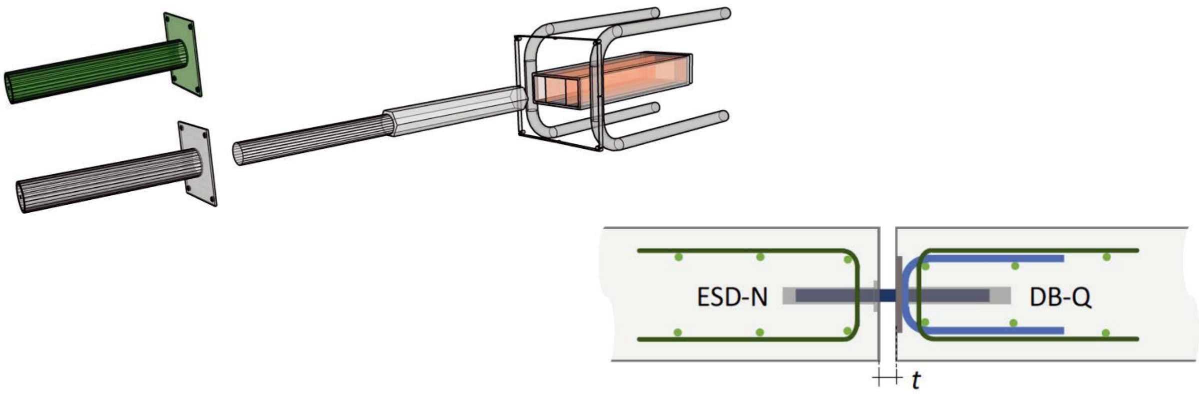
➥ For the NURSID combination DB-N with DB-Q the resistances to steel failure of DB-Q are valid, see Annex B6.

NURSID – Resistances to Steel Failure	**Annex B7**
Performances	

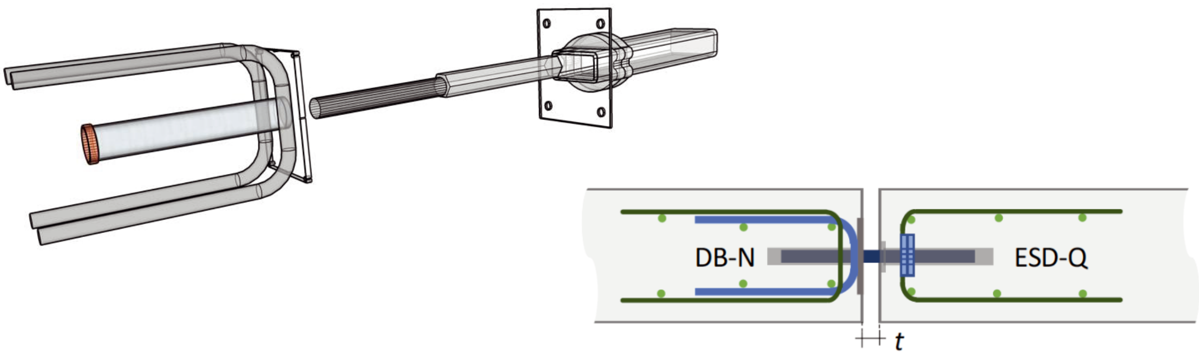
NURSID (continued)

c) NURSID crossed combinations

ESD-N with DB-Q



DB-N with ESD-Q



NURSID crossed combinations, dowel bar $R_{p0,2}$ = 750 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]		
		10	20	30
d bar [mm]	Ø 20	66,1	49,1	36,8
	Ø 22	81,9	63,1	47,8
	Ø 25	108,6	87,3	67,7
	Ø 30	161,5	136,0	110,5

NURSID – Resistances to Steel Failure (continued)

Performances

Annex B8

NURSID (continued)

NURSID crossed combinations, dowel bar $R_{p0,2}$ = 690 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]		
		10	20	30
d bar [mm]	Ø 20	60,8	45,2	33,9
	Ø 22	75,3	58,1	44,0
	Ø 25	99,9	80,3	62,3
	Ø 30	148,6	125,1	101,6

NURSID crossed combinations, dowel bar $R_{p0,2}$ = 460 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]		
		10	20	30
d bar [mm]	Ø 20	40,5	30,1	22,6
	Ø 22	50,2	38,7	29,3
	Ø 25	66,6	53,6	41,5
	Ø 30	99,1	83,4	67,7

NURSID crossed combinations, dowel bar $R_{p0,2}$ = 355 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]		
		10	20	30
d bar [mm]	Ø 20	31,3	23,2	17,4
	Ø 22	38,7	29,9	22,6
	Ø 25	51,4	41,3	32,0
	Ø 30	76,4	64,4	52,3

NURSID crossed combinations, dowel bar $R_{p0,2}$ = 275 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]		
		10	20	30
d bar [mm]	Ø 20	24,2	18,0	13,5
	Ø 22	30,0	23,1	17,5
	Ø 25	39,8	32,0	24,8
	Ø 30	59,2	49,9	40,5

NURSID crossed combinations, dowel bar $R_{p0,2}$ = 235 N/mm²

$V_{Rd,s,ULS}$ [kN]		joint width *t* [mm]		
		10	20	30
d bar [mm]	Ø 20	20,7	15,4	11,5
	Ø 22	25,6	19,8	15,0
	Ø 25	34,0	27,4	21,2
	Ø 30	50,6	42,6	34,6

NURSID – Resistances to Steel Failure (continued)

Performances

Annex B9

Resistances to Concrete Edge Failure

The characteristic resistance to concrete edge failure of the slab at ULS is calculated following EOTA TR065, chapter 2.4, whereas equation (5a) is supplemented by the statical reduction factor k_{stat}.

$$V_{Rk,ce,ULS} = V_{Rk,ce,1} + V_{Rk,ce,2}$$

$$V_{Rk,ce,1} = X_1 \cdot k_{stat} \cdot \sum \psi_i \cdot A_s \cdot f_{yk} \cdot \left(\frac{f_{ck}}{f_{ck,nom}}\right)^{k_1}$$

$$\psi_i = 1 - 0.2 \cdot \left(\frac{l_{c,i}}{c_1}\right) \quad ; \quad f_{ck,nom} = 20\ N/mm^2$$

$$V_{Rk,ce,2} = \pi \cdot d_s \cdot \sum l'_{1,i} \cdot 2.25 \cdot 0.7 \cdot 0.3 \cdot f_{ck}^{2/3}$$

$$l'_{1,i} = l_{1,i} - l_{1,min}$$

$$l_{1,min} = d_s + 0.5 \cdot d_b \qquad \text{with} \qquad d_b \geq 4 \cdot d_s$$

The characteristic resistance to concrete edge failure of the slab at SLS is calculated acc. to EOTA TR065, chapter 2.5.

$$V_{Rk,ce,SLS} = X_2 \cdot V_{Rk,ce,ULS}$$

In accordance with EOTA TR065 [2], chapters 2.2, 2.4 and 2.5 the design values of the resistances to concrete edge failure of the slab are:

$$V_{Rd,ce,ULS} = \frac{V_{Rk,ce,ULS}}{\gamma_{m,ce,ULS}}$$

$\gamma_{m,ce,ULS} = 1.5$ partial safety factor

$$V_{Rd,ce,SLS} = \frac{V_{Rk,ce,SLS}}{\gamma_{m,ce,SLS}}$$

$\gamma_{m,ce,SLS} = 1.0$ partial safety factor

Resistances to Concrete Edge Failure – Design Equations	**Annex B10**
Performances	

Resistances to Concrete Edge Failure (continued)

Statical reduction factor k_{stat} for ESD and NURSID with ESD

k_{stat}	joint width t [mm]					
dowel bar	10	20	30	40	50	60
Ø 16 mm	1,00	0,91	0,84	0,77	0,72	0,67
Ø 25 mm	1,00	0,93	0,87	0,82	0,77	0,73
Ø 35 mm	1,00	0,94	0,89	0,85	0,81	0,77

Note 1: For intermediate dowel bar diameters a linear interpolation is possible.
Note 2: For ESD the joint width t from 10 mm to 60 mm and for NURSID with ESD the joint width t from 10 mm to 30 mm is applicable. For the definition of t see Annexes B1 to B9.

Alternatively the statical reduction factor k_{stat} for ESD and NURSID with ESD can be calculated under consideration of the joint width t (see Annexes B1 to B9)

– for all dowel bar sizes from Ø 16 mm or greater to:

$$k_{stat,ESD} = \frac{5 \cdot (t-10)^2}{100.000} - \frac{9 \cdot (t-10)}{1.000} + 1$$

with a joint width t from 10 mm to 60 mm for ESD and a joint width t from 10 mm to 30 mm for NURSID with ESD.

Statical reduction factor k_{stat} for DB and NURSID with DB

k_{stat}	joint width t [mm]											
dowel bar	10	20	30	40	50	60	70	80	90	100	110	120
Ø 20 mm	1,00	0,92	0,85	0,78	0,73	0,68	0,64	0,61	0,57	0,55	0,52	0,50
Ø 30 mm	1,00	0,94	0,89	0,84	0,80	0,76	0,72	0,69	0,66	0,64	0,61	0,59
Ø 40 mm	1,00	0,95	0,91	0,87	0,84	0,80	0,77	0,75	0,72	0,70	0,67	0,65

Note 1: For intermediate dowel bar diameters a linear interpolation is possible.
Note 2: For DB the joint width t from 10 mm to 120 mm and for NURSID with DB the joint width t from 10 mm to 30 mm is applicable. For the definition of t see Annexes B1 to B9.

Alternatively the statical reduction factor k_{stat} for DB and NURSID with DB can be calculated under consideration of the joint width t (see Annexes B1 to B9)

– for all dowel bar sizes from Ø 20 mm or greater to:

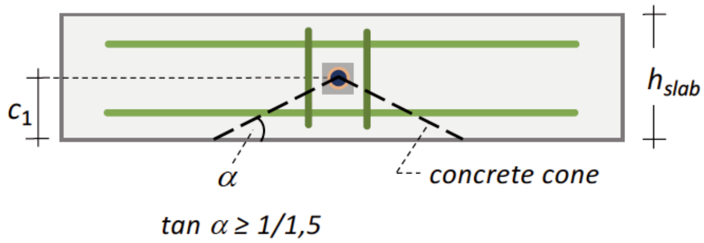
$$k_{stat,DB} = \frac{3 \cdot (t-10)^2}{100.000} - \frac{8 \cdot (t-10)}{1.000} + 1$$

with a joint width t from 10 mm to 120 mm for DB and a joint width t from 10 mm to 30 mm for NURSID with DB.

Resistances to Concrete Edge Failure (continued) – Statical Reduction Factor	Annex B11
Performances	

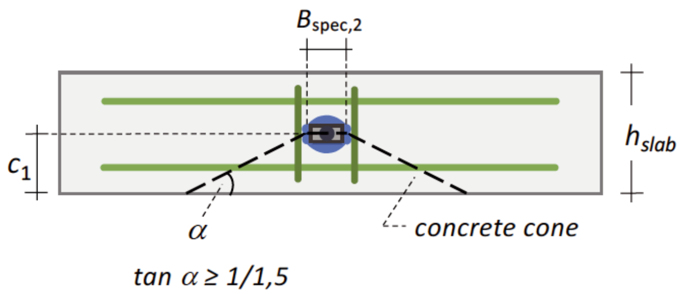
Resistances to Concrete Edge Failure (continued)

ESD-N – Design parameters



For ESD-N the design parameters are in general:
$B_{spec,1} = 0$
$H_{spec,1} = c_1$

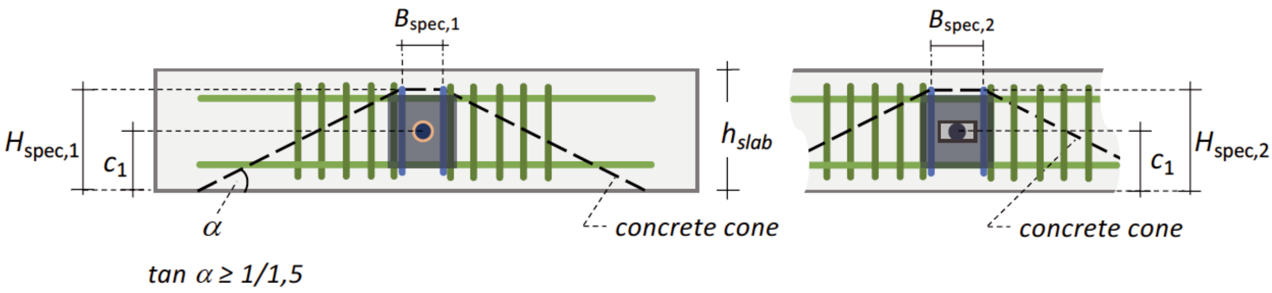
ESD-Q – Design parameters



Dowel name	ESD-Q 16	ESD-Q 20	ESD-Q 22	ESD-Q 24 ESD-Q 25	ESD-Q 27	ESD-Q 30	ESD-Q 35
d_{bar} [mm]	16	20	22	24/25	27	30	35
$B_{spec,2}$ [mm]	53	58	61	64	68	73	81
$H_{spec,2}$ [mm]	c_1						

Resistances to Concrete Edge Failure (continued) – ESD Design Parameters	Annex B12
Performances	

Resistances to Concrete Edge Failure (continued)



DB-N – Design parameters

Dowel name	DB-N 20	DB-N 22	DB-N 24 DB-N 25	DB-N 27	DB-N 30	DB-N 35	DB-N 40
d_{bar} [mm]	20	22	24/25	27	30	35	40
U-bars [mm]	2 Ø10	2 Ø10	2 Ø12	2 Ø12	2 Ø14	2 Ø16	2 Ø20
$h_{U\text{-}bar}$ [mm]	100	100	120	140	150	170	210
l_{c0} , l_{c0s} [mm]	21	22	25	26,5	29,5	34,5	40
$B_{spec,1}$ [mm]	42	44	50	53	59	69	80
$H_{spec,1}$ [mm]	c_1+45	c_1+45	c_1+54	c_1+64	c_1+68	c_1+77	c_1+95

DB-Q – Design parameters

Dowel name	DB-Q 20	DB-Q 22	DB-Q 24 DB-Q 25	DB-Q 27	DB-Q 30	DB-Q 35	DB-Q 40
d_{bar} [mm]	20	22	24/25	27	30	35	40
U-bars [mm]	2 Ø10	2 Ø12	2 Ø12	2 Ø14	2 Ø16	2 Ø20	2 Ø25
$h_{U\text{-}bar}$ [mm]	100	100	120	140	150	170	210
l_{c0s} [mm]	36	38	40	42,5	45,5	51,5	60,5
$B_{spec,2}$ [mm]	72	76	80	85	91	103	121
$H_{spec,2}$ [mm]	c_1+45	c_1+44	c_1+54	c_1+63	c_1+67	c_1+75	c_1+92,5

Resistances to Concrete Edge Failure (continued) – DB Design Parameters

Performances

Annex B13

Performance characteristics with regard to load-bearing performance in case of fire

If the performance characteristics specified in Section 3 are complied with, the load-bearing capacity of the connection of reinforced concrete members with the shear force dowel in accordance with the intended use is also given under fire exposure according to the standard temperature curve for a duration of 120 minutes if the following conditions are met:

- Compliance with the design conditions in accordance with Annex A and the design requirements according to Annex B.
- Use and installation in accordance with Annex A and B.
- The design of the load-bearing capacity of the connection with the shear force dowel under normal temperatures was carried out in accordance with EOTA TR 065 and Annex B.
- For structural fire design (accidental fire situation), the action shall be determined on the basis of the normal temperature design of the load-bearing capacity, using a maximum reduction coefficient η_{fi} in accordance with EN 1992-1-2 or EN 1993-1-2 respectively, Section 2.4.2 of η_{fi} = 0,7.
- The load-bearing capacity of the reinforced concrete members under fire exposure shall be verified for the intended use.
- The required axis distances of the steel reinforcement bars in case of fire have to be considered in accordance with EN 1992-1-2. The resulting concrete covers c_v and the minimum slab thickness h_{slab} acc. to Annex A12 and the minimum beam widths w_{beam} or wall thicknesses t_{wall} acc. to Annex A13 have to be met.

ESD and DB Dowels – Performance Characteristics in Case of Fire	**Annex C1**
Resistance to fire	

NOTES

PHILIPP GmbH
Lilienthalstrasse 7-9
63741 Aschaffenburg
+ 49 6021 40 27-0
info@philipp-gruppe.de

PHILIPP GmbH
Roßlauer Strasse 70
06869 Coswig/Anhalt
+ 49 34903 6 94-0
info@philipp-gruppe.de

PHILIPP GmbH
Sperberweg 37
41468 Neuss
+ 49 2131 3 59 18-0
info@philipp-gruppe.de

PHILIPP ACON Hydraulik GmbH
Hinter dem grünen Jäger 3
38836 Dardesheim
+ 49 39422 95 68-0
info@philipp-gruppe.de

PHILIPP Vertriebs GmbH
Leogangerstraße 21
5760 Saalfelden / Salzburg
+ 43 6582 7 04 01
info@philipp-gruppe.at

Visit us!
www.philipp-group.de