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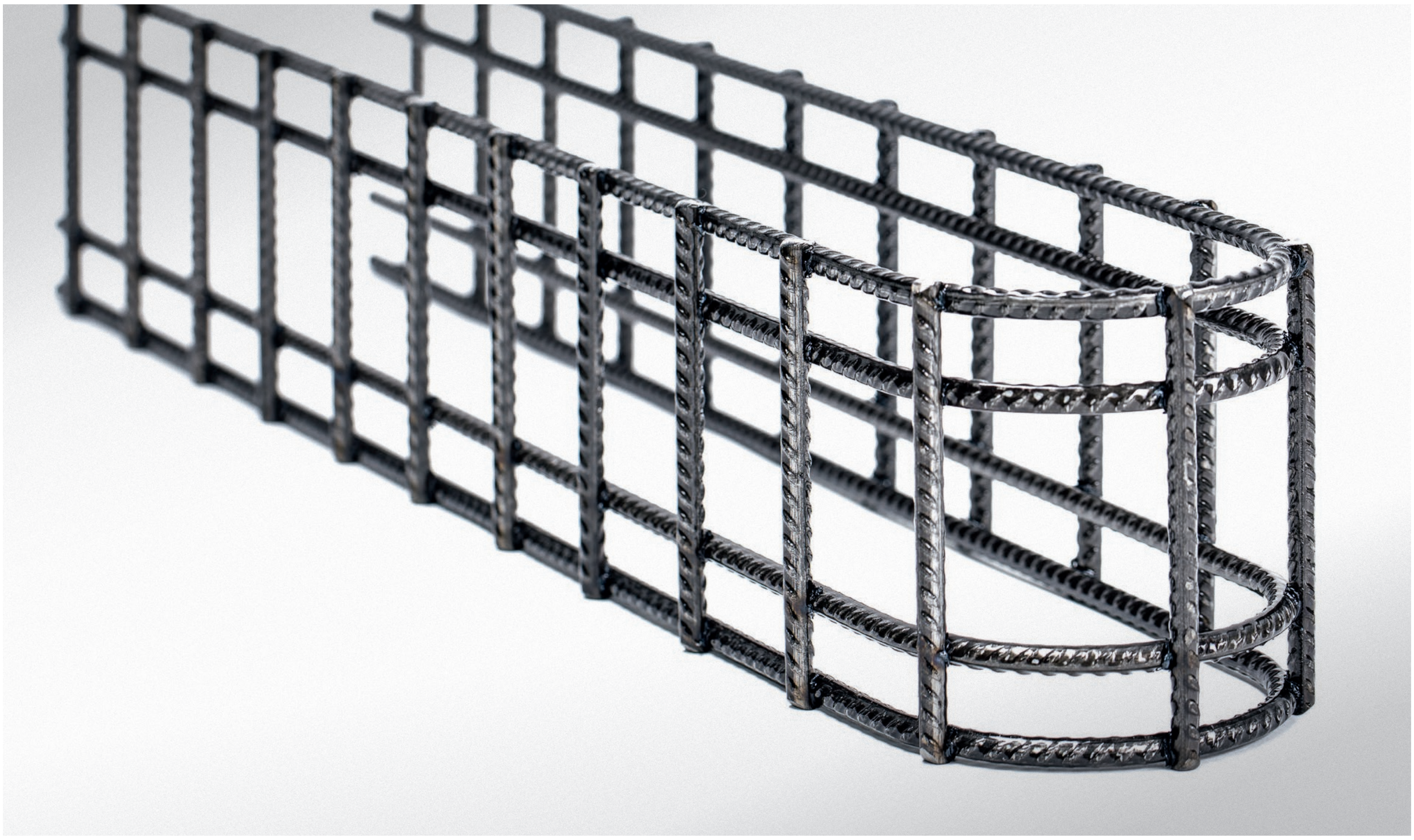
SHEAR REINFORCING ELEMENT QE

A QUICK SOLUTION TO COVER SHEAR FORCES IN SLABS AND WALLS



PATENTED

SHEAR REINFORCEMENT FOR REINFORCED CONCRETE SLABS AND WALLS UNDER SHEAR FORCE

DESCRIPTION

Shear elements QE are U-shaped mesh-like (or ladder-like) reinforcing elements, which are industrially produced by electric resistance welding similar to the production of reinforcing wire fabrics. The wire used for both the chords and the vertical bars is reinforcing steel B500A according to ÖNORM B 4707.

Shear elements QE are manufactured in various heights and lengths and can be basically used as shear reinforcement in plate-like reinforced concrete structures. They are placed in parallel to each other. The height of the shear elements QE results from the depth of cross section minus the concrete covers and the thickness of the lower and upper reinforcement layers. Shear elements QE can be used in slabs or walls with a depth of cross section of up to 750 mm. Maximum concrete grade is C40/50.

Shear elements QE are especially suited as shear reinforcement at the support of floor slabs resting on walls or beams and as shear reinforcement of foundation slabs.

Compared to conventional shear reinforcement made of stirrups, workload can be reduced by up to 70% when using shear elements QE. No more laborious inserting of upper and lower reinforcing bars into stirrups. Shear elements QE are placed on top of the bottom reinforcement layers, and they also serve as spacers between layers.

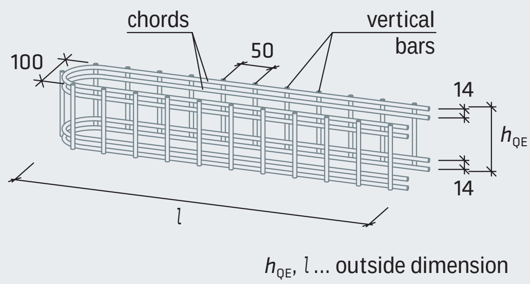
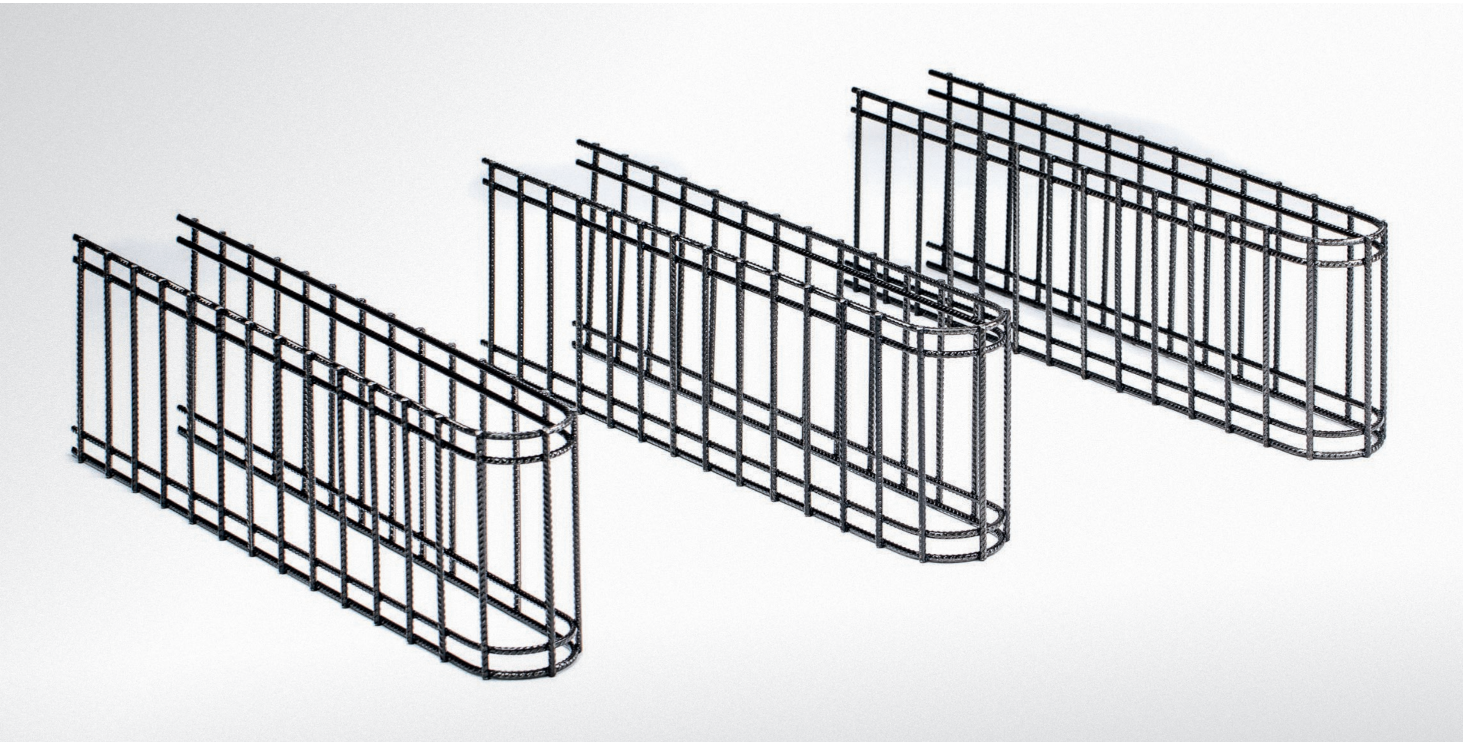


Fig. 1: Shear element QE and its dimensions



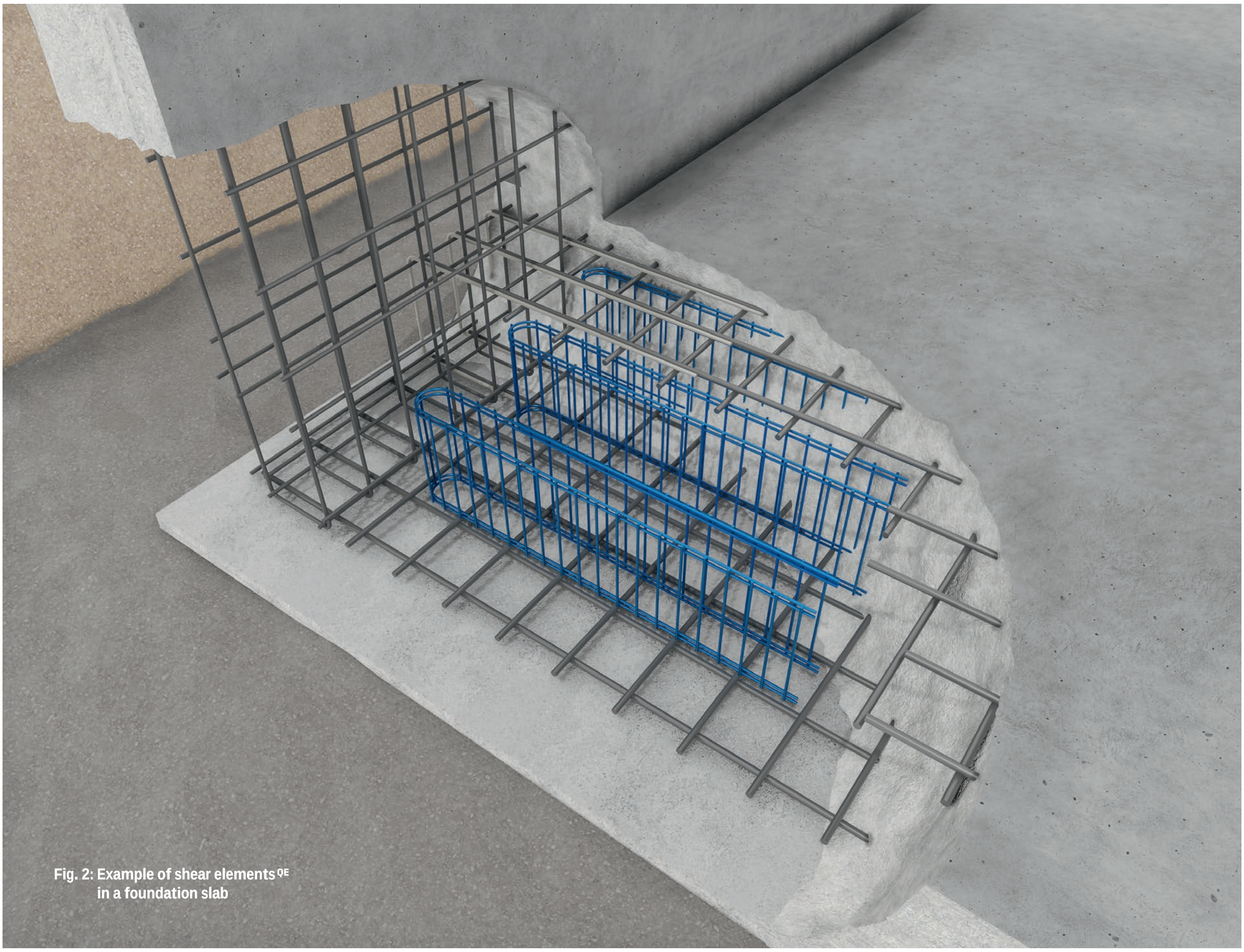
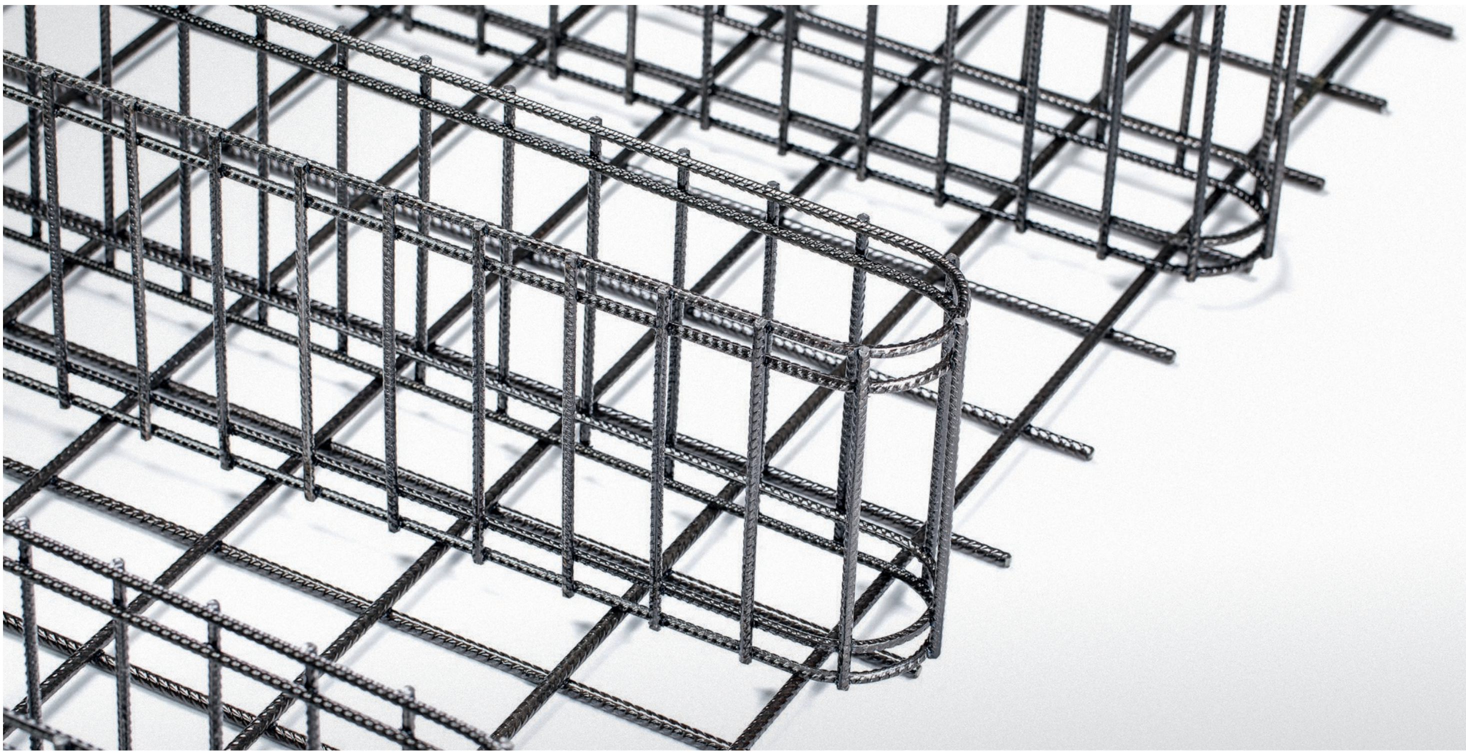


Fig. 2: Example of shear elements QE in a foundation slab



TYPES

Shear elements QE come in heights from 100 mm to 600 mm. The most commonly used types are available in stock.

Type	Height	Chords	Vertical Bars		Elements			$a_{sw,QE}$ [2]
	h_{QE}	Ø	Ø	distance	width[1] b	leg length l	weight	
	mm	mm	mm	mm	mm	mm	kg	mm²/(m · elem.)
QE 100	100	6	6	50	100	550	1.53	1131
QE 120	120	6	6	50	100	550	1.63	1131
QE 140	140	6	6	50	100	550	1.74	1131
QE 160	160	6	6	50	100	700	2.32	1131
QE 180	180	6	6	50	100	700	2.45	1131
QE 200	200	6	6	50	100	700	2.57	1131
QE 220	220	6	6	50	100	850	3.26	1131
QE 240	240	6	6	50	100	850	3.42	1131
QE 260	260	6	6	50	100	850	3.57	1131
QE 280	280	6	6	50	100	1000	4.37	1131
QE 300	300	6	6	50	100	1000	4.55	1131
QE 320	320	6	6	50	100	1000	4.73	1131
• QE 340	340	6	6	50	100	1000	4.91	1131
QE 360	360	6	6	50	100	1000	5.10	1131
• QE 380	380	6	6	50	100	1000	5.28	1131
• QE 400	400	6	6	50	100	1000	5.46	1131
QE 420	420	6	6	50	100	1000	5.64	1131
• QE 440	440	6	6	50	100	1000	5.82	1131
QE 460	460	6	6	50	100	1000	6.01	1131
• QE 480	480	6	6	50	100	1000	6.19	1131
• QE 500	500	6	6	50	100	1000	6.37	1131
QE 520	520	6	6	50	100	1000	6.55	1131
• QE 540	540	6	6	50	100	1000	6.73	1131
QE 560	560	6	6	50	100	1000	6.92	1131
• QE 580	580	6	6	50	100	1000	7.10	1131
• QE 600	600	6	6	50	100	1000	7.28	1131

QE-Types marked with • are available on request.

[1] Width of elements refers to the centre distance of vertical bars in cross direction.
[2] The required amount of shear reinforcement $a_{sw,req}$ (e.g. based on a FEM calculation in accordance with ÖNORM EN 1992-1-1 with f_{yk} = 500 N/mm²) has to be increased by the factor 1.0/0.9. V_{Ed} must not exceed 0.45 x $V_{Rd,max}$. The angle θ between the concrete compression struts and the beam axis perpendicular to the shear force is limited by $1.0 \leq \cot\theta \leq 1.7$.

LOAD-BEARING BEHAVIOUR AND ELEMENT HEIGHT

In slabs resting on beams or walls, sections subject to high shear stress are reinforced by the vertical bars of the shear element QE using a very close-meshed design. The anchoring of the vertical bars in the tension and compression zone of the reinforced concrete slab is accomplished by two welding joints each on the double chords.

Transfer of forces to the flexural reinforcement is ensured via the double chords.

The required element height results in:

$$h_{QE} = h_{slab} - \sum c_{nom} - \sum \text{Ø}_p$$

- h_{QE} height of shear element QE
- h_{slab} depth of cross-section
- c_{nom} nominal concrete cover
- $\sum c_{nom}$ sum of nominal concrete covers at the top and bottom
- $\sum \text{Ø}_p$ sum of thickness of top and bottom reinforcement layers

Please mind that ribbed bars usually require more space than their nominal diameter (see ÖNORM B 1992-1-1, 11.2.2).

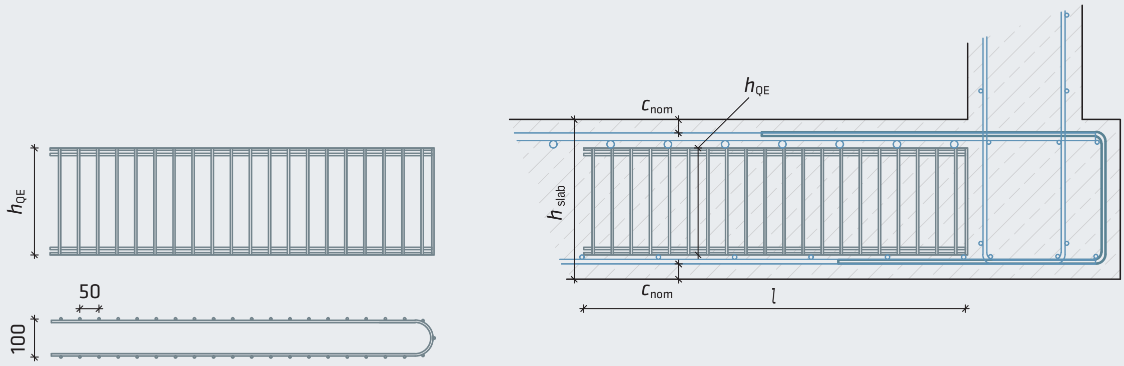


Fig. 3: Section of a foundation slab

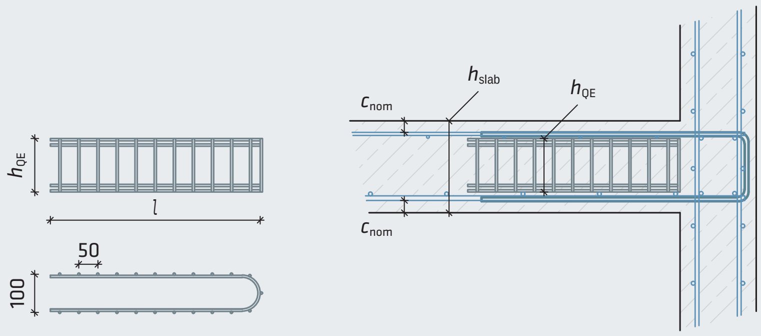


Fig. 4: Section of a floor slab

PLACEMENT

Shear elements QE are placed between the upper and lower layers of flexural reinforcement and, thus, they also serve as spacers. The round section of the U-shaped shear elements QE is placed along the face of support (e.g. inner edge of wall). They are placed in parallel to the main flexural reinforcement (in accordance with the truss model for shear force). The type of shear element QE has to be chosen in dependence of the depth of cross section. When placed perpendicular to the face of support, shear elements QE are effective as shear reinforcement up to the final vertical bar.

In order to extend the effective range of shear reinforcement, additional rows of shear elements QE can be added (see fig. 5).

Shear elements QE also can be used in portions of slabs where load distribution occurs in two directions (e.g. in corners). By sliding shear elements QE inside each other the required distance of vertical bars of 50 mm can be obtained both in x and y direction (see fig. 5, right). A distance of 50 mm is necessary in order to achieve the required shear resistance.

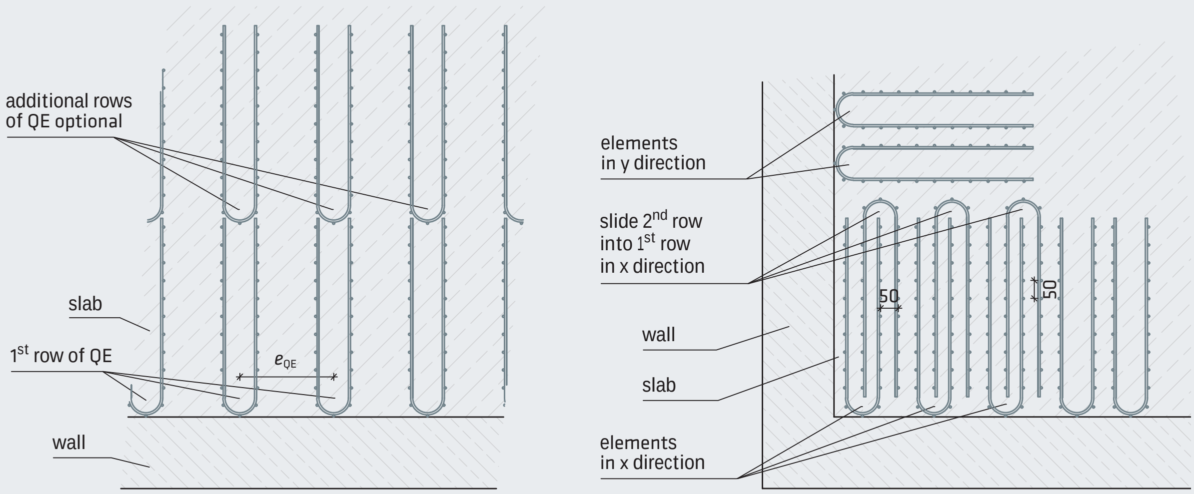


Fig. 5: placement of shear elements QE, ground plan - portion of a slab (left) and corner of a slab (right)

The required amount of shear reinforcement $a_{sw,req}$ (e.g. based on a FEM calculation in accordance with ÖNORM EN 1992-1-1 with f_{yk} = 500 N/mm²) has to be increased by the factor 1.0/0.9. V_{Ed} must not exceed 0.45 × $V_{Rd,max}$. The angle θ between the concrete compression strut and the beam axis perpendicular to the shear force is limited by $1.0 \leq \cot\theta \leq 1.7$.

Verification of shear reinforcement:

$$a_{sw,actual,QE} \geq 1.0/0.9 \times a_{sw,required,EC2}$$

Actual shear reinforcement of slabs and walls can be calculated as:

$$a_{sw,actual,QE} = a_{sw,QE} \ / \ e_{QE}$$

$a_{sw,QE}$	cross sectional area of shear elements QE in mm²/m
e_{QE}	centre distance of shear elements QE in m
$a_{sw,actual,QE}$	actual amount of shear reinforcement mm²/m²

EXAMPLE:

centre distance e_{QE} = 0.25 m

$$a_{sw,actual,QE} = 1131\ [mm^2/(m \times elem.)] \ / \ 0.25\ [m/elem.] = 4524\ [mm^2/m^2]$$

STRUCTURAL DESIGN SOFTWARE

The design of shear elements QE is accomplished by using a calculation software based on Excel, which can be downloaded from our website (www.avi.at). A summary of the results is shown directly on the input screen. Additionally, detailed results can be printed.

AVI® SHEAR ELEMENTS QE BASED ON ÖNORM EN 1992-1-1

Version 1.02

User name:	Structural department of AVI	Project no.:	001
Project name:	Design of shear element	Position:	Floor slab

Material specifications

Concrete grade		C25/30	
Steel grade flexural reinf.		B550	
Flexural reinforcement	A_{sl}=	565	mm²/m

Geometry

Width of slab	b =	1000	mm
Overall depth of slab	h =	200	mm
Effective depth of slab	d =	160	mm
Width of support	t =	250	mm
Inclination of struts	$\cot\theta$ =	1.70	

Admissible range: 1.00 ≤ cotθ ≤ 1.70

☑ Inclination of compression struts automatically

QE

Type of QE: QE 100

Height of QE

Shear force

Method of calculation		Calculation of shear for	
Type of support		Direct support	
Shear force at support	V_{Ed}=	140.00	kN/m

This shear force refers to the axis of the support.

Distributed load	g_d+q_d=	15.00	kN/m²
Shear reinforced section	l_B=	1000	mm
Shear reinforcement	$a_{sw,req}$=	4000	mm²/m²
Steel grade shear reinf.		B550	

Concentrated load

Concentrated load		Single load	
Single load	g_d+q_d=	50.00	kN
Distance to face of support	a =	300	mm
Width of single load	t_y=	300	mm

Print-out | Information

Shear reinforcement **QE 100**

Spacing of QE e_{QE}= 340 mm — Required shear reinforcement $a_{sw,req}$= 1421 mm²/m²

(Max. distance: $e_{QE,max}$= 340 mm) — (Calculated for min. inclination of compression struts: $\cot\theta$= 1.70)

Length shear reinforcement l_B= 610 mm — Cross section of QE $a_{sw,QE}$= 3326 mm²/m²

Design shear force at the distance d from the face of the support $V_{Ed,c}$= 136.10 kN/m

Maximum design shear force at the face of the support $V_{Ed,max}$= 138.50 kN/m

Design shear resistance without shear reinforcement $V_{Rd,c}$= 79.36 kN/m < $V_{Ed,c}$

$V_{Rd,c}$ < $V_{Ed,c}$ Resistance of unreinforced cross-section smaller than action; Shear reinforcement required!

Design value of maximum shear resistance $V_{Rd,max,QE}$= 272.36 kN/m ≥ $V_{Ed,max}$ ✓

Design resistance of shear reinforcement $V_{Rd,s,QE}$= 272.36 kN/m ≥ $V_{Ed,c}$ ✓

Inclination of compression struts: $\cot\theta$ = 1.45

Additional tensile force in the longitudinal reinforcement ΔF_{dt}= 98.88 kN/m

CALCULATION OF SHEAR STRENGTH:

Shear resistance without shear reinforcement $V_{Rd,c}$ = 79.36 kN/m
Maximum shear resistance of cross section $V_{Rd,max,QE}$ = 272.36 kN/m
Shear resistance of shear reinforcement $V_{Rd,s,QE}$ = 272.36 kN/m
Additional tensile force in the longitudinal reinforcement due to shear ΔF_{dt} = 98.88 kN/m
Shear elements QE at e_{QE} = 340 mm

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Please direct your inquiries about availability and price of products to our sales department.

Shear reinforcing element OE-02/21-E

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