

## **FILIGRAN** Punching Shear Reinforcement **FDB II**

for Filigran Flat Slabs



**With protruding loops  
for maximum loads !**

European Technical Approval ETA-13/0521  
according to Eurocode 2

*Maximum resistance with a high degree of planning and execution reliability !*

## Filigran Flat Slabs

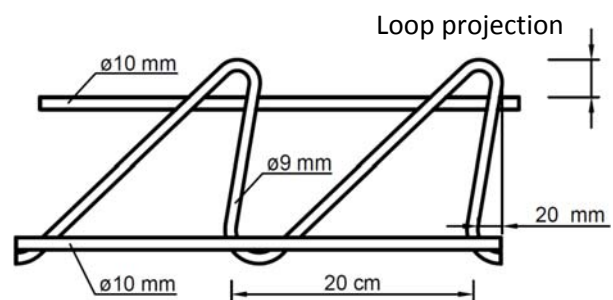
Prefabricated Filigran flat slabs reinforced with lattice girders have been successfully produced for many years. They are based on normative design rules and approvals for reinforcement systems for increasing the punching shear resistance of these slabs.

The Filigran FDB punching shear reinforcement has been developed for use in Filigran slabs. With the highest levels of punching shear resistance and simple installation, this reinforcement guarantees a high degree of execution reliability.



### Punching Shear Reinforcement FDB II

The FDB II is a further development of the nationally approved Filigran punching shear reinforcement. The ribbed struts consisting of  $\varnothing 9$  mm B500A, which provide support as punching shear reinforcement, protrude above the upper chord by a defined amount. Anchorage is provided by means of these loops and the rigid welded connection with the chords consisting of B500A with  $\varnothing 10$  mm. The struts are alternately inclined to different degrees.



A typical feature of the further developed FDB II is the additional inclination of the originally vertical struts by 2 cm in the direction of the loaded area.

*Designation example:*

*FDB II 16 / 4 - 60*  
*Filigran punching shear reinforcement*  
*FDB II*  
*Installation height 16 cm*  
*Top loop projection 4 cm*  
*Element length 60 cm*

#### *Dimensions and designations*

Strut diameter	9 mm (B500A)
Slab thickness	18 cm to 36 cm
Height of the punching shear reinforcement	13 cm to 30 cm
Top loop projection	3 / 4 <sup>1)</sup> / 5 <sup>2)</sup> / 6 cm
Bearing lengths	40 cm / 60 cm / 80 cm

<sup>1)</sup> Standard projection up to installation height 19 cm

<sup>2)</sup> Standard projection from installation height 20 cm

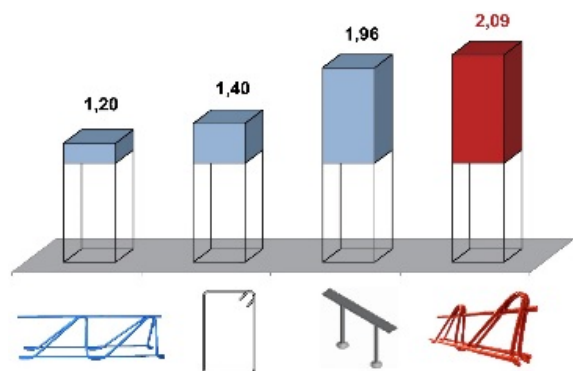
## Maximum Punching Shear Resistance

The load bearing resistance of the FDB II has been determined in full scale tests at RWTH Aachen University. Cut-outs in semi-precast slabs with a horizontal shear joint, butt joints between the precast concrete slabs and varying distances of the precast concrete slabs from the column were tested. The inclination of the supporting struts and the arrangement of the elements close to the column also guarantee effective penetration of the punching shear cracks when the precast concrete slabs are moved right up to the column.

The punching shear resistance of the slabs is more than doubled if the Filigran punching shear reinforcement FDB II is installed. The increase in load factor compared to slabs according to Eurocode 2 without punching shear reinforcement is  $\alpha_{FDBII} = 2.09$ . A comparison with the increase in load factors for other punching shear reinforcements shows the possible increase in load.

The optimum punching shear reinforcement for Filigran slabs

- is easy to install,
- secures the bond between the precast concrete slabs and in-situ concrete,
- is insensitive to deviations from the required position of the reinforcement,
- allows the free selection of the distance from the precast concrete slab to the column,
- guarantees the maximum punching shear resistance.



*Increases in load factors of different punching systems*

## European Technical Approval ETA-13/0521

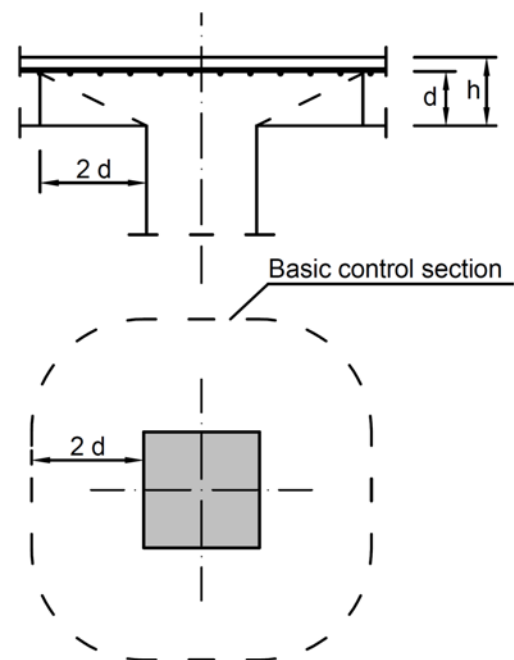
Full scale tests in accordance with test guidelines co-ordinated throughout Europe form the basis of European Technical Approval ETA-13/0521 of 13th June 2013.

## Design according to Eurocode 2

In order to verify the maximum shear stress  $v_{Rd,max}$  in the design control perimeter, the design equation was determined on the basis of Eurocode 2 for a section at a distance of twice the static height  $d$  and the load-bearing capacity of the shear-unreinforced slab  $v_{Rd,c}$  according to Eurocode 2:

$$v_{Rd,max} = 2.09 \cdot v_{Rd,c}$$

$v_{Rd,c}$  Design resistance according to national application document for Eurocode 2 for slabs without punching shear reinforcement



*Control section for punching verification*

## Construction

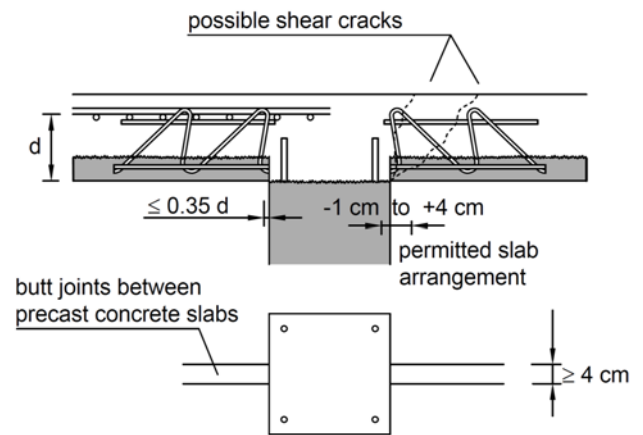
Slab thicknesses: 18 cm to 36 cm  
Concrete grades: C20/25 to C50/C60

### Slab Arrangement in the Punching Area

Joints between the precast concrete slabs: 4 cm

Distance of the precast concrete slab from the column:  
- 1 cm to + 4 cm

Maximum distance of the reinforcement from the column: 0.35 d

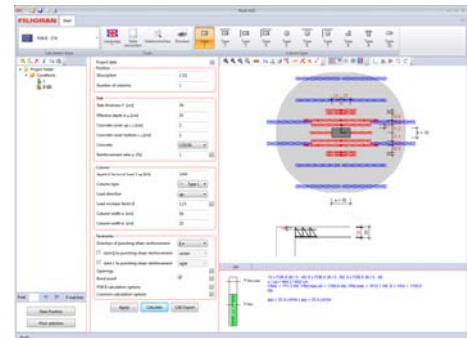


## ProFi-2 Dimensioning Program

For the dimensioning and performance of the necessary verifications, a ProFi-2 dimensioning program is made available.

The program offers:

- punching shear design and verifications
- verification of the shear joint
- interface with CAD systems



ProFi 4.0 Dimensioning Program

Subject to technical changes. (04/17)

### Advantages for Planners and Users

- **high level of planning reliability**
  - punching tests on semi-precast slabs
  - ETA approval with clear rules for semi-precast slabs
  - FDB II stipulated as composite reinforcement
  - Dimensioning program with CAD interface for precast plants
- **very cost-effective**
  - fair purchasing conditions
  - simple installation in the prefabricated system
  - easy installation on the construction site
- **high degree of execution reliability**
  - the precast concrete slabs can be moved right up to the column
  - installation parallel to the assembly lattice girders
  - robust punching shear reinforcement
  - upper flexural tension reinforcement on the upper chords
- **maximum punching shear resistance**
  - punching shear resistance more than doubled!

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