

A photograph showing a complex network of steel reinforcement bars (rebar) on a construction site. Some bars are grey and straight, while others are red and curved. The bars are laid out on a light-colored concrete or sand surface.

**BIBM CONGRESS COPENHAGEN  
NOVEMBER 15<sup>TH</sup> 2021**

## **NEW EUROPEAN ASSESMENT FOR PUNCHING SHEAR REINFORCEMENT**

Dipl.-Ing. (FH) Ulrich Bauermeister

The logo for bIBM, featuring the lowercase letters 'bIBM' in a stylized font, enclosed within a white diamond shape on a red background.

*bIBM*

**FILIGRAN<sup>®</sup>**  
TRÄGERSYSTEME

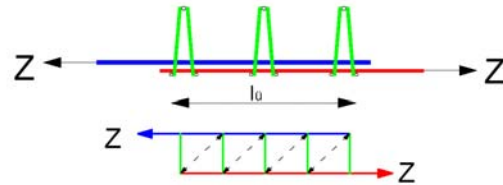
# Two Way Spanned Slabs with Lattice Girders

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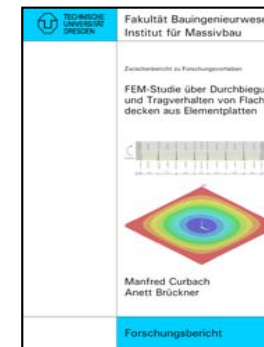


# Two Way Spanned Slabs with Lattice Girders

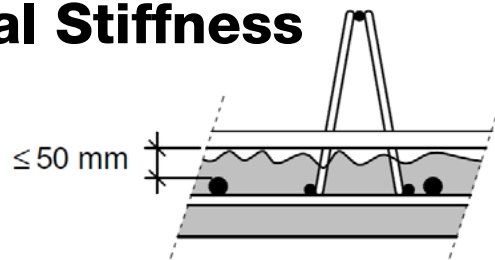
## Reinforcement laps



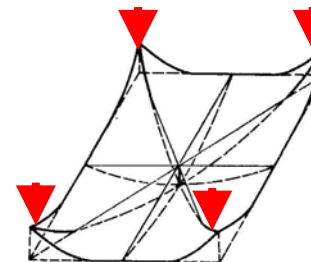
## Deflection



## Biaxial Stiffness



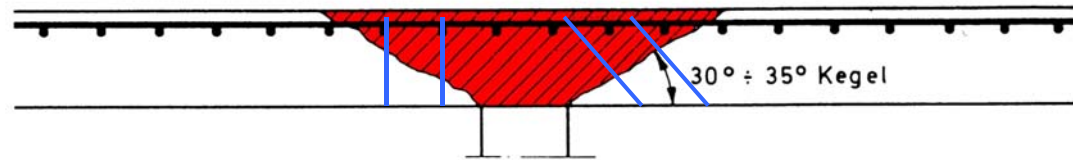
## Torsional Stiffness





# Flat Slabs - Punching Shear Failure

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# Filigran-Punching-Shear-Reinforcement FDB

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Diagonals  $\varnothing$  9mm

Protruding loops

Inclination (2 cm)

Ribbed bars

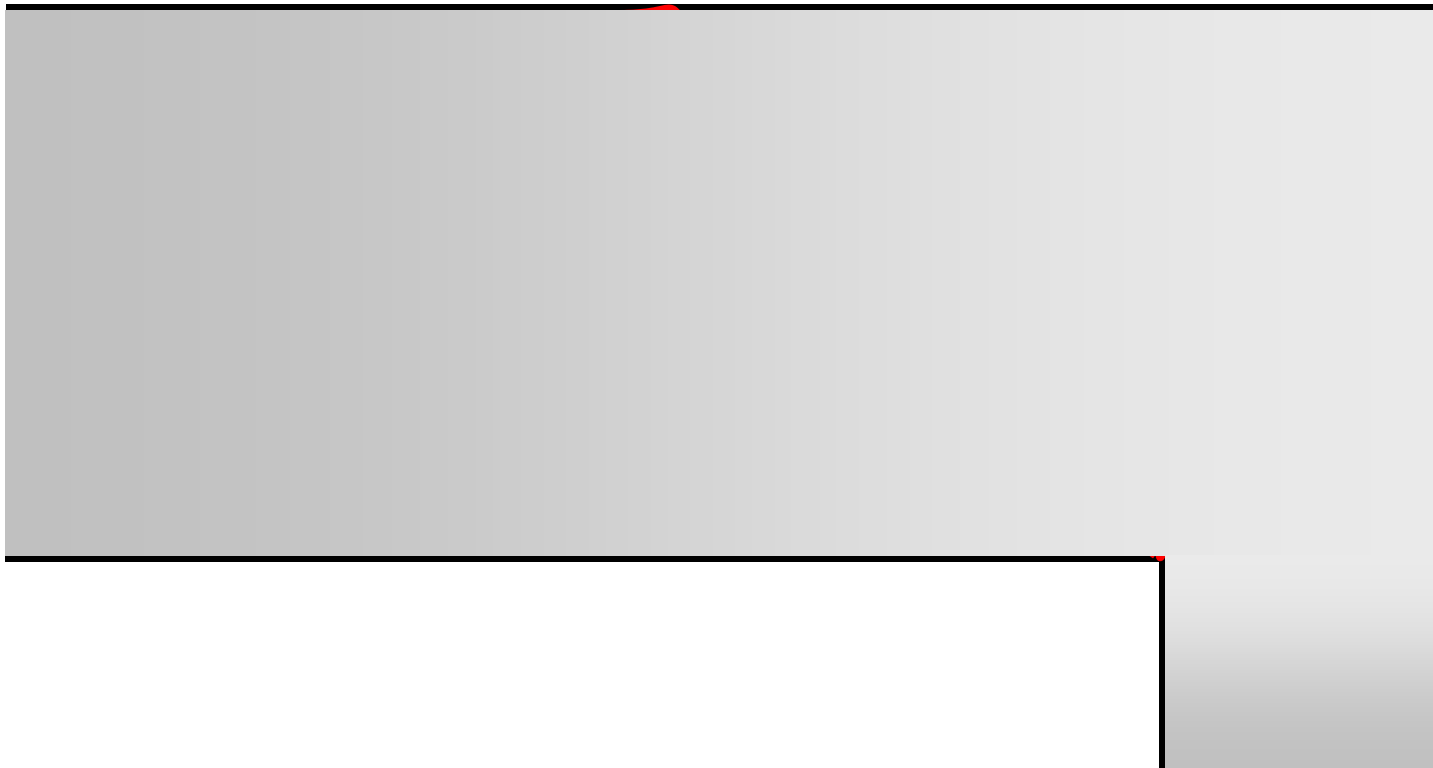
Lower chord  $\varnothing$  10mm

→ only parameter height → easy stockpiling



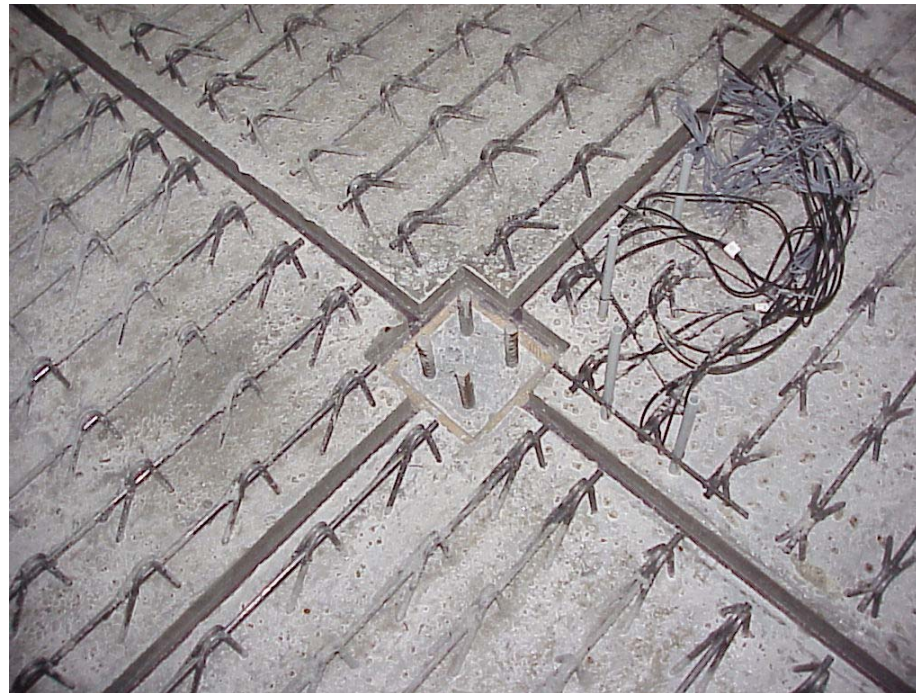
# Possible Punching Shear Cracks

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# Full Scale Tests at University Aachen

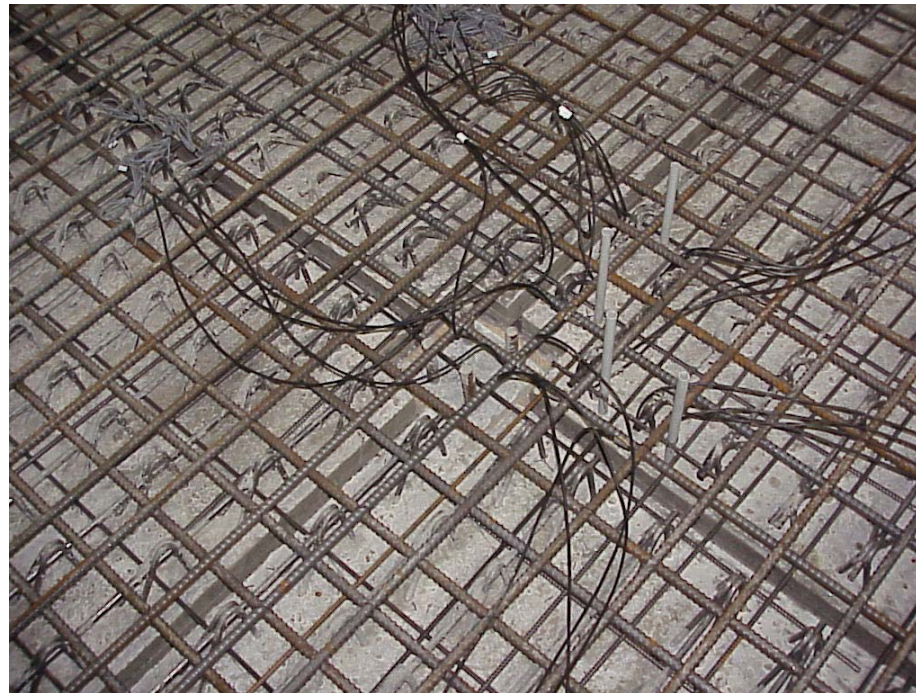
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# Full Scale Tests at University Aachen

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# Full Scale Tests at University Aachen

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# Crack Pattern After Testing

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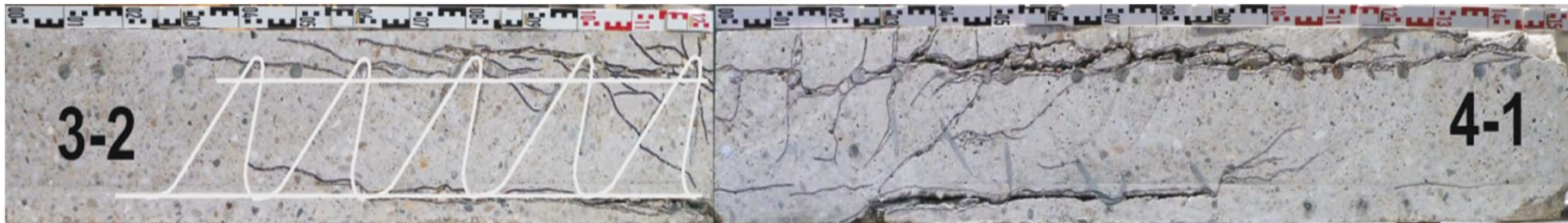
# Internal Crack Pattern - Section

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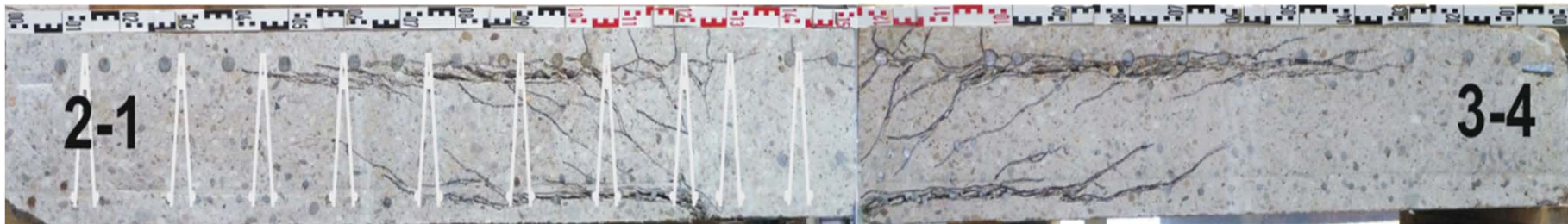


# Internal Crack Pattern - Both Directions

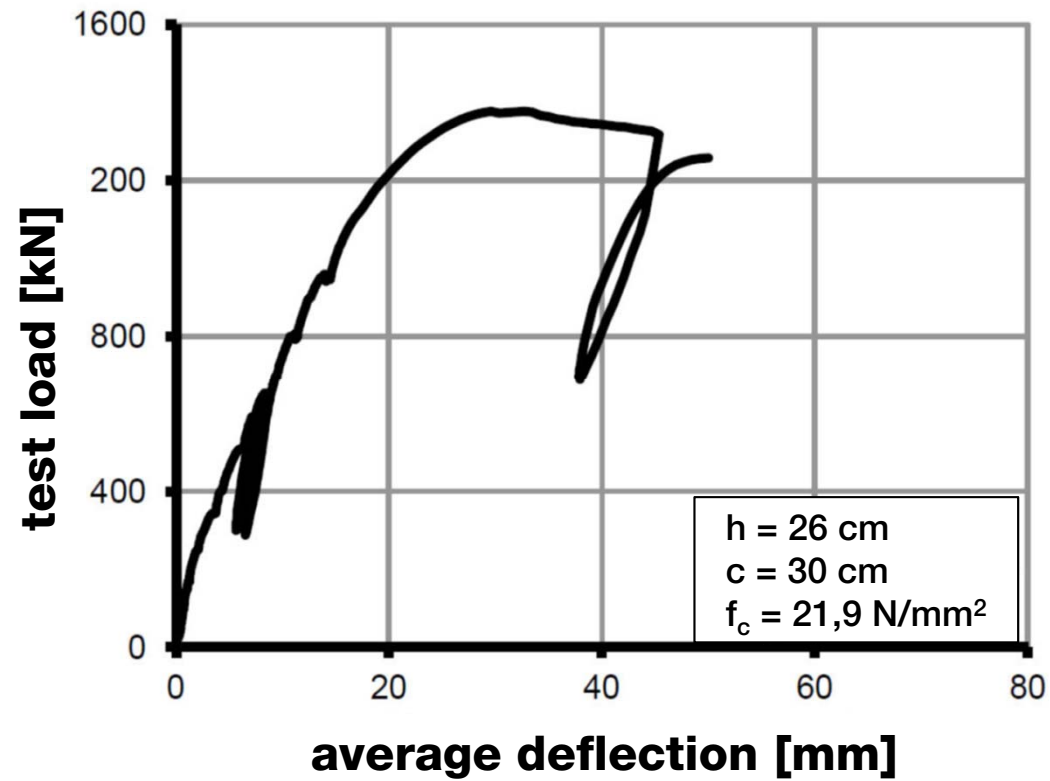
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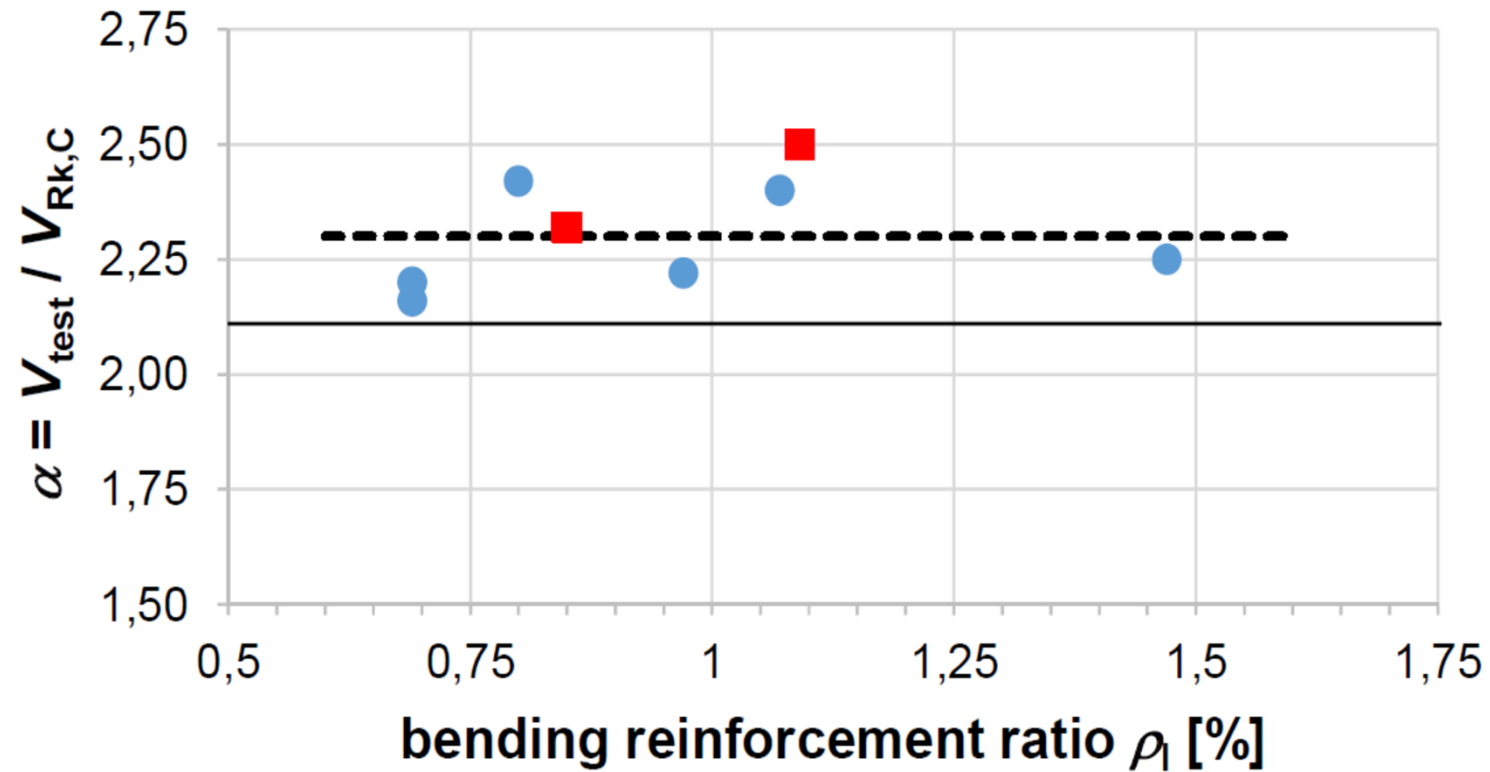
schematische Anordnung der Gitterträger



# Load-Deflection-Curve



# Evaluation of Maximum Shear Load



# European Technical Assessment

Deutsches Institut für Bautechnik (DIBt) logo and EOTA logo are visible at the top. The text on the cover includes: 'Approval body for construction products and types of construction', 'Bautechnisches Prüfamt', 'European Technical Assessment ETA-13/0521 of 14 June 2013', 'English translation prepared by DIBt - Original version in German language', 'General Part', 'Technical Assessment Body issuing the European Technical Assessment: Deutsches Institut für Bautechnik', 'Trade name of the construction product: Filigran punching reinforcement', 'Product family to which the construction product belongs: Filigran lattice girders', 'Manufacturer: Filigran Trägersystem Zappenberg 5, 31533 Leese, DEUTSCHLAND', 'Manufacturing plant: D-31633 Leese, Zapp; D-06896 Coswig OT; PL-42285 Herby, ul. L.', 'This European Technical Assessment contains: 11 pages including 2 pages of this assessment', 'This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of: EAD 160055-00-0301', and 'This version replaces: ETA-13/0521 issued on 13 June 2013'. Contact information for DIBt is provided at the bottom.

## 3.1

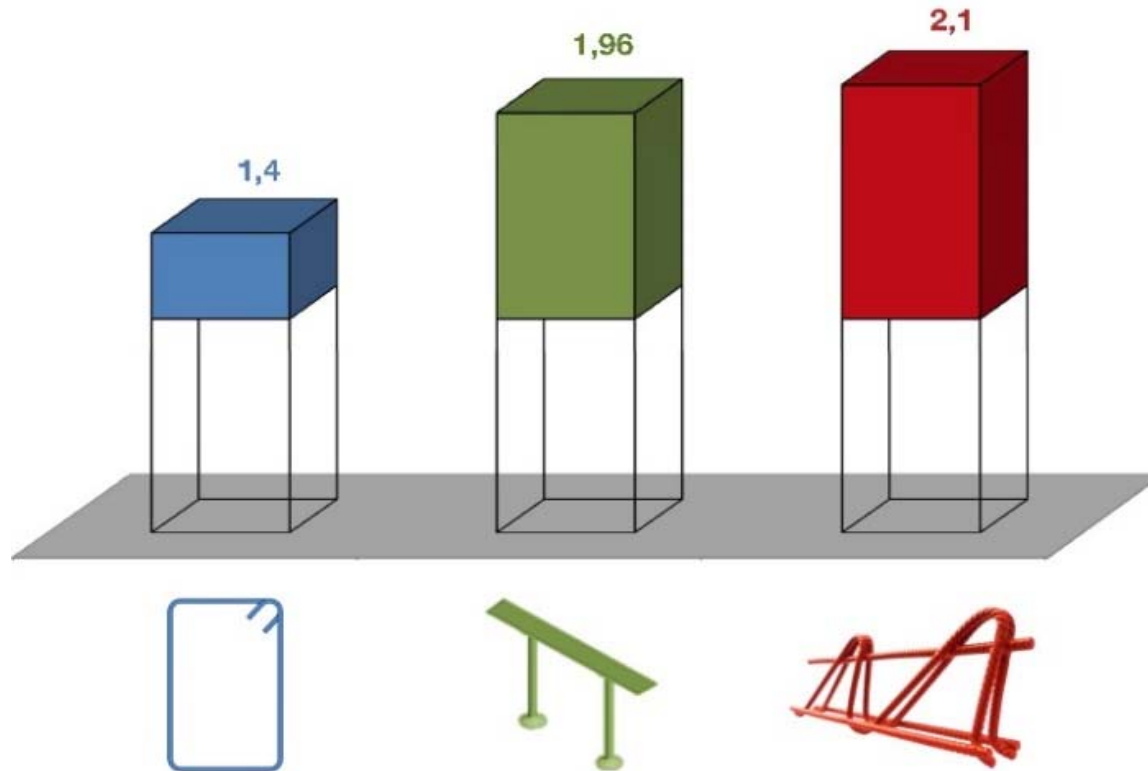
### Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Increasing factor for punching shear resistance	$k_{pu,msl} = 2,1$ $k_{pu,csl} = 2,1$ $k_{pu,asl} = 2,1$

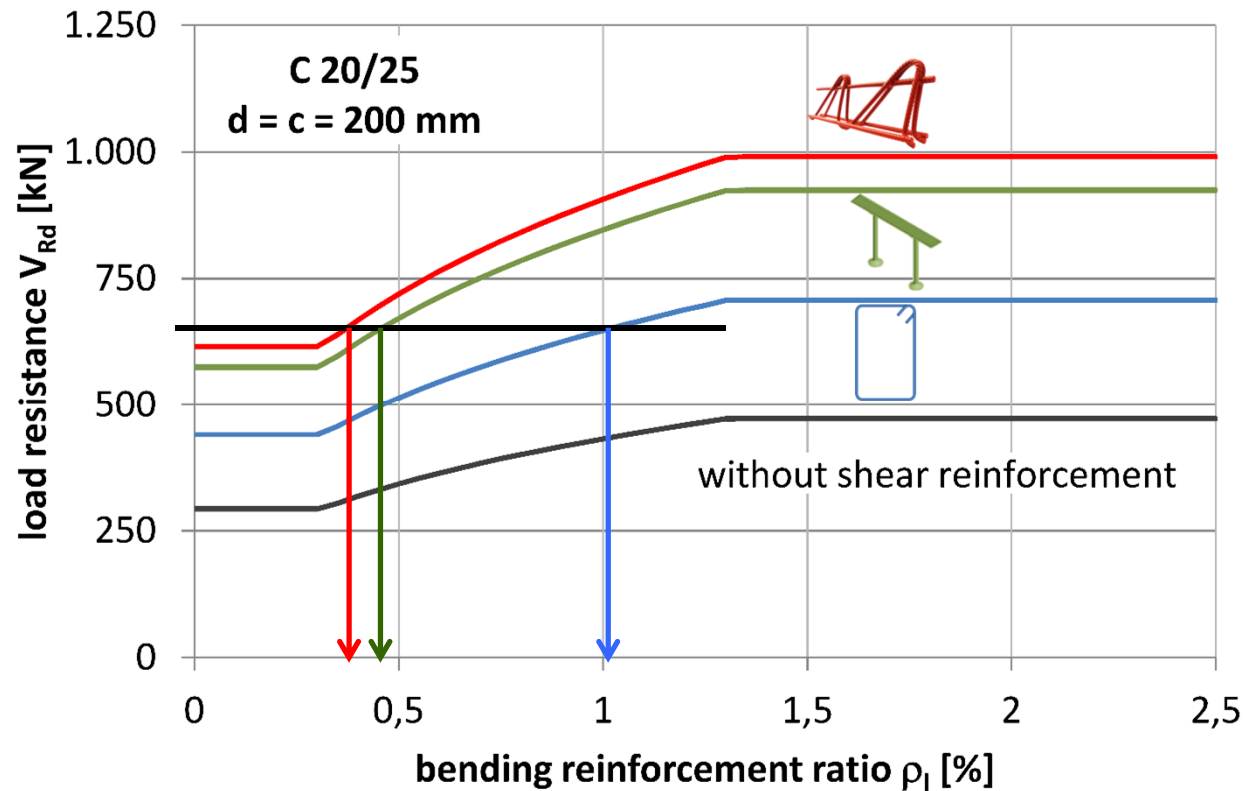


# Punching Shear Resistance in Comparison

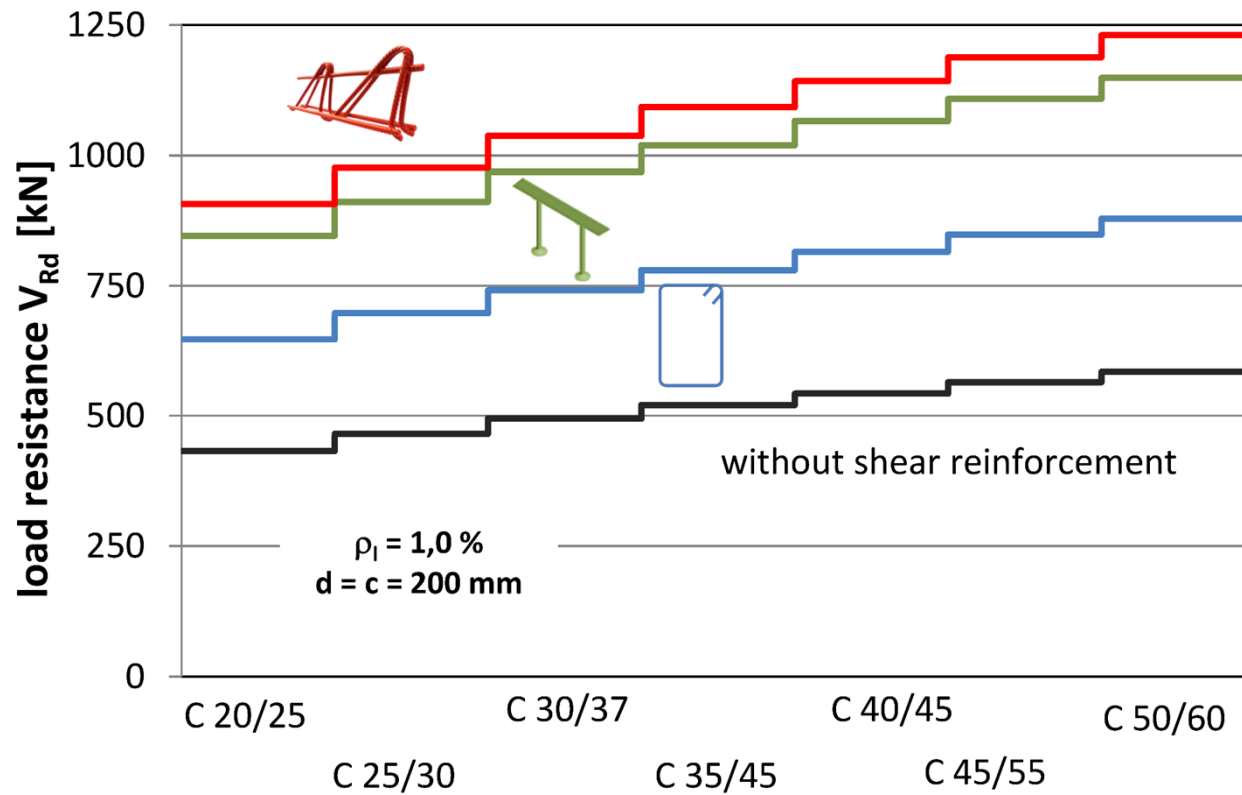
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# Option: Reduced Flexural Reinforcement



# Option: Reduced Concrete Strength

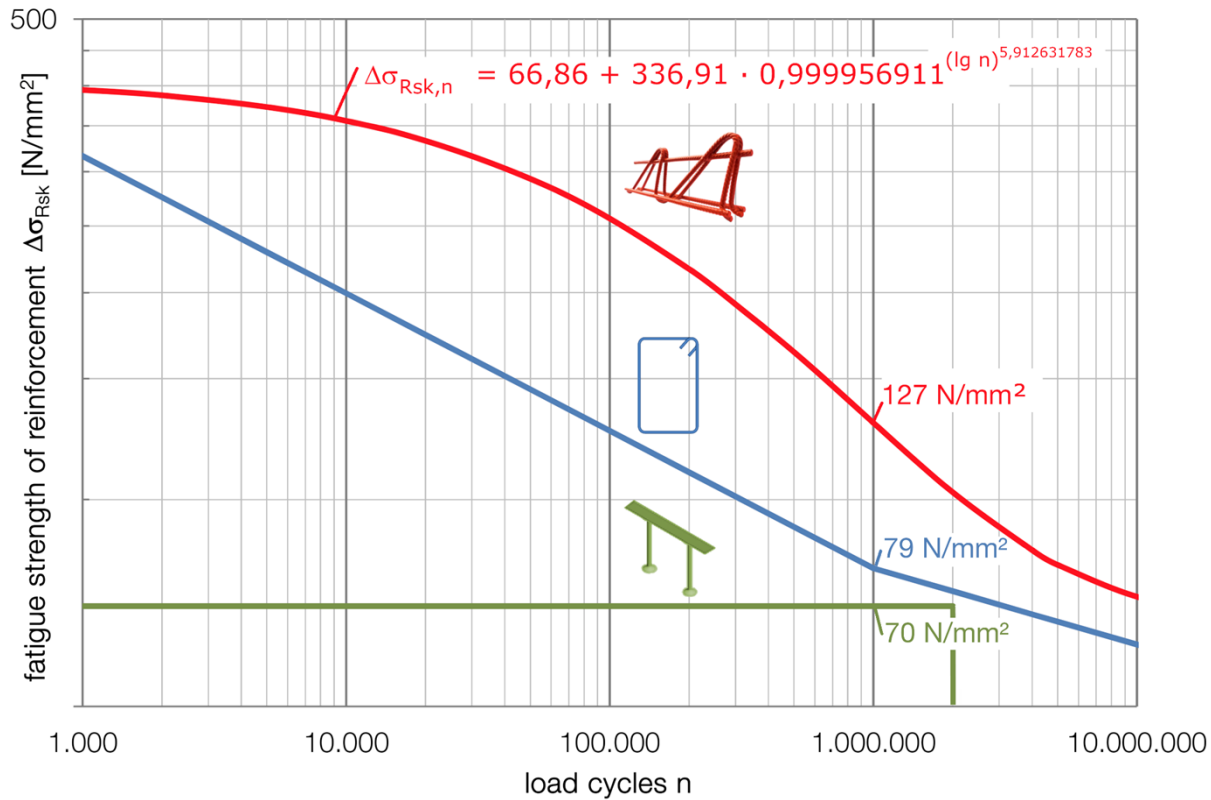


# Surface of Precast Slabs: Untreated

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# Fatigue Resistance of FDB



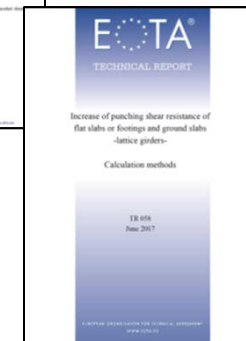
# Design-Software ProFi

The screenshot displays the FILIGRAN ProFi software interface. On the left, a sidebar shows a project folder with 'Positions' and '1'. The main window is divided into several sections:

- Project data:**
  - Position: 1
  - Description: 1
  - Number of columns: 1
- Slab:**
  - Slab thickness  $h$  [cm]: 20
  - Effective depth  $d_{eff}$  [cm]: 16
  - Concrete cover  $c_p$  [cm]: 2
  - Concrete cover bottom  $c_b$  [cm]: 2
  - Concrete: C25/30
  - Reinforcement ratio  $\rho$  [%]: 1
- Column:**
  - Applied factored load  $V_{Ed}$  [kN]: 580
  - Column type: Type 1
  - Load direction:  $45^\circ$
  - Load increase factor  $\beta$ : 1.15
  - Column width  $a$  [cm]: 25
  - Column width  $b$  [cm]: 25
- Parameter:**
  - Direction of punching shear reinforcement:  $a$
  - Joint  $\parallel$  to punching shear reinforcement: center
  - Joint  $\perp$  to punching shear reinforcement: center
  - Openings:
  - Bond proof:
  - FDB calculation options:
  - Common calculation options:
  - Fatigue design:

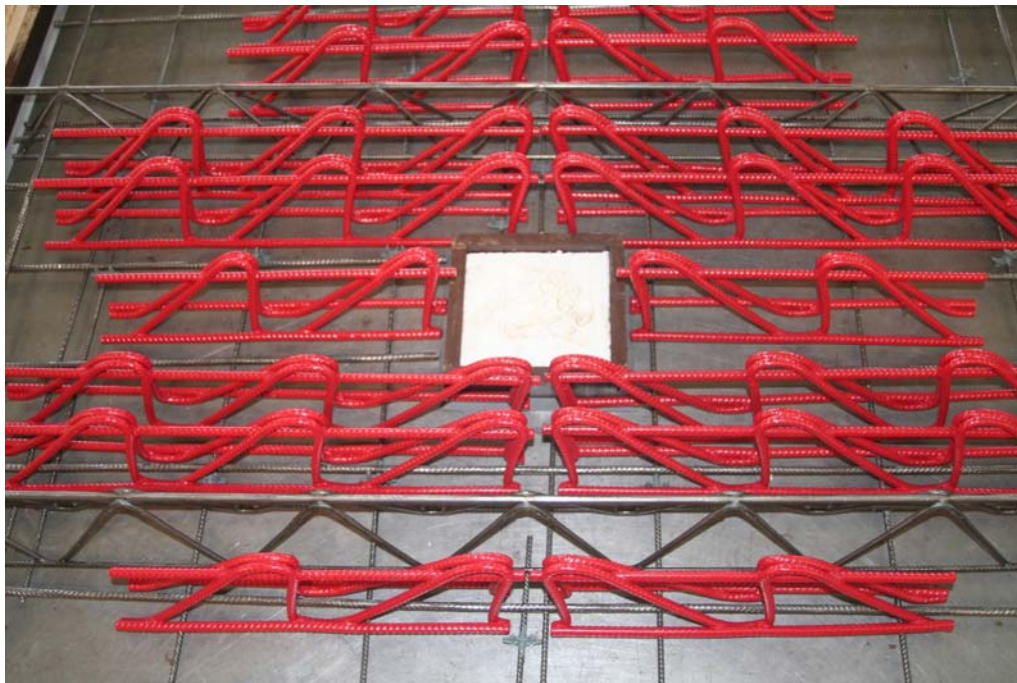
The central area shows a circular reinforcement diagram for a column with a grid of red lines and a cross-section diagram below it. At the bottom, calculation results are displayed:

$V_{Ed,max}$  16 x FDB 16 / 4 - 40; 8 x FDB 16 / 4 - 60; 8 x FDB 16 / 4 - 80  
 $u_{l,req} = 301.1 / 594 \text{ cm}$   
 $V_{Ed,c} = 338.0 \text{ kN}$ ;  $V_{Rd,max,u0} = 576.0 \text{ kN}$ ;  $V_{Rd,max} = 709.9 \text{ kN}$ ;  $S = V_{Ed} = 667.0 \text{ kN}$   
 $l_{s,req} = 54.0 \text{ cm}$   
 $a_{ax} = 16.0 \text{ cm/m}$  |  $a_{ay} = 16.0 \text{ cm/m}$



[www.filigran.com](http://www.filigran.com)

# FDB - Installation



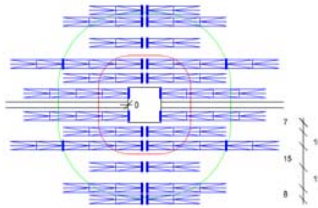
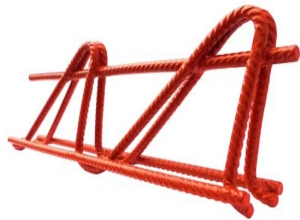
Precast - parallel

In-situ - cruciform



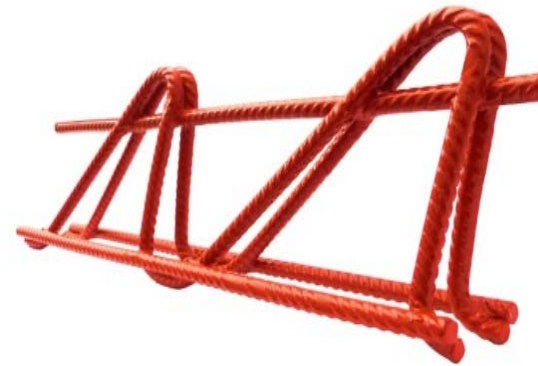
# Application of FDB

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- easy to install
- easy to stockpile
- highly effective
- $V_{Rd,max} = 2,1 V_{Rdc}$
- successful application



**Thank you for your attention!**

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