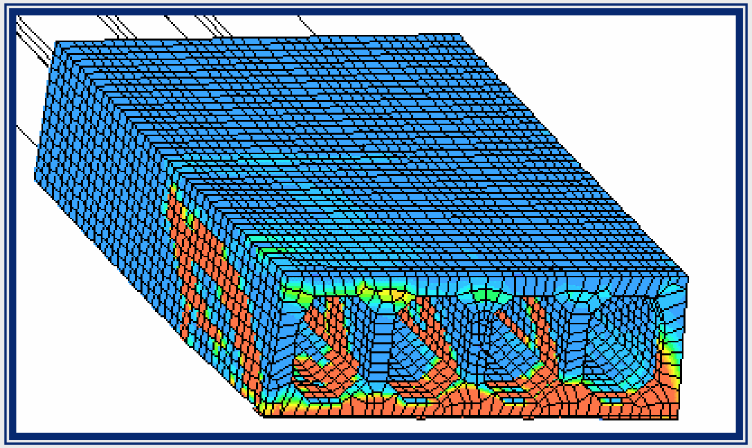
CHALMERS

Shear and Torsion in Hollow Core Slabs

Holcotors

A European research project



Financiers and collaboration partners

- European Commission
- International Prestressed Hollow Core Association
- Bundesverband Spannbeton-Hohlplatten
- Castelo
- Consolis
- Echo
- A. Van Acker
- Strängbetong
- VTT
- Chalmers

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Shear and Torsion in Hollow Core Slabs

Helén Broo
Ph.D. Student
Chalmers

Karin Lundgren
Ass. Professor
Chalmers

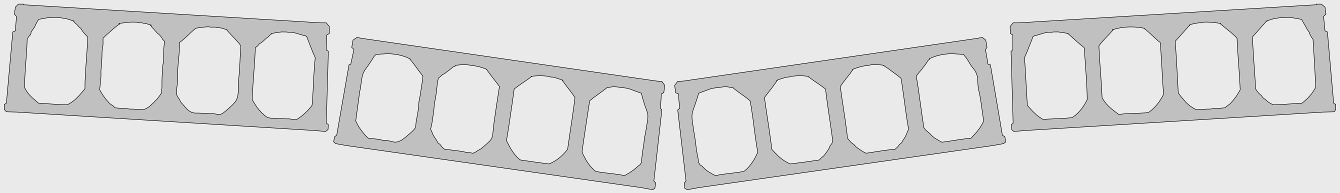
Björn Engström
Professor
Chalmers

Matti Pajari
D.Sc. (tech.)
VTT

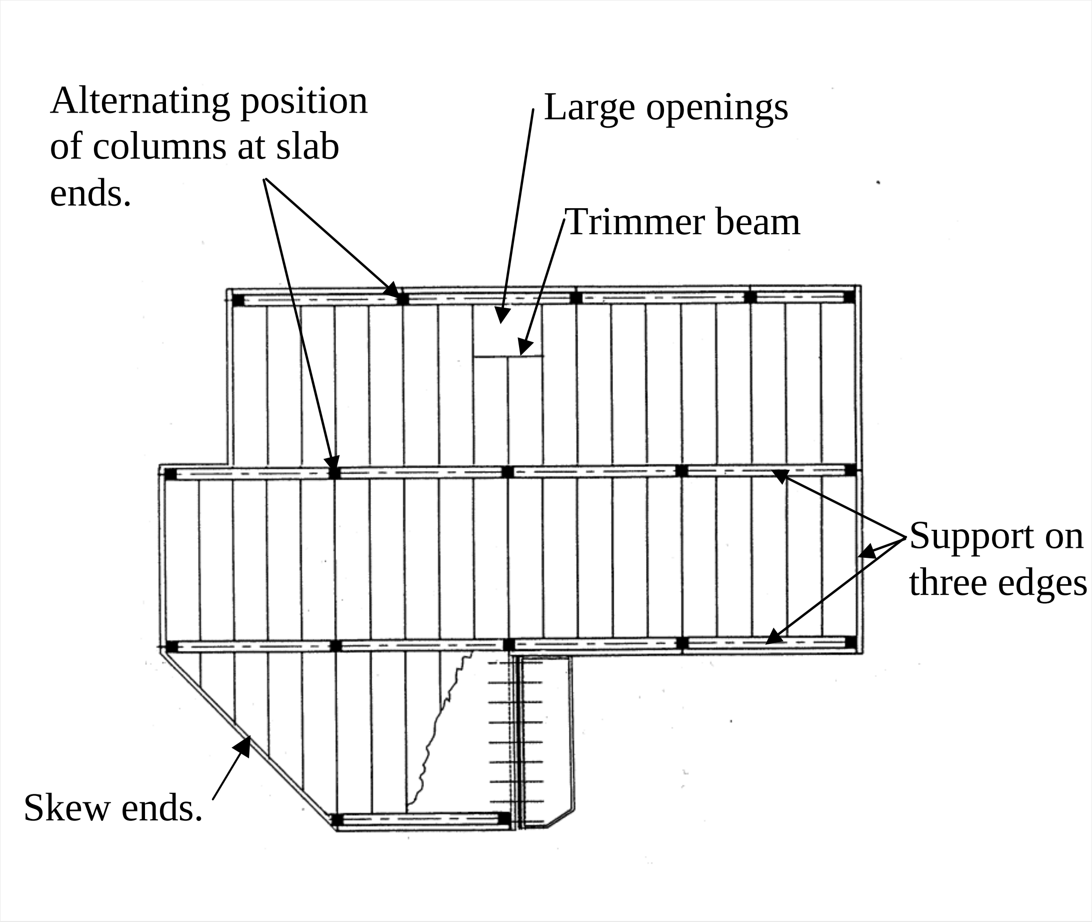
Project started January 1, 2002 and ended December 31, 2004

Aim of the project

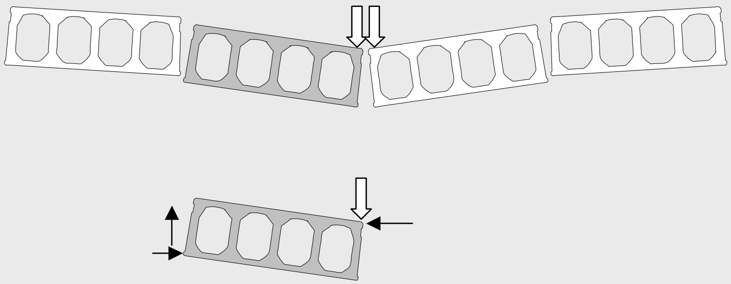
- To use the capacity of the hollow core slabs better
- To develop methods to design for combined shear and torsion in hollow core slabs
  - Single units
  - Whole floors



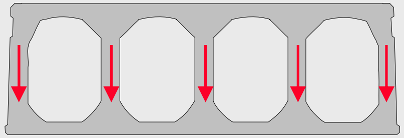
Practical cases where torsion appears



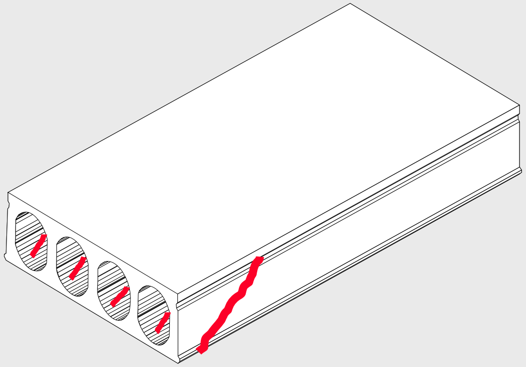
Concentrated load



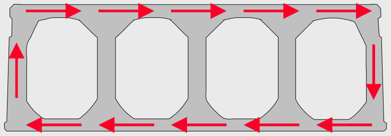
Shear



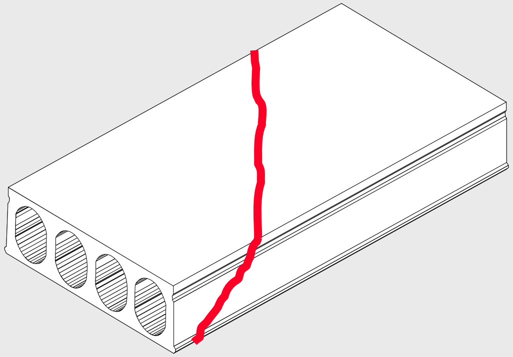
Web shear tension failure



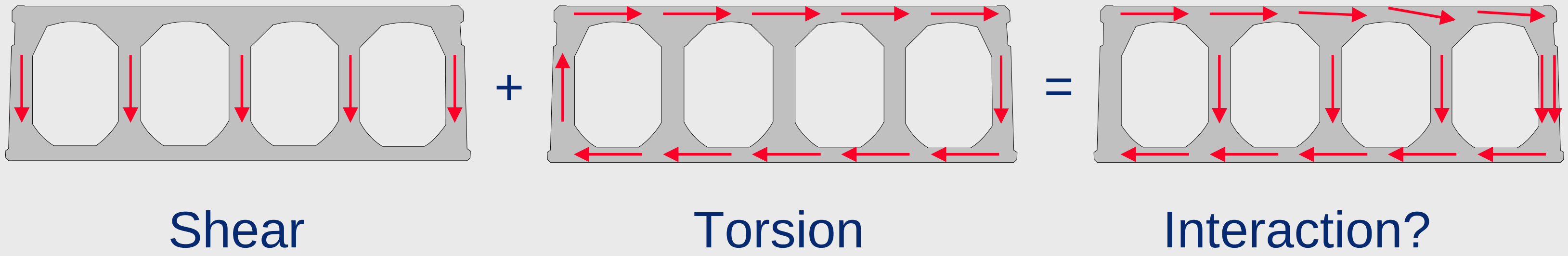
Torsion



Torsion failure

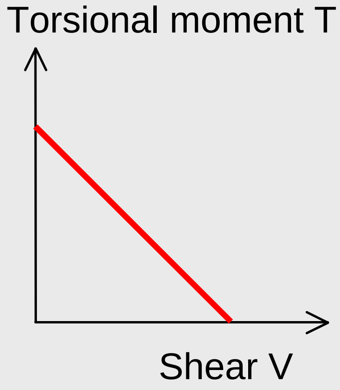


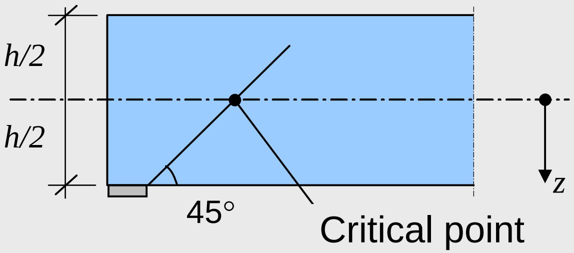
Combined shear and torsion in a hollow core unit



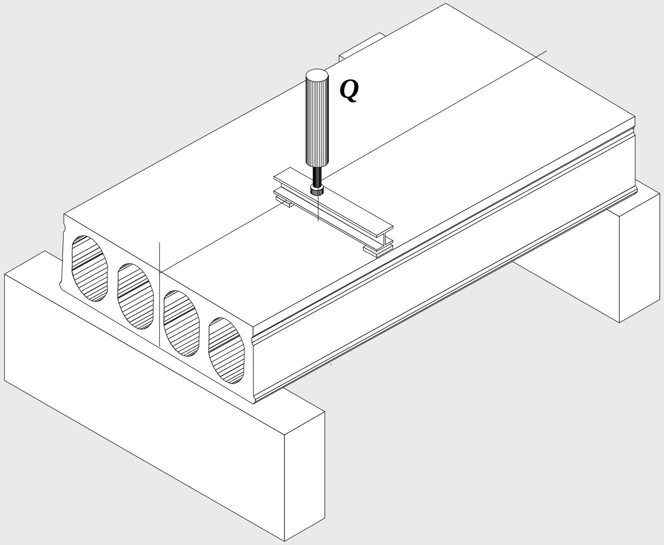
Design method used today (EN 1168):

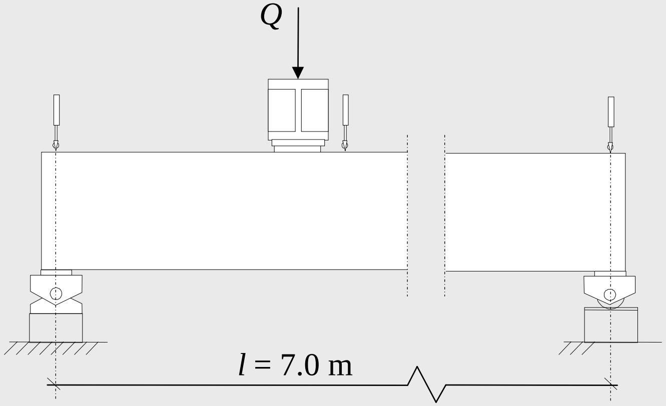
- Cracking means failure
- Only crack in web is considered
- One critical point
- Stresses are added linearly

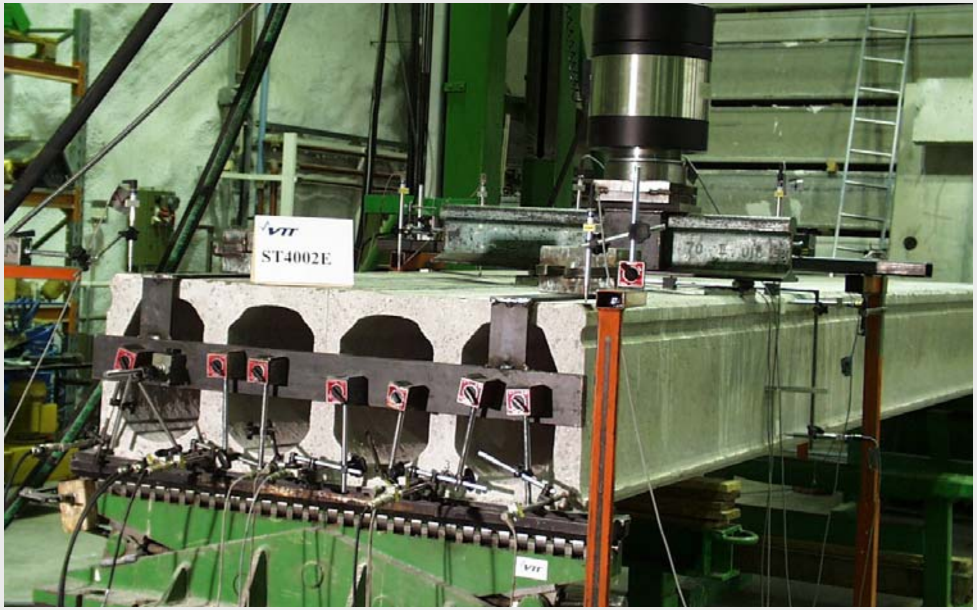




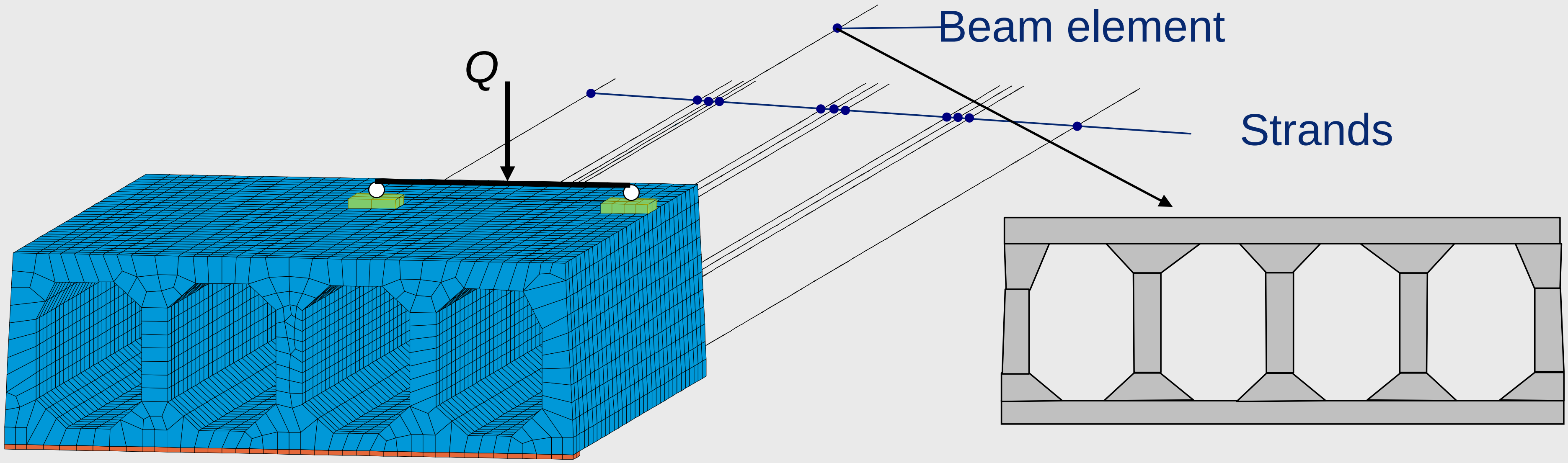
Tests on hollow core units loaded in shear and torsion



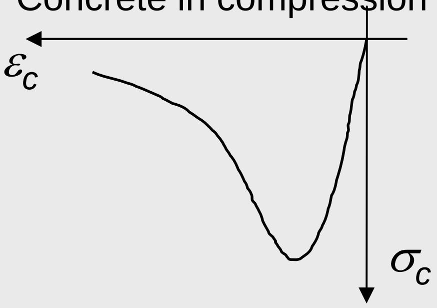




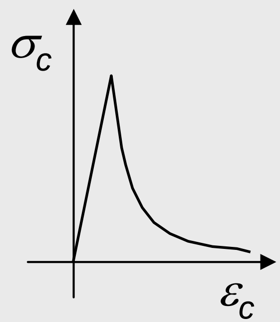
FE model of hollow core unit



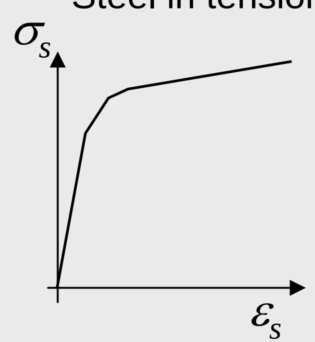
Concrete in compression



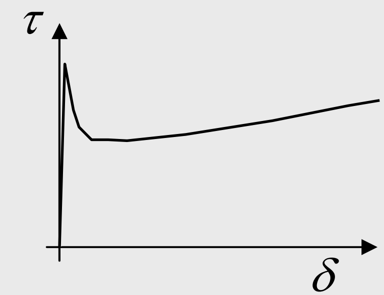
Concrete in tension



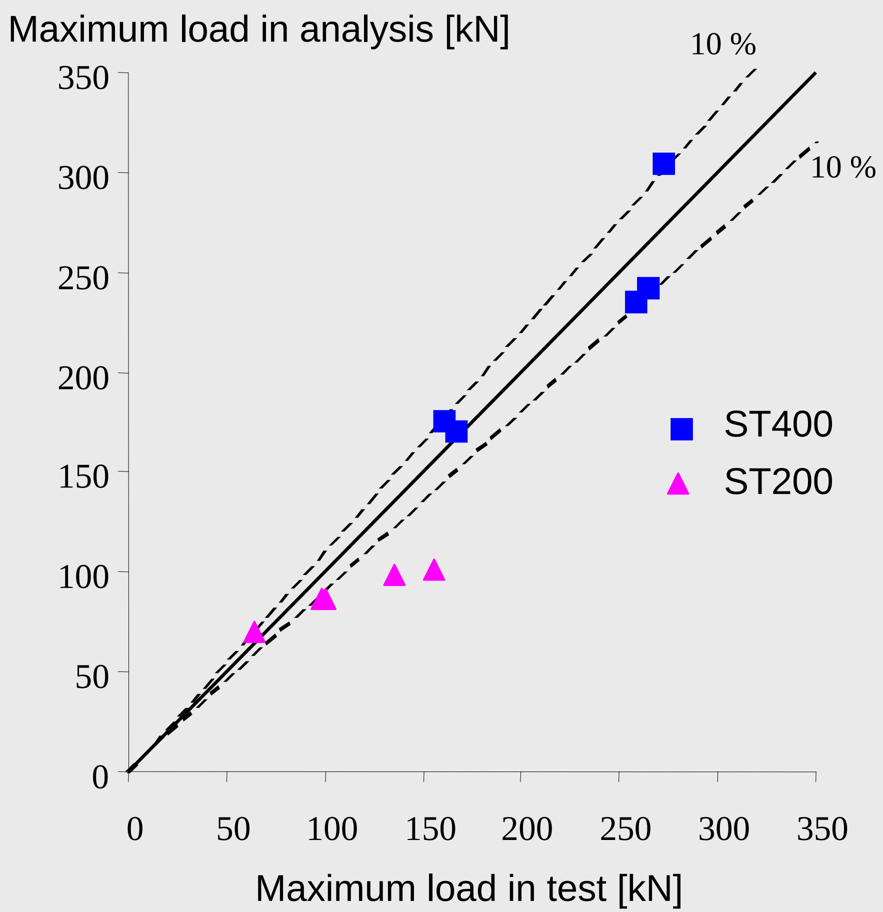
Steel in tension



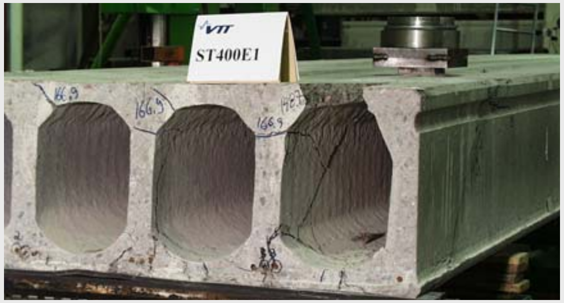
Bond-slip relationship

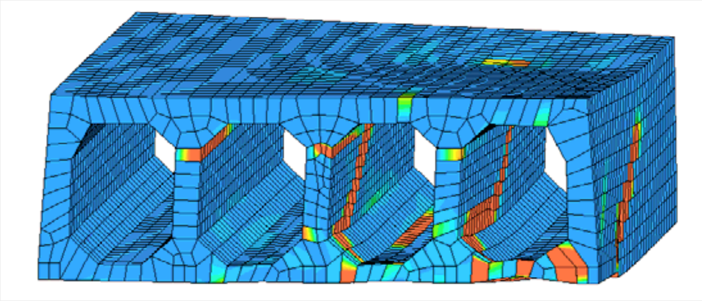


Comparison of results

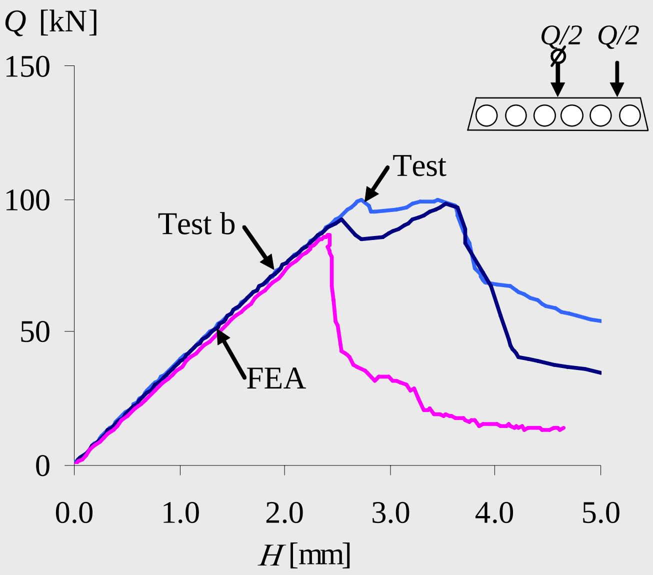


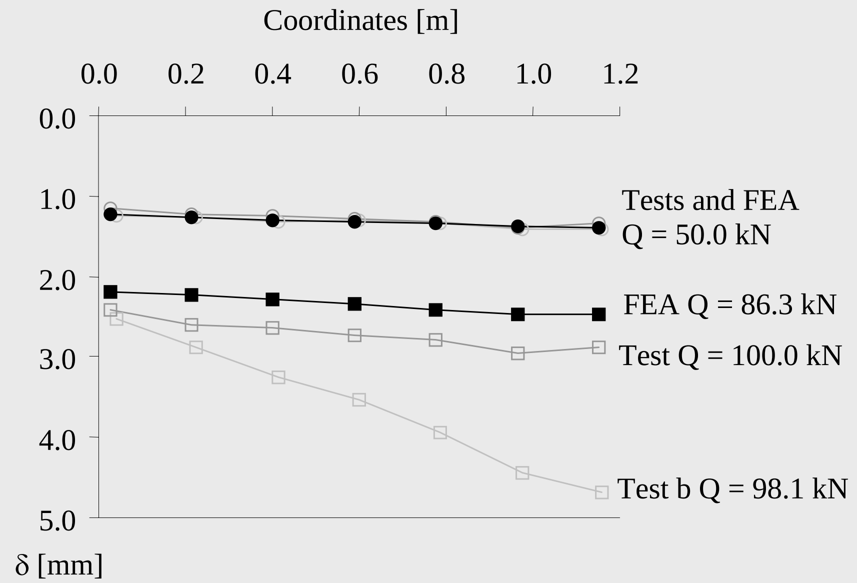
- Maximum load
- Load versus deflection
- Failure mode
- Crack pattern

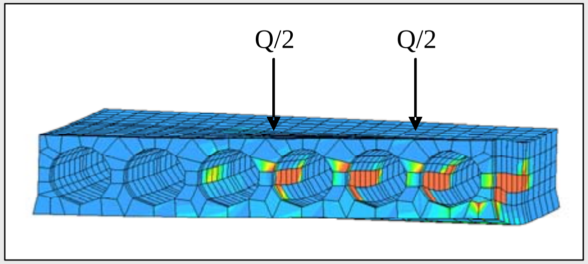




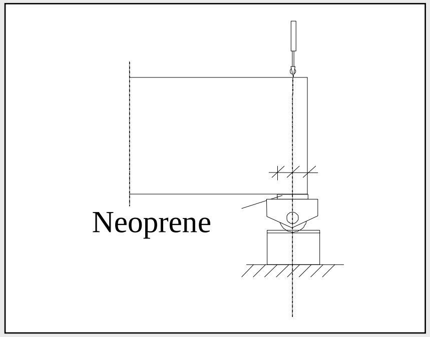
Comparison of results

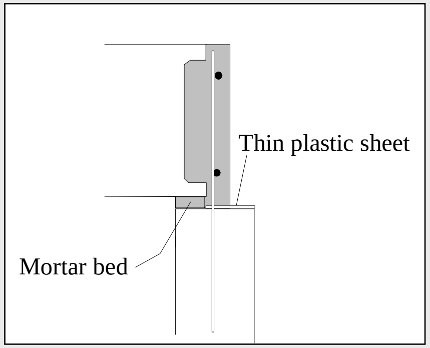


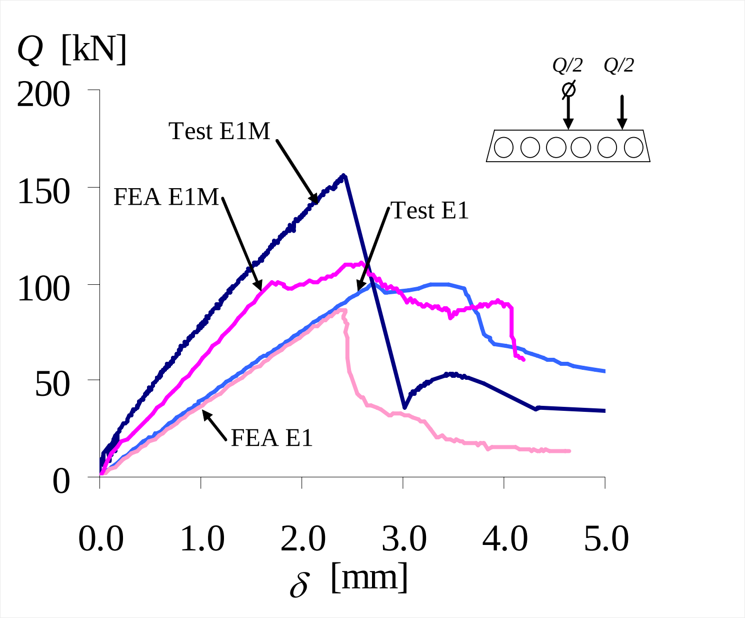


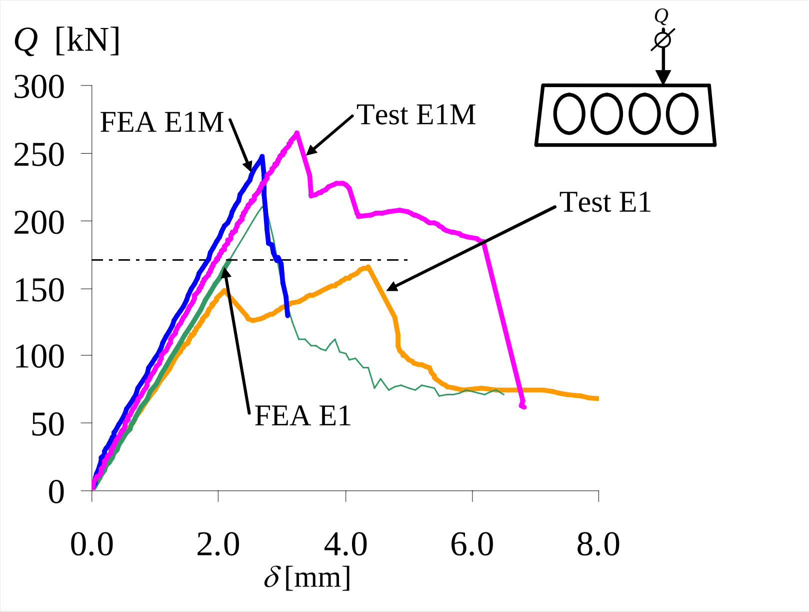


Comparison of results

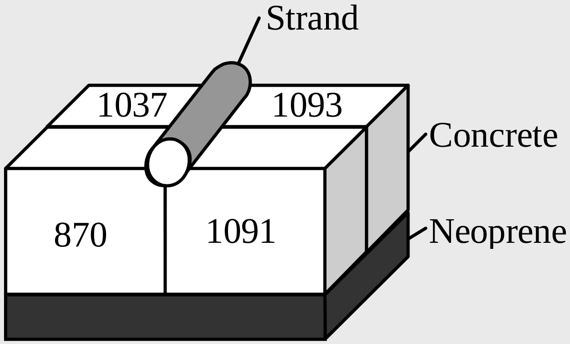


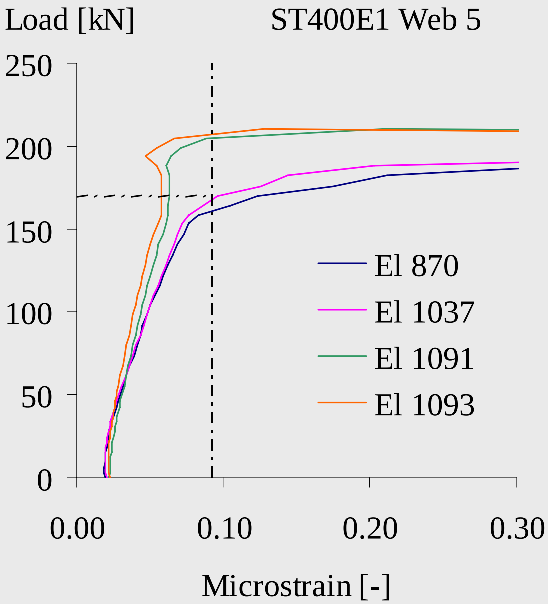


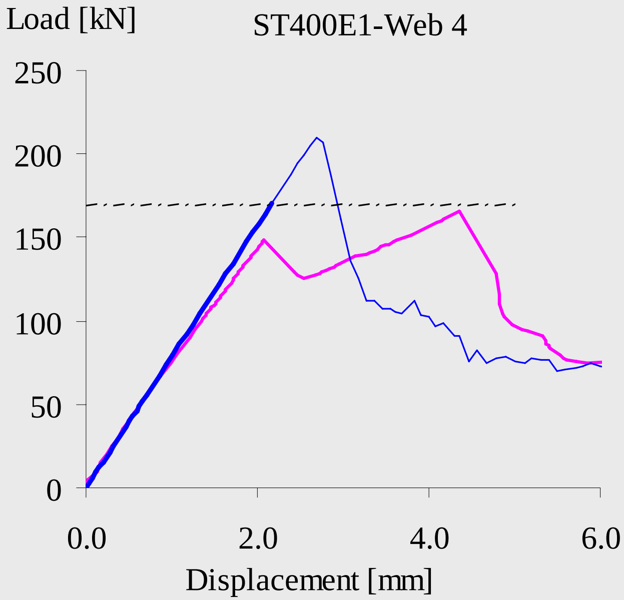




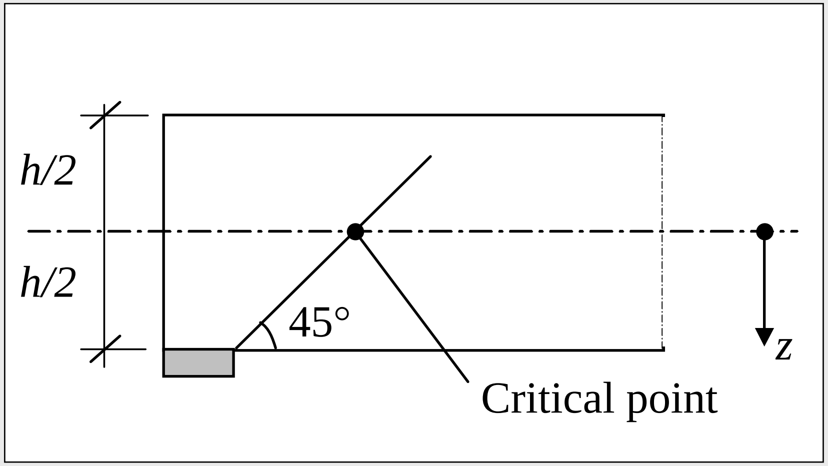
Effect of neoprene



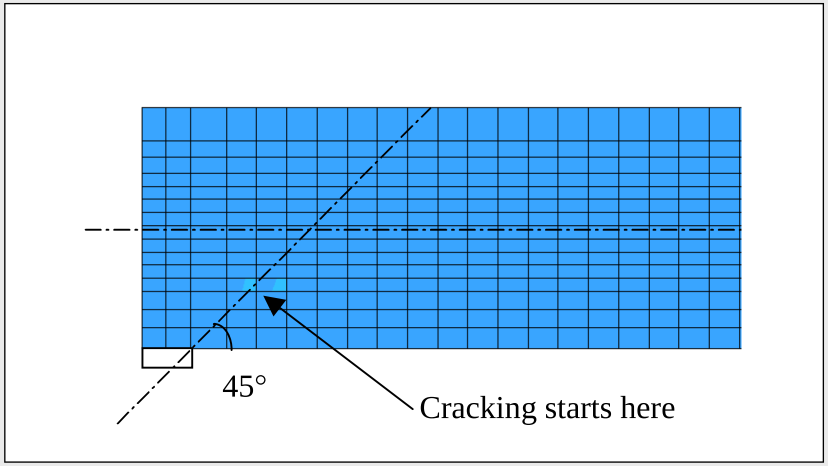




Critical section for shear tension crack in 400 mm unit



Analytical model

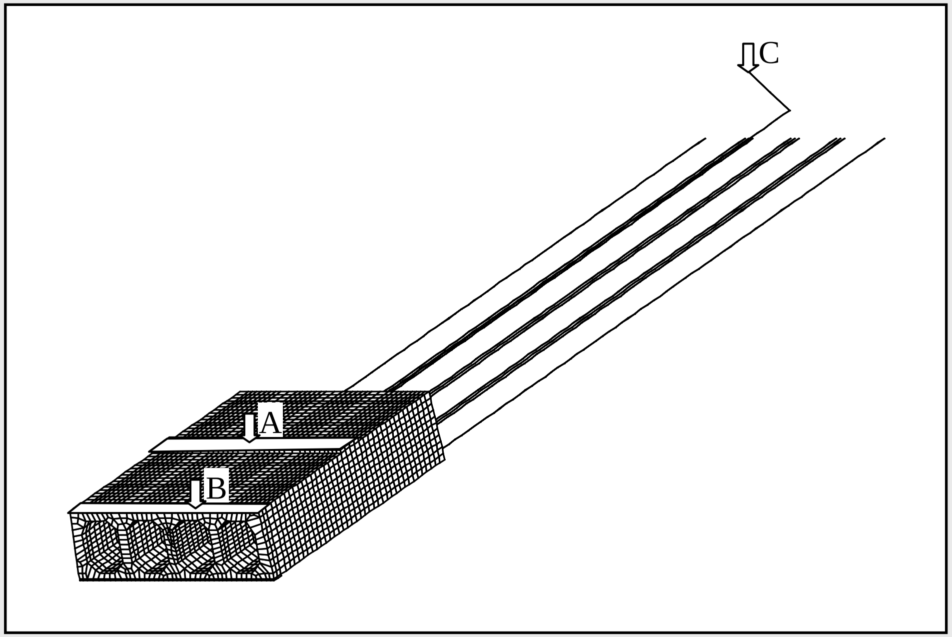


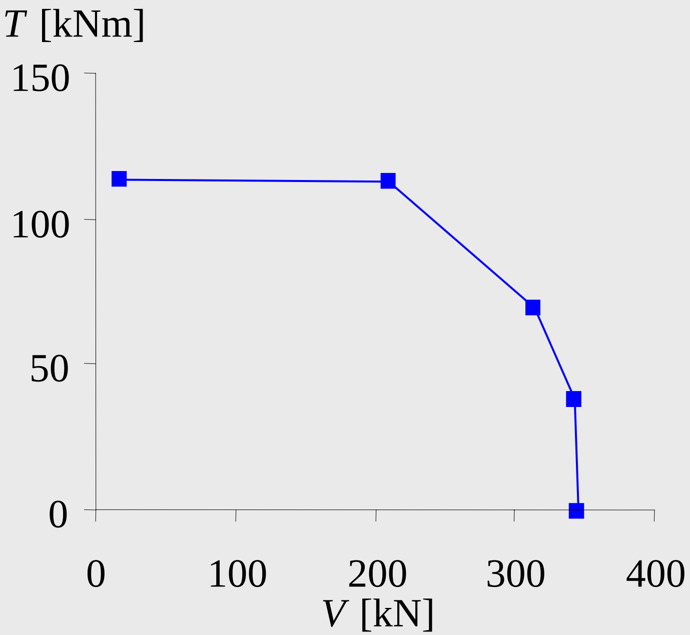
FE-analysis, pure shear

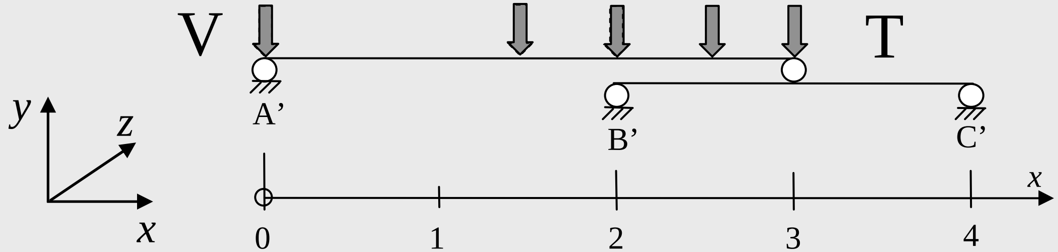
Conclusions FE-analyses of HC-units

- FE-analyses of tests are able to capture the overall behaviour:
  - Failure mode
  - Maximum obtained load
  - Crack pattern
  - Vertical deflections (until first crack)
- Large difference in capacity due to support condition

FE analyses to establish interaction diagram





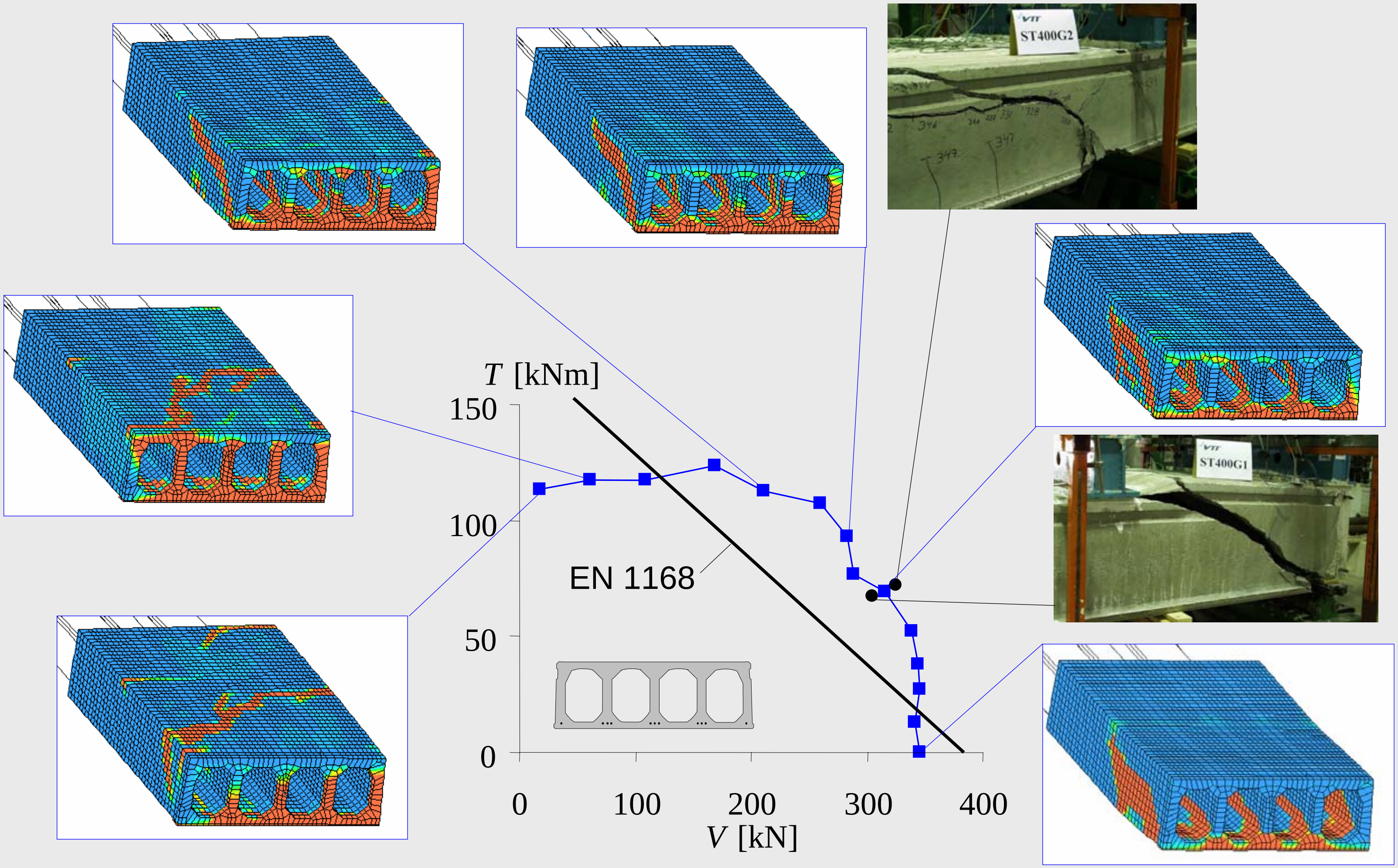


$$\delta_y^A = \delta_y^{A'}$$

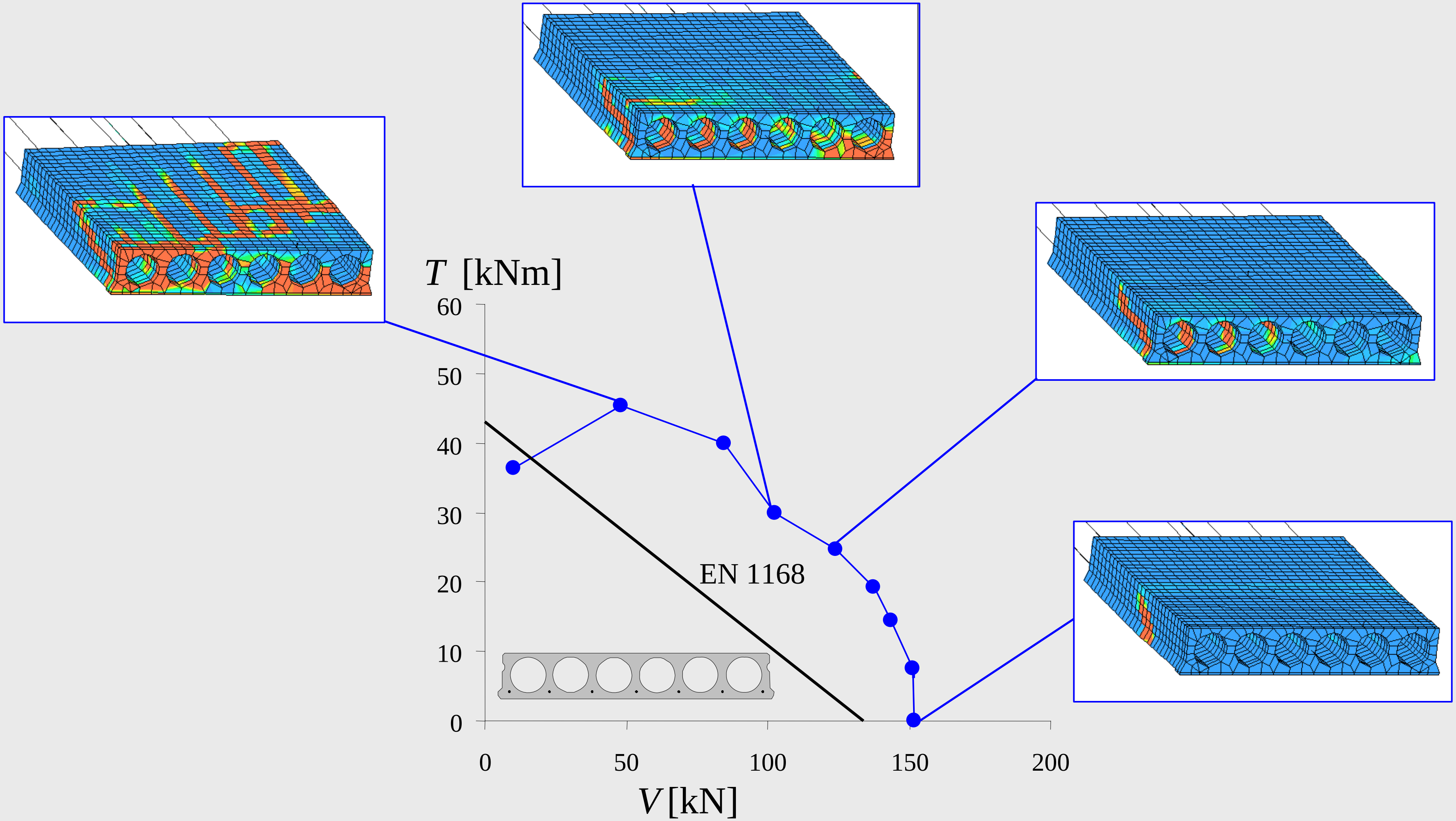
$$\delta_y^B = \delta_y^{B'}$$

$$\delta_y^C = \delta_y^{C'}$$

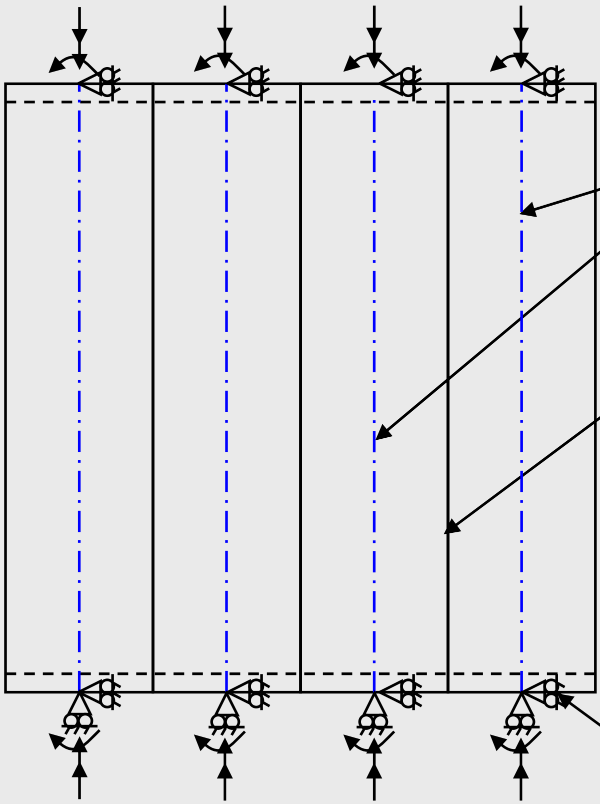
Interaction diagram for 400 mm unit



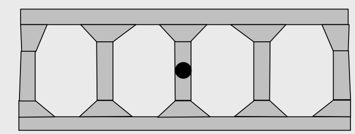
Interaction diagram for 200 mm unit



FE model of hollow core floor

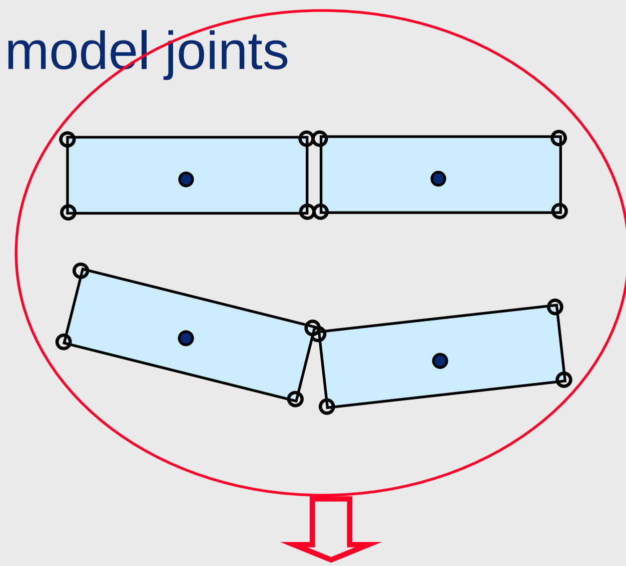


Beam elements to model single hollow core units



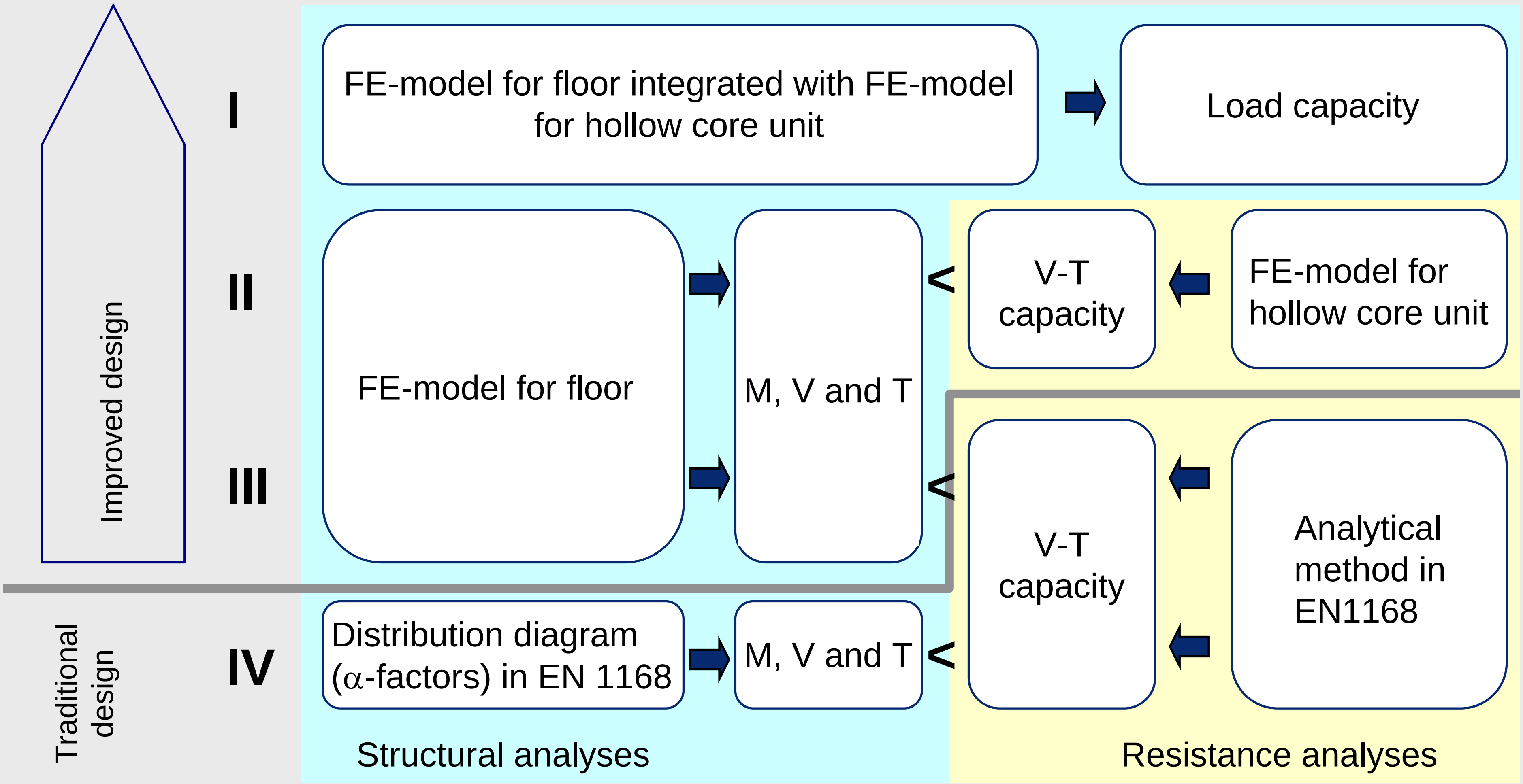
Interface elements to model joints

Tie beam modelled by tyings

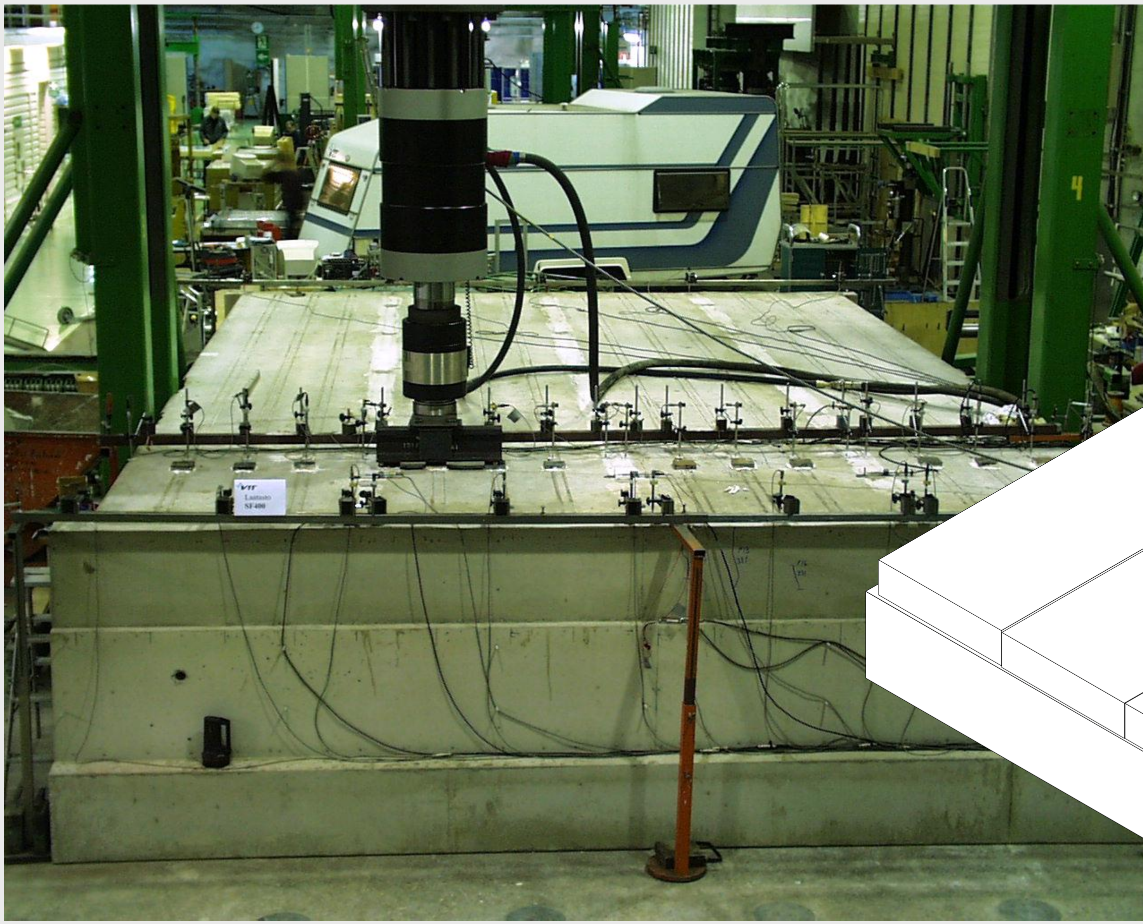


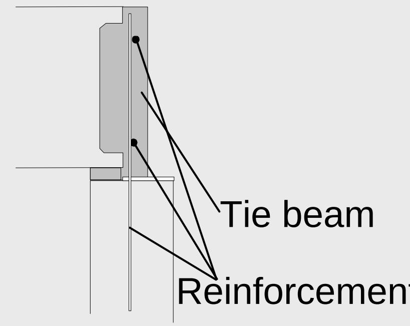
Reduced torsional moment

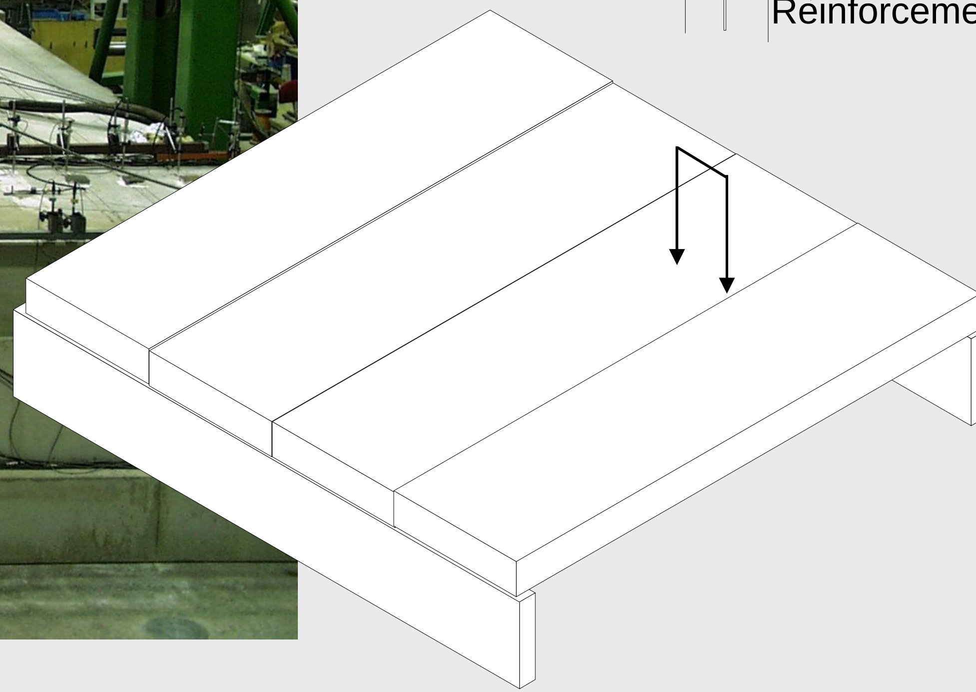
Design of hollow core slabs



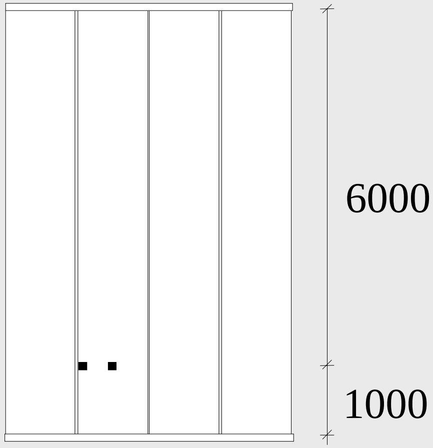
Test on hollow core floor

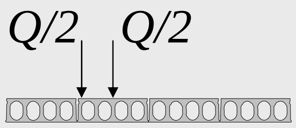


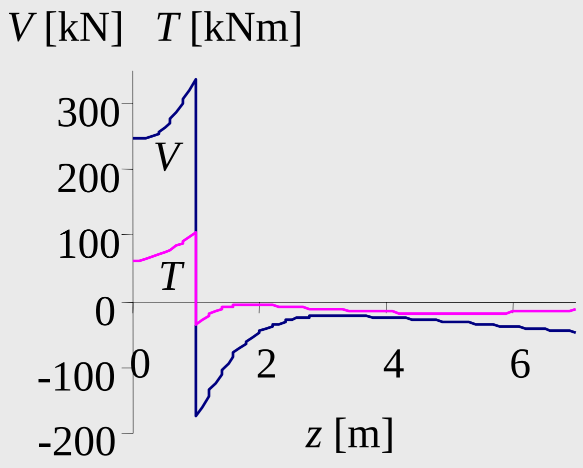


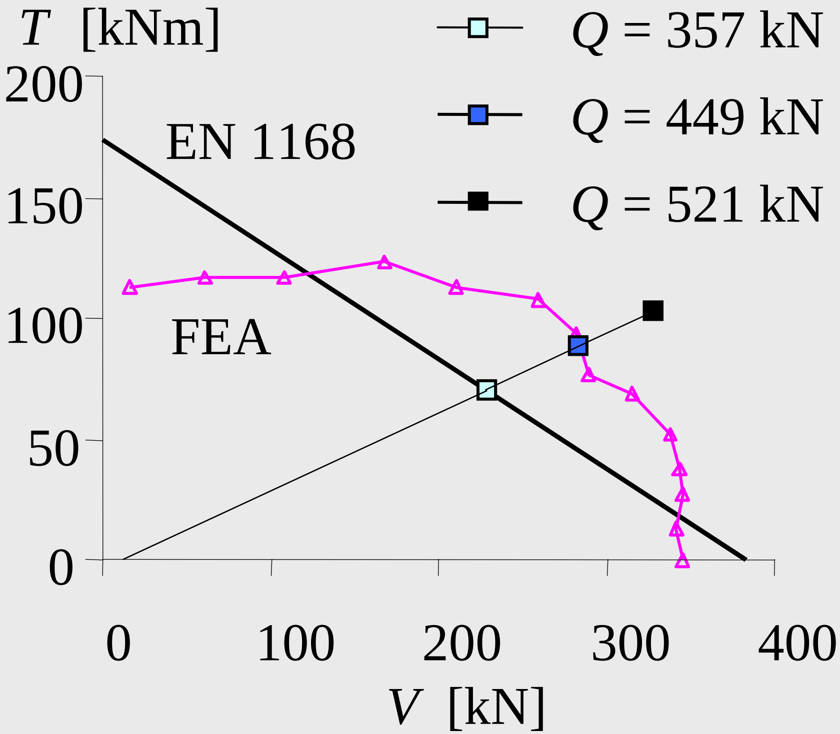


Designing a floor – Design level III and II

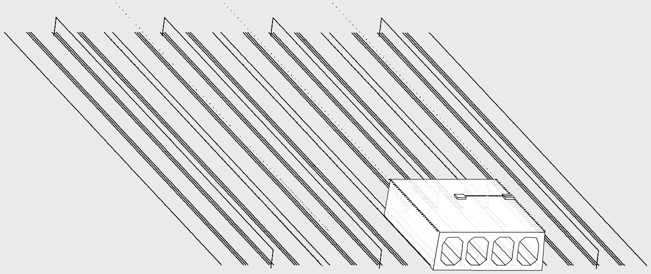


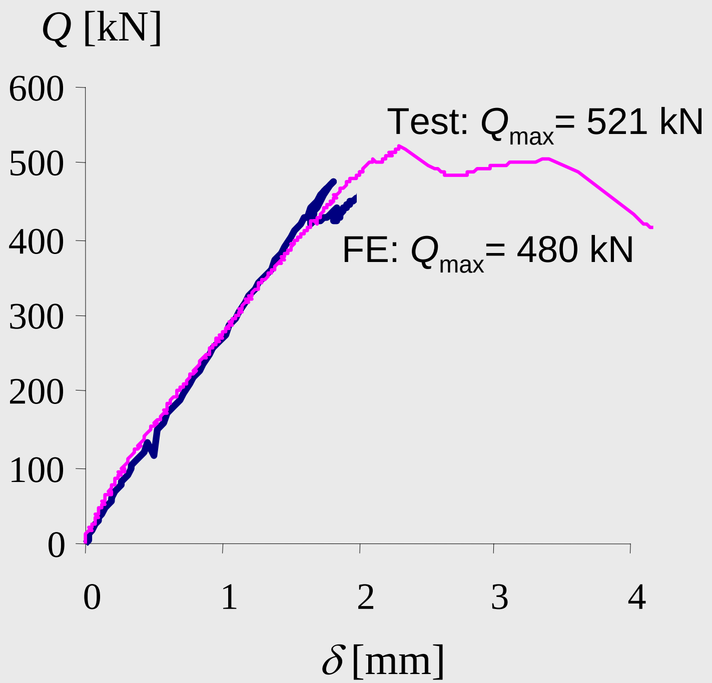


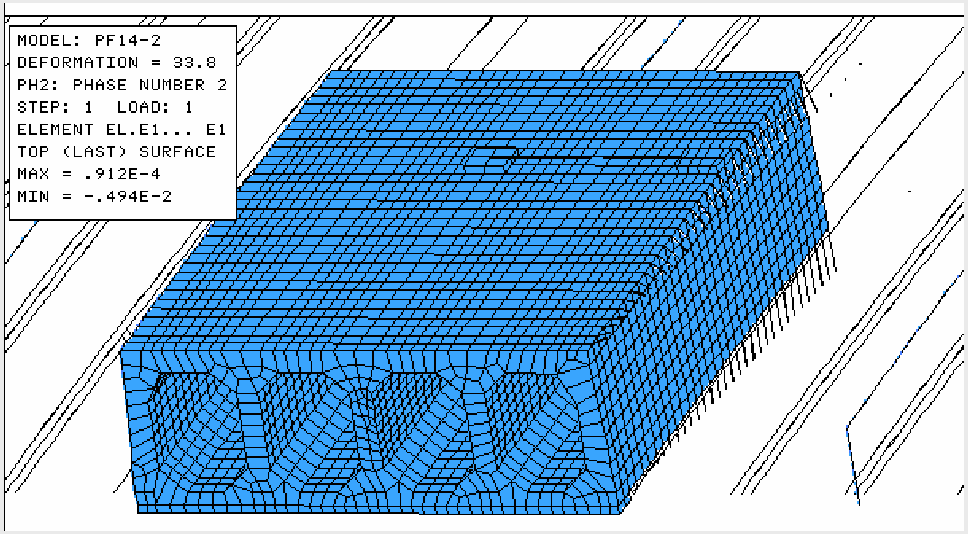




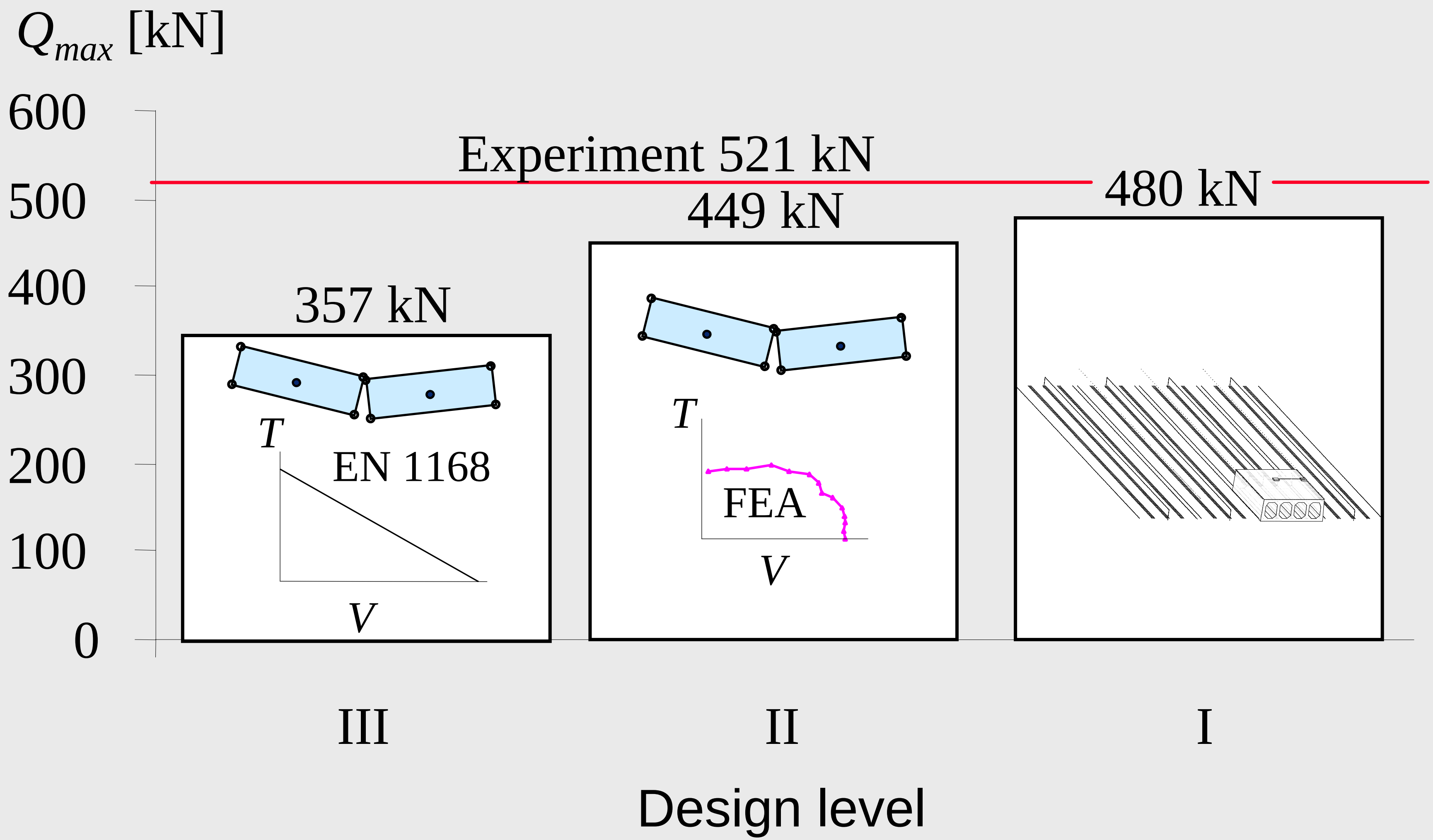
Simulation of a floor test – Design level I







Floor, design example



Conclusions

- Modelling methods for hollow core slabs were developed
  - Hollow core floor $\Rightarrow$ Sectional forces M, V and T
    - Reduced torsional moment
    - Arbitary geometries and loadings
  - Hollow core unit $\Rightarrow$ Shear-torsion capacity
    - Higher resistance
- The capacity of the hollw core units can be used better

Thanks!