On the influence of fibres on tensile laps of reinforcement loops

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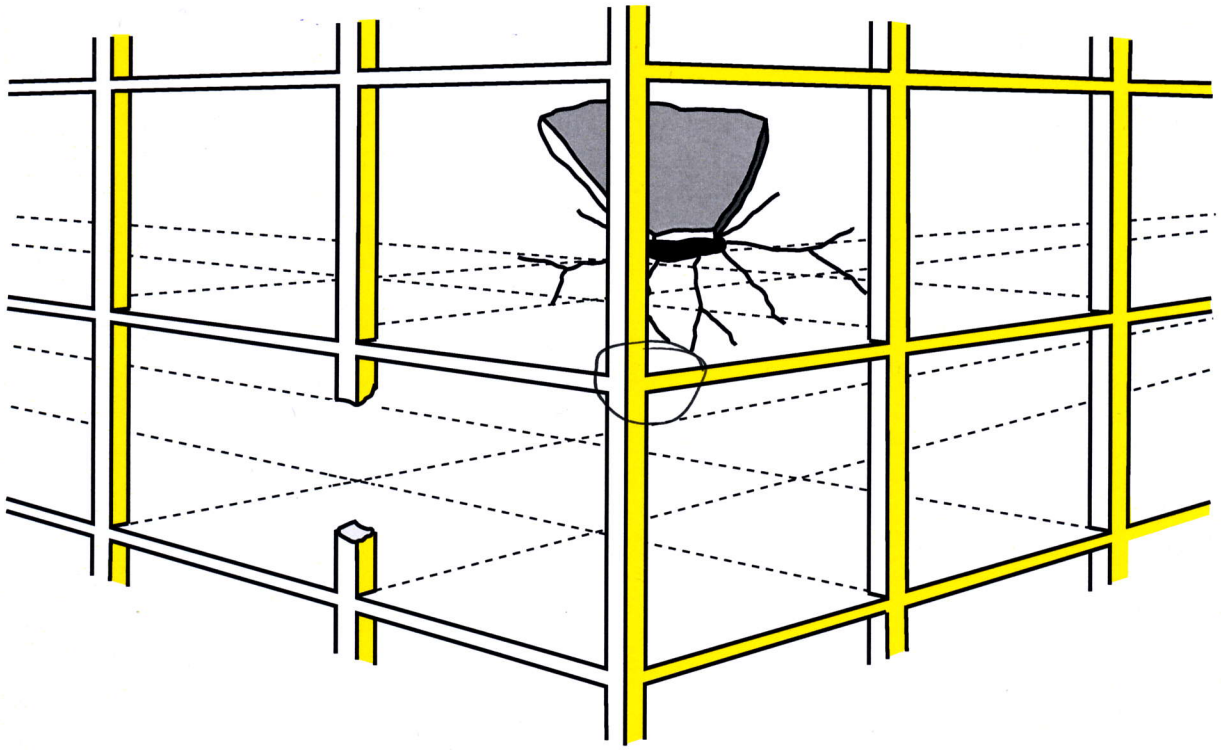
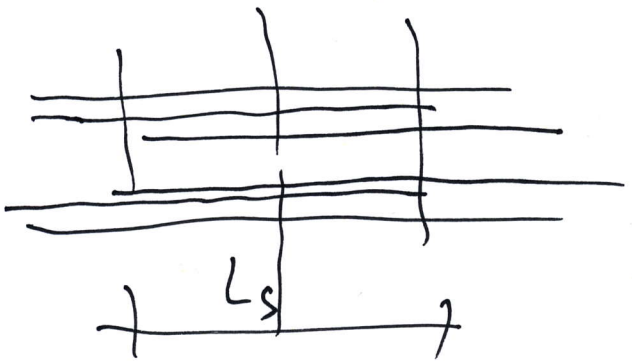
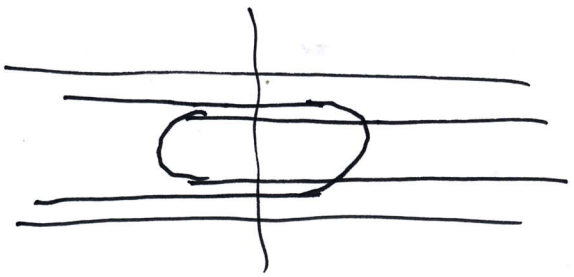
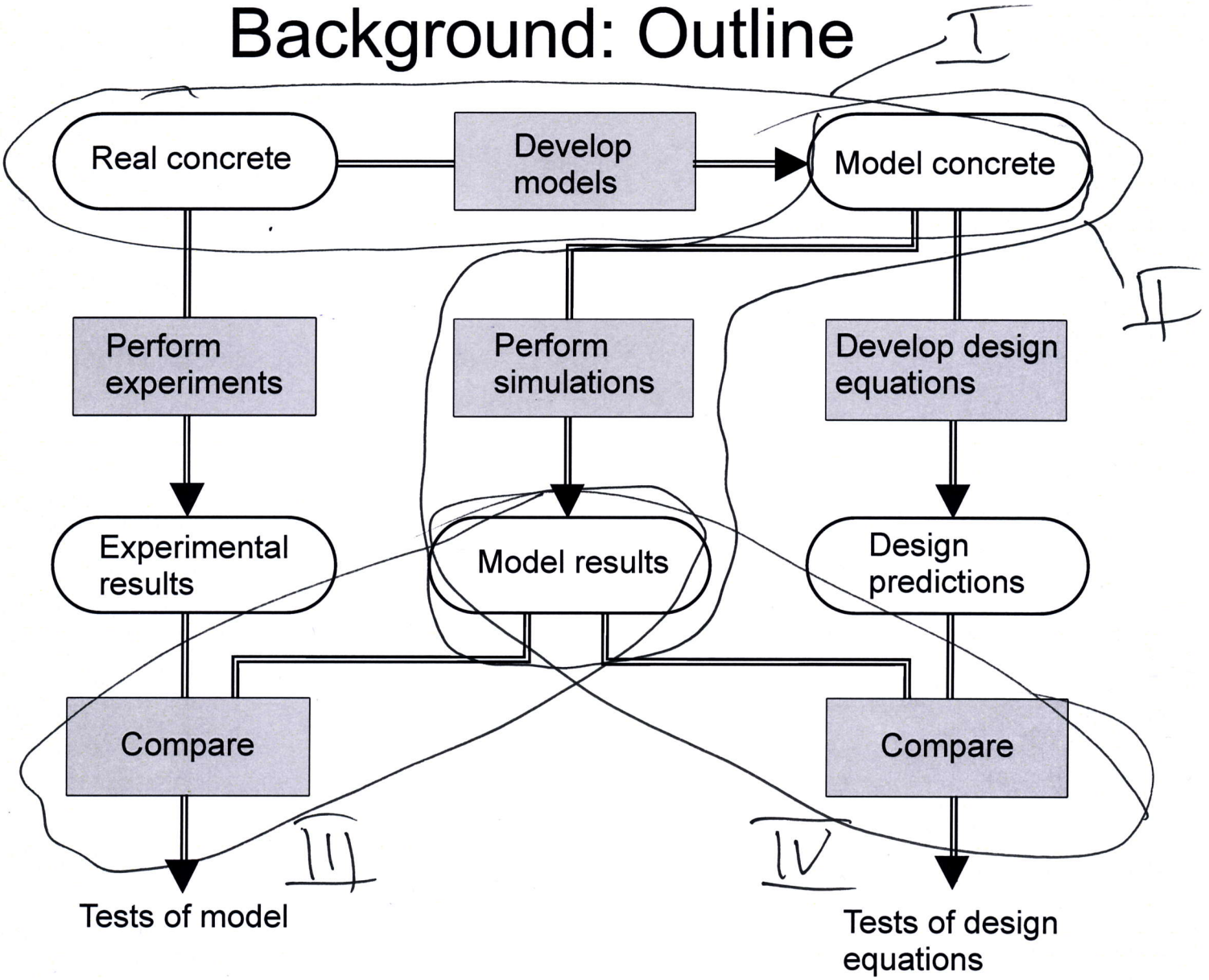
Background: Structural concrete





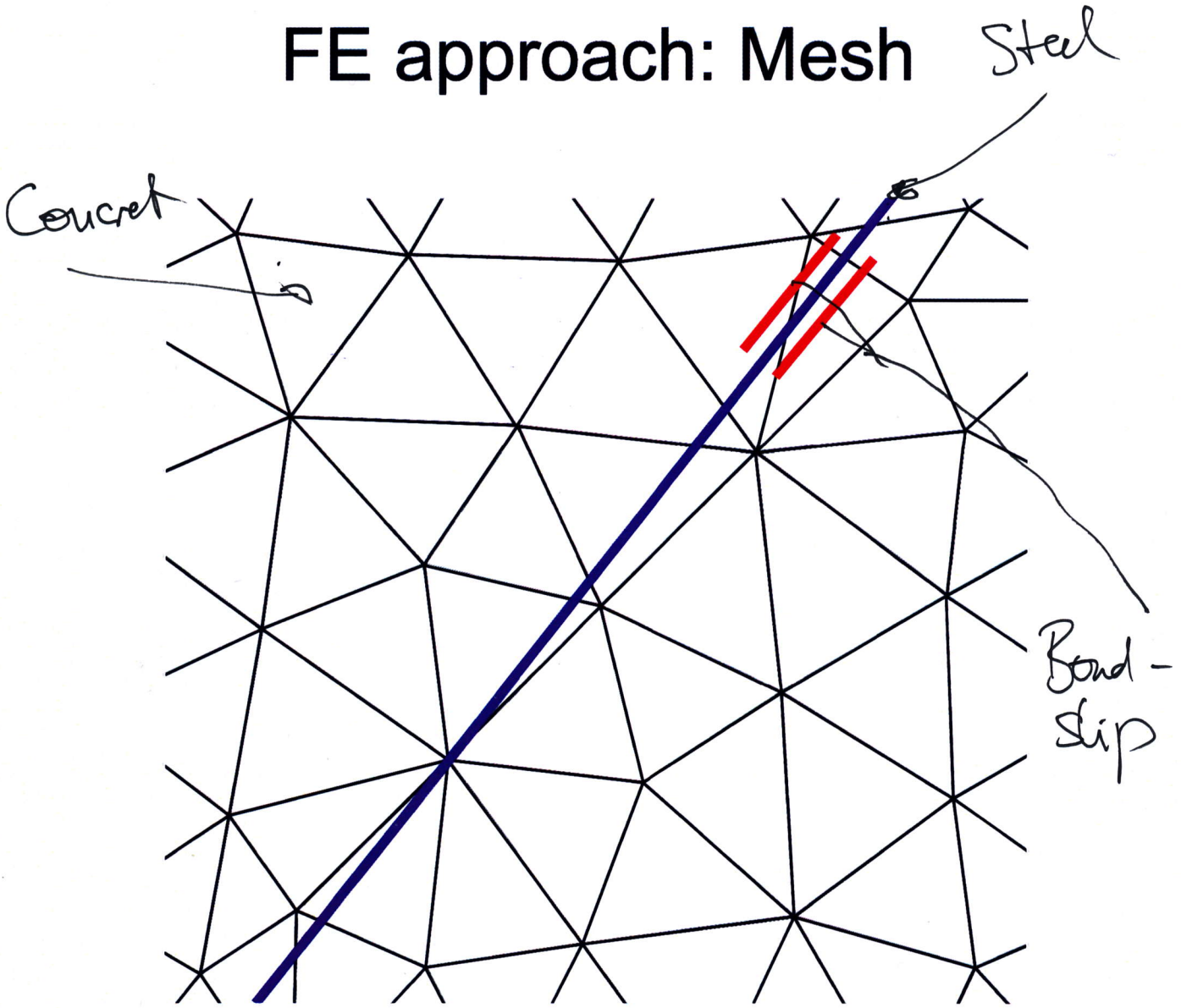


Background: Outline



Inspired from Allen and Tildesley (2017)

FE approach: Mesh



Constitutive model for concrete

damage

$$\boldsymbol{\sigma} = (1-\omega)\mathbf{D}_\mathrm{e} : \boldsymbol{\varepsilon}$$

plasticity

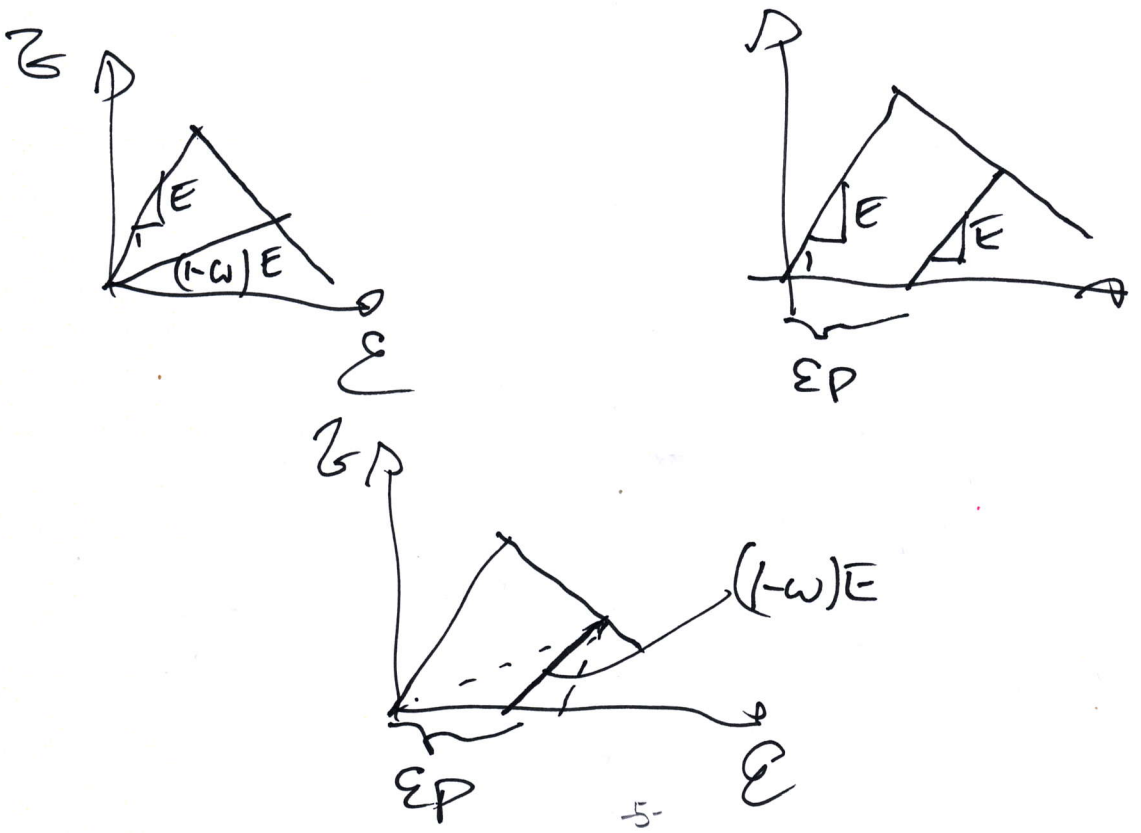
$$\boldsymbol{\sigma} = \mathbf{D}_\mathrm{e} : (\boldsymbol{\varepsilon} - \boldsymbol{\varepsilon}_\mathrm{p})$$

damage-plasticity

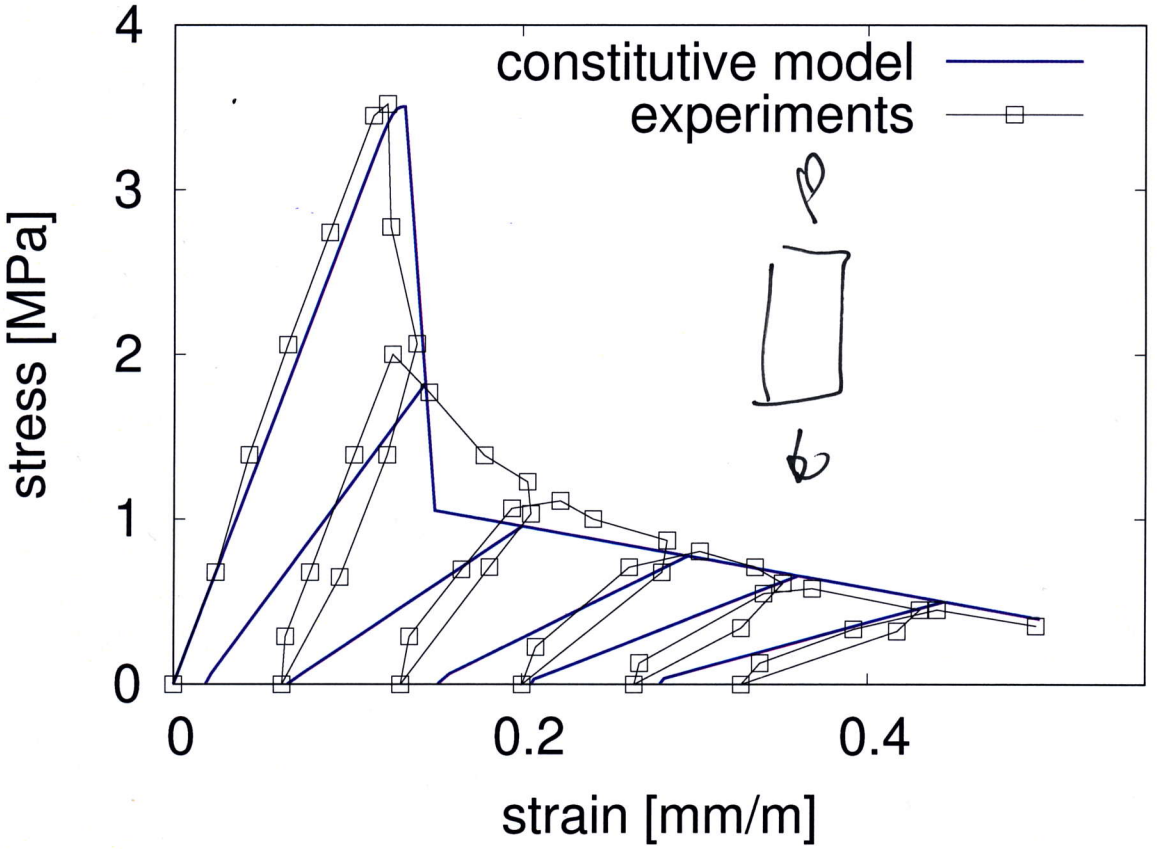
$$\boldsymbol{\sigma} = (1-\omega_\mathrm{t})\bar{\boldsymbol{\sigma}}_\mathrm{t} + (1-\omega_\mathrm{c})\bar{\boldsymbol{\sigma}}_\mathrm{c}$$

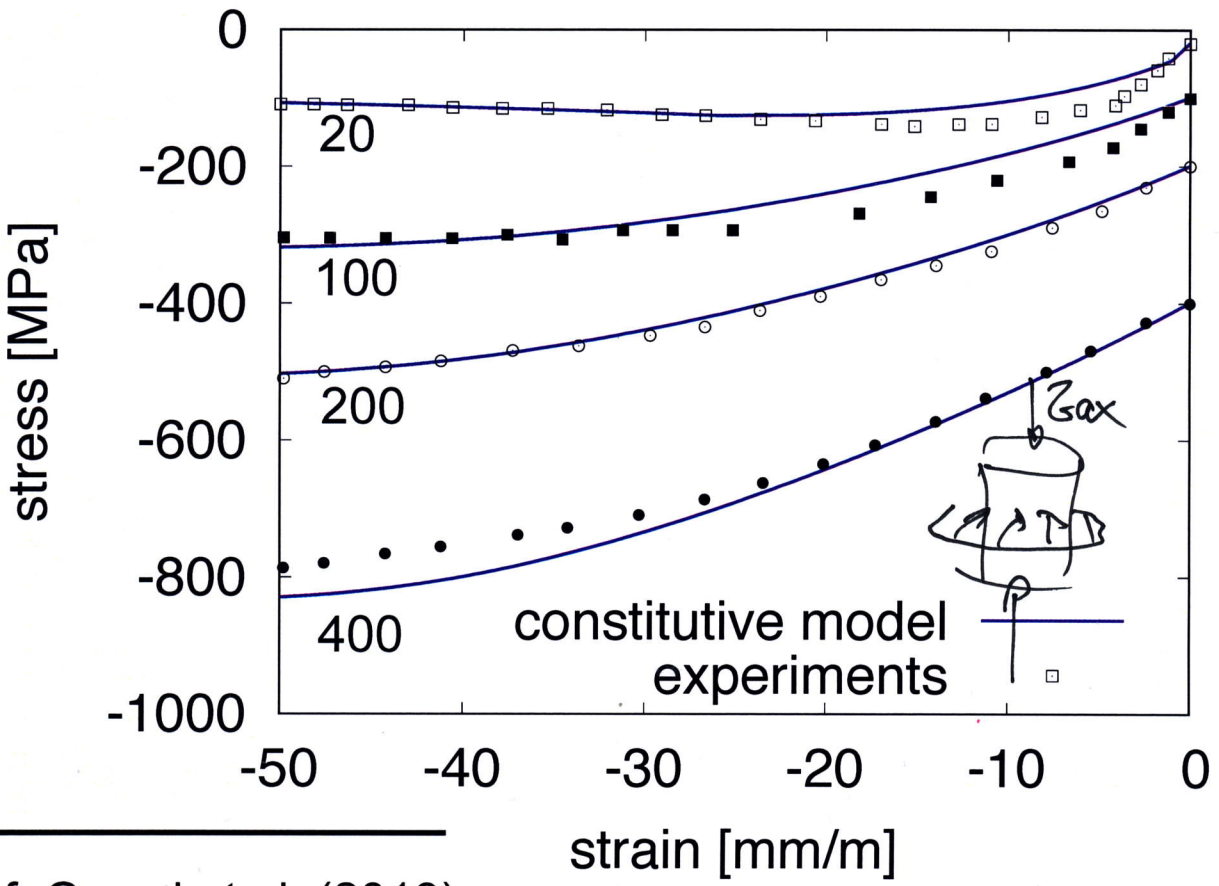
$$\bar{\boldsymbol{\sigma}} = \mathbf{D}_\mathrm{e} : (\boldsymbol{\varepsilon} - \boldsymbol{\varepsilon}_\mathrm{p}) = \bar{\boldsymbol{\sigma}}_\mathrm{t} + \bar{\boldsymbol{\sigma}}_\mathrm{c}$$

Ref: Grassl et al. (2013)



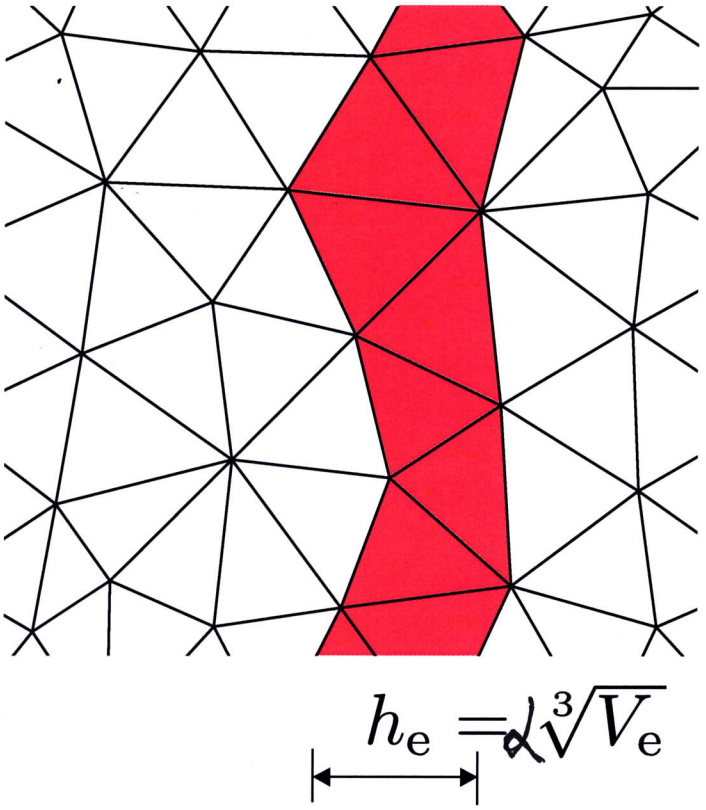
Constitutive response for concrete

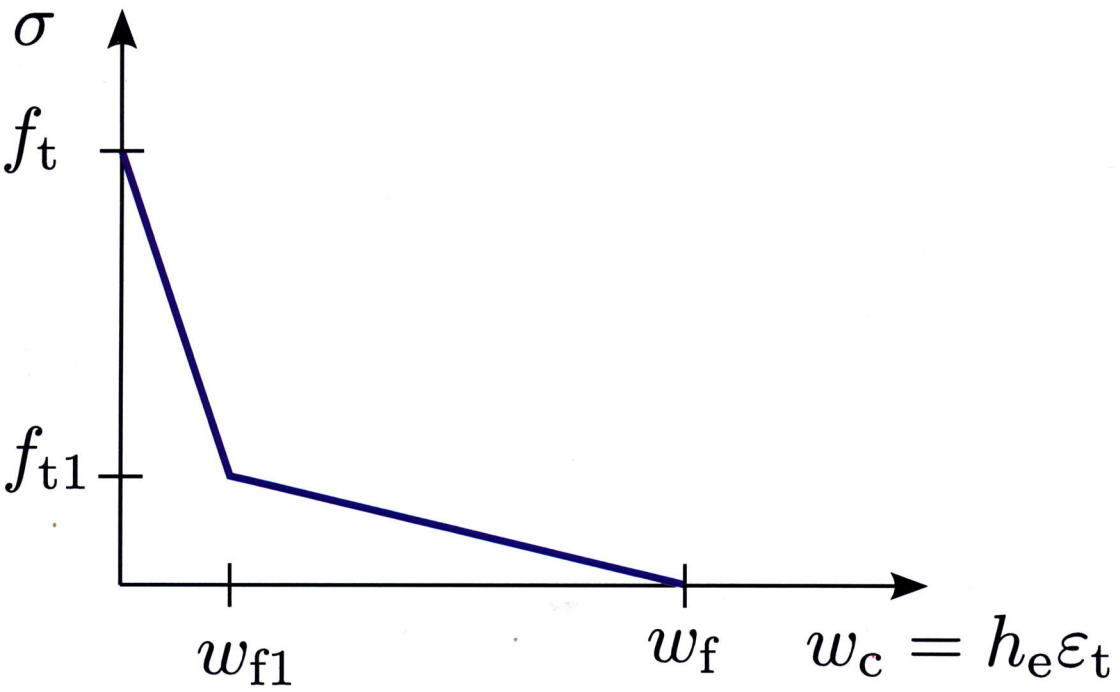




Ref: Grassl et al. (2013)

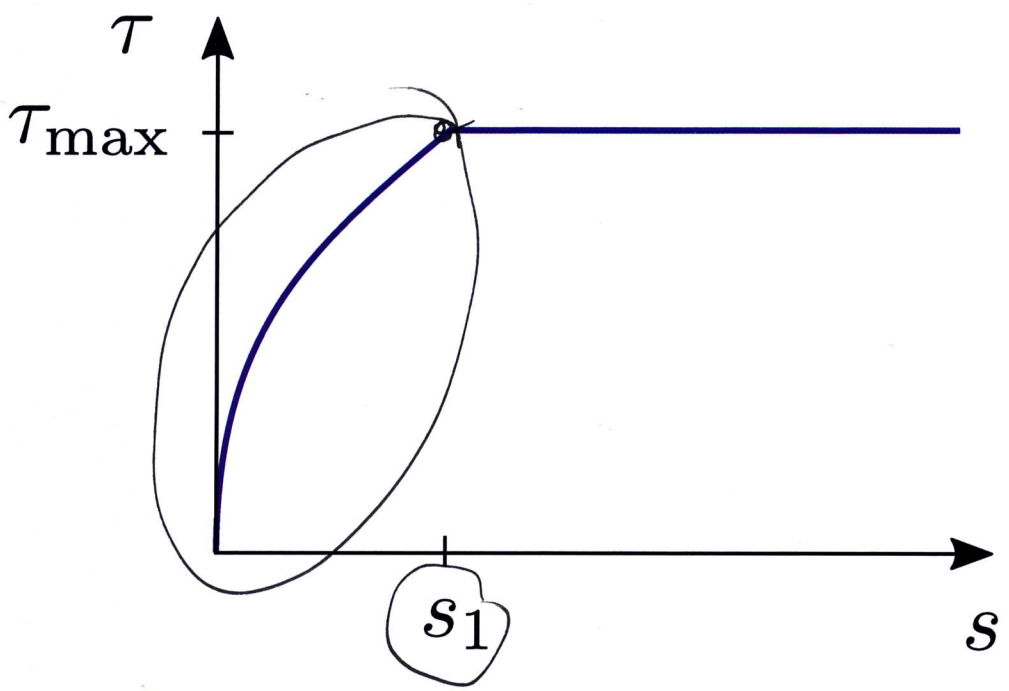
Crack-band approach



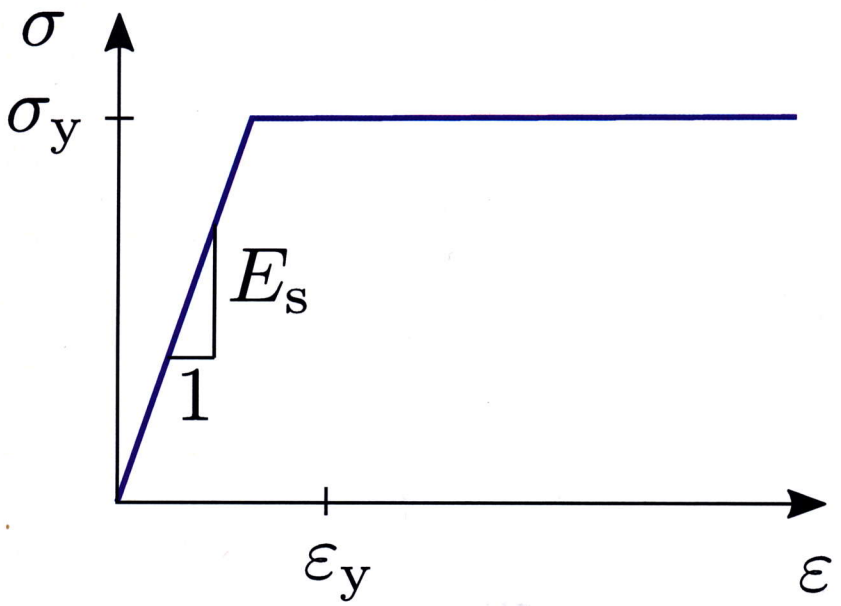


Constitutive models

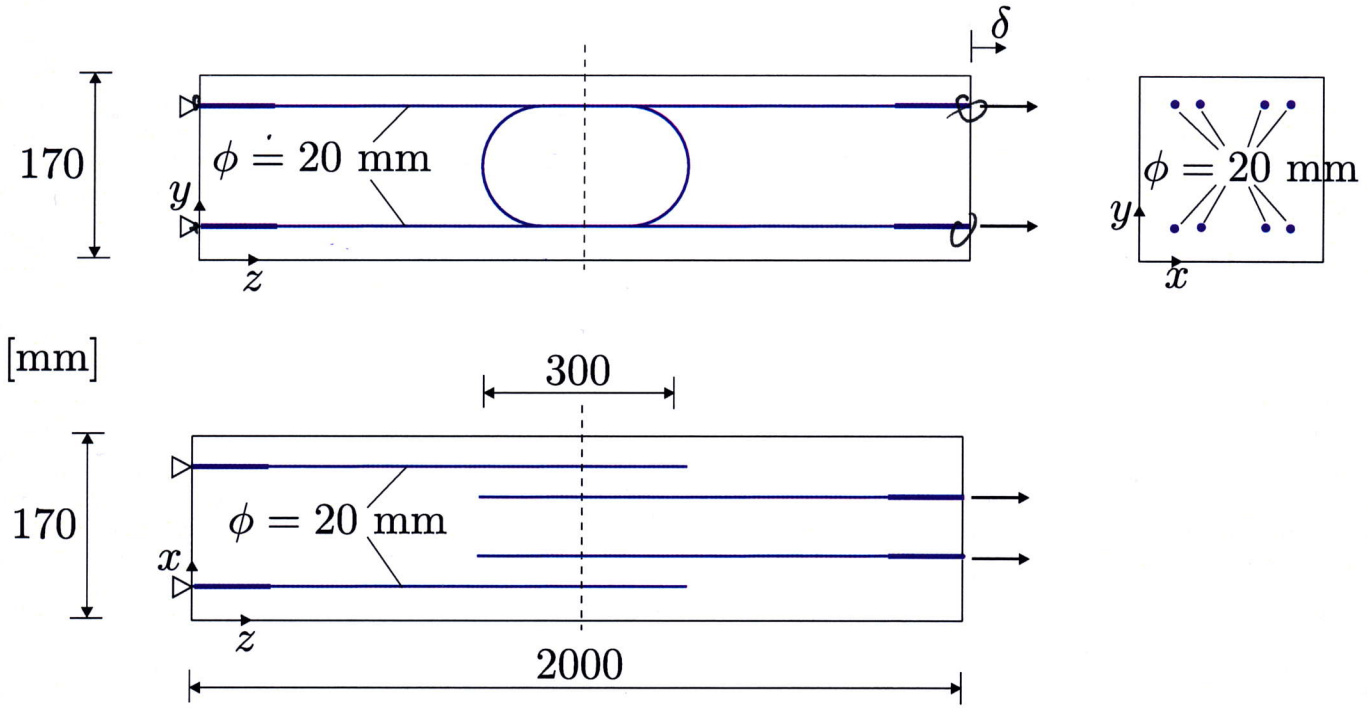
Bond



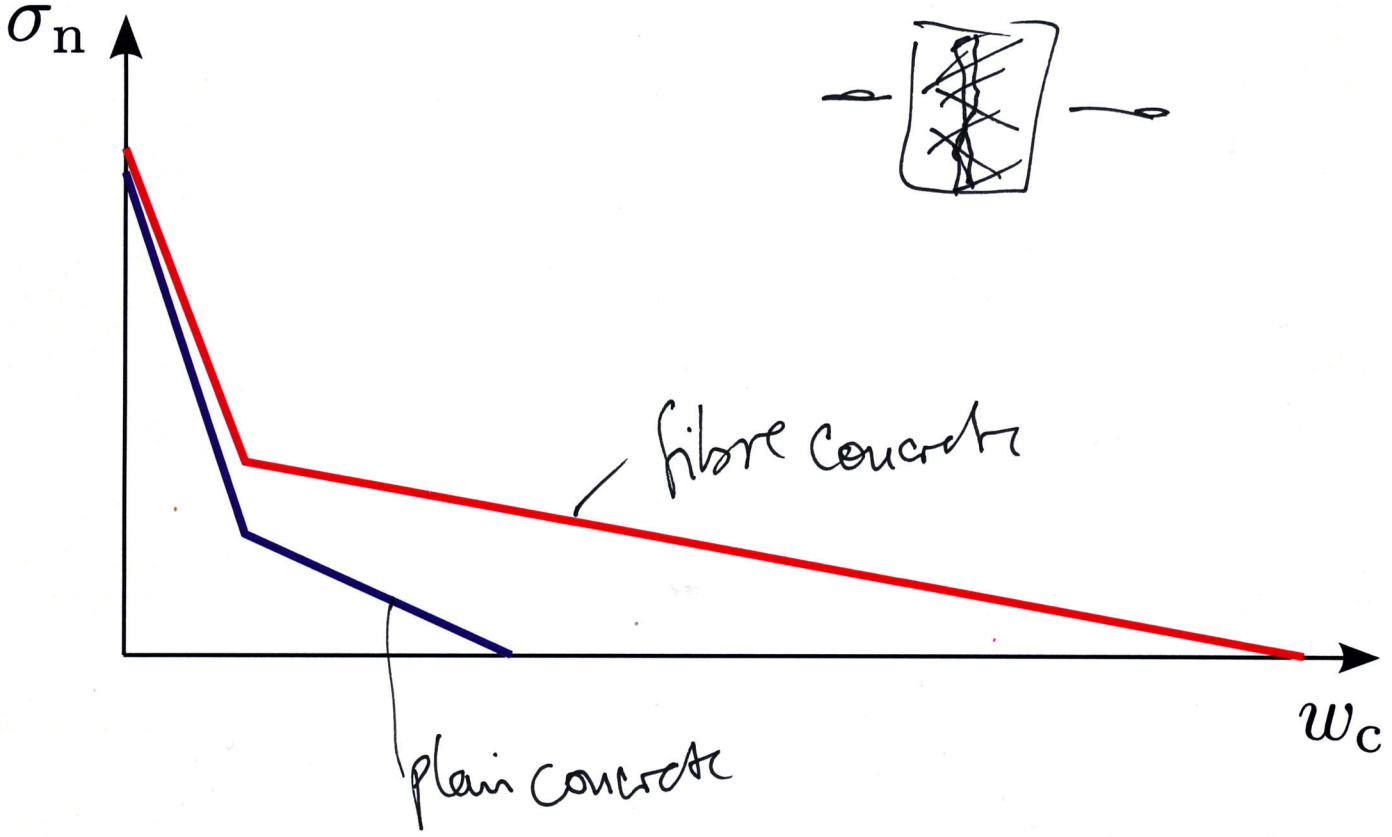
Steel



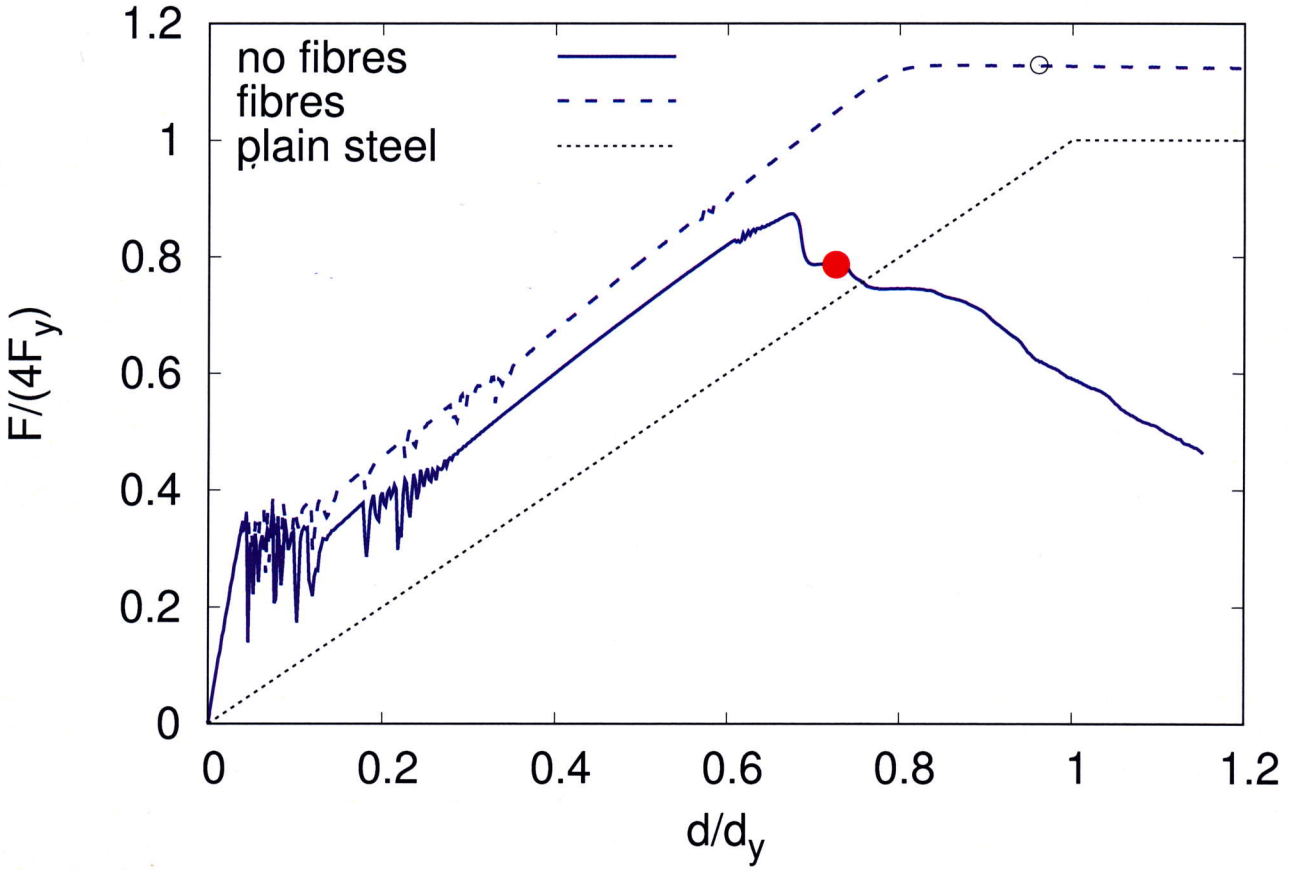
Geometry and setup



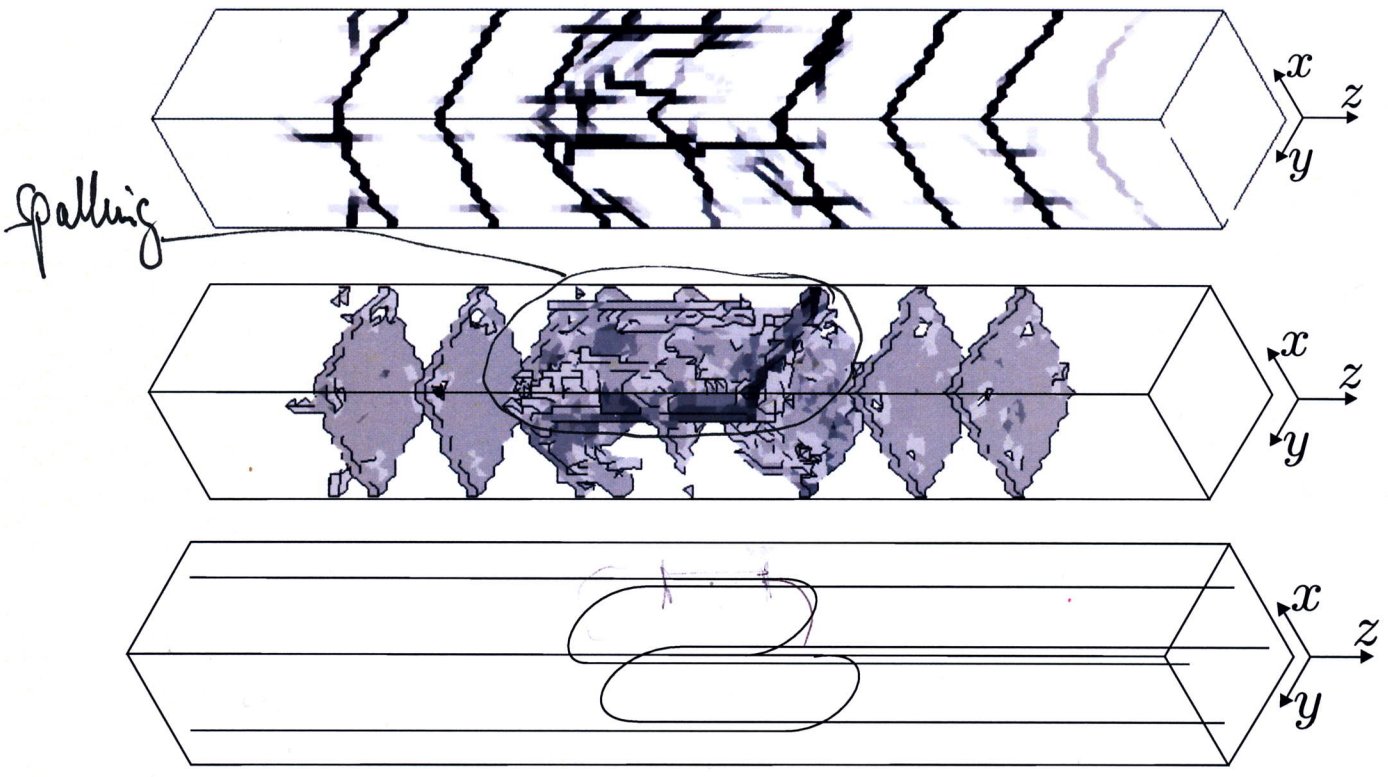
Plain and fibre concrete



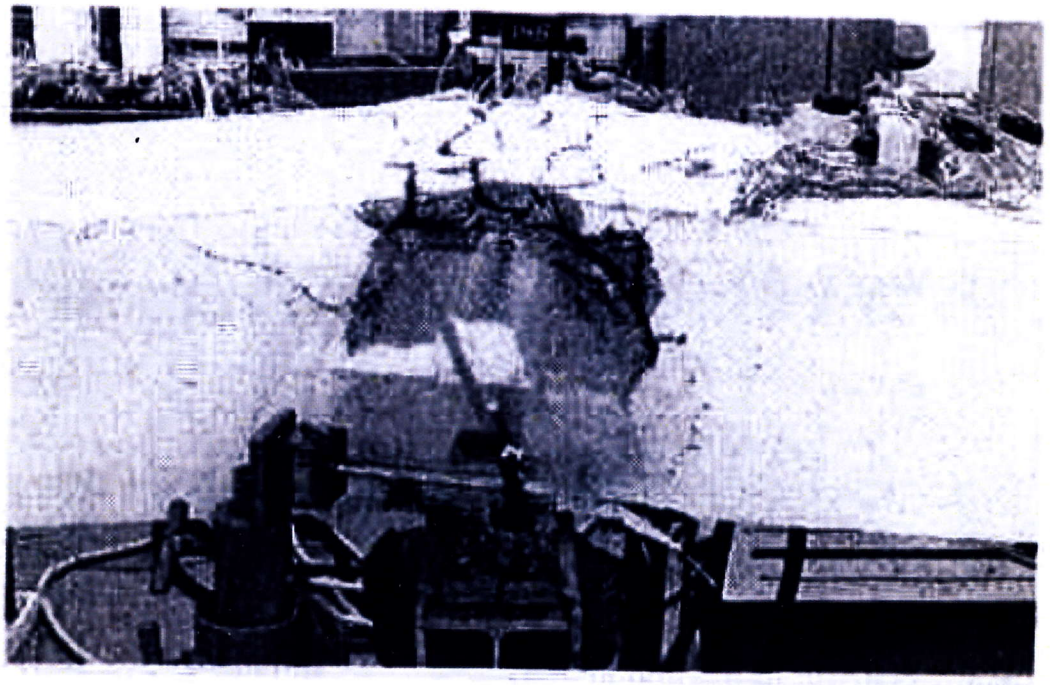
Load-displacement



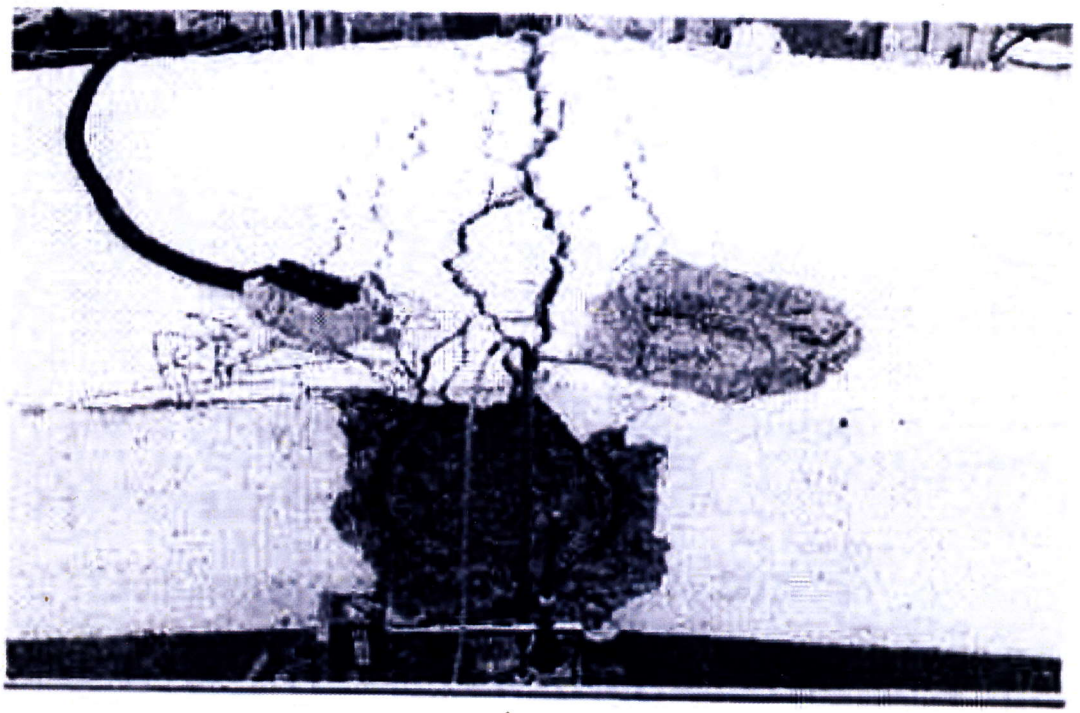
No fibres



Comparison with experiments



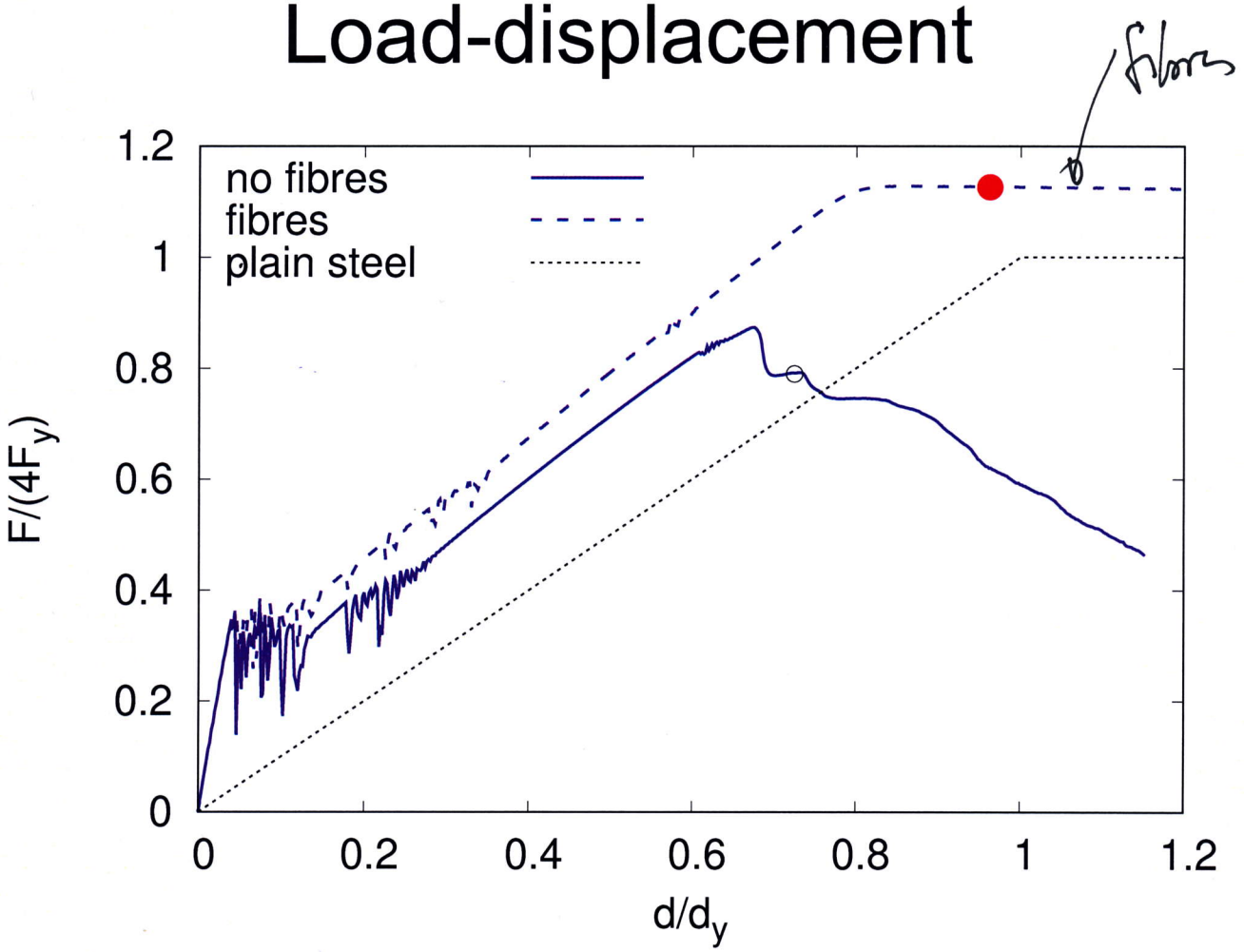
R12



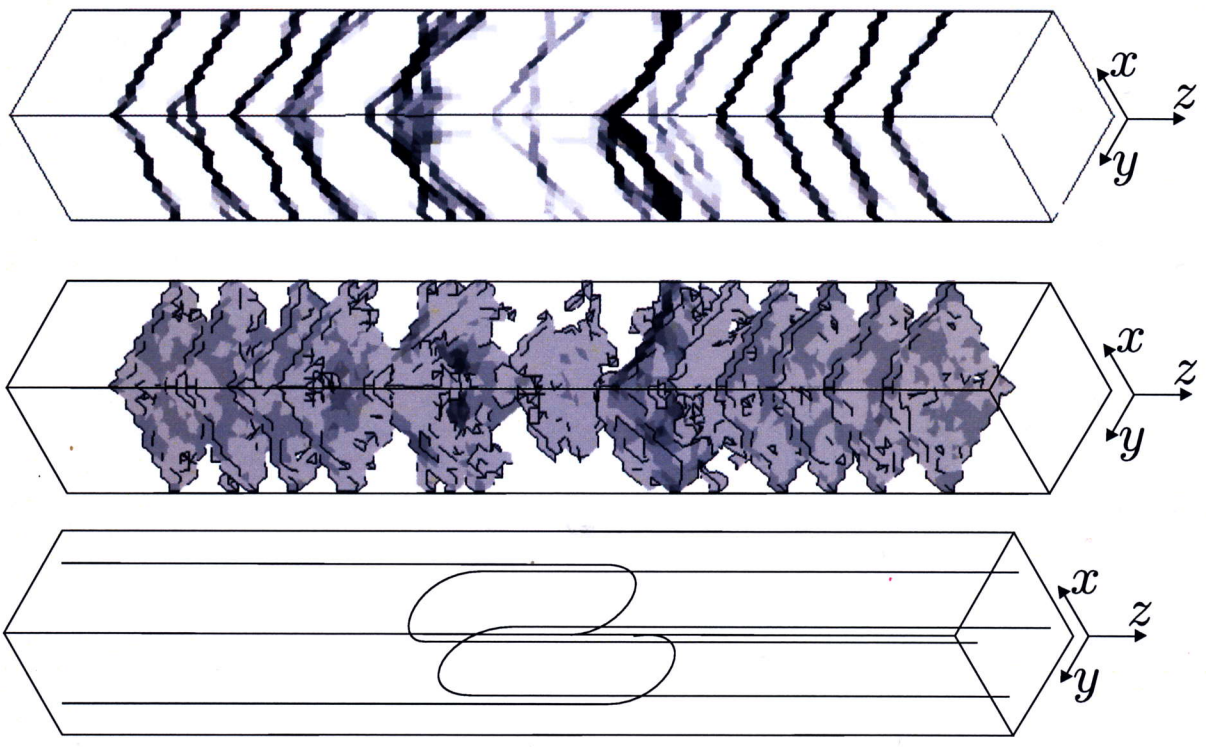
R14

Ref: Grassl (1999)

Load-displacement



Fibres



Discussion

FE-approach is capable of producing spalling failure in loop splices with plain concrete.

Adding fibres prevents sudden spalling failure mode.

Next steps

Model: Should reinforcement be modeled using solid elements? How strongly does it affect the results?

Design equations: Use detailed 3D results to review existing design equations for reinforcement arrangements.