CIEM1110-1: FEM, lecture 4.1

Workshop: Nonlinear material models

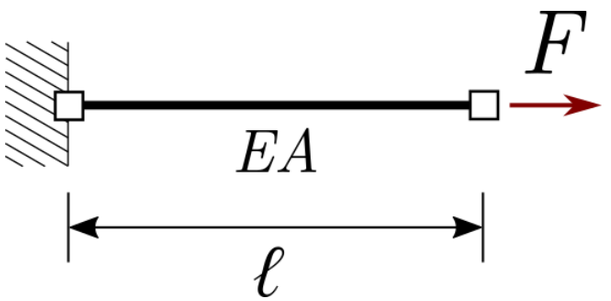
Iuri Rocha

TU Delft

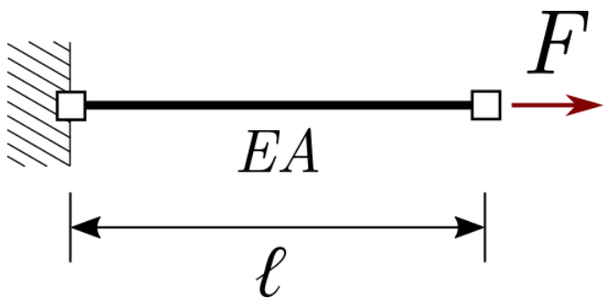
Notebook 1

Run the model as is:

- Load or displacement control?
- Convergence behavior?



Notebook 1



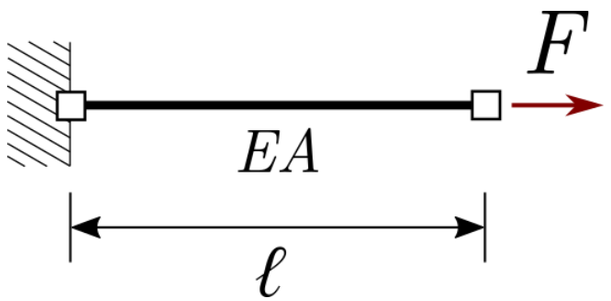
Run the model as is:

- Load or displacement control?
- Convergence behavior?

Non-consistent tangent stiffness matrix:

- Perturb the consistent tangent with `alpha*np.linalg.norm(strain)`
- Convergence behavior for different values of α?
- Time step size influence?

Notebook 1



Run the model as is:

- Load or displacement control?
- Convergence behavior?

Non-consistent tangent stiffness matrix:

- Perturb the consistent tangent with `alpha*np.linalg.norm(strain)`
- Convergence behavior for different values of α?
- Time step size influence?

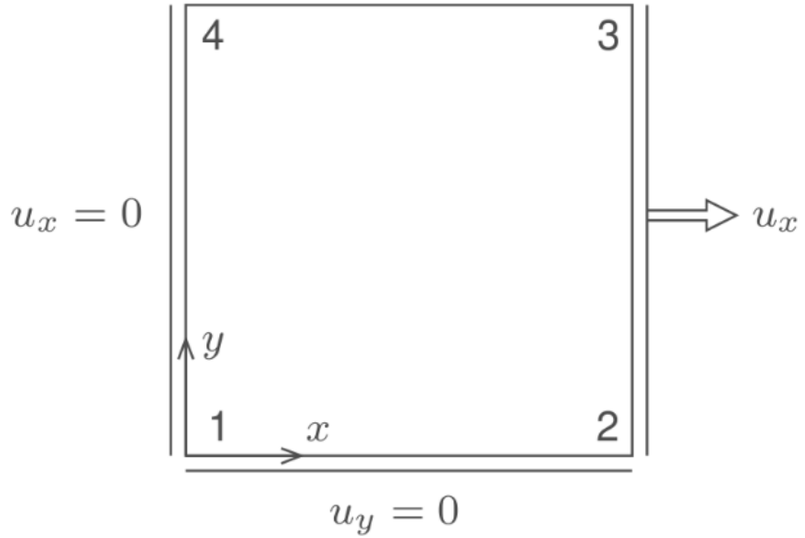
Secant stiffness:

- Change `stiff` to a constant 1000
- Convergence behavior?

Notebook 2

Run the model as is:

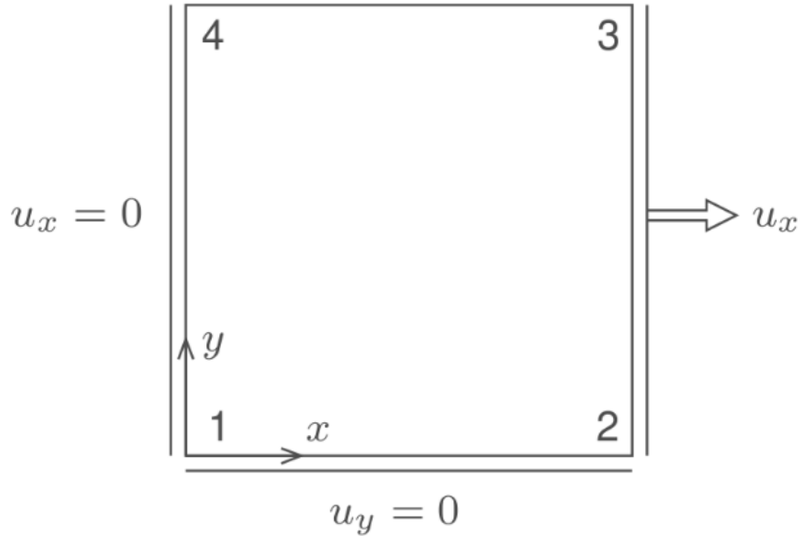
- Convergence behavior?



Notebook 2

Run the model as is:

- Convergence behavior?



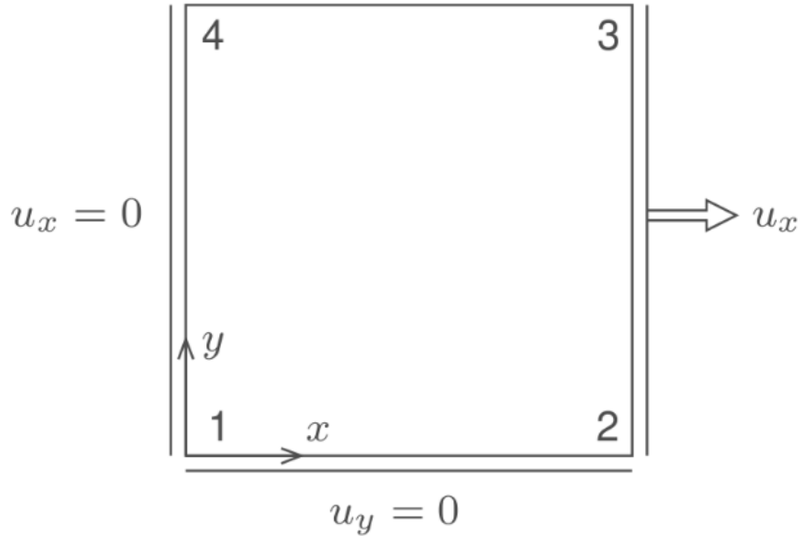
Try with exponential hardening:

- Change yield function to $\sigma_y = 64.8 - 33.6 \exp\left(-\frac{\kappa}{0.003407}\right)$
- What happens to convergence?
- Does a smaller time step help?

Notebook 2

Run the model as is:

- Convergence behavior?



Try with exponential hardening:

- Change yield function to $\sigma_y = 64.8 - 33.6 \exp\left(-\frac{\kappa}{0.003407}\right)$
- What happens to convergence?
- Does a smaller time step help?

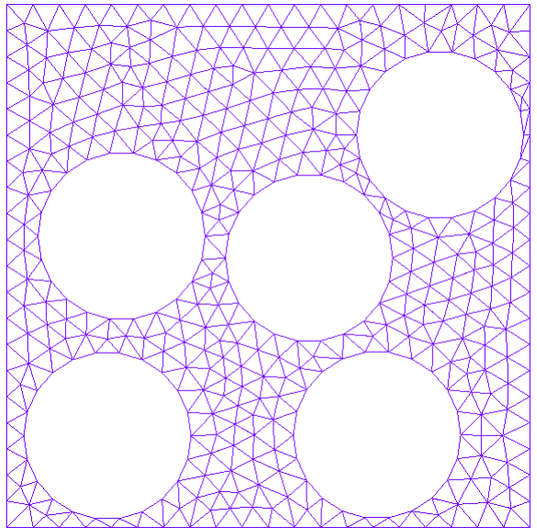
Switch to displacement control:

- Convergence behavior?
- Try with Modified Newton-Raphson

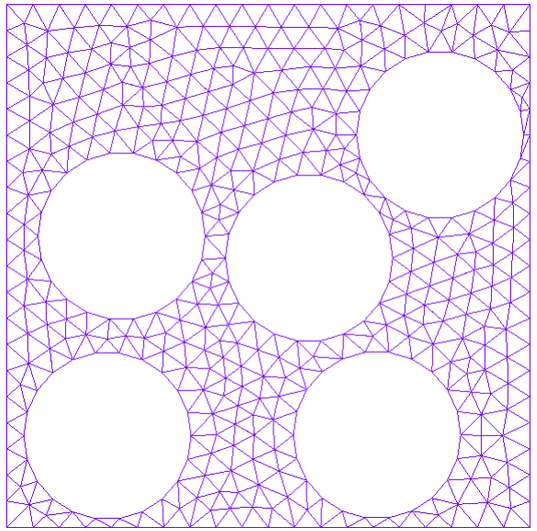
Notebook 3

Run the model as is:

- How are the BCs evolving in time?
- How is κ evolving?
- How is strain distribution changing with time?



Notebook 3



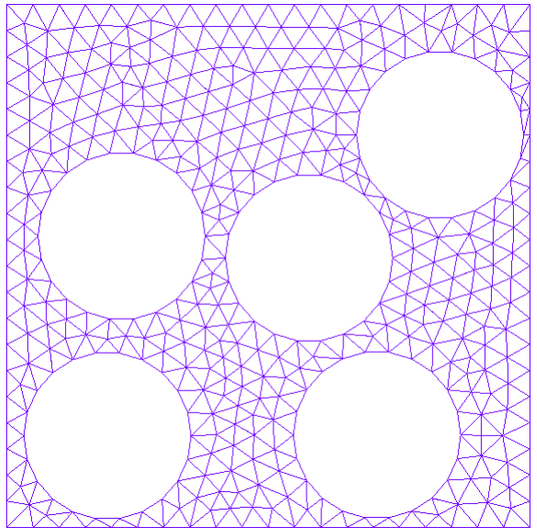
Run the model as is:

- How are the BCs evolving in time?
- How is κ evolving?
- How is strain distribution changing with time?

Non-monotonic displacement path:

- Change the `timeSignal` and run the model
- How is the average plastic strain changing in time?
- Look at the evolution of κ, what is happening?

Notebook 3



Run the model as is:

- How are the BCs evolving in time?
- How is κ evolving?
- How is strain distribution changing with time?

Non-monotonic displacement path:

- Change the `timeSignal` and run the model
- How is the average plastic strain changing in time?
- Look at the evolution of κ, what is happening?

Try a more complex path:

- How are κ and the strains changing in time?

Outlook

This week:

- Viscoelasticity with Cor Kasbergen
- Workshop on Thursday — first graded assignment

Next week:

- Lattice methods with Branko Šavija