Computer lab in
'Structural Optimization'

Division of Solid Mechanics

The task is to write an optimization program for the simple structure depicted below.

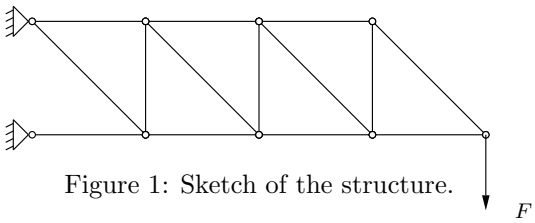

Figure 1: Sketch of the structure.

Objective of lab

The purpose of this lab is to get you started with the computer oriented part of the course. It is unlikely that you will complete the lab during the dedicated two hours, i.e. you are expected to complete the lab at home.

Problem description

The nodes at the left end of the structure are clamped and the right hand side tip is loaded as indicated in the figure above. The Young's modulus is taken as $E = 210 \cdot 10^3 MPa$. The length of the bars are $1m$ and $\sqrt{2}m$, respectively. The total mass of the structure may not exceed $1000kg$. The maximum cross sectional area is $0.1m^2$ and the applied force is taken as $F = 500N$. The density of the material is $7800kg/m^3$.

The task is to minimize the displacement of the tip (in the direction of F) where the load is applied. Assume that no body forces are present.

Homework

To be able to solve the problem during the computer lab it is important that the following tasks are solved prior to the lab.

a) Use CALFEM to solve the structural problem assuming that all bars have the same cross section. (you should not optimize the structure)

b) Formulate the problem as a mathematical optimization problem.

c) Calculate the derivates of the constraint and objective functions.

d) Read the CONLIN section in Christensen and Klarbring, chapter 4 and chapter 5.

e) Derive the CONLIN approximation for the problem.

Problem formulation

a) Use a CONLIN approximation to derive the optimal solution.

b) Calculate the stresses in the bars. How are the stresses related to λ^* ?

c) Instead of using $A_{max} = 0.1m^2$, use $A_{max} = 0.01m^2$. Can you relate λ^* to the stresses ?