Exercise 1

Let the elastic properties of a material be fully described by a Youngs modulus (E), and a Poisson ratio (ν). We now "pull" this material from the x direction with a stress σ_{xx}.

What are the different elements of the stress and strain tensor?

$$\boldsymbol{\sigma} = \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix} \quad \mathbf{u} = \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}$$

Exercise 2.1

Consider a huge 1m^3 block of Gouda cheese. One meter on every side. Google the rheology of cheese to find a reasonable Youngs modulus and Poisson ratio. Put a 10kg load on top of it.

1. What is σ_{zz}, assuming the load is evenly distributed across the top surface.
2. How does the dimensions of the cheese change due to the load?

(Note ask Aslak if you cannot find the elastic parameters of Gouda or cheese).

Exercise 2.2

Now consider if put the cheese into a box, so that it is constrained in the x and y directions. How does the dimensions now change due to the load. Use parameters that are consistent with those in exercise 2.1.

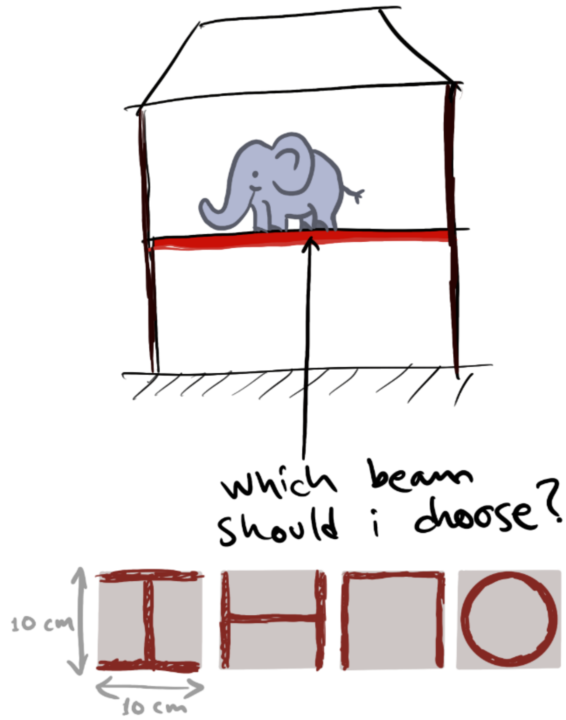
Exercise 3

Consider the case in exercise 2.1. The deformation of the Cheese takes work, and the internal energy stored 'in the bonds' between molecules of the cheese must increase. How much does the energy density increase due to the deformational work. Calculate it from the strain tensor and the elastic properties.

Compare this to the potential energy loss of the 10 kg load.

Exercise 4

I want to support a floor with a steel beam. It is a design requirement that the beam cross section must not take up more space than 10x10 cm. I do not want the beams to weigh too much. So, I found four different beam profiles that all weigh 12 kg/m, and I would like to use the one with the greatest bending stiffness.



1. Which one do you intuitively think is the stiffest?
2. Estimate the bending stiffness for each of the profiles.
3. What is the bending stiffness ratio between the least stiff and most stiff beam?
4. Calculate the bending moment associated with a 1cm deflection over 10m.

Exercise 5

Write a finite difference code to solve the gravitational settling of a 2d block. Start with writing a code that reproduces figure 9.2. Chapter 11 outlines how this is done in practice.

Modify your code to experiment with different materials and boundary conditions. Ideas:

- Gravitational settling of a block of cheese
- Slippery bottom vs no-slip.
- Make a beam attached to a wall at both ends.
- Test if Saint-Vernant’s principle holds.