Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Lecture „Methods of Finite Elements II"
Prof. Dr. M. H. Faber; Dr. N. Mojsilovic

Name :.....

Stud. Nr.:.....

Date :.....

Assignment 1

1. Deformation of cantilever beam

A bar rigidly supported at one end is subjected to a concentrated load (P) at the other end as is shown in Figure 1 (left). The cross section of the bar is shown in Figure 1 (right). The stress(σ)-strain(ε) relation and the characteristic values are given in Figure 2. Answer the following questions, assuming that the deformation is small.

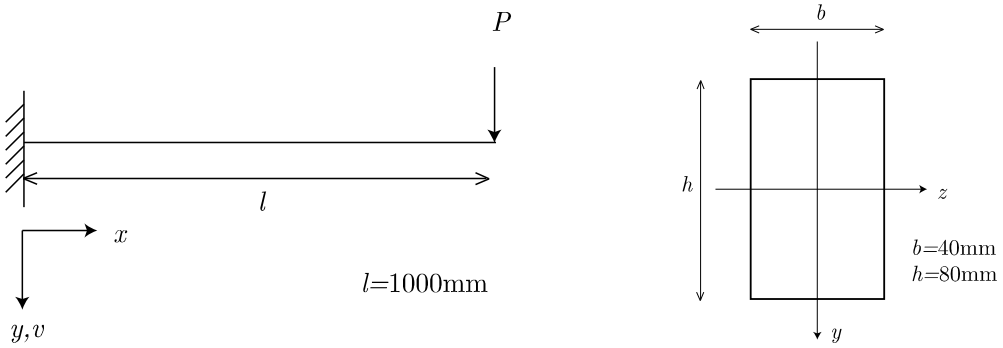

Figure 1. Considered cantilever beam and its cross section.

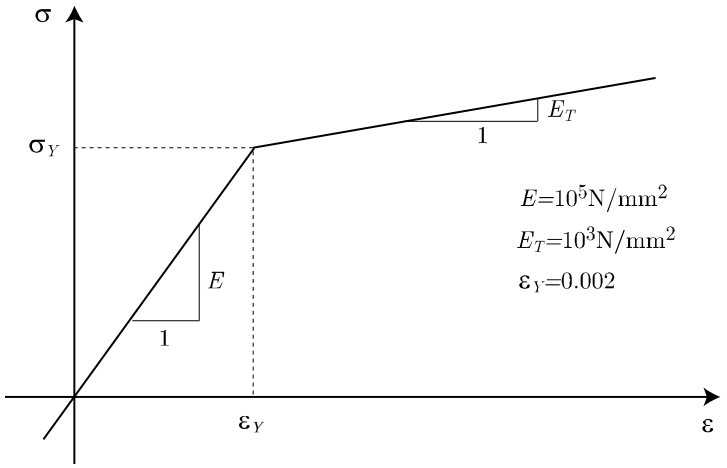

Figure 2. Stress-strain relation of the material used.

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1.1) Derive the moment(M)-curvature($1/\rho$) relation as is shown as the curve in Figure 3. Use the following relations:

$$\varepsilon = \frac{y}{\rho} \tag{1.1}$$

$$M = \int_A y\sigma dA \tag{1.2}$$

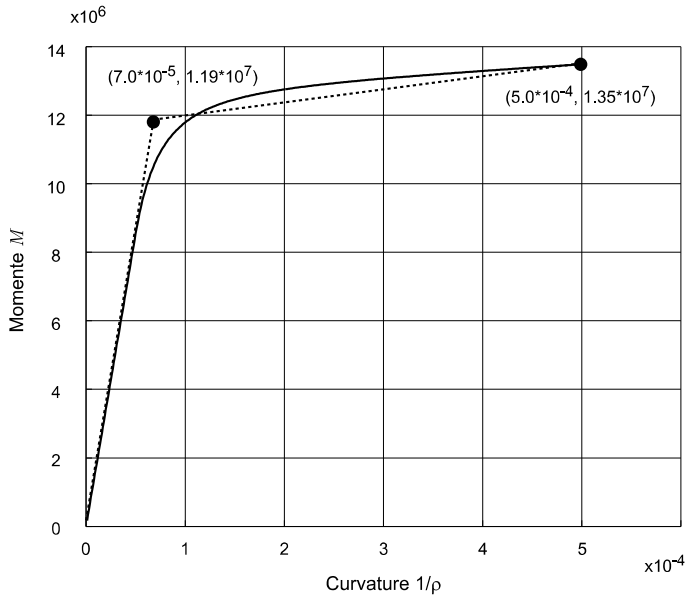

Figure 3. Moment-curvature relation.

1.2) The moment-curvature relation given as a curve in Figure 3 may be approximated by a bi-linear function (dash line). Calculate the displacement at the point of load application for different load applications (P=6kN, 12kN and 13kN). Use the following equation:

$$\frac{1}{\rho} = -\frac{d^2v}{dx^2} \tag{1.3}$$

Observe that for large applied loads the assumption that the deformation is small may be violated.

1.3) Investigate where in this exercise the assumption that the deformation is small is used.