Nonlinear analysis – Assignment 6

**Problem 1:**

**Problem 2:**

**Step 1:**

For this first step, the stiffness matrix is calculated using the tangent element stiffness matrix of a displacement-based fiber beam-column element. It is then compared with the stiffness matrix calculated for an elastic beam element.

To compute the stiffness matrix using the tangent element stiffness of a displacement-based fiber beam-column element, a numerical integration is used to obtain a numerical estimate of the integral: [N/m].The Gauss-Lobato numerical integration is used. Five integration points are considered. The conditions which satisfy all error partial derivatives for five integration points are:

r=[-1,-sqrt(21)/7,0,sqrt(21)/7,1]

ω=[0.1, 49/90, 32/45, 49/90, 32/45, 0.1]

B is calculated as follows:

()

To calculate the integral, the domain is normalised from [0,L] to [-1,1], using a coordinate transformation: and .

The cross-section is considered constant along the length of the cantilever. Moreover, the stress in fibers is constant and equal to 1 MPa.

Therefore in N/mm:

Une image contenant texte, capture d’écran, Police, nombre

Description générée automatiquement

Computing the stiffness matrix for an elastic beam element, we get in N/mm:

Une image contenant texte, Police, capture d’écran, blanc

Description générée automatiquement

Computing the error between both stiffness matrix, we get an error of 1%.

The minimum number of fibers to have an error lower than 2% is 8 fibers (error of 1.562%).

The element resisting force Q is also using the Gauss Lobato numerical integration:

[N]

Une image contenant texte, reçu, capture d’écran, Police

Description générée automatiquement

We can verify that Q1=-a\*b=-200\*200=40000 N and Q4=a\*b=40000 N, and that the remaining entries are equal to 0 when the stress in the fibers is equal to 1 MPa.