Assignment 1 - Report

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1 Introduction

The following report has the purpose to explain the necessary steps for the computation of displacements, stress and strain of a bar with variable area along the x-coordinate

2 Main Assumptions

- **Uni-dimensional displacement**: The bar will simply along the x-coordinate, hence the displacements along y will be equal to 0.
- **Underestimation of the area**: The first step is to divide the bar with equal-spaced nodes, so each element of the bar will have a specific area. This area is assumed to vary linearly with the x-coordinate and consequently it will be little different from the effective one. The formula used for the calculation of the areas is the one below:

$$A_i = [w_1 + (\frac{w_2 - w_1}{L})x_i]t \tag{1}$$

- **Linear deformation**: This assumption concerns the usage of the formula (2.2), even if the stiffness is not constant between each element. The formula is the following:

$$F_i = K_i u_i \tag{2}$$

3 Verification in ABAQUS

In order to evaluate the accuracy of the model and code, ABAQUS has been used. The problem has been approximated with a truss element and its first node will be the topic of the given boundary conditions. Indeed, a null displacement was considered at the first node. Figure (1) shows the displacements for each node in the truss :

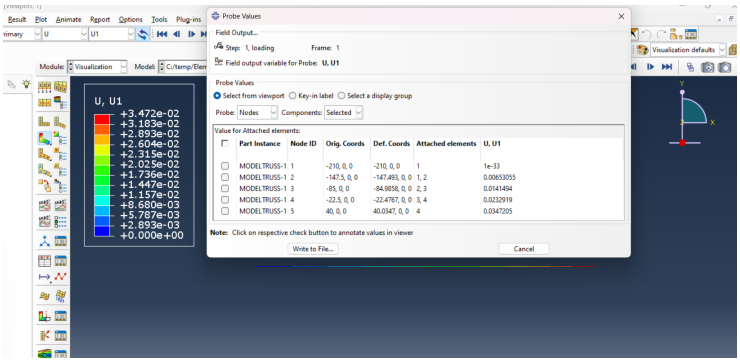

Figure 1: Displacements of nodes in ABAQUS

The calculated displacements using the code in Python are the following:

```
Total displacements at each node:
[0.         0.00653061 0.01414966 0.02329252 0.03472109]
```

Figure 2: Displacements of nodes in Python

Hence, there can be seen that the results are very well approximated by the written code. Also, this code will work for other boundary conditions, different from the one just considered, and for a different amount of them.

4 Asked Question

If the area of the bar was constant along the x-coordinate, then **there would not be any difference** between using a single element or four elements, since there is no relative cross-sectional error during the approximation of the effective area into elementary ones.

5 Partners

For the project code, I worked with Leonardo Medici with student number 6285503.