

In-class Exercise – Week #9: Displacement-based elements

The rectangular cross section shown in Figure 1 is made of a material that is described with the constitutive law according to Equation 1. The cross section is subjected to the strain distribution shown in Figure 1.

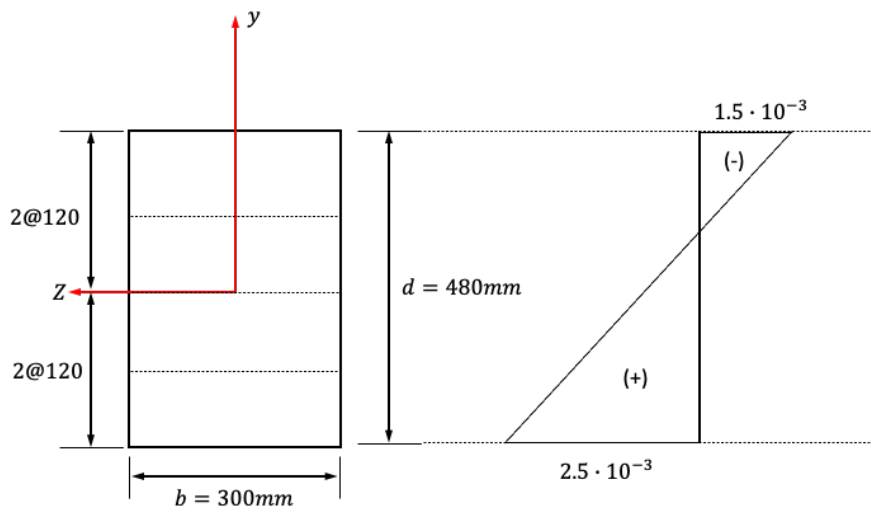


Figure 1. Cross section and strain distribution

Stress-strain constitutive law,

$$\sigma(\varepsilon) = \text{signum}(\varepsilon) \cdot f_y \cdot \left(1 - e^{-0.5 \frac{\text{signum}(\varepsilon) \cdot \varepsilon}{\varepsilon_y}} \right) \quad (1)$$

Where,

- $\text{signum}(\varepsilon)$ provides the sign depending on the sign of the longitudinal strain. However, when inputting compressive strains into Eq. (1), please always use absolute values.
- Yield strength, $f_y = 275 \text{ MPa}$
- Reference modulus, $E = 135 \text{ GPa}$

Answer the following questions:

1. Compute the section forces
2. Compute the tangent stiffness matrix of the cross section