CE 3310: Advanced Structural Analysis

Tutorial - 5 : Beams and Grids (Matrix Methods)

Take ***P* = 100 + last two digits of your Roll No** (kN).

1. (a) Generate the structure stiffness matrix $[\boldsymbol{k}_{AA}]$ and net load vector $[\mathbf{F_A}-\mathbf{F_{fA}}]$ for the continuous beam shown in Fig. 1, considering $D_1=\Delta_B$ (↑), $D_2=\theta_B$ (↻), $D_3=\Delta_C$ (↑), $D_4=\theta_C$ (↻).

   (b) Apply the Reduced Stiffness Method, (considering $D_1=\theta_B$) to analyse the beam in Fig. 1. Find the support reactions and draw the shear force and bending moment diagrams.

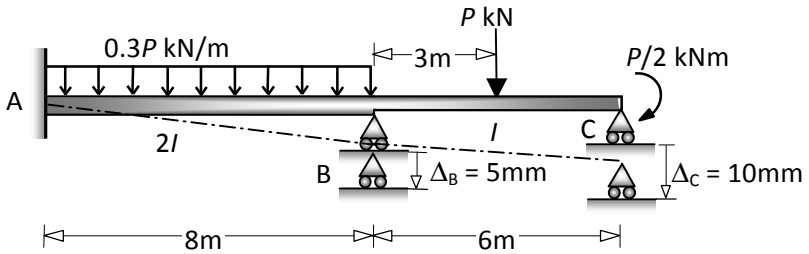
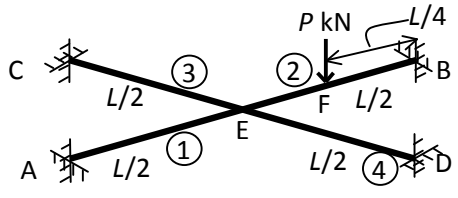


Fig.1 $EI = 80\,000\text{kNm}^2$

2. Repeat Problem 1 by the Flexibility Method, choosing the support reactions at B and C as the redundant X_1 and X_2.

3. Fig. 2 shows two identical horizontal beams, AB and CD, at right angles to each other in plan, and monolithically connected at E, corresponding to the mid-span locations of the two beams. Assume both beams to have the same span L = 5m and the same flexural rigidity EI = 80 000 kNm^2, and torsional rigidity $GJ = 0.2EI$, with fixity (restraints against flexure and torsion) at both ends. The beam AB is subject to a concentrated load of magnitude P kN, acting at the quarter-span point F, as shown.
   a) Sketch the likely shapes (without values) of the shear force, bending moment and twisting moment diagrams of AB and CD.
   b) Hence, appropriately choose grid or beam elements to find the missing values in the above SFD, BMD and TMD, by the Reduced Element Stiffness Method.
   [Hint: Only 3 global coordinates are required!]



$EI = 80\,000\text{kNm}^2$
$GJ = 0.2\,EI$
L = 5m

Fig. 2