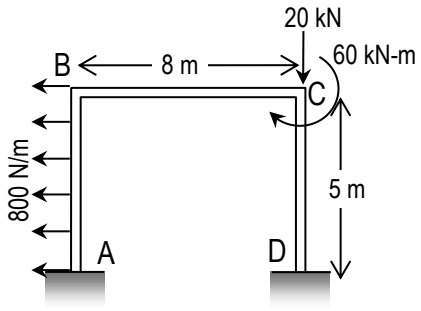
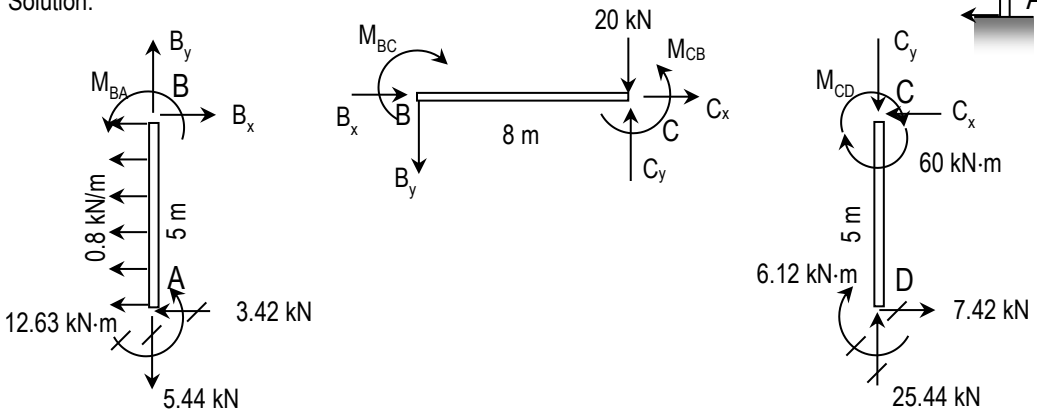
Example EXTRA

The rigid frame shown has been analyzed using an advanced structural analysis technique. The reactions at support A are: A_x = -3.42 kN, A_y = -5.44 kN, M_A = 12.63 kN·m. The reactions at support D are: D_x = 7.42 kN, D_y = 25.44 kN, M_D = -6.12 kN·m. Draw the shear and bending moment diagrams, and identify V_{max} & M_{max}.



Solution:



Reactions The values given were found from non-static analysis techniques and put on the FBD's.

Member End Forces The free-body diagrams of all the members and joints of the frame are shown above assuming joint force directions on one body and opposite directions on the joining body. Because there is a force and moment at C, these must be put on only one body of the joint, and it doesn't matter which body.

Member AB $\sum F_x = -3.42kN - 0.8kN/m \cdot 5m + B_x = 0$ B_x = -7.42 kN

$\sum F_y = -5.44kN + B_y = 0$ B_y = 5.44 kN

$\sum M_B = -3.42kN(5m) - 0.8kN/m(5m)(2.5m) + 12.63kN \cdot m + M_{BA} = 0$ M_{BA} = 14.47 kN·m

Joint B $M_{BA} = M_{BC}$ = 14.47 kN·m

Member BC $\sum F_x = -7.42kN + C_x = 0$ C_x = 7.42 kN

$\sum F_y = -5.44kN + C_y = 0$ C_y = 5.44 kN

$\sum M_C = -14.47kN \cdot m + 5.44kN(8m) + M_{CB} = 0$ M_{CB} = -29.05 kN·m

Joint C $M_{CB} = M_{CD}$ = -29.05 kN·m

Member CD $\sum F_x = -7.42kN + 7.42kN = 0$

(checking) $\sum F_y = -5.44kN - 20kN + 25.44kN = 0$

$\sum M_C = -(-29.05kN \cdot m) - 60kN \cdot m - 6.12kN \cdot m + 7.42kN(5m) = 0$