

Problem 1 – Internal Forces II

Determine the internal normal force, shear force, and the moment at points C and D.

$\sum M_A = 0$

$$0 = -12 \text{ kN}(3 + 6 \cos 45^\circ) \text{ m} + B_y(6 + 6 \cos 45^\circ) \text{ m}$$

$$B_y = 8.49 \text{ kN} \uparrow$$

$$\uparrow \sum F_y = 0 = A_y - 12 + 8.49$$

$$A_y = 3.51 \text{ kN} \uparrow$$

$$\rightarrow \sum F_x = 0 = A_x$$

**(FBD) "AC"**

Free Body Diagram of member AC:

- At A: Reaction forces  $A_x$  (horizontal, right) and  $A_y$  (vertical, up).  $A_y = 3.51 \text{ kN}$ .
- At C: Internal forces  $N_C$  (normal force, along the member),  $V_C$  (shear force, perpendicular to the member), and  $M_C$  (moment, counter-clockwise).
- Dimensions: Horizontal distance from A to C is 2 m. The member AC is 6 m long at a  $45^\circ$  angle to the horizontal.

$$\downarrow \sum F_x = 0 = -3.51 \sin 45^\circ + N_C$$

$$N_C = 2.48 \text{ kN} \searrow \text{on CA}$$

$$\uparrow \sum F_y = 0 = 3.51 \cos 45^\circ - V_C$$

$$V_C = 2.48 \text{ kN} \nearrow \text{on CA}$$

$$\sum M_C = 0 = -3.51 (\cos 45^\circ)(2 \text{ m}) + M_C$$

$$M_C = 4.96 \text{ kN.m} \curvearrowright \text{ on CA}$$

**(FBD) DB**

Free Body Diagram of member DB:

- At D: Internal forces  $N_D$  (normal force, along the member),  $V_D$  (shear force, perpendicular to the member), and  $M_D$  (moment, counter-clockwise).
- At B: Reaction force  $B_y = 8.49 \text{ kN}$  (vertical, up).
- Dimensions: Horizontal distance from D to B is 3 m. A uniformly distributed load of  $2 \text{ kN/m}$  acts downwards over the 3 m span. The total load is  $6 \text{ kN}$ .

$$\rightarrow \sum F_x = 0 = N_D$$

$$\uparrow \sum F_y = 0 = -V_D - 6 + 8.49$$

$$V_D = 2.49 \text{ kN} \downarrow \text{ on DB}$$

$$\sum M_D = 0 = -M_D - 6(1.5) + 8.49(3)$$

$$M_D = 16.47 \text{ kN.m} \curvearrowright \text{ on DB}$$