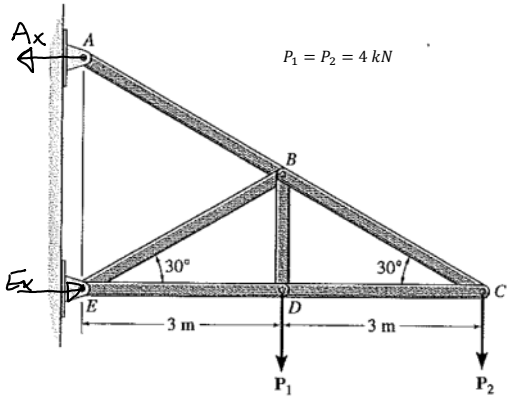
Forces in a Truss (Solution)



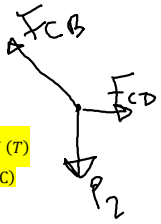
$P_1 = P_2 = 4\ kN$

Q5-8/9 from Statics & Mechanics of Materials 2e by Hibbeler

Why: Need to solve for the forces in each member.

Steps:

1. FBD
2. Solve for forces in each member using Method of Joints



At joint C:

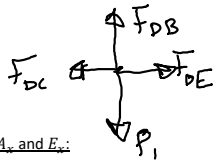
$\sum F_y = F_{CB}\sin(30) - P_2 = 0 \Rightarrow F_{CB} = \frac{P_2}{\sin(30)} = \frac{4kN}{\sin(30)} = 8\ kN\ (T)$

$\sum F_x = F_{CD} - F_{CB}\cos(30) = 0 \Rightarrow F_{CD} = F_{CB}\cos(30) = 6.93\ \text{kN}\ (C)$

At joint D:

$\sum F_y = F_{DB} - P_1 = 0 \Rightarrow F_{DB} = P_1 = 4\ kN\ (T)$

$\sum F_x = F_{DE} - F_{DC} = 0 \Rightarrow F_{DE} = F_{DC} = 6.93\ kN\ (C)$



$F_{CB} = 8\ kN\ (T)$
$F_{CD} = 6.93\ kN\ (C)$
$F_{DE} = 6.93\ kN\ (C)$
$F_{DB} = 4\ kN\ (T)$
$F_{BE} = 4\ kN\ (C)$
$F_{BA} = 12\ kN\ (T)$

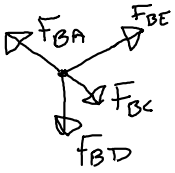
At joint B:

$\sum F_y = F_{BA}\sin(30) - F_{BC}\sin(30) + F_{BE}\sin(30) - F_{BD} = F_{BA} - 8 + F_{BE} - \frac{4}{\sin(30)} = 0$

$\sum F_x = -F_{BA}\cos(30) + F_{BC}\cos(30) + F_{BE}\cos(30) = -F_{BA} + 8 + F_{BE} = 0$

$2F_{BE} = \frac{4}{\sin(30)} \Rightarrow F_{BE} = \frac{2}{\sin(30)} = 4\ kN\ (C)$

$F_{BA} = F_{BC} + F_{BE} = 12\ kN\ (T)$



Alternatively, solve for reaction A_x and E_x:

$\tan(30) = \frac{AE}{6} \Rightarrow AE = 6\tan(30)$

$M_E = 6\tan(3)\,A_x - 3P_1 - 6P_2 = 0 \Rightarrow A_x = \frac{3(4) + 6(4)}{6\tan(30)} = 10.39\ kN$

External forces:

$\sum F_x = E_x - A_x = 0 \Rightarrow E_x = A_x = 10.39\ kN$

At joint A:

$\sum F_x = F_{AB}\cos(30) - A_x = 0 \Rightarrow F_{AB} = \frac{A_x}{\cos(30)} = 12\ kN\ (T)$

At joint E:

$\sum F_x = E_x - F_{ED} - F_{BE}\cos(30) = 0 \Rightarrow F_{BE} = \frac{E_x - F_{ED}}{\cos(30)} = \frac{10.39 - 6.93}{\cos(30)} = 4\ kN\ (C)$