Solution

ME 323: Mechanics of Materials ***Homework Set H02***

Summer 2025 ***Assigned/Due: June 17/June 20***

In the truss shown below, all members have a cross-sectional area of A. Members HK, CD and BH are vertical, and members DH and BC are horizontal. A horizontal force P acts on joint H of the truss. All members are made up of a material having a Young's modulus of E and a Poisson's ratio of ν. The weights of the members should be considered negligible compared to the applied loads.

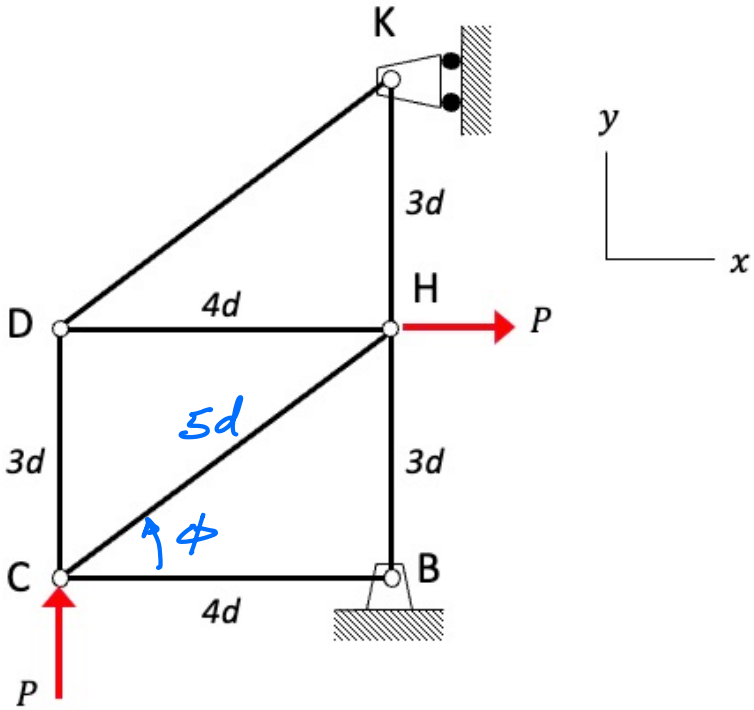
a) Determine the load carried by each member connected to joint H.

b) Determine the stress experienced by each member. For each, state whether the member is in tension or compression.

c) Determine the change in length of member DH.

d) Evaluate your answer in Part c) above using the following: $E = 30 \times 10^6$ psi, $\nu = 0.3$, $A = 3$ in^2, $d = 12$ in and $P = 20$ kips.

Do not substitute in numbers until Part d) of the problem.

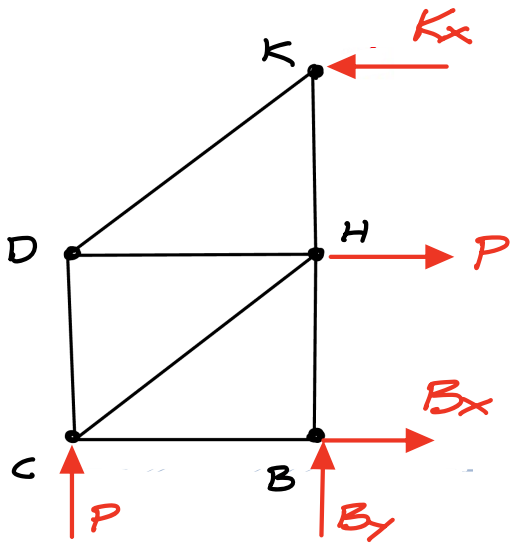


$\cos\phi = \frac{4}{5}$

$\sin\phi = \frac{3}{5}$

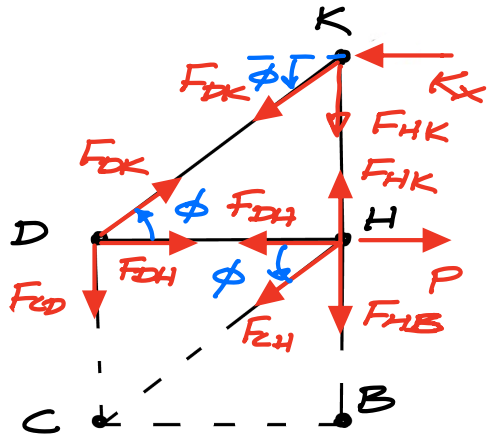
Part a)

FBD of entire truss



- $\sum M_B = -P(4d) - P(3d) + K_x(6d) = 0$
  - $K_x = \frac{1}{6}[4P + 3P] = \frac{7}{6}P$
- $\sum F_x = B_x + P - K_x = 0$
  - $B_x = K_x - P = \frac{1}{6}P$
- $\sum F_y = B_y + P = 0$
  - $B_y = -P$

Method of joints



- **Joint K**

$$\Sigma F_x = -K_x - F_{DK}\cos\phi = 0$$

$$\hookrightarrow F_{DK} = -\frac{K_x}{\cos\phi} = -\frac{35}{24}P \quad (C)$$

$$\Sigma F_y = -F_{DK}\sin\phi - F_{HK} = 0$$

$$\hookrightarrow F_{HK} = -F_{DK}\sin\phi = \frac{7}{8}P \quad (T)$$

- **Joint D**

$$\Sigma F_x = F_{DK}\cos\phi + F_{DH} = 0$$

$$\hookrightarrow F_{DH} = -F_{DK}\cos\phi = \frac{7}{6}P \quad (T)$$

- **Joint H**

$$\Sigma F_x = -F_{DH} - F_{CH}\cos\phi + P = 0$$

$$\hookrightarrow F_{CH} = \frac{1}{\cos\phi}\left[-F_{DH} + P\right]$$

$$= \frac{5}{4}\left[-\frac{7}{6}P + P\right] = -\frac{5}{24}P \quad (C)$$

$$\Sigma F_y = F_{HK} - F_{HB} - F_{CH}\sin\phi = 0$$

$$\hookrightarrow F_{HB} = F_{HK} - F_{CH}\sin\phi$$

$$= \frac{7}{8}P - \left(-\frac{5}{24}P\right)\left(\frac{3}{5}\right) = P \quad (T)$$

Part b)

$$\sigma_{HK} = \frac{F_{HK}}{A} = \frac{7}{8}\frac{P}{A} \quad (T)$$

$$\sigma_{DH} = \frac{F_{DH}}{A} = \frac{7}{6}\frac{P}{A} \quad (T)$$

$$\sigma_{CH} = \frac{F_{CH}}{A} = -\frac{5}{24}\frac{P}{A} \quad (C)$$

$$\sigma_{HB} = \frac{F_{HB}}{A} = \frac{P}{A} \quad (T)$$

Part c)

$$\varepsilon_{DH} = \frac{\sigma_{DH}}{E} = \frac{7}{6}\frac{P}{EA}$$

$$e_{DH} = \varepsilon_{DH}(4d) = \frac{14}{3}\frac{Pd}{EA}$$

Part d)

$$e_{DH} = \frac{14}{3}\frac{(20\times10^3\,\text{lb})(12\,\text{in})}{\left(30\times10^6\,\frac{\text{lb}}{\text{in}^2}\right)(3\,\text{in}^2)} = \frac{(14)(20)(12)}{(3)(30)(10^3)(5)}\,\text{in} = \left(\frac{112}{9}\times10^{-3}\right)\text{in}$$