STRUCTURES WEEK

WHAT'S A FRAME?  (CHAPTER 6.6)

6.4 METHOD OF SECTIONS
alternative to 6.2 method & joints
read @ home

6.5 SPACE TRUSSES
similar to 6.2 method & joints but 3D
read @ home

6.6 FRAMES & MACHINES

STRUCTURES composed of pin-connected
MULTIFORCE members, e.g. weight, load...

definition: "frame" \(\rightarrow\) support loads
"machine" \(\rightarrow\) moving parts to transmit
& alter forces

FREE BODY DIAGRAM

1p for structure as a whole
1p for each member
(1p for each joint)
EXAMPLE 6.9 - assume pin-connected

Free Body Diagram

\[ \sum \text{MA} = 0: \quad W_1 \cdot \frac{d_2}{4} + W_2 \cdot \frac{3d_2}{4} - B_v \cdot \frac{4d_2}{4} = 0 \]

\[ \sum \text{MB} = 0: \quad A_v \cdot \frac{4d_2}{4} - W_1 \cdot \frac{3d_2}{4} - W_2 \cdot \frac{1d_2}{4} = 0 \]

Control:

\[ \sum \text{FY} = 0: \quad A_v + B_v - W_1 - W_2 = 0 \]

= \( \frac{3}{4} W_1 + \frac{1}{4} W_2 + \frac{1}{4} W_1 + \frac{3}{4} W_2 - W_1 - W_2 = 0 \)
\[ L_S - \sum M_{\text{joint}} = 0 \]

\[ A_H \cdot \frac{2d_2}{4} - W_1 \frac{d_2}{4} - A_H \cdot d_1 = 0 \]

\[ A_H = \left[ -W_1 \frac{d_2}{4} + \frac{3}{4} W_1 \frac{d_2}{4} - \frac{W_2}{4} \right] \]

\[ A_H = + \frac{1}{8} [W_1 + W_2] \frac{d_2}{d_1} \]

\[ F_H = - A_H = - \frac{1}{8} [W_1 + W_2] \frac{d_2}{d_1} \]

\[ B_H = - F_H = + \frac{1}{8} [W_1 + W_2] \frac{d_2}{d_1} \]

\[ B_H = - F_H = + \frac{1}{8} [W_1 + W_2] \frac{d_2}{d_1} \]

\[ F_V = B_X - W_2 = \frac{1}{4} W_1 + \frac{3}{4} W_2 - W_2 \]

\[ F_V = \frac{1}{4} W_1 - \frac{1}{4} W_2 \]

\[ A_V + F_V - W_1 = 0 \]

\[ \frac{3}{4} W_1 + \frac{1}{4} W_2 + \frac{1}{4} W_1 - \frac{1}{4} W_2 - W_1 = 0 \]

\[ W_1 \frac{d_2}{4} + F_H d_1 - F_V \cdot \frac{2d_2}{4} = 0 \]

\[ W_1 \frac{d_2}{4} - \frac{1}{8} W_1 d_2 - \frac{1}{2} W_2 d_2 - \frac{1}{4} W_1 \frac{2}{4} d_2 \]

\[ + \frac{1}{8} W_1 d_2 - \frac{1}{8} W_2 d_2 - \frac{1}{4} W_1 \frac{2}{4} d_2 = 0 \]
remark: although there are no external horizontal forces, there are horizontal reactions in \( A_H \) and in \( B_H \).

**For the first example**

\[
W_1 = 600 \text{N} \quad W_2 = 500 \text{N} \\
\dot{d}_1 = 1.50 \text{m} \quad \dot{d}_2 = 2.0 \text{m}
\]

then...

\[
A_v = \left[ \frac{3W_1 + W_2}{4} \right] = 575 \text{N} \\
B_v = \left[ \frac{W_1 + 3W_2}{4} \right] = 525 \text{N} \\
A_H = B_H = \frac{1}{8} \left[ W_1 + W_2 \right] \frac{d_2}{d_1} = 18.3 \text{N} = -F_H \\
F_v = \frac{1}{4} W_1 - \frac{1}{4} W_2 = 25 \text{kN}
\]

**For the second example**

\[
W_1 = 700 \text{N} \quad W_2 = 700 \text{N} \\
\dot{d}_1 = 1.50 \text{m} \quad \dot{d}_2 = 2.25 \text{m}
\]

then

\[
A_v = 700 \text{N} \\
B_v = 700 \text{N} \\
A_H = B_H = 291.7 \text{N} = -F_H \quad \text{for } d_1 = \frac{1}{2} d_2 \quad 350 \text{N}
\]

\[
F_v = 0 \text{N}
\]