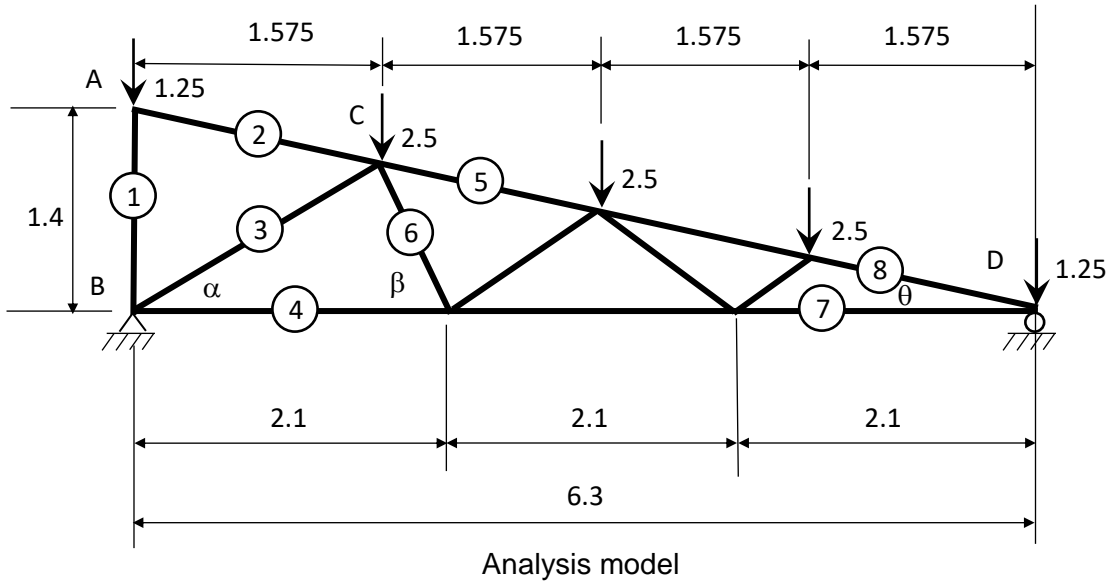




Nodal analysis of a monopitch roof truss

Solution



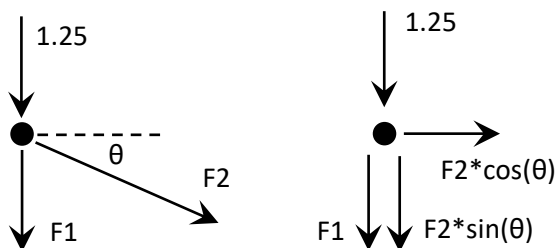
Total load on frame: 10.0 kN

Frame and loading are symmetrical, therefore reactions are equal = 5.0 N

Angles

	Y	X	angle(rads)	cos(angle)	sin(angle)
θ	1.4	6.3	0.2186689	0.976	0.217
α	1.05	1.575	0.5880026	0.832	0.555
β	1.05	0.525	1.1071487	0.447	0.894
$\alpha - \beta$			0.3693337	0.933	0.361
$\beta - \theta$			0.8884798	0.631	0.776

Node A



Horizontal

$$F2 \cdot \cos(\theta) = 0.0$$

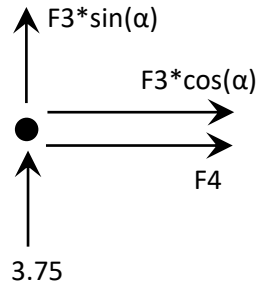
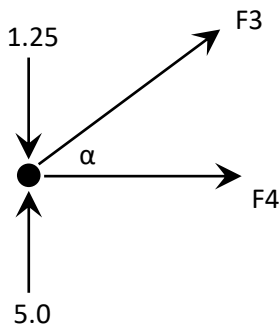
$F2 = 0.0$ (zero force member)

Vertical

$$-1.25 - F1 = 0$$

$F1 = -1.25$ (compression)

Node B



Vertical

$$3.75 + F3 \cdot \sin(\alpha) = 0.0$$

$$F3 = -3.75 / \sin(\alpha) = -3.75 / 0.555$$

$$F3 = -6.76 \text{ (compression)}$$

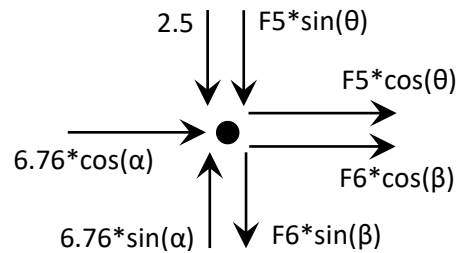
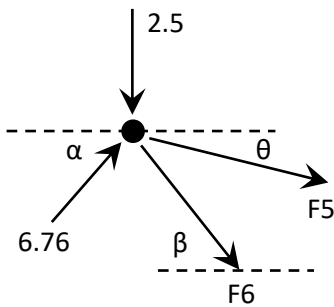
Horizontal

$$F2 \cdot \cos(\alpha) + F4 = 0.0$$

$$F4 = -F3 \cdot \cos(\alpha) = -(-6.76) \cdot 0.832$$

$$F4 = 5.62 \text{ (tension)}$$

Node C



Vertical

$$6.76 \sin(\alpha) - 2.5 - F6 \sin(\beta) - F5 \sin(\theta) = 0.0$$

$$6.76 \cdot 0.555 - 2.5 - F6 \cdot 0.894 - F5 \cdot 0.217 = 0$$

$$1.25 - F6 \cdot 0.894 - F5 \cdot 0.217 = 0$$

$$F5 = -F6 \cdot 0.894 / 0.217 + 1.25 / 0.217$$

$$F5 = -F6 \cdot 4.12 + 5.76$$

Horizontal

$$6.76 \cos(\alpha) + F6 \cos(\beta) + F5 \cos(\theta) = 0.0$$

$$6.76 \cdot 0.832 + F6 \cdot 0.447 + F5 \cdot 0.976 = 0$$

$$5.62 + F6 \cdot 0.447 + F5 \cdot 0.976 = 0$$

$$\text{Substitute } F5 = -F6 \cdot 4.12 + 5.76$$

$$5.62 + F6 \cdot 0.447 + (-F6 \cdot 4.12 + 5.76) \cdot 0.976 = 0.0$$

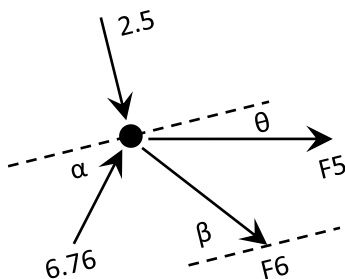
$$F6 \cdot 0.447 - F6 \cdot 4.12 \cdot 0.976 + 5.62 + 5.76 \cdot 0.976 = 0.0$$

$$F6 \cdot (0.447 - 4.12 \cdot 0.976) + 11.24 = 0.0$$

$$F6 = -11.24 / (0.447 - 4.12 \cdot 0.976) = 3.14 \text{ (tension)}$$

$$F5 = -3.15 \cdot 4.12 + 5.76 = -7.22 \text{ (compression)}$$

Alternatively, rotate the free body diagram so that F5 acts along the x axis:



'Vertical' equilibrium

$$-2.5 \cdot \cos(\theta) - F6 \cdot \sin(\beta - \theta) + 6.76 \cdot \sin(\alpha + \theta) = 0$$

$$-2.5 \cdot 0.976 - F6 \cdot 0.776 + 6.76 \cdot 0.722 = 0$$

$$F6 = (-2.5 \cdot 0.976 + 6.76 \cdot 0.722) / 0.776 = 3.14$$

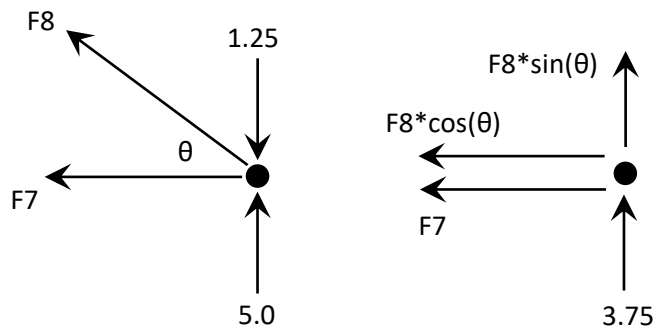
'Horizontal' equilibrium

$$F5 + F6 \cdot \cos(\beta - \theta) + 6.76 \cdot \cos(\alpha + \theta) + 2.5 \cdot \sin(\theta) = 0.0$$

$$F5 + 3.14 \cdot 0.631 + 6.76 \cdot 0.692 + 2.5 \cdot 0.217 = 0$$

$$F5 = -7.20$$

Node D



Vertical

$$3.75 + F8 \sin(\theta) = 0.0$$

$$F8 = -4.5 / \sin(\theta) = 3.75 / 0.217$$

$$F8 = -17.28 \text{ (compression)}$$

Horizontal

$$-F7 - F8 \cos(\theta) = 0.0$$

$$F7 = -F8 \cos(\theta) = -(-17.28) * 0.976$$

$$F7 = 16.9 \text{ (tension)}$$

Note that the highest axial forces are in member 7 and 8. If all the members in the frame are the same size, then that size would be controlled by F8.

Metadata

Keywords: Nodal analysis, equilibrium

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