

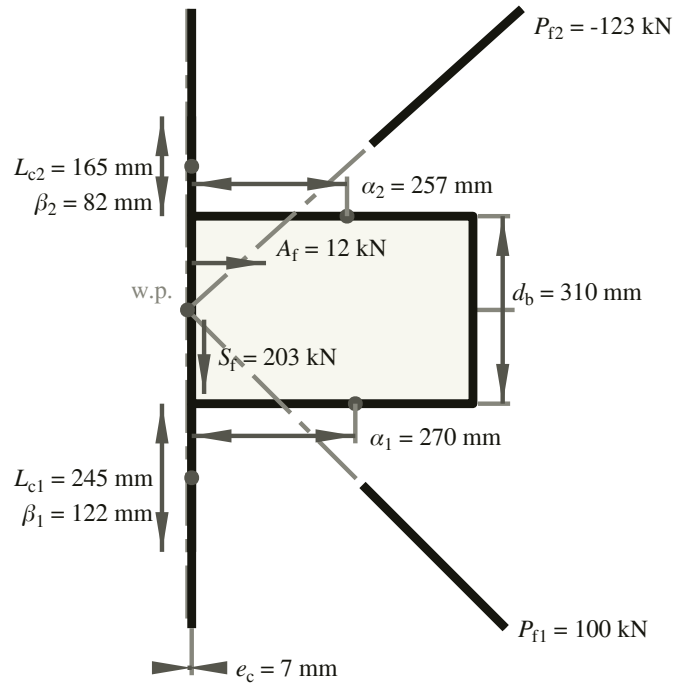
Connection transfer force

Axial force and shear on a braced beam-to-column connection, by the uniform force method.

Inputs

Symbol	Value	Unit	Description
e_c	7	mm	Column centreline to its connected face
d_b	310	mm	Beam depth
L_{c1}	245	mm	Bolted length of the V-1 gusset on the column
L_{c2}	165	mm	Bolted length of the V-2 gusset on the column
P_{f1}	100	kN	Factored force in V-1, below the beam, tension positive
ϕ_1	45		Angle of V-1 from the column, degrees
P_{f2}	-123	kN	Factored force in V-2, above the beam, tension positive
ϕ_2	48		Angle of V-2 from the column, degrees
P_{f3}	50	kN	Factored force in H-1, tension positive
ϕ_3	46		Angle of H-1 from the beam, in plan, degrees
P_{f4}	70	kN	Factored force in H-2, tension positive
ϕ_4	47		Angle of H-2 from the beam, in plan, degrees
H_f	-50	kN	Factored axial force in the beam, tension positive
V_f	110	kN	Factored shear in the beam, downward positive

Figures



Elevation of the joint, to scale: V-1 below the beam, V-2 above, the work point (w.p.), the distances beta up the column face and alpha along the beam to the control points, and the transfer forces at the column face. The horizontal braces are in plan and not drawn.

Results

Quantity	Description	Value	Unit
A_f	Connection axial force on the column	12.42	kN
S_f	Connection shear on the column	203.2	kN

Derivation

$$\begin{aligned}
 e_b &= \frac{d_b}{2} \\
 &= \frac{310 \text{ mm}}{2} \\
 &= 155 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 \beta_1 &= \frac{L_{c1}}{2} \\
 &= \frac{245 \text{ mm}}{2} \\
 &= 122.5 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 \alpha_1 &= \beta_1 \cdot \tan(\text{radians}(\phi_1)) + e_b \cdot \tan(\text{radians}(\phi_1)) - e_c \\
 &= 122.5 \text{ mm} \cdot \tan(\text{radians}(45)) + 155 \text{ mm} \cdot \tan(\text{radians}(45)) - 7 \text{ mm} \\
 &= 270.5 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 r_1 &= \sqrt{(\alpha_1 + e_c)^2 + (\beta_1 + e_b)^2} \\
 &= \sqrt{(270.5 \text{ mm} + 7 \text{ mm})^2 + (122.5 \text{ mm} + 155 \text{ mm})^2} \\
 &= 392.4 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 F_{v1} &= \frac{e_b}{r_1} \\
 &= \frac{155 \text{ mm}}{392.4 \text{ mm}} \\
 &= 0.395
 \end{aligned}$$

$$\begin{aligned}
 F_{h1} &= \frac{\alpha_1}{r_1} \\
 &= \frac{270.5 \text{ mm}}{392.4 \text{ mm}} \\
 &= 0.6893
 \end{aligned}$$

$$\begin{aligned}
 V_{c1} &= \frac{P_{f1} \cdot \beta_1}{r_1} \\
 &= \frac{100 \text{ kN} \cdot 122.5 \text{ mm}}{392.4 \text{ mm}} \\
 &= 31.21 \text{ kN}
 \end{aligned}$$

$$\begin{aligned}
 H_{c1} &= \frac{P_{f1} \cdot e_c}{r_1} \\
 &= \frac{100 \text{ kN} \cdot 7 \text{ mm}}{392.4 \text{ mm}} \\
 &= 1.784 \text{ kN}
 \end{aligned}$$

$$\begin{aligned}
 \beta_2 &= \frac{L_{c2}}{2} \\
 &= \frac{165 \text{ mm}}{2} \\
 &= 82.5 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 \alpha_2 &= \beta_2 \cdot \tan(\text{radians}(\phi_2)) + e_b \cdot \tan(\text{radians}(\phi_2)) - e_c \\
 &= 82.5 \text{ mm} \cdot \tan(\text{radians}(48)) + 155 \text{ mm} \cdot \tan(\text{radians}(48)) - 7 \text{ mm} \\
 &= 256.8 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 r_2 &= \sqrt{(\alpha_2 + e_c)^2 + (\beta_2 + e_b)^2} \\
 &= \sqrt{(256.8 \text{ mm} + 7 \text{ mm})^2 + (82.5 \text{ mm} + 155 \text{ mm})^2} \\
 &= 354.9 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 F_{v2} &= \frac{e_b}{r_2} \\
 &= \frac{155 \text{ mm}}{354.9 \text{ mm}} \\
 &= 0.4367
 \end{aligned}$$

$$\begin{aligned}
 F_{h2} &= \frac{\alpha_2}{r_2} \\
 &= \frac{256.8 \text{ mm}}{354.9 \text{ mm}} \\
 &= 0.7234
 \end{aligned}$$

$$\begin{aligned}
 V_{c2} &= \frac{P_{f2} \cdot \beta_2}{r_2} \\
 &= \frac{(-123 \text{ kN}) \cdot 82.5 \text{ mm}}{354.9 \text{ mm}} \\
 &= -28.59 \text{ kN}
 \end{aligned}$$

$$\begin{aligned}
 H_{c2} &= \frac{P_{f2} \cdot e_c}{r_2} \\
 &= \frac{(-123 \text{ kN}) \cdot 7 \text{ mm}}{354.9 \text{ mm}} \\
 &= -2.426 \text{ kN}
 \end{aligned}$$

$$\begin{aligned} A_f &= H_f + P_{f1} \cdot F_{h1} + P_{f2} \cdot F_{h2} + P_{f3} \cdot \cos(\text{radians}(\phi_3)) + P_{f4} \cdot \cos(\text{radians}(\phi_4)) \\ &\quad \text{AISC 14th ed. Part 13, Uniform Force Method, Fig. 13-2} \\ &= (-50 \text{ kN}) + 100 \text{ kN} \cdot 0.6893 + (-123 \text{ kN}) \cdot 0.7234 + 50 \text{ kN} \cdot \cos(\text{radians}(46)) + 70 \text{ kN} \cdot \cos(\text{radians}(47)) \\ &= 12.42 \text{ kN} \end{aligned}$$

$$\begin{aligned} S_f &= V_f + P_{f1} \cdot F_{v1} - P_{f2} \cdot F_{v2} \quad \text{AISC 14th ed. Part 13, Uniform Force Method, Fig. 13-2} \\ &= 110 \text{ kN} + 100 \text{ kN} \cdot 0.395 - (-123 \text{ kN}) \cdot 0.4367 \\ &= 203.2 \text{ kN} \end{aligned}$$