Lateral Load on a Single-Storey Multi-Bay Frame (Portal Method)

Column shears and moments, beam moments and shears and exterior column axial forces of a one-storey multi-bay frame under lateral load (portal method).

Method: Portal method of approximate analysis

Input parameters

Unit system: SI

Parameter	Value	Unit
Lateral load at beam level	60.000	kN
Number of bays	3.0000	
Storey height	4.0000	m
Bay width	6.0000	m

Calculated results

Parameter	Value	Unit
Shear in each exterior column	10.000	kN
Shear in each interior column	20.000	kN
Exterior column end moment	20.000	kN·m
Interior column end moment	40.000	kN·m
Beam end moment	20.000	kN·m
Beam shear	6.6667	kN
Exterior column axial force	6.6667	kN

Notes for this case

• The portal method assumes points of contraflexure at mid-height of every column and midspan of every beam, and that each bay acts as a portal, so interior columns take twice the shear of exterior ones: V_ext = H/(2n_b), V_int = H/n_b. Column end moments are V·h/2. At an exterior joint the beam moment equals the column moment, the beam shear is 2M_b/L, and only the exterior columns carry axial force (equal and opposite) because beam shears cancel at interior joints. It suits low, regular frames with fixed bases; use the cantilever method for tall, slender frames.

Formula and method

$$V_{ext} = \frac{H}{2n_b}, \quad V_{int} = \frac{H}{n_b}, \quad M = V\frac{h}{2}, \quad V_b = \frac{2M_b}{L}$$

Variables

H	Lateral load at beam level	N
n_b	Number of bays	-
h	Storey height	m
L	Bay width	m
V_{ext}	Shear in each exterior column	N
V_{int}	Shear in each interior column	N
M_{ext}	Exterior column end moment	N·m
M_{int}	Interior column end moment	N·m
M_b	Beam end moment	N·m
V_b	Beam shear	N

N_{ext}	Exterior column axial force	N

Method and standards

Portal method.

Assumptions and limits

- Fixed bases; equal bays; contraflexure at mid-height and midspan.

References

Portal method of approximate analysis

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/civil/steel/portal-frame-portal-method

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Reopens the calculator with the inputs of this report.