Plastic Collapse Load of a Beam

Plastic moment and collapse load of simply supported, propped cantilever and fixed-ended beams under a central point load or uniform load, with the load factor.

Method: Plastic hinge mechanism method

Input parameters

Unit system: SI

Parameter	Value	Unit
Plastic section modulus	1,000.0	cm^3
Yield stress	275.00	MPa
Span	8.0000	m
Support and load case	Propped cantilever, uniform load	
Working (service) total load	150.00	kN

Calculated results

Parameter	Value	Unit
Plastic moment	275.00	kN·m
Collapse load (total)	400.70	kN
Load factor against collapse	2.6714	
Sagging hinge position from the propped end	3.3137	m

Notes for this case

• The plastic moment M_p = Z_pf_y is the moment a fully yielded section carries. Collapse needs enough plastic hinges to form a mechanism; equating external work to M_p times the hinge rotations gives W_c = 4M_p/L (simply supported, central load), 6M_p/L (propped), 8M_p/L (fixed), and for a total uniform load W = wL: 8M_p/L, 11.66M_p/L (propped, hinge at 0.414L from the propped end) and 16M_p/L (fixed). Plastic design needs compact sections and lateral restraint so that hinges can rotate without local or lateral buckling.

Formula and method

$$M_p = Z_p f_y, \quad W_c = \frac{\alpha M_p}{L}, \quad \alpha = 4, 6, 8 \text{ (point)}; \; 8,6 + 4\sqrt{2}, 16 \text{ (uniform)}$$

Variables

Z_p	Plastic section modulus	m^3
f_y	Yield stress	Pa
L	Span	m
case	Support and load case	-
W_s	Working (service) total load	N
M_p	Plastic moment	N·m
W_c	Collapse load (total)	N
λ	Load factor against collapse	-
x_h	Sagging hinge position from the propped end	m

Method and standards

Plastic collapse.

Assumptions and limits

- Compact, laterally restrained section; rigid-plastic behaviour; no axial or shear interaction.

References

Plastic hinge mechanism method

Report details

Report reference	FCC-6965-B9MS (the same inputs always give the same reference)
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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/plastic-collapse-load-beam

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.