Roof Purlin under Biaxial Bending with Sag Rods

Bending moments about both axes of a purlin on a sloping roof, with sag rods reducing the weak-axis span, and the combined bending stress ratio.

Method: Biaxial bending with continuous weak-axis spans

Input parameters

Unit system: SI

Parameter	Value	Unit
Gravity load on purlin per metre	1.5000	kN/m
Roof slope	15.000	°
Purlin span (between rafters)	6.0000	m
Sag rods	One at mid-span	
Section modulus, strong axis	89.000	cm³
Section modulus, weak axis	14.700	cm³
Allowable bending stress	165.00	MPa

Calculated results

Parameter	Value	Unit
Strong-axis moment	6.5200	kN·m
Weak-axis moment	0.43676	kN·m
Strong-axis stress	73.258	MPa
Weak-axis stress	29.711	MPa
Combined stress ratio	0.62406	

Notes for this case

• Load splits into w·cosθ normal to the roof and w·sinθ along it. M_x = w·cosθ·L²/8 (simply supported). Along the slope the sag rods act as supports: one rod gives a two-span continuous beam, M_y = w·sinθ(L/2)²/8 at the rod; two rods give about 0.1·w·sinθ(L/3)². Ratio = f_bx/f_b + f_by/f_b ≤ 1 (use the user's code interaction and lateral-torsional checks, and wind suction as a separate case).

Formula and method

$$M_x = \frac{w \cos\theta L^2}{8}, \quad M_y = \frac{w \sin\theta (L/2)^2}{8}, \quad \eta = \frac{M_x/Z_x + M_y/Z_y}{f_b}$$

Variables

w	Gravity load on purlin per metre	N/m
θ	Roof slope	rad
L	Purlin span (between rafters)	m
n_{sag}	Sag rods	-
Z_x	Section modulus, strong axis	m³
Z_y	Section modulus, weak axis	m³
f_b	Allowable bending stress	Pa
M_x	Strong-axis moment	N·m
M_y	Weak-axis moment	N·m
f_{bx}	Strong-axis stress	Pa

f_{by}	Weak-axis stress	Pa
η	Combined stress ratio	-

Method and standards

Purlin bending.

Assumptions and limits

- Load through the shear centre; simple strong-axis span.

References

Biaxial bending with continuous weak-axis spans

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/purlin-biaxial-bending

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.