

SB1 • STATIC-BEAM

Euler-Bernoulli 1D cantilever (tip deflection)

PASS

Tip deflection under a transverse point load — 1-D flexural absolute check

error +0.00020% • tol 1%

§2 TECHNICAL FEATURES TESTED

elasticBeamColumn — linear-static beam element

Euler-Bernoulli flexure (no shear area emitted)

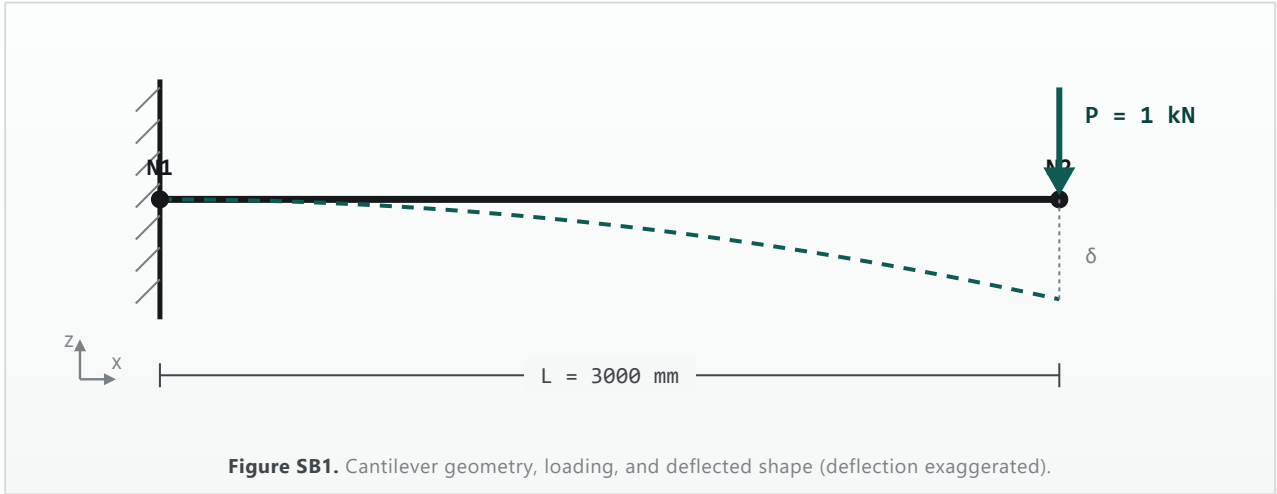
Strong-axis routing \$ly ← sec.lz

geomTransf Linear, auto vecxz [0,0,1]

Nodal load & single-node fixity

§3 PROBLEM DESCRIPTION

A prismatic cantilever of length L is fully fixed at node N1 and free at node N2, where a downward transverse load P acts along global $-Z$. The tip deflection is compared with the Euler-Bernoulli closed-form solution. Because the static element carries no shear area, the response is pure bending — the element should reproduce the closed form to machine precision, independent of subdivision.



§4 GEOMETRY, PROPERTIES & LOADING

GEOMETRY		MATERIAL		LOADING & BC	
Length L	3000 mm	Model	Elastic	N1	fixed 6-DOF
Section $b \times h$	300×500	E	26700 MPa	N2 load	F_z -1000 N
Area A	150000	ν	0.2	Self-weight	off
I strong (I_z)	3.125×10^9	Units	N · mm	Analysis	Linear static
I weak (I_y)	1.125×10^9				

§5 REFERENCE SOLUTION

Tip deflection u_z : $-P \cdot L^3 / (3 \cdot E \cdot I) = -0.107865$ mm

Tip rotation r_y : $+P \cdot L^2 / (2 \cdot E \cdot I) = 5.3933 \times 10^{-5}$ rad

Timoshenko & Gere, Mechanics of Materials — cantilever tip deflection under an end load (Euler-Bernoulli).

§6 RESULTS COMPARISON

RESPONSE QUANTITY	PROBE	STRIX	REFERENCE	DIFF	VERDICT
Tip deflection u_z (mm)	N2.uz	-0.107865	-0.107865	+0.00020%	PASS
Tip rotation r_y (rad)	N2.ry	5.3933×10^{-5}	5.3933×10^{-5}	0.00%	PASS
Support reaction R_z (N)	N1.Fz	1000	1000	0.00%	PASS
Support moment M_y (N·mm)	N1.My	-3×10^6	-3×10^6	0.00%	PASS

§7 CONVERGENCE

MESH	UZ (MM)	DIFF
1 element	-0.107865	+0.00020%

The cubic Hermite shape functions of the Euler–Bernoulli element are exact for a linearly varying moment field, so a single element already recovers the closed form. Subdivision is **mesh-independent** — no refinement study is required for this benchmark.

§8 CONCLUSION

PASS

STRIX reproduces the reference solution to **+0.00020%** (tolerance 1%). The tested element and its formulation are verified against the reference.

§9 REFERENCES & ANALYSIS FILES

- Timoshenko, S. & Gere, J. — *Mechanics of Materials*. Cantilever end-load deflection $\delta = PL^3/3EI$.
- STRIX headless harness: generatePyForLoadCase → python.exe → parseAll.

EVIDENCE ARCHIVE `verif-evidence-eng1.0.6-win-x64.zip` · SB1/ `sha256` (pending publish)