

Static-28

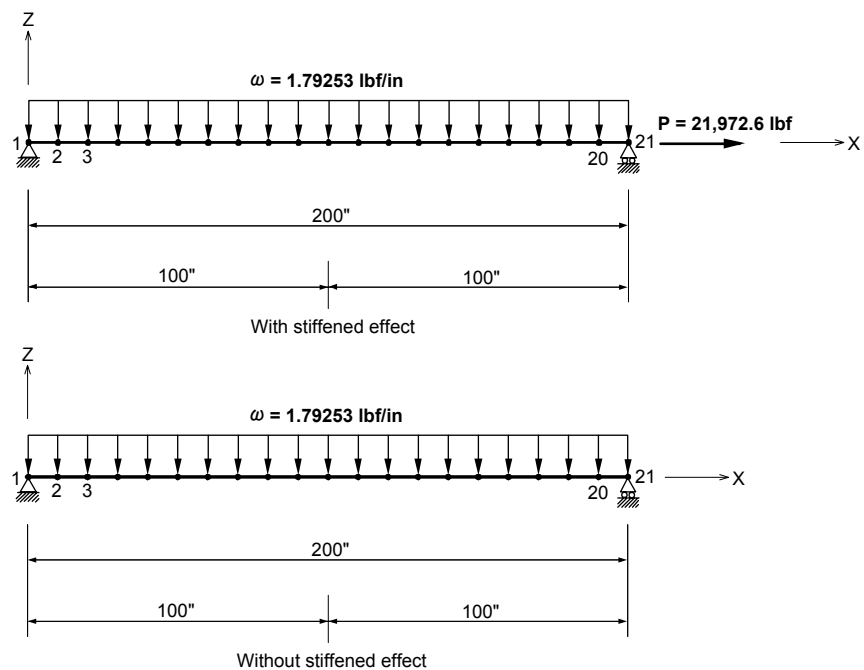
Title

Prestressed beam subjected to the uniformly distributed load

Description

A simply supported beam is subjected to the action of a tensile force and a uniformly distributed load.

Determine the maximum deflection, the slope at the left-hand end, and the maximum bending moment with and without the stress stiffening effect.



Structural geometry and analysis model

MODEL

Analysis Type

2-D static analysis (X-Z plane)

Unit System

in, lbf

Dimension

Length 200 in

Element

Beam element

Material

Modulus of elasticity $E = 3.0 \times 10^7$ psi

Sectional Property

Rectangular cross-section: $b = h = 2.5$ in (Neglect shear deformation)

Area: 6.25 in^2

Moment of inertia: 3.2552 in^4

Boundary Condition

Node 1: Constrain D_X and D_Z

Node 11: Constrain D_Z

Load Case

Case 1: with stress stiffened effect (P-delta effect)

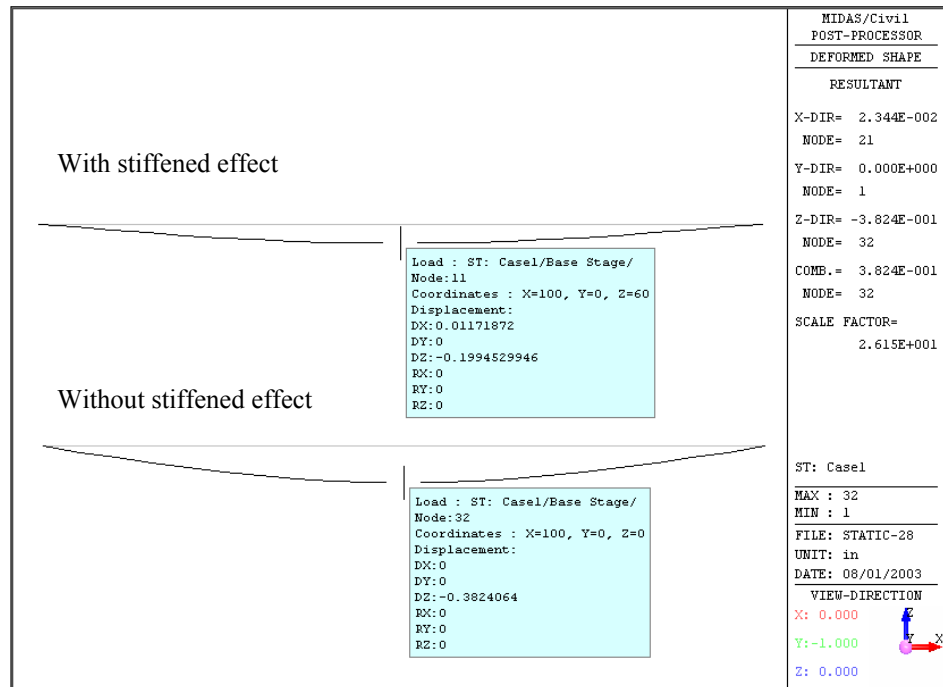
Tensile force, $P = 21,972.6 \text{ lb}$

Uniformly distributed load, $\omega = 1.79253 \text{ lb/in}$

Case 2: without stress stiffened effect

Uniformly distributed load, $\omega = 1.79253 \text{ lb/in}$

Results



Displacements(δ_z) of the structure

| | Node | Load | DX (in) | DY (in) | DZ (in) | RX ([rad]) | RY ([rad]) | RZ ([rad]) |
|---|------|-------|------------|------------|------------|---------------|---------------|---------------|
| ▶ | 1 | Case1 | 0,0000000 | 0,0000000 | 0,0000000 | 0,0000000 | 0,0032352 | 0,0000000 |
| | 21 | Case1 | 0,0234374 | 0,0000000 | 0,0000000 | 0,0000000 | -0,0032352 | 0,0000000 |
| | 22 | Case1 | 0,0000000 | 0,0000000 | 0,0000000 | 0,0000000 | 0,0061185 | 0,0000000 |
| | 42 | Case1 | 0,0000000 | 0,0000000 | 0,0000000 | 0,0000000 | -0,0061185 | 0,0000000 |

End slope (θ) of the structure

| | Elem | Load | Part | Axial (lbf) | Shear-y (lbf) | Shear-z (lbf) | Torsion (lbf-in) | Moment-y (lbf-in) | Moment-z (lbf-in) |
|---|------|-------|------|----------------|------------------|------------------|---------------------|----------------------|----------------------|
| ▶ | 11 | Case1 | i | 21972,60 | 0,00 | 0,00 | 0,00 | 4580,15 | 0,00 |
| | 31 | Case1 | i | 0,00 | 0,00 | 0,00 | 0,00 | 8962,65 | 0,00 |

Maximum bending moments

Comparison of Results

| Unit: in, rad, lbf-in | | | |
|-----------------------|--------------------------|-------------|-------------|
| Results | Case | Theoretical | MIDAS/Civil |
| Max. deflection | With stiffened Effect | -0.19945 | -0.19945 |
| End slope | | 0.0032352 | 0.0032352 |
| Max. bending | | 4580.10 | 4580.15 |
| Max. deflection | Without stiffened Effect | -0.38241 | -0.38241 |
| End slope | | 0.0061185 | 0.0061185 |
| Max. bending | | 8962.70 | 8962.65 |

Reference

Timoshenko, S. “*Strength of Materials, Part I, Elementary Theory*”, 3rd Edition, D. Van Nostrand Co., Inc., New York, NY.,1955.