
Description:

Natural frequency of a cantilevered beam with a weight at the top. Ref: Paz Ex 6.4 and Roarke Table 36.

Material properties:

$$E := E_s \quad E = 29000.00 \text{ ksi}$$

$$\text{Moment of Inertia: } I := 400 \text{ in}^4$$

Geometry:

$$\text{Cantilevered Beam: Length: } L := 20 \text{ ft}$$

Loading:

$$\text{Distributed weight of cantilevered arm: } w := 900 \frac{\text{lbf}}{\text{ft}}$$

$$\text{Concentrated Load at the end of the cantilever: } W := 0 \text{ kips}$$

Design:

$$\text{Angular frequency: } \omega := \sqrt{\frac{3 \cdot E \cdot I \cdot g}{W \cdot L^3 + \frac{33}{140} \cdot w \cdot L^4}} \quad \omega = 15.1 \text{ Hz}$$

$$\text{First Natural Frequency: } f := \frac{\omega}{2\pi} \quad f = 2.4 \text{ Hz}$$

$$\text{First Natural Frequency per Design Guide 11: } f_{11} := .18 \cdot \sqrt{\frac{g}{w \cdot L^4 \div (8 \cdot E \cdot I)}} \quad f_{11} = 2.2 \text{ Hz}$$

$$\frac{f - f_{11}}{f_{11}} = 12 \%$$