Problem 3

11 January 2022 09:59 AM

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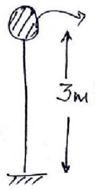
13-01-2022 CE629A :- Earthquake Analysis & Design of Structures B.De

Q:-3)



m = 1000 kg. 10

Diameter of steel tube (D_o) (Outer) = 168.3 mm

thickness (t) = 4.85 mm.

Area of cross section = 2490 mm^2

Inner diameter (D_i) = $D_o - 2 \times t$

$= 168.3 - 2 \times 4.85$

$= 158.6$ mm.

Youngs Modulus = 200 GPa.

MOI of section = 83,24,000 mm^4.

Natural Frequency $(\omega_n) = \sqrt{\frac{K}{m}}$

Stiffness $(K) = \frac{3EI}{L^3}$ (for cantilever)

$$= \frac{\cancel{3} \times 2\cancel{00} \times 10^{9} \times 83,24,00\cancel{0}}{(3)^{\cancel{3}\,2} \times 10^{12}}$$

$= 184977.78$ N/m.

$\therefore \omega_n = \sqrt{K/m} = \sqrt{\frac{184977.78}{1000}}$

$= 13.6$ rad/s.

Natural period $(T_n) = \frac{2\pi}{\omega_n}$

$= \frac{2\pi}{13.6}$

$= \underline{0.462\ s}$.

Using this T_n and given $\zeta = 2\%$ we observe the SD spectrum plot from Q(2).

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SD for $T_n = 0.462$ sec and $\zeta = 0.02$ is obtained as $= 0.058$ m.

$\therefore$ PSA corresponding to this SD $= \omega_n^2 \times 0.058$

$= (13.6^2 \times 0.058)$ m/s^2

$= 10.728$ m/s^2.

$\therefore$ Equivalent static force

$= m \times r\omega^2$

$= 1000 \times 10.728$

$= 10727.68 \text{ N}.$

Moment at the base $= f \cdot h$

$= (\cancel{107}^{10727.68} \times 3)$

$= 32183.04 \text{ Nm}.$

Using Euler–Bernoulli's theorem –

$\sigma = M/I \times y$

$\Rightarrow \sigma_{max} = M/I \times (D_o)$

$= \dfrac{32183.04}{83,24,000 \times 10^{-12}} \times \dfrac{168.3 \times 10^{-3}}{2}$

$\sigma_{max} = \dfrac{650.697 \text{ MPa}}{2} = \underline{\underline{325.35 \text{ MPa}}}$

Next, we use the tripartite plot given in the question to find the above quantities –

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