SOM

Answer Keys and Explanations

1. **[Ans. *]Range: 140 to 160**

$\epsilon_y = -60 \times 10^{-5}$

$\Rightarrow \epsilon_x = \left[\frac{60 \times 10^{-5}}{0.3}\right] = 200 \times 10^{-5}$

$\sigma_x = 300$ MPa

We have $\epsilon_x = \left(\frac{\sigma_x}{E}\right) - \mu\left(\frac{\sigma_y}{E}\right)$

$\epsilon_x = \left(\frac{\sigma_x}{E}\right)$

$E = \left(\frac{\sigma_x}{\epsilon_x}\right) = 300 \times \frac{10^6}{200 \times 10^{-5}}$

$E = 150$ GPa

2. **[Ans. *]Range: 0.25 to 0.35**

$E = 2G\,(1 + \mu)$

$\frac{G}{E} = \frac{1}{2(1+\mu)} = 0.385$

$\mu = 0.298$

3. **[Ans. B]**

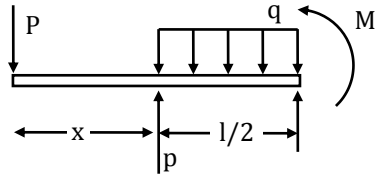
When material is same, strength is same now stiffness $k = \left(\frac{GJ}{L}\right)$

$k \propto \frac{J}{L}$

For k to be same J and L must be same

4. **[Ans. C]**

BM at mid Point



$M = P\left(x + \frac{l}{2}\right) + \left(\frac{ql}{2}\right)\left(\frac{l}{4}\right) - P\frac{l}{2}$

$\Rightarrow Px = -\frac{ql^2}{8}$

$\Rightarrow x = \frac{ql^2}{8P}$

$\Rightarrow x = \frac{ql^2}{8P}$

5. **[Ans. *]Range: 0.2 to 0.25**

$$\epsilon_v = \frac{PD}{4tE}(5 - 4\mu)$$
$$\Rightarrow \mu = 0.218$$

6. **[Ans. *]Range: 250 to 350**

$$I = \frac{12 \times 20^3}{12}\ cm^4$$
$$= 8 \times 10^3\ cm^4$$
$$L = 12\ cm$$
$$P = 80\ kN$$
$$M_{max} = \left(\frac{PL}{4}\right) = 240\ kNm$$
$$\sigma = \left(\frac{M_y}{I}\right) = \frac{240 \times 10^3 \times 0.1}{8 \times 10^{-5}}$$
$$\sigma = 300\ MPa$$

7. **[Ans. *]Range: 36 to 38**

$$\delta_{concentrated} = \frac{PL^3}{48\ EI}$$
$$\delta_{uniformly} = \frac{5_q L^4}{384EI} = \frac{5PL^3}{384\ EI}$$
$$\%\ change = \frac{\left(\frac{1}{48} - \frac{5}{384}\right)}{\left(\frac{1}{48}\right)} \times 100$$
$$= 37.5\%$$

8. **[Ans. A]**

$$w(h + \delta) = \frac{1}{2} R\,\delta \cdots (1)$$
$$\text{Also, } \delta = \left(\frac{RL^3}{48\ EI}\right)$$
$$R = \left(\frac{48EI}{L^3}\right)^{\delta}$$
Substituting in (1)
$$\left(\frac{24EI}{L^3}\right)\delta^2 - (w\delta) - (wh) = 0$$
$$\delta = 4.3\ mm$$

9. **[Ans. *]Range: 3.7 to 4.5**

$$\left(\frac{w}{2\pi}\right) = 25$$
$$w = 50\pi$$
$$180 \times 10^3 = T \times (50\pi)$$
$$T = 1145.91\ Nm$$

$$\frac{T}{J}=\frac{\tau}{r}\Rightarrow\frac{1145.91}{\left(\frac{\pi}{32}\right)[(0.06)^4-d^4]}=\frac{(60\times10^6)}{(0.03)}$$

$$\Rightarrow\left(\frac{1145.91\times0.03\times32}{\pi\times60\times10^6}\right)=(0.06)^4-d^4$$

$$d^4=7.112\times10^{-6}$$

$$d=51.6\text{ mm}$$

$$\Rightarrow\text{Thickness}=\left[\frac{60-51.6}{2}\right]=4.2\text{ mm}$$

10. **[Ans. D]**

$$2=2\pi R\Rightarrow R=\frac{1}{\pi}M$$

$$\left(\frac{1}{R}\right)=\left(\frac{M}{EI}\right)\Rightarrow M=\left(\frac{EI}{R}\right)$$

$$\Rightarrow\frac{M=200\times10^9\times\frac{\pi}{64}\times(0.02)^4}{\left(\frac{1}{\pi}\right)}$$

$$m=200\times10^9\times\frac{\pi^2}{64}\times(0.02)^4$$

$$m=4.9\text{ kNm}\simeq5\text{ kNm}$$