TOPIC

Strength of Materials – Section VIII - Question 3

QUESTION

A hollow aluminum tube (E=69 GPa, ν=0.3) with circular cross-section is twisted by a torque of 62.8 N-m. The tube has an outer radius of 32 mm and an inner radius of 16 mm, and is 500 mm long. The maximum shear stress in MPa in the tube most nearly is

(A) 0.813
(B) 0.651
(C) 1.22
(D) 1.30

HINT

Change mm to meters.

Polar second moment of area, $J = \frac{\pi}{2}({r_o}^4 - {r_i}^4)$

Shear stress under torsion, $\tau = \frac{Tr}{J}$

SOLUTION

The shear stress is given by

$$\tau = \frac{Tr}{J}$$

where

T = torque applied,
r = radial location,
J = polar second moment of area.

For a circular hollow tube,

$$J = \frac{\pi}{2}({r_o}^4 - {r_i}^4)$$

where

r_o=outer radius of tube,
r_i=inner radius of tube.

Since the radial location, r is maximum at $r = r_o$, we get the maximum shear stress as

$$\tau|_{max} \frac{Tr_o}{J}$$

Given

T =62.8 N-m
r_o=32 mm = $32 \times 10^{-3} m$
r_i=16 mm = $16 \times 10^{-3} m$

$$J = \frac{\pi}{2}({r_o}^4 - {r_i}^4)$$
$$= \frac{\pi}{2}((32 \times 10^{-3})^4 - (16 \times 10^{-3})^4)$$
$$= 1.5442 \times 10^{-6} \text{m}^4$$

Hence

$$\tau \left| \frac{62.8\times(32\times10^{-3})}{1.5442\times10^{-6}} \right._{max}$$

$=1.3014 \times 10^{6}$ Pa

=1.30 MPa

ANSWER

(D)

CONTRIBUTOR

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