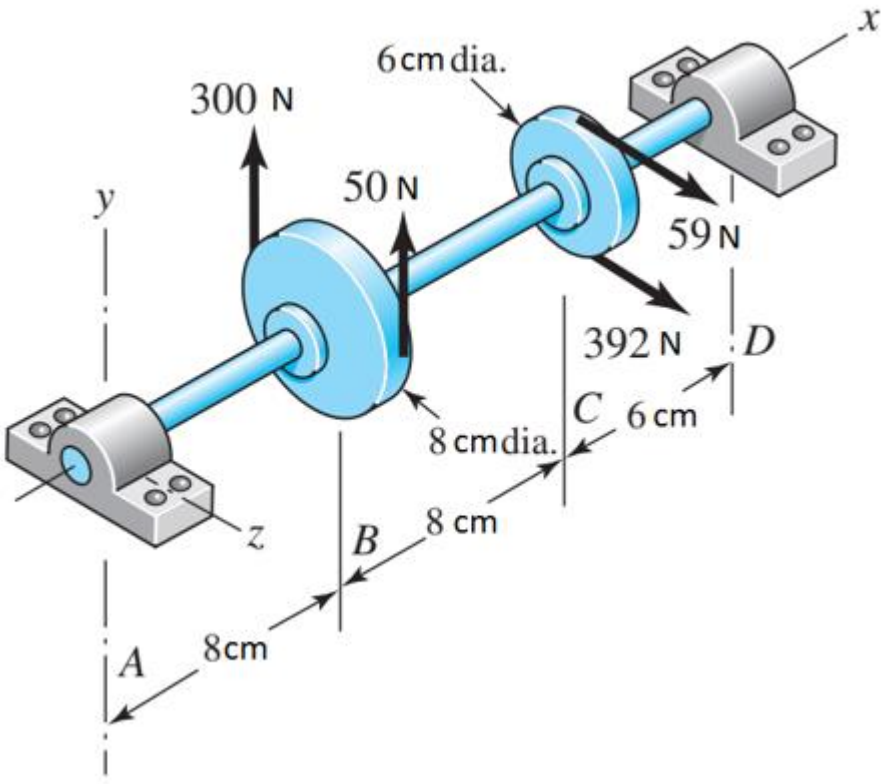
Failure Theories



The minimum shaft diameter can be determined by calculating the maximum stresses that occur in the shaft due to the belt tensions and comparing it with the yield stress of the AISI 1035 CD steel.

A)

For the least conservative failure theory, we can use the maximum bending stress theory, which assumes that the maximum stress occurs at the outer fibers of the shaft.

The formula

σ_b = My/I

M = bending moment,

y = distance from the neutral axis to the outer fibers,

I = moment of inertia.

The bending moment

M = (T_1 * r_1) + (T_2 * r_2)

T_1 and T_2 are the belt tensions,

r_1 and r_2 are the distances from the center of the shaft to the pulleys.

The moment of inertia

$I = \pi/64 * d^4$

d is the diameter of the shaft.

The yield stress of the AISI 1035 CD steel = ca. 355 MPa.

With a design factor of 2, the maximum allowable stress is half of the yield stress, 177.5 MPa.

So, the minimum diameter can be calculated as:

$d = ((8 * M * 64)/(\pi * 177.5 * y))^{(1/4)}$

B)

the most conservative failure theory, we can use the maximum shear stress theory, which assumes that the maximum stress occurs at a 45-degree angle to the longitudinal axis of the shaft. The formula

$\sigma_s = T/J$

T = torque,

J = torsional constant.

The torque

$T = (T_1 * r_1) - (T_2 * r_2)$

The torsional constant

$J = \pi/32 * d^4$

With a design factor of 2.5, the maximum allowable stress is 40% of the yield stress, or 142 MPa.

So, the minimum diameter can be calculated as:

$d = ((16 * T * 32)/(\pi * 142 * J))^{(1/4)}$

C)

the most conservative failure theory provides a larger minimum diameter, which ensures a safer design by considering a more “stringent” encompassing maximum allowable stress. the minimum shaft diameter to avoid yielding has been determined by using both the least conservative and the most conservative failure theories. The results of these calculations are only approximate and may not take into account other factors that could affect the design of the shaft, such as fatigue, buckling, or other forms of stress

if i were to make the part i would use the most conservertive because of the more safety