MET 4501 Fall 2024: Practice In-Class Quiz 6 Name: SOLUTION

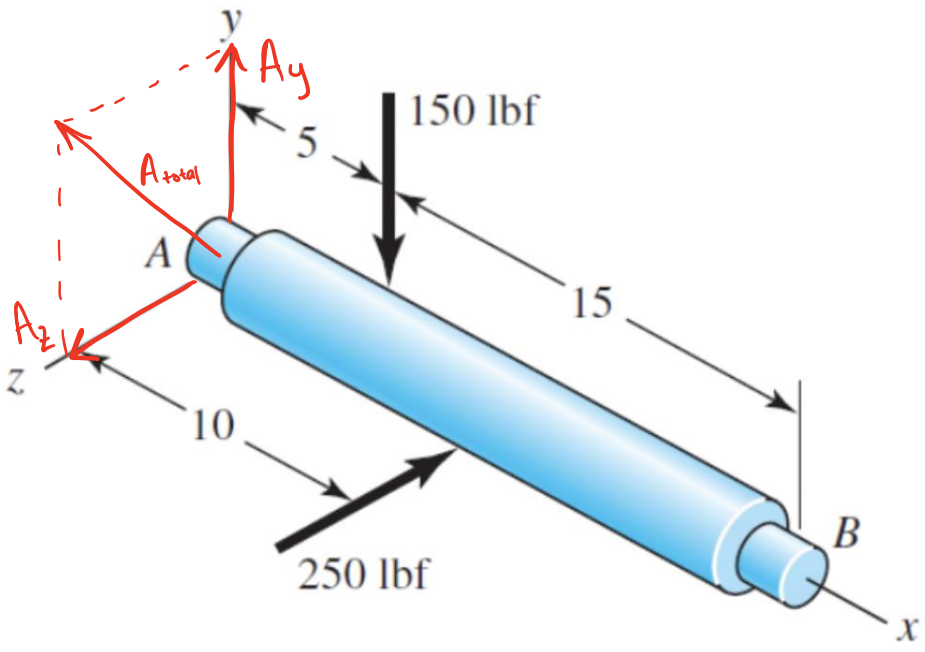
INSTRUCTIONS:

This quiz is open-book and open-note, and you may work with your classmates. Please answer all questions and show all of your work.

GIVEN:

The steel shaft shown is supported by ball bearings at locations *A* and *B*. Dimensions are in inches.

A catalog page with bearing specifications is attached.

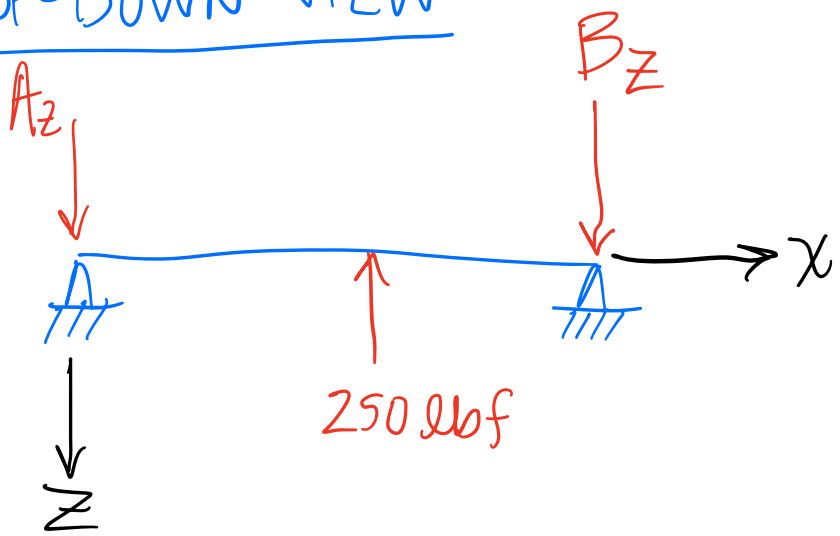


FIND:

a) The radial load supported by bearing *A*.
b) Using the bearing specifications attached, how many cycles do you predict for bearing *A* for 95% reliability?

NOTE: 1 lbf = 4.448 N

(a) TOP-DOWN VIEW



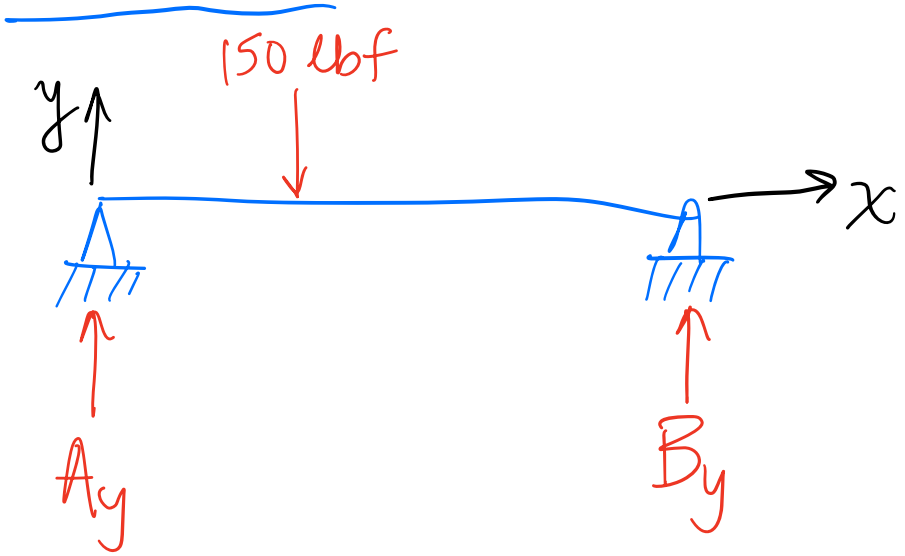
$$\Sigma M_{Bz} = 0: (-250\,\text{lbf})(10\,\text{in}) + A_z(20\,\text{in}) = 0$$

$$A_z = 125\,\text{lbf}$$

$$\Sigma F_z = 0: \quad A_z + B_z = 250\,\text{lbf}$$

$$B_z = 125\,\text{lbf}$$

SIDE VIEW



$$\Sigma M_{By} = 0: -A_y(20\,\text{in}) + (150\,\text{lbf})(15\,\text{in}) = 0$$

$$A_y = 112.5\,\text{lbf}$$

$\Sigma F_y = 0$: $A_y + B_y = 150\ lbf$

$B_y = 37.5\ lbf$

THE RADIAL LOAD AT A IS THE MAGNITUDE OF THE COMBINED VECTORS A_z AND A_y.

$$A_{total} = \sqrt{A_z^2 + A_y^2} = \sqrt{(125\ lbf)^2 + (112.5\ lbf)^2}$$

$$\boxed{A_{total} = 168.2\ lbf}$$

(b) $a_1 F_R L_R^{1/a} = F_D L_D^{1/a}$

$a_1 = 0.64$ (FOR 95% RELIABILITY)

$F_R = 17.8\ kN \cdot \frac{1\ lbf}{4.448\ N} = 4002\ lbf$

$L_R = 10^6$ REVS

$a = 3$ (FOR BALL BEARING)

$F_D = 168.2\ lbf$ ($F_D = A_{total}$ FROM PART (a))

$(0.64)(4002\ lbf)(10^6)^{1/3} = (168.2\ lbf) L_D^{1/3}$

$(L_D^{1/3})^3 = (1522.8)^3$

$L_D = 3.53 \times 10^9$ CYCLES (REVS)

Image may differ from product. See technical specification for details.

RLS 8

Deep groove ball bearing

Single row deep groove ball bearings are particularly versatile, have low friction and are optimized for low noise and low vibration, which enables high rotational speeds. They accommodate radial and axial loads in both directions, are easy to mount, and require less maintenance than many other bearing types.

- Simple, versatile and robust design
- Low friction
- High-speed capability
- Accommodate radial and axial loads in both directions
- Require little maintenance

Overview

Dimensions

Bore diameter	25.4 mm
Outside diameter	57.15 mm
Width	15.875 mm

Performance

≈4002 lbf

Basic dynamic load rating	17.8 kN
Basic static load rating	9.65 kN
Reference speed	24 000 r/min
Limiting speed	17 000 r/min

Properties

Filling slots	Without
Number of rows	1
Locating feature, bearing outer ring	None
Bore type	Cylindrical
Cage	Sheet metal
Matched arrangement	No
Radial internal clearance	CN
Material, bearing	Bearing steel
Coating	Without
Sealing	Without
Lubricant	None
Relubrication feature	Without

Logistics

Product net weight	0.17 kg
eClass code	23-05-08-01
UNSPSC code	31171504

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