

HW#3

Shown in figure below is the pin joint that is used in the connection between the dump cylinder and the secondary boom. The pin is fixed to the frame and is stationary. When the cylinder strokes, it will create a rotating motion between the pin eye of the cylinder and the pin. In order to reduce wear in this rotating contact, a wear resistance bronze sleeve bearing is used.

Aluminum Bronze Bearing:

Max. P (psi):	4,500	
Max. PV	125,000	(V in fpm)

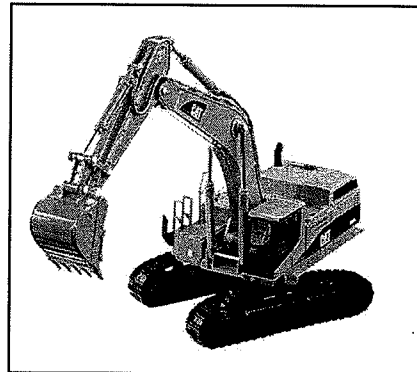
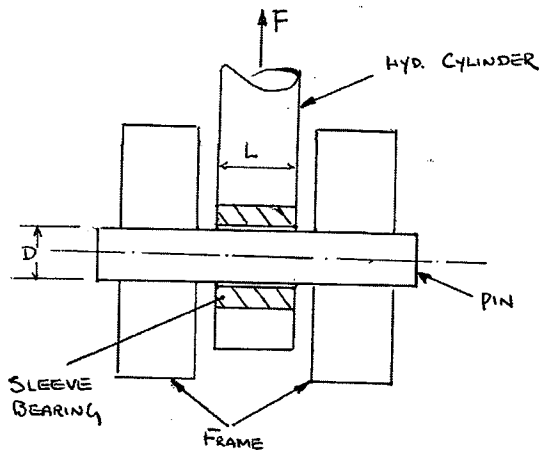
AISI 4140 Alloy Steel

Tensile strength:	148,000 psi
Yield strength	95,000 psi
Yield strength in shear:	50,000 psi

(Note: use yield strength instead of tensile strength as failure criterion)

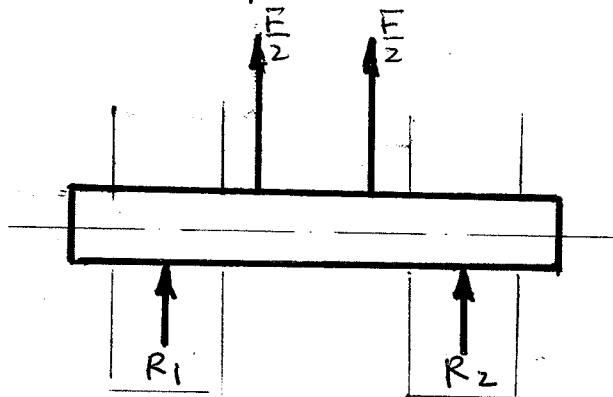
The material specs for the pin (4140) and bronze sleeve bearing are listed above. The diameter of the pin "D" is 2 inch and the width of bearing "L" is 3 inch. The load from the hydraulic cylinder "F" is 200,000 lb. Assume the rotating speed of cylinder is 100 rpm. (Note: the V is in fpm)

- What is the maximum shear stress on the pin?
- How much is the safety factor of the pin in terms of resisting shearing?
- What is the bearing pressure? Is it within the specs?
- What is the PV value? Is it within the specs?
- If the bearing pressure calculated is larger than what is allowed, what are the possible options to fix the problem?

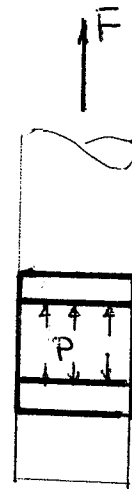


SOLUTION

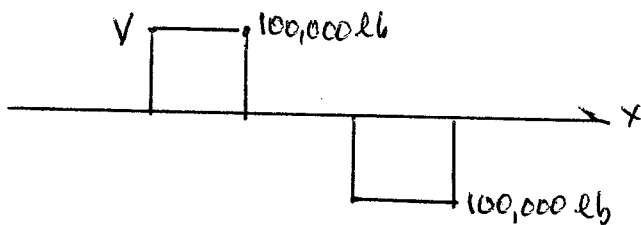
FREE-BODY DIAGRAM OF PIN:



FREE-BODY DIAGRAM OF BUSHING:



SHEAR DIAGRAM:



(a). $\tau_s = \frac{V}{A} = \frac{100,000}{\frac{1}{4}\pi D^2} = \frac{100,000}{\frac{1}{4}\pi \cdot 2^2} = 31,847 \text{ PSI}$

(b). $SF = \frac{\text{STRENGTH}}{\text{WORKING STRESS}} = \frac{50,000}{31,847} = 1.57$

(c). $P = \frac{F}{D \cdot L} = \frac{200,000}{2.3} = 33,000 \text{ PSI}$

$P = 33,000 > 4,500 \text{ (ALLOWABLE)} \quad \text{NOT GOOD}$

(d) VELOCITY $V = \frac{1}{2} \omega D = \frac{1}{2} \cdot 2\pi n \cdot D = \pi n D = 3.14 \times 100 \times 2 = 628 \text{ ipm}$

OR $V = \frac{628}{12} = 52.3 \text{ fpm}$

$P \cdot V = 33,000 \times 52.3 = 1,725,900 > 125,000 \quad \text{NOT GOOD}$

(e). GIVEN THE LOAD, WE CAN REDUCE THE BEARING LOAD (P) BY INCREASING THE BEARING AREA. THIS CAN BE ACCOMPLISHED BY INCREASE

(1) PIN DIAMETER (D) OR

(2) BEARING LENGTH (L).