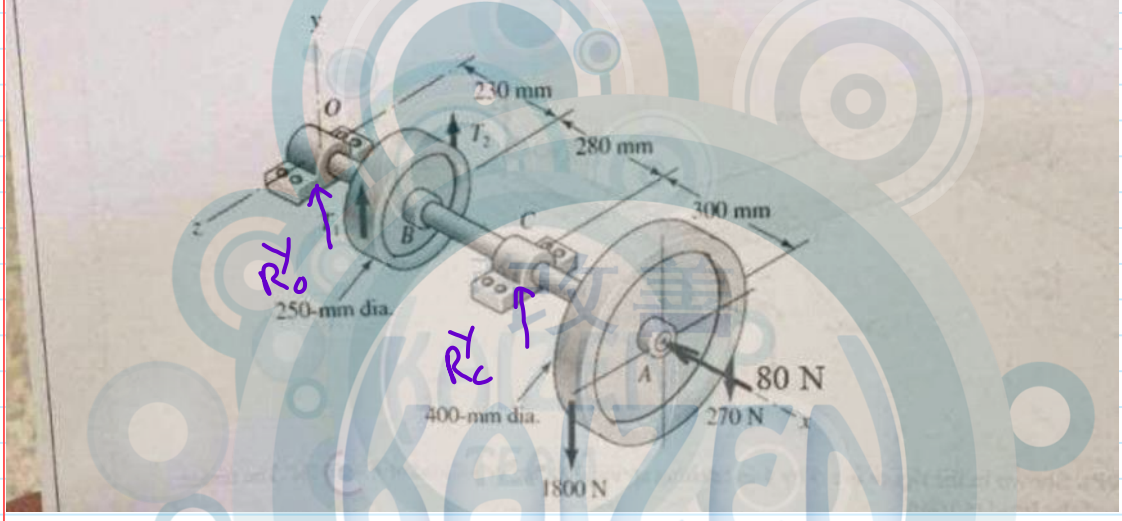
Q3(20P)- A belt-driven jack-shaft is shown in the figure below. The weight of each pulley is 900 N. The shaft is made of AISI 1050 CD (hardened steel) and is driven by a motor at 1200 rpm. All important surfaces have a ground finish. If the shaft is to be designed for an infinite life with a reliability of 99.9% and a safety factor of 1.5. The power is transmitted through the shaft and delivered to the belt on pulley *B*. Assume the belt tension on the loose side at *B* is 15 percent of the tension on the tight side. Determine:

a-Select two bearings for O and C using an application factor of unity and a desired life for each bearing is 9 kh with a 95 percent reliability for the two bearings. (use direct mount)

b-Draw shear-force and bending-moment diagrams for the shaft.

c- Using a factor of safety of 2.5 determine the minimum allowable diameter of the shaft based on a fatigue- failure analysis Modified Goodman. (Make any necessary assumptions).

d-draw the resulting shaft showing all necessary dimensions



load analysis → Bearing selection

$T_2 = 0.15 T_1$

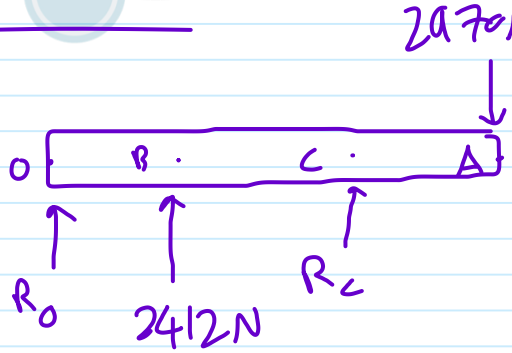
$\Sigma T = 0$

$(1800 - 270) * (200) - (T_1 - T_2) * 125 = 0$

$\vdots$

$T_1 = 2880\ N$

$T_2 = 432\ N$



$\Sigma M_O = 0$

$(2412 * 230) - (2470 * 810) + R_C * 510 = 0$

$R_C = 3630\ N$

$\Sigma f_y = 0$

$2412 + 3630 - 7970 + R_0 = 0$

$R_0 = -3071.3\ N$

Bearing selection:

→ Point O:

$R_0 = 3071.3\ N$

→ Point C:

$R_0 = 3630\ N$, $f_a = 80\ N$

* combine loadings at C using eqn 11-12

→ combined loading? ⇒ Guess and check loop...

* $\frac{F_a}{F_r} = \frac{80}{3630} = 0.022$ → it is more convenient for "i" to be equal to 0 !

assume $i = 1$

$F_e = f_r = 3.63\ kN$

$L_D = 9 \times 10^3 \times 1200 * 60 = 648 * 10^6\ rev$

$R_D = \sqrt{0.95} \simeq 0.975$

$C_{10} = 3.63 * \left[\frac{648}{0.02 + 4.439\left(\ln\frac{1}{0.975}\right)^{\frac{1}{1.483}}}\right]^{\frac{1}{3}}$

$C_{10} = 42.9\ kN$

Catalog 11-2

assume Deep Groove Bearings

→ Bore: 55 mm, OD = 100 mm