FUNDAMENTALS OF MACHINE DESIGN AND DRAWING (A.Y. 2015-2016)

Example of Written Text

A camshaft rotates at 30 Hz causing a follower to raise and lower once per revolution. The follower is held against the cam by a helical compression spring. A rolling-element bearing guarantees the relative motion between cam and follower.

For the design of the spring, consider that due to geometric constraints, the internal diameter of the spring (D_i= D-d) needs to be at least 25 mm while the external diameter (D_e= D+d) cannot exceed 50 mm.
The height of the housing where the spring is to be mounted is 60 mm; during operation the spring length varies over a range of 21 mm.
In the hypothesis that inertia forces can be neglected, the spring must guarantee a minimum contact force between the cam and the bearing (F_{cmin}) of 200 N.
Assume ground end finishing; the material is 50 CrV4 (R_m=1500 MPa, R_{p02}=1200 MPa, σ_{D-1}=750 MPa).

For bearing life calculation, the harmonic behaviour of the contact force over time can be discretized by 4 force values (F_1, F_2, F_3, F_4) as shown in Figure 2.
Time percentage for the four contact load conditions are reported in the table, together with the values that can be assumed for the cam radius of curvature at each load condition.
For calculating the rotating velocity of the bearing, assume pure rolling at the contact.

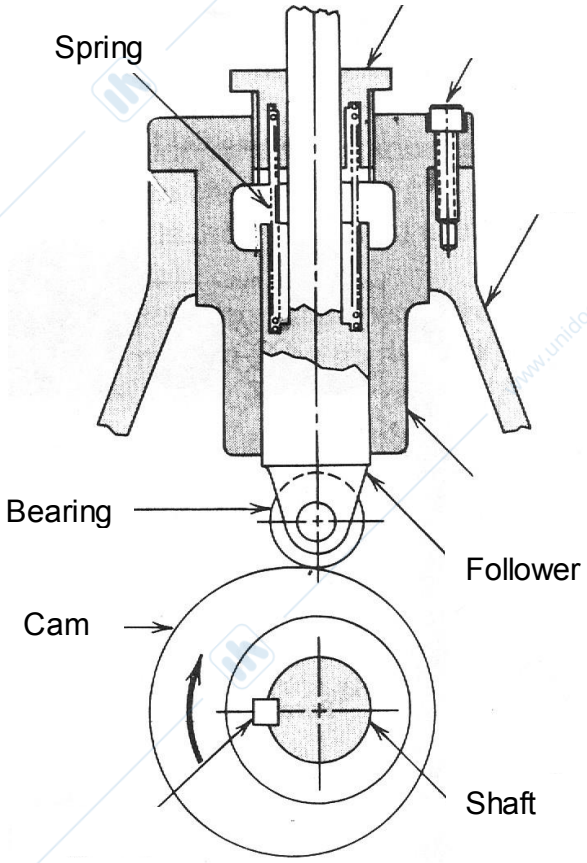

Figure 1- The camshaft- follower system

contact force	**% time**	**cam radius of curvature** *(D_b is the external diameter of the bearing)*
$F_1=F_{cmin}$	30%	$r_1=0.55\cdot D_b$
$F_2=(3\cdot F_{cmin}+F_{cmax})/4$	22%	$r_2=0.65\cdot D_b$
$F_3=(F_{cmin}+3\cdot F_{cmax})/4$	37%	$r_3=0.8\cdot D_b$
$F_4=F_{cmax}$	11%	$r_4=1.5\cdot D_b$

Figure 2- Contact force-time plot

It is requested to:

- design the helical compression spring, specifying
  - the wire diameter and the mean coil diameter;
  - the number of active coils and the free height of the spring.

  Given values will have to be compatible with the geometric constraints and to ensure the static and fatigue resistance of the spring.
- compute the bearing basic rating life in hours (bearing code: SKF 608; d_b=8mm, D_b= 22mm; B=7mm, C= 3450N; C_0= 1370 N).
- compute the maximum Hertzian pressure at the contact (between the cam and the bearing) during operation. Assume the length of the rectangular contact area equal to the axial size B of the bearing.