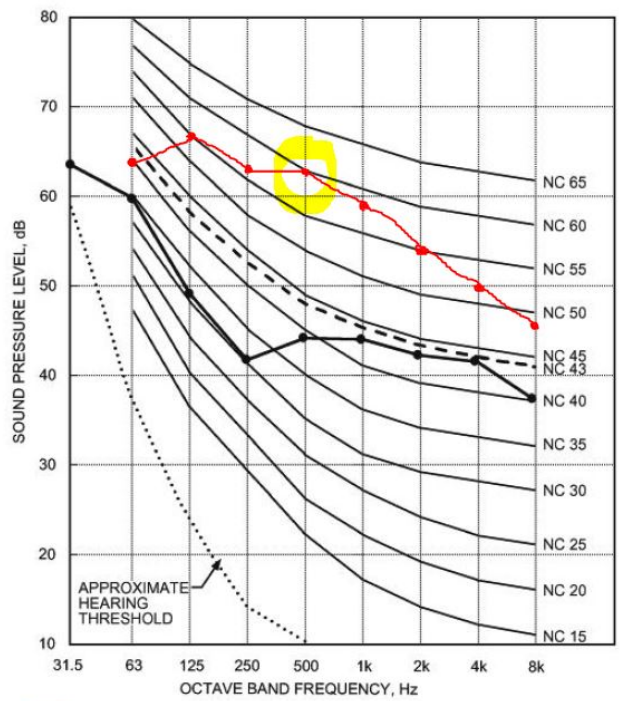

Fig. 7 NC (Noise Criteria) Curves and Sample Spectrum (Curve with Symbols)

In this case, the worst case octave band is the $500Hz$ frequency, and the rating is NC-60.
Answer D

45.6 A $5000lb_m$ machine rotates at $1800rpm$ and is mounted on vibration isolators with a combined stiffness of $40,000\frac{lb_f}{in}$. In parallel with the springs, a damper has been included. The damping ratio is 0.3. An unbalanced force of $2000lb_f$ is caused by the machine. What is the maximum force transmitted through the base?

A. $550lb_f$

B. $950lb_f$

C. $1050lb_f$

D. $1450lb_f$

Start by finding the natural frequency of the machine which is a function of the total combined spring stiffness and the mass. Note that g_c must be included to make the units consistent.

$$\omega_n = \sqrt{\frac{kg_c}{m}} = \sqrt{\frac{\left(40,000\frac{lb_f}{in}\right)\left(12\frac{in}{ft}\right)\left(32.2\frac{lb_m \cdot ft}{lb_f \cdot s^2}\right)}{5,000lb_m}} = 55.6\frac{rad}{s}$$

Find the forcing frequency, which is a function of the rotational speed.

$$\omega = \left(1800\frac{rev}{min}\right)\left(\frac{1min}{60s}\right)\left(\frac{2\pi rad}{rev}\right) = 188.5\frac{rad}{s}$$

Find the frequency ratio, r.

$$r = \frac{\omega}{\omega_n} = \frac{55.6\frac{rad}{s}}{188.5\frac{rad}{s}} = 3.39$$

Determine the vibration transmissibility, $\frac{F_T}{F_o}$, where F_T is the transmitted force and F_o is the unbalanced force. The damping ratio is given as $\varsigma = 0.3$.

$$\frac{F_T}{F_o} = \left[\frac{1 + (2\varsigma r)^2}{(1 - r^2)^2 + (2\varsigma r)^2}\right]^{\frac{1}{2}} = \left[\frac{1 + [2\,(0.3)\,(3.39)]^2}{\left(1 - (3.39)^2\right)^2 + [2\,(0.3)\,(3.39)]}\right]^{\frac{1}{2}} = 0.72$$

Solve for the transmitted force.

$$F_T = (0.72)\,F_o = (0.72)\,(2000lb_f) = 1440lb_f$$

Answer D

45.7 A $1.5in$ diameter steel shaft ($E = 2.9 \times 10^7 psi$) is $4ft$ long and supported by two frictionless bearings at its ends. A $200lb_m$ flywheel is mounted on the center of the shaft. The shaft weight is negligible and there is no damping. What is the critical speed of the shaft?

A. $4Hz$

B. $12Hz$

C. $78Hz$

D. $590Hz$

The critical speed depends on the linear natural frequency of the shaft which can be determined from the static deflection due to the mass of the flywheel modeled as a point load applied to the center of a simple beam.

Start by calculating the area moment of inertia for a the shaft.

$$I = \frac{\pi r^4}{4} = \frac{\pi\,(0.75in)^4}{4} = 0.2485in^4$$

Find the formula for the static deflection of a simple beam with a concentrated load at center. Calculate the maximum static deflection.

$$\delta_{st} = y = \frac{Pl^3}{48EI} = \frac{(200lb_f)\,(48in)^3}{48\left(2.9 \times 10^7\frac{lb_f}{in^2}\right)(0.2485in^4)} = 0.064in$$