Critical Mass Systems

Sample Isolation Problem:

> The problem that follows provides a sample calculation which identifies 6.14% transmissibility at 60Hz. Granted, 93.86% isolation at 60Hz is inadequate for audio but the problem is revelatory of the associated mathematics. Please note: Ancillary nomographs, definitions, assumptions and calulations were omitted for simplicity.

Solution:

Shape Factor:

Square: $$sf = \frac{(L)}{(4)\ (t)} = \frac{1}{(4)\ (1.25)} = \frac{1}{5} = .2$$

Static Deflection:

Compressive Modulus: $$= \frac{\text{Cs (See Fig. 1)}}{\text{(Assumed Percent Deflection) / 100}} = \frac{14.05}{(.2)\ /\ 100} = \frac{14.05}{.2} \bigg/ 100$$

$$= \frac{7025}{100} = 70.25 \text{ psi}$$

Compressive Modulus Corrected for Shape Factor:

$$= \text{(Compressive Modulus)}\ (1 + (2)\ (sf^2)) = (70.25)\ (1 + (2 \times .04)) = (70.25)\ (1.08)$$

$$= 75.87 \text{ psi}$$

Static Deflection: $$= \frac{\text{(Load Per Isolator) (t)}}{\text{(Corrected Compressive Modulus) (Area)}} = \frac{(15)\ (1.25)}{(75.87)\ (1)} = \frac{18.75}{75.87} = .247''$$

Percent Deflection: $$= \frac{\text{Static Deflection}}{t} \times 100 = \frac{.247}{1.25} \times 100 = 19.76\%$$

System Natural Frequency:

Assume a Natural Fequency of 9 Hz

Eod is Dynamic Compressive Modulus
K' is Compressive Stiffness
pi = 3.1416

Eod $= Gd \times 3$ (Gd is found in Figure 2 and is equal to 48.4 for this sample) $= 48.4 \times 3$

$= 145.2$ psi

$$K' = ((Eod)\ (1 + (2\ sf^2))) \times \frac{\text{Area}}{t} = ((145.2)\ (1.08)) \times \frac{1}{1.25}$$

$= 156.816 \times .8 = 125.4528$ lbs per inch

Natural Frequency $$= \frac{1}{2\ (pi)} \times \sqrt{\frac{K' \times 386}{\text{Load per Isolator}}} = \frac{1}{6.2832} \times \sqrt{\frac{125.4538 \times 386}{15}}$$

$$= .1592 \times \sqrt{3228.31872} = .1592 \times 56.818 = 9.04 \text{ Hz}$$

Transmissibility:

Tangent of Delta is @ Excitation Frequency found in figure 3.

Tangent of Delta $= .48085825$

Frequency Ratio $$= \frac{\text{Excitation Frequency}}{\text{System Natural Frequency}} = \frac{60 \text{ Hz}}{9.04 \text{ Hz}} = 6.64$$

Transmissibility $$= \sqrt{\frac{1 + \text{Tangent of Delta}^2}{(1 - (\text{Frequency Ratio}^2)\left[\frac{\text{Gd @ Natural Frequency}}{\text{Gd @ Excitation Frequency}}\right]\Bigg]^2 + (\text{Tangent of Delta})^2}}$$

$$= \sqrt{\frac{1 + .48085825}{(1 - (44.04976)\left[\frac{48.4}{112}\right]\Bigg]^2 + (.23112)}} = \sqrt{\frac{1.4808}{190.219 + .23112}} = \sqrt{\frac{1.4808}{190.45}}$$

$= .0614$

Percent Isolation $= (1 - \text{Transmissibility}) \times 100 = 1 - .0614 \times 100 =$ **93.86%**