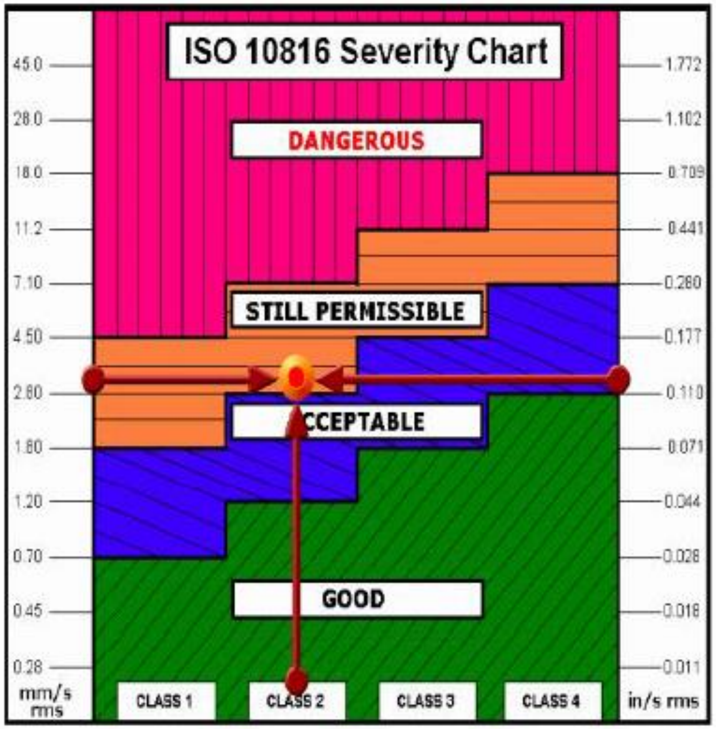
Diagnose of Vibration Causes and Fault Detection

Vibration as a machine condition indicator

Limits and standards of

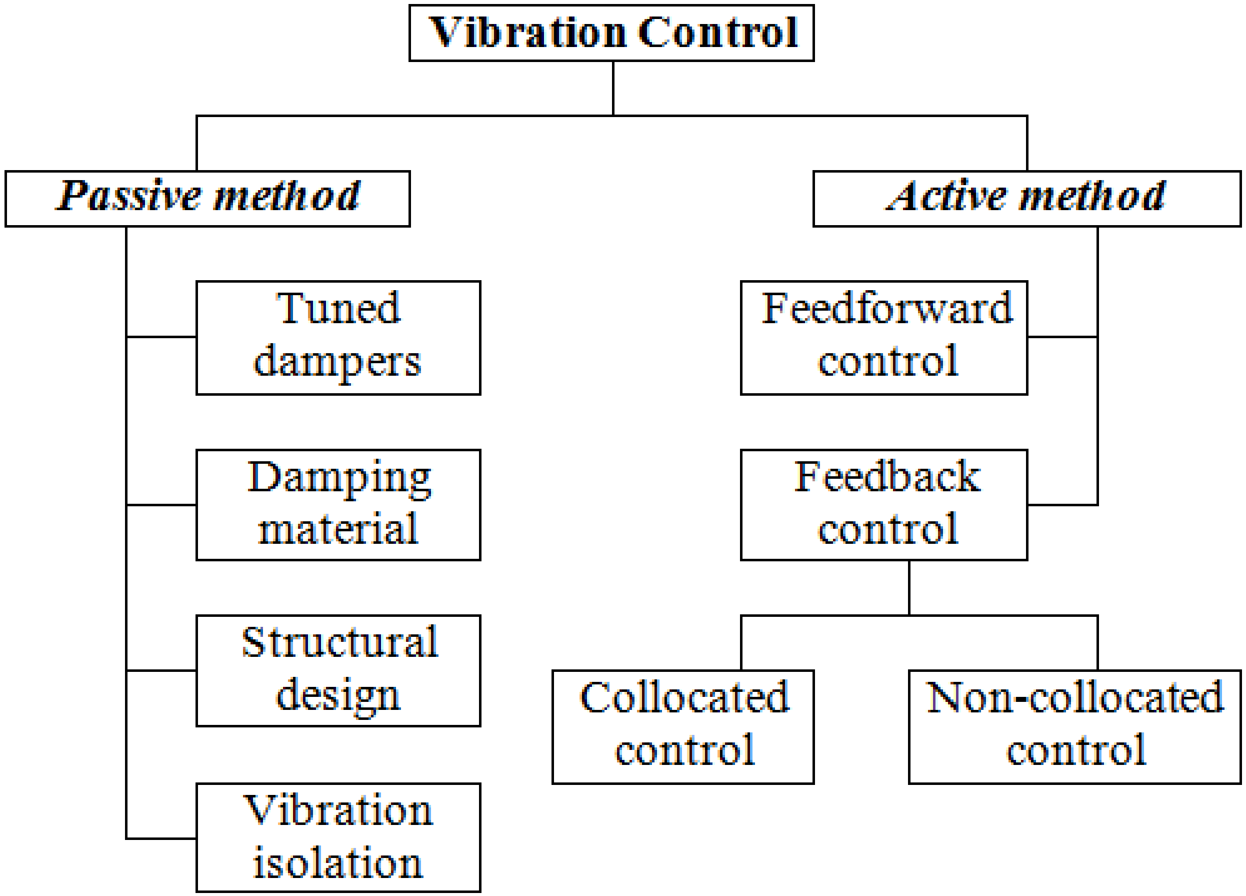


Diagnose of Vibration Causes and Fault Detection

ISO 2372 – ISO Guideline for Machinery Vibration Severity					
Ranges of Vibration severity		Examples of quality judgment for separate classes of machines			
Velocity – in/s – Peak	Velocity – mm/s – rms	Class I	Class II	Class III	Class IV
0.015	0.28	A	A	A	A
0.025	0.45	A	A	A	A
0.039	0.71	A	A	A	A
0.062	1.12	B	A	A	A
0.099	1.8	B	B	A	A
0.154	2.8	B	B	B	A
0.248	4.5	B	B	B	B
0.392	7.1	D	B	B	B
0.617	11.2	D	D	B	B
0.993	18	D	D	D	B
1.54	28	D	D	D	D
2.48	45	D	D	D	D
3.94	71	D	D	D	D

A – Good
B – Acceptable
C – Still acceptable
D – Not acceptable

Control of Vibration



Control of Vibration

Passive vibration control methods

Reduction at the source

It is particularly important to be able to isolate vibration sources because structure borne vibration can otherwise be easily transmitted to parts which radiate well, and serious noise problems can occur. Theoretically, low stiffness isolators are desirable to give a low natural frequency.

There are four types of spring material commonly used for resilient mountings and vibration isolation: air, metal, rubber and cork.

Control of Vibration

Passive vibration control methods

Reduction of the response

1. **Alteration of Natural Frequency**
2. **Energy Dissipation or isolation**

Control of Vibration

The design procedure for selecting springs for vibration isolation

1. Determine the weight of the machinery to be isolated, the lowest expected forcing frequency, the degree of isolation, and the number of mounting points.

2. The percent isolation yields the transmissibility τ, and the lowest forcing frequency is the quantity f. Hence, if the damping ratio is essentially zero, the transmissibility equation reduces to

$$\tau = \frac{1}{(f/f_n)^2 - 1} \qquad \text{.. (6.1)}$$

where $\zeta = 0$

Combining this equation with the equation for the natural frequency

$$f_n = 4.98\sqrt{\frac{1}{\delta_{st}}}$$

We obtain

$$\delta_{st} = \frac{(1+\tau)24.8}{\tau f^2} \qquad \text{.. (6.2)}$$

Control of Vibration

The design procedure for selecting springs for vibration isolation

3. The total weight of the machinery in Newton and the number of mounting points yields W_{mp}, which is the weight per mounting point. The k coefficient for the spring is then calculated from the expression

$$k = \frac{W_{mp}}{\delta_{st}} \quad \text{...} (6.3)$$

This value and/or the static deflection can be used to select a spring from the manufacturer's catalog.

Control of Vibration

Example (6.1)

A machine set operating at 2400 rpm is mounted on an inertia block. The total system weighs 907 N. The weight is essentially evenly distributed. We want to select four steel springs upon which to mount the machine. The isolation required is 90%.

Solution:

Weight = 9.7 N

Lowest forcing frequency = 2400 rpm

Percent isolation = 90%

Number of mounting points = 4

90 % isolation yields $\tau = 0.1$

Since, percent isolation = (1- transmissibility). 100%

$\%I = (1-\tau).100\%, \quad \tau \leq 1$

$f = \frac{2400}{60} = 40\,Hz$ therefore $\delta_{st} = \frac{(1.1)(24.8)}{0.1(40)^2} = 0.171\,cm$

$W_{mp} = \frac{907}{4} = 226.75\,N$ therefore $k = \frac{226.75}{0.171} = 1330\,N/cm$

Control of Vibration

Example (6.2)

A drum weighing 120 N and operating at 3600 rpm induces vibration in adjacent equipment. Four vertical mounting points support the drum. Choose one of the isolators shown in Figure (6.15) so as to achieve 90% vibration isolation.

1. W=120 N

   Speed 3600 rpm

   % I =90 %

   Number of mounting points = 4

2. % I = 90 % isolation yields $\tau = 0.1$

$$f = \frac{3600}{60} = 60\,Hz \quad \text{therefore} \quad \delta_{st} = \frac{(1.1)(24.8)}{0.1(60)^2} = 0.076\,cm$$

3. $W_{mp} = \dfrac{120}{4} = 30\,N$

Hence Figure (6.15) indicates that for static deflection of 0.076 cm and a weight per mounting point of 30 N, isolator B is the best choice.

Note that isolator B is chosen because at a load of 30 N, it has a $\delta_{st} > 0.076\,cm$. Recall that as shown in Figure (6.16), δ_{st} increases, f_n

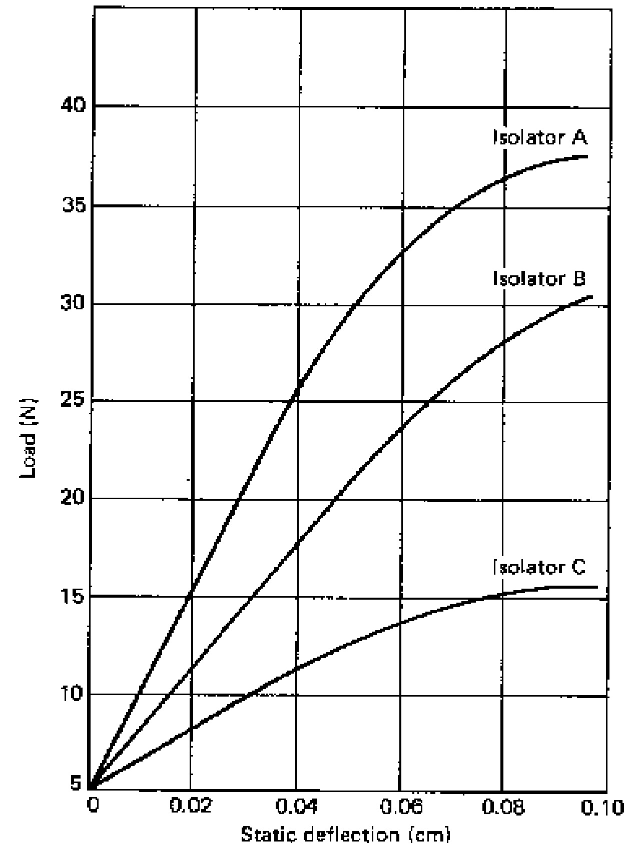
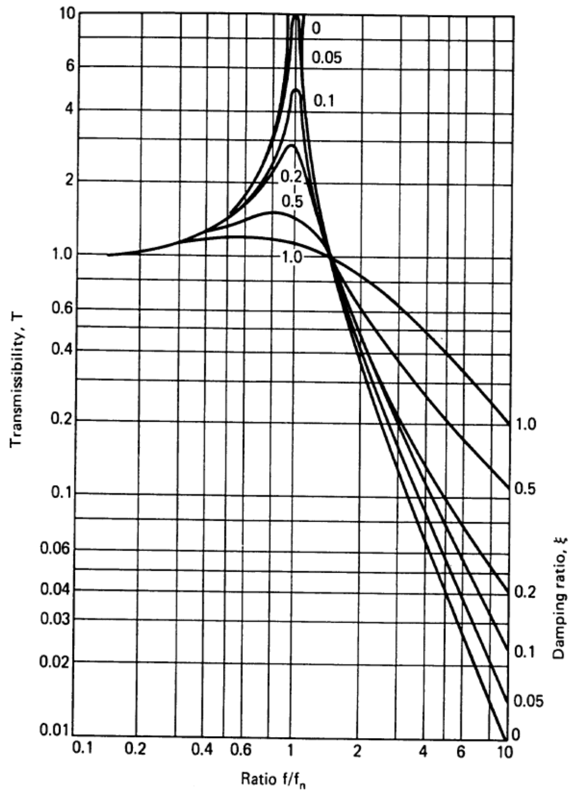


Fig. 6.15

Control of Vibration

decreases. A decrease in f_n increases the ratio f / f_n, which, as shown in Figure (6.17) or Figure (3.17), increases the percent isolation.



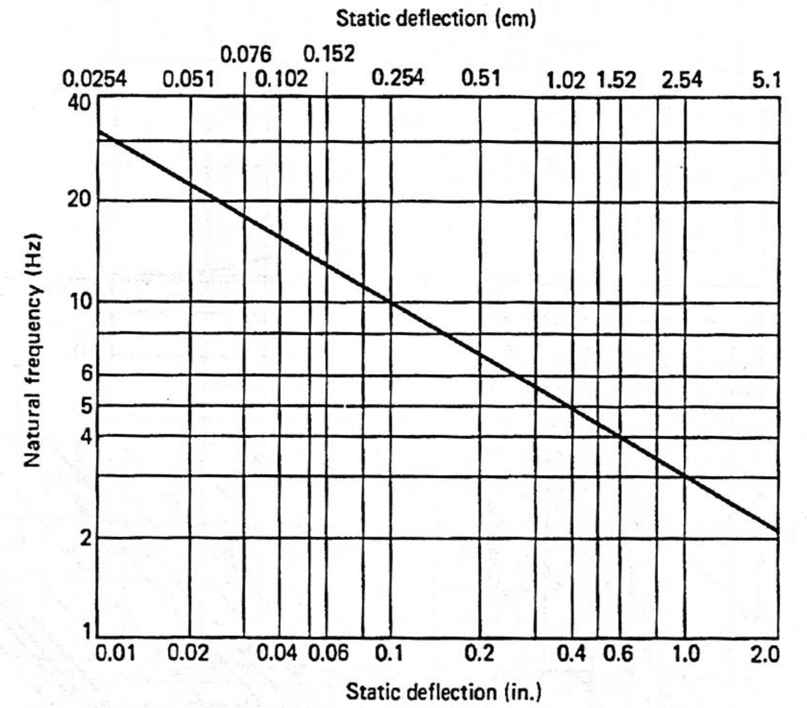


Fig. 6.16

Control of Vibration

Active vibration control methods

1. Balancing of moving masses.
2. Balancing of magnetic Forces.
3. Control of clearances.
4. Collocated control

If, after careful selection and design of machinery and equipment, careful installation and commissioning, and carrying out isolation as necessary the vibration levels in the system are still too large, then some increase in the damping is necessary. This is also the case when excitation occurs from sources beyond the designers' control such as cross winds, earthquakes and currents.

Thank you