Spring calculation

1. Calculation of spring constant:

The vibrating mass m is calculated from the weight of the trough plus twenty percent of the weight of the load, distributed over n support points:

(1) $$m = \frac{m_1 + 0.2 \times m_2}{n} [kg]$$

For systems whose working frequency f is close to the resonant frequency, the following applies:

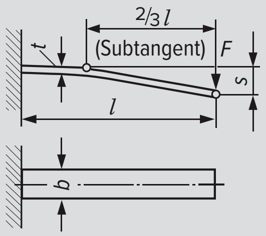
(2) $$f[Hz] = \frac{1}{2\pi} \times \sqrt{\frac{c[N/m]}{m[kg]}}$$

This results in the spring rate c (total system):

(3) $$c[N/mm] = \frac{(f[Hz] \times 2\pi)^2 \times m[kg]}{1000}$$

2. Spring calculation:

Rectangular spring



$$F_{acc} = \frac{bt^2}{6} \cdot \frac{\sigma_{b\,acc}}{l}$$

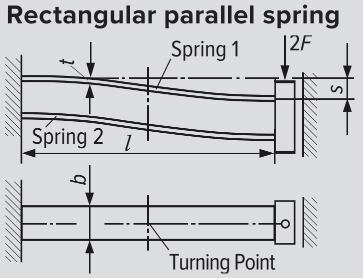
$$s = \frac{Fl^3}{3E\,I} = \frac{4Fl^3}{bt^3\,E}$$

$$s_{acc} = \frac{2l^2 \sigma_{b\,acc}}{3t\,E}$$

$$c = \frac{F}{s} = \frac{bt^3\,E}{4l^3}$$

$$W = \frac{btl}{18E} \sigma_b^2 ; \quad \eta_A = \frac{1}{9}$$

Rectangular parallel spring



$$2F_{acc} = 2 \cdot \frac{bt^2}{3} \cdot \frac{\sigma_{b\,acc}}{l}$$

$$s = \frac{Fl^3}{12E\,I} = \frac{Fl^3}{bt^3\,E}$$

$$s_{acc} = \frac{l^2 \sigma_{b\,acc}}{3t\,E}$$

$$c = \frac{bt^3\,E}{l^3} \text{ per spring}$$

$$W_{ges} = 2 \frac{btl}{18E} \sigma_b^2 ; \quad \eta_A = \frac{1}{9}$$

The most common configuration has springs that are mounted as a trapezium with an S-shaped deflection.

In which case, the spring thickness t is calculated as follows (n is the number of support points / springs over which the total spring constant is distributed, and for a single spring n = 1):

(4) $$t = \sqrt[3]{\frac{c \times l^3}{b \times E \times n}}$$

3. Checking the max. bending stress σ_b:

(5) $$\sigma_b = \frac{3 \times E \times t \times s}{l^2}$$

S-Ply® yellow (E = 28,000 N/mm2; $\sigma_{b(acc.)}$ = 138 N/mm²)

S-Ply® blue (E = 28,000 N/mm2; $\sigma_{b(acc.)}$ = 138 N/mm²)

S-Ply® carbon (E = 100,000 N/mm2; $\sigma_{b(acc.)}$= 315 N/mm²)

If the value reached for σ_b does not exceed the allowed value of $\sigma_{b(acc.)}$, the spring is suitable for a vibratory conveyor. However, if the value is exceeded, damage (delamination or breakage) due to overuse can occur.

The following design changes are possible:

a) Increase of free spring length l

b) Increase in the number of support points

c) Installation of more springs per support point.

4. Replacement of individual springs:

On reaching the maximum allowed bending stress [N/mm²] it is acceptable to replace single springs of thickness t_1 with spring assemblies comprising n individual springs of thickness t_2:

(6) $$t_2 = \sqrt[3]{\frac{t_1^3}{n}}$$

5. Replacement of springs:

(e.g. for steel or GRP alternative products)

The following conversion applies where
n = number of steel springs:

$$t_{S\text{-}Ply} = t_{Steel} \times \sqrt[3]{\frac{n_{Steel} \times E_{Steel}}{E_{S\text{-}Ply}}}$$

For a “one to one” conversion, n=1.
With steel leaf springs in particular, several springs (spring assemblies) can usually be replaced by one S-Ply leaf spring, but to confirm this the bending stress must be checked, as described in Section 3 above.

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