PRECISION POINT

Construction Fundamentals

FLEXURE ENGINEERING FUNDAMENTAL: LEAF SPRING

S-shape stiffness

$$C_x = \frac{Ebt^3}{L^3}$$

$$C_y = \frac{Etb^3}{L^3} \text{ if } R_x \text{ is fixed, } C_y = \frac{Etb^3}{4L^3} \text{ if } R_x \text{ is free}$$

$$C_z = \frac{EA}{L} \text{ only if } u_x = 0$$

$$C_z = \frac{700EAI_y}{L(700I_y + u_x^2A)} \text{ for } u_x \neq 0$$

 $K_x = \frac{Etb^3}{12L} \text{ for } u_x = 0$ $K_y = \frac{Ebt^3}{12L} \text{ for } u_x = 0$ $K_z = \frac{Gbt^3}{3L} = \frac{Ebt^3}{6(1+\nu)L} \text{ for } u_x = 0$

S-shape motion characteristics

$$u_x = \frac{F_x}{C_x} \qquad u_{xmax} = \frac{1}{3} \frac{L^2}{Et} \sigma_{max}$$
$$u_z = \frac{3}{5} \frac{u_x^2}{L}$$

S-shape force limits

$$\sigma_{max} = \frac{M_{max}}{I} \frac{1}{2}t = \frac{\frac{F_{xL}}{2}}{I} \frac{1}{2}t = \frac{F_{xLt}}{4I}$$

 $\begin{array}{ll} \textit{dynamic movements:} & \sigma_{max} < \textit{fatigue stress limit} \\ \textit{static deformation:} & \sigma_{max} < \textit{yield stress limit} (\sigma_{0.2}) \end{array}$

See *Beam Theory: Buckling* for equations to calculate the maximum buckling load.

C-shape stiffness

$$C_x = \frac{Ebt^3}{4L^3}$$

$$C_y = \frac{Etb^3}{4L^3}$$

$$C_z = \frac{EA}{L} \text{ only if } u_x = 0$$

$$K_x = \frac{Etb^3}{12L} \text{ for } u_x = 0$$

$$K_x = \frac{Ebt^3}{12L} \text{ for } u_x = 0$$

$$K_y = \frac{Ebt^3}{12L} \text{ for } u_x = 0$$

$$K_z = \frac{Gbt^3}{3L} = \frac{Ebt^3}{6(1+\nu)L} \text{ for } u_x = 0$$

C-shape motion characteristics

$$u_x = \frac{F_x}{C_x} \qquad u_{xmax} = \frac{2}{3} \frac{L^2}{Et} \sigma_{max}$$
$$u_z = \frac{3}{5} \frac{u_x^2}{L}$$

C-shape force limits

$$\sigma_{max} = \frac{M_{max}}{I} \frac{1}{2}t = \frac{F_{x}L}{I} \frac{1}{2}t = \frac{F_{x}Lt}{2I}$$

 $\begin{array}{ll} \mbox{dynamic movements: } \sigma_{max} < \mbox{fatigue stress limit} \\ \mbox{static deformation: } & \sigma_{max} < \mbox{yield stress limit} (\sigma_{0.2}) \end{array}$

See *Beam Theory: Buckling* for equations to calculate the maximum buckling load.



Leaf spring in s-shape deformation



Leaf spring in c-shape deformation

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On the design of plate-spring mechanisms – J. van Eijk

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