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Theory:

The continuous systems are more complex systems for doing their analysis. So for developing analysis of this complex system, we will treat it as SDOF system which usually calls as generalized SDOF systems.

Equation of motion for a generalized SDOF system is,

$$\tilde{m}\ddot{z} + \tilde{c}\dot{z} + \tilde{k}z = \tilde{p}(t)$$

where

generalized mass, $\tilde{m} = \int_0^l m(x)[\Psi(x)]^2\, dx$

generalized damping, $\tilde{c} = \int_0^l c(x)[\Psi(x)]^2\, dx$

generalized stiffness $\tilde{k} = \int_0^l EI[\Psi(x)]^2\, dx$

generalized force $\tilde{p} = \int_0^l p(x)[\Psi(x)]^2\, dx$

and $\Psi(x)$ = shape function

Natural frequency of the system $(\widetilde{\omega_n})$ is

$$\widetilde{\omega_n}^2 = \frac{\tilde{k}}{\tilde{m}} = \frac{\int_0^l EI(x)[\Psi(x)]^2\, dx}{\int_0^l m(x)[\Psi(x)]^2\, dx}$$

Finally the deflection of the system at any level of height can be related by using,

Where z(t) = generalized displacement, $\Psi(x)$ = shape function

$$u(x,t) = \Psi(x)z(t)$$