



**NATURAL
FREQUENCIES
FOR
COMMON
SYSTEMS**



BEAMS WITH UNIFORM SECTIONS AND UNIFORM LOAD

The natural frequency is defined as $\omega_n = A \sqrt{\frac{EI}{\mu L^4}}$ where

- E - Young's modulus
- I - area moment of inertia
- L - length of beam
- μ - mass per unit length of beam

A is given below for common configurations

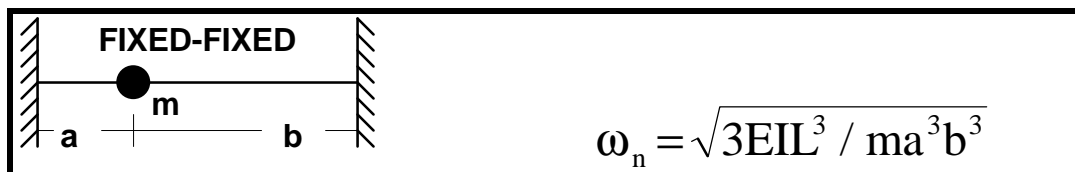
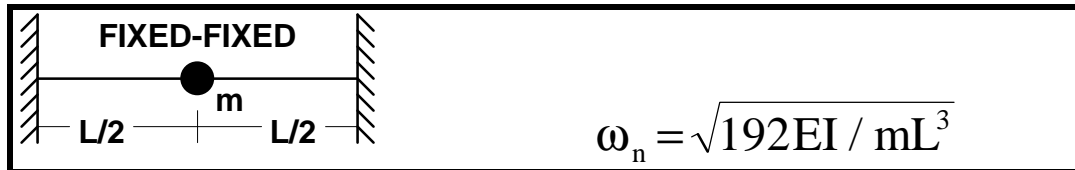
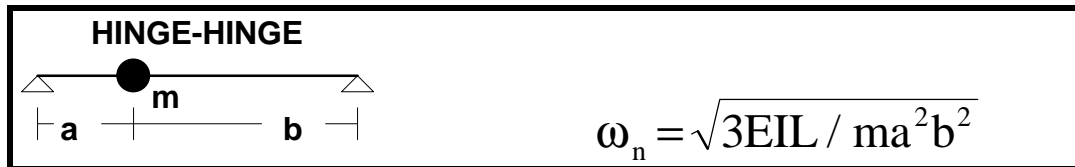
	MODE 1	MODE 2	MODE 3
Fixed-Free (Cantilever)	3.52	22.0	61.7
Hinged-Hinged (Simple)	9.87	39.5	88.9
Fixed-Fixed (Builtin)	22.4	61.7	121.0
Free-Free	22.4	61.7	121.0
Fixed-Hinged	15.4	50.0	104.0
Hinged-Free	15.4	50.0	104.0

Source: Third Edition Shock and Vibration Handbook



MASSLESS BEAMS WITH CONCENTRATED MASS

The natural frequency for the following configurations is



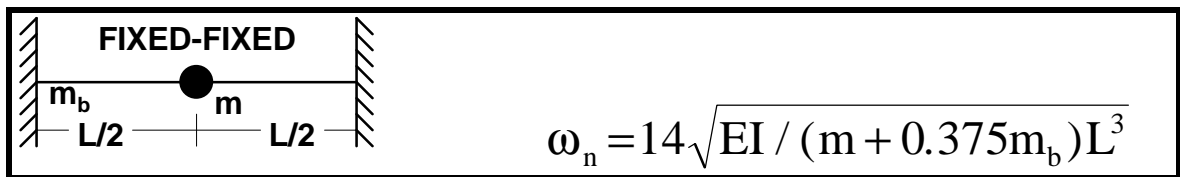
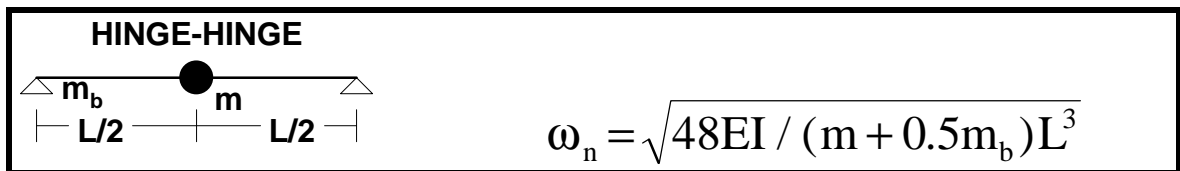
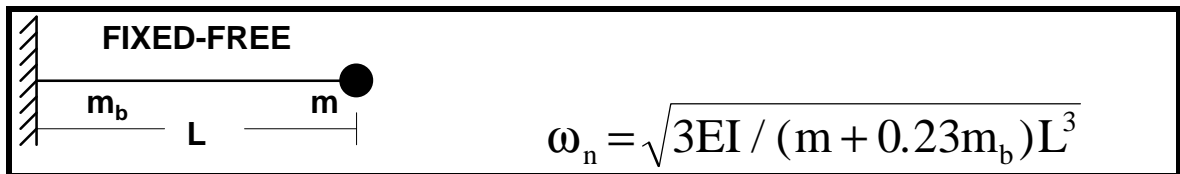
E - Young's modulus
L - length of beam

I - area moment of inertia
m - mass of load

Source: Third Edition Shock and Vibration Handbook



BEAM MASS WITH CONCENTRATED MASS



E - Young's modulus
L - length of beam

I - area moment of inertia
m - mass of load
 m_b - mass of beam

Source: Third Edition Shock and Vibration Handbook



CIRCULAR PLATES

The natural frequency is defined as

$$\omega_n = B \sqrt{Et^3 / \rho a^4 (1 - \nu^2)}$$

where

- E - Young's modulus
- I - area moment of inertia
- a - diameter of plate
- ν - Poisson's ratio
- ρ - mass density

B is given below for common configurations

	MODE 1	MODE 2	MODE 3
Clamped at edge	11.84	24.61	40.41
Free at edge	6.09	10.53	14.19
Clamped at center	4.35	24.26	70.39
Hinged at edge	5.90		

Source: Third Edition Shock and Vibration Handbook



SQUARE PLATES

The natural frequency is defined as

$$\omega_n = B \sqrt{Et^3 / \rho a^4 (1 - \nu^2)}$$

where

- E - Young's modulus
- I - area moment of inertia
- a - length of plate side
- ν - Poisson's ratio
- ρ - mass density

B is given below for common configurations

	MODE 1	MODE 2	MODE 3
1 edge clamped - 3 edges free	1.01	2.47	6.20
4 edges clamped	10.40	21.21	31.29
2 edges clamped - 2 edges free	2.01	6.96	7.74
4 edges free	4.07	5.94	6.91
1 edge clamped - 3 edges hinged	6.83	14.94	16.95
2 edge clamped - 2 edges hinged	8.37	15.82	20.03
4 edges hinged	5.70	14.26	22.82

Source: Third Edition Shock and Vibration Handbook