EXPERIMENT 5
MODES OF VIBRATION OF SIMPLY SUPPORTED BEAM UNDER FLEXURE

INTRODUCTION

This simulation based experiment aims to study the modes of vibration of a simply supported beam under flexure. The simply supported beam, a continuous system, is different from a discrete system. Unlike a discrete system that possess a finite number of degree of freedom (DOF), a distributed system, which is considered to be composed of infinite number of infinitesimal mass particles, theoretically possesses an infinite number of DOF. However, only the first few modes are significant. It is therefore not necessary to study all of them.

By using this online simulation, the user can easily determine the natural frequencies of beams and simulate the first five mode shapes. In addition, there is an exercise for user: The user can study and plot a graph between natural frequency and length of beams keeping all others factors constant. Similarly, relation between natural frequency and the Young's Modulus of Elasticity can be studied.

THEORY

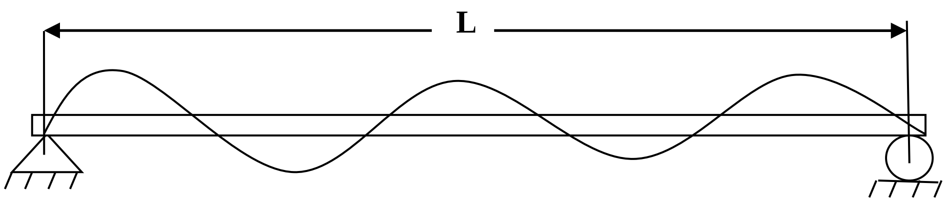

Figure 1 *n*th mode of vibration of a simply supported beam

General solution for displacement for a beam (see Fig. 1) is given by (Chopra, 2001)

$$y(X) = c_1 \sinh \beta x \ + c_2 \cosh \beta x + c_3 \sin \beta x + c_4 \cos \beta x \quad (1)$$

The final solution for frequencies is

$$f_n = \frac{\pi n^2}{2L^2}\sqrt{\frac{EI}{\rho A}} \quad (2)$$

For the n^{th} mode shape, the solution is

$$y(x) = \sin\frac{n\pi x}{L} \tag{3}$$

where *L* is the length of the beam, *EI* the flexural rigidity (*E* = Young's modulus, *I* = Moment of inertia), *A* the cross- sectional area and f_n the n^{th} natural frequency.

REFERENCES

1. Chopra, A. (2001), Dynamics of Structures, Prentice Hall of India limited, New Delhi.

2. Paz, M. (2004), Structural Dynamics: Theory and Computations, 2nd ed., CBS Publishers and Distributors, New Delhi.