DEPARTMENT OF CIVIL ENGINEERING

IIT DELHI

VIRTUAL SMART STRUCTURES AND DYNAMICS LAB

EXPERIMENT 2 (SIMULATION)

Modes of Vibration of Simply Supported Plate

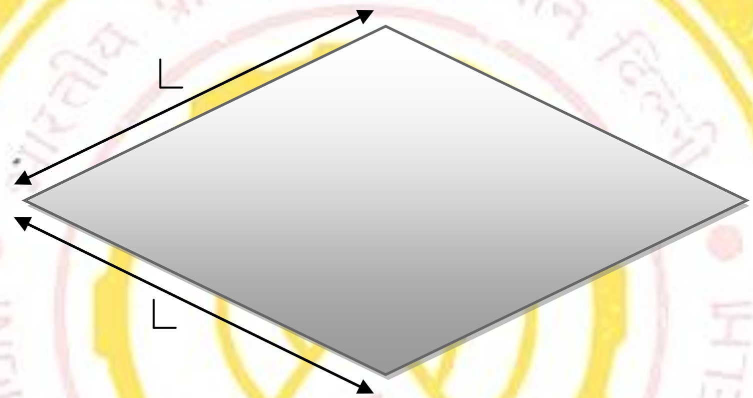

Figure 1: Square plate simply supported on all four edges

INTRODUCTION

This simulation experiment aim to study the modes of vibrations of a square plate simply supported on all edges. The simply supported plate is different from a discrete system. Where the stiffness, the mass and the damping are modelled as discrete properties. The mathematical models for discrete system are ordinary differential equations, which thereby render themselves quite conducive to numerical solution techniques. The alternative continuous method of modelling physical system, which is considered here, is based on the principle of distributed mass and stiffness characteristics. Such a system for which stiffness and mass are considered to be distributed properties (rather than discrete) is referred as a distributed or continuous system.

The distributed systems are considered to be composed of infinite number of infinitesimal mass particles. Theoretically, they possess an infinite number of degrees of freedom (DOF). Only the first few modes are much significant. It is thus not necessary to study all of them.

This computational model of a square plate simply supported on all edges is based on distributed system. By using this online simulation, the student/user can easily determine the natural frequencies of plate as well as the corresponding mode shapes. In addition, there is an exercise for user. The user can study and plot a graph between natural frequency and length of plate keeping all others factors constant. Similarly, relation between natural frequency and the Young’s modulus of elasticity can be studied.

THEORY

For simply supported plate, the frequencies f_n and the mode shapes $\phi(x,y)$ are given by (Mukhopadhyay, 2006)

$$f_n = \frac{\pi(m^2+n^2)}{2L^2}\sqrt{\frac{D}{\rho t}} \tag{1}$$

$$\phi(x,y) = \sin\left(\frac{n\pi x}{L}\right)\sin\left(\frac{m\pi y}{L}\right) \tag{2}$$

Where, the parameter D is given by

$$D = \frac{Et^3}{12(1-\nu)} \tag{3}$$

n and m are the number of troughs/crests in x and y directions respectively. Further, L is the length of plate, E is the Young's modulus of elasticity, ρ is the density, t is the thickness of the plate and υ is the Poisson's ratio.

User can get different modes of vibration of simply supported plate from this program, just in single click.

REFERENCES

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

2. Mukhopadhyay, M. (2006), Structural Dynamics Vibrations and Systems, Ane Books India, New Delhi.

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