THE FUNDAMENTAL BENDING FREQUENCY OF A SQUARE PLATE WITH FIXED CORNERS AND OTHERWISE FREE EDGES

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The fundamental bending frequency fn of a square plate fixed at each corner is

$$fn = \frac{1.13}{a^2}\sqrt{\frac{D}{\rho h}} \tag{1}$$

The edges in between the corners are free.

The independent variables are

a	is the length of each edge
h	is the plate thickness
ρ	is the mass per volume
D	is the plate stiffness factor

The plate stiffness factor D is given by

$$D = \frac{Eh^3}{12\left(1-\mu^2\right)} \tag{2}$$

where

E	is the elastic modulus
μ	is Poisson's ratio

Equations (1) and (2) are taken from Reference 1.

Example

Consider a square plate fixed at each corner. The edges are free between each corner.

The plate has the following properties.

a = 8.8 m

h = 0.180 m

ρ = 2430 kg/m^3

E = 11e+09 N/m^2

μ = 0.15

The plate stiffness factor is

$$D = \frac{(11e+09\ \text{N/m}^2)(0.180\ \text{m})^3}{12\left(1-0.15^2\right)} = 5.469E+06\ \ \text{N m} \tag{3}$$

The bending frequency is

$$f_n = \frac{1.13}{(8.8\ \text{m})^2}\sqrt{\frac{5.469E+06\ \ \text{N m}}{(2430\ \text{kg/m}^3)(0.180\ \text{m})}} = 1.63\ \text{Hz} \tag{4}$$

Reference

1. D. Steinberg, Vibration Analysis for Electronic Equipment, 2nd Edition, Wiley-Interscience, New York, 1988.