Description :

Modal analysis of a rectangular strip with axial stress (N_2) on short edge.

Reference :

Arthur W.Leissa ,Vibration of Plates,NASA SP-160, pg:277, Ch:10.2.

Material and Geometric data :

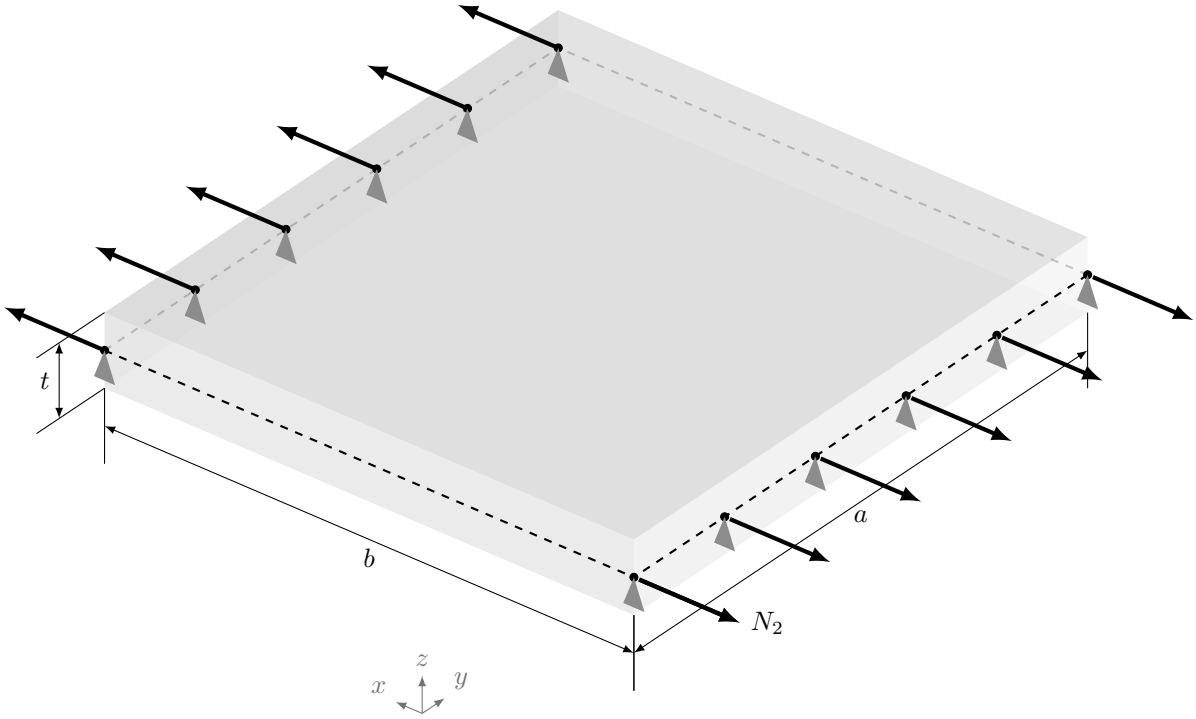


Figure 1: NAS277

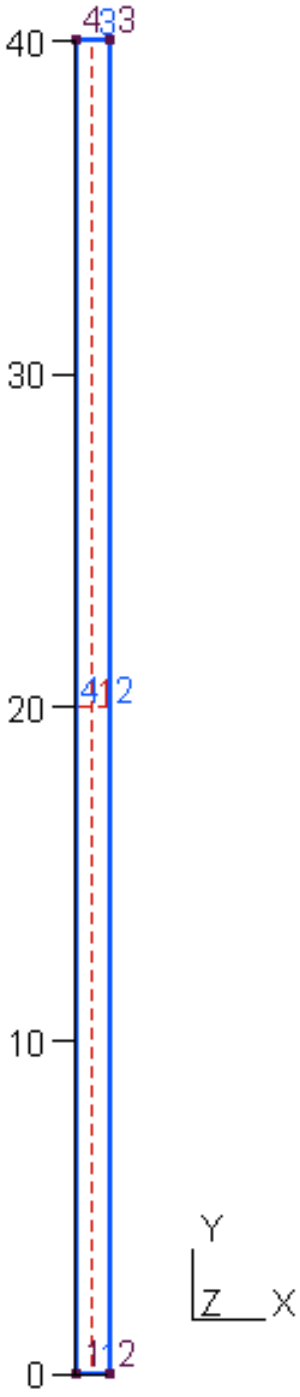
Table 1: Input Data

Material Property		Geometric Data		Loading Data	
Young's Modulus (E)	1E11 pa	Length (a)	1 m	N_2	3E11 N/m^2
Poission's Ratio (ν)	0.3	Breath (b)	40 m		
Density (ρ)	7810 Kg/m^3	Thickness(t)	1 m		

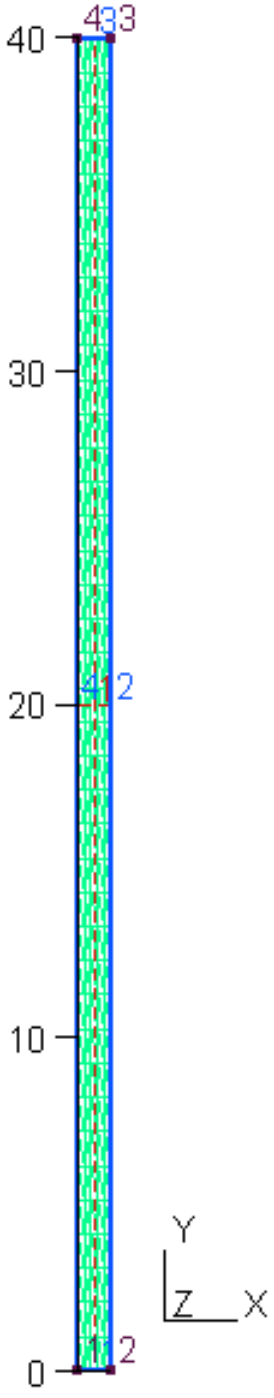
Mesh and boundary condition :

Table 2: FEM and Boundary condition data

Direchlet Boundary				Loading Conditions	
Geo -Entity	w	θ_x	θ_y	Geo -Entity	N_2
line {1,3}	Fixed	Free	Free	line {1,3}	3E11 N/m^2



(a) Geomentry of the problem



(b) Discritization

Analytically solution :

The analytical solution of the this problem is given by

$$\omega_{mn} = \sqrt{\frac{1}{\rho}\left(D\left[\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2\right] + N_1\left(\frac{m\pi}{a}\right)^2 + N_2\left(\frac{n\pi}{b}\right)^2\right)} \tag{1}$$

Natural frequencies are
mode 1 : 77.479 Hz
mode 2 : N.A
mode 3 : 155.00 Hz

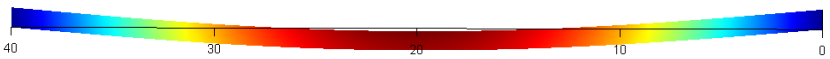
mode 4 : N.A
mode 5 : 232.61 Hz
mode 6 : N.A

note : modes 2,4 and 6 are twisting modes, which are not given by the formula.

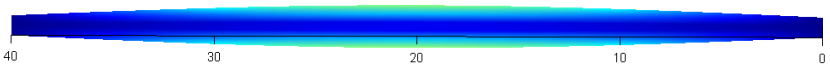
Result and error analysis :

The natural frequencies of the plates are provided below.
mode 1 : 77.458 Hz
mode 2 : 95.610 Hz
mode 3 : 154.98 Hz
mode 4 : 191.46 Hz
mode 5 : 232.63 Hz
mode 6 : 287.38 Hz

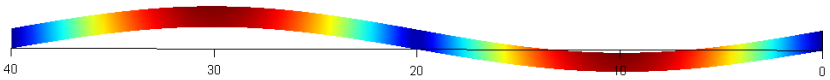
So the Error percentage for each mode is :
mode 1 : 0.026 %
mode 3 : 0.012 %
mode 5 : 0.013 %



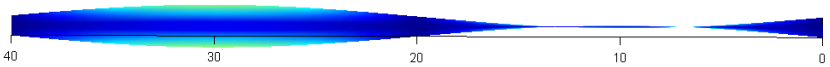
(a) Mode Shape 1



(b) Mode Shape 2

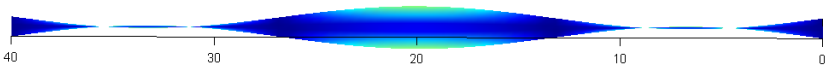


(c) Mode Shape 3



(d) Mode Shape 4

(e) Mode Shape 5



(f) Mode Shape 6

Figure 3: Natural Modes of a rectangular strip