Modal and Frequency Response Function Analysis of a thin plate

Natural frequency

- It is the frequency at which body vibrates.
- A system can have infinite number of natural frequency.
- The natural frequency of a system depends only on the stiffness and mass of the system and the boundary conditions.

Modal Analysis

- Modal analysis is an approach to find out the natural frequency of a system.
- For each natural frequency we find out the mode shape.
- Each mode shape represent the shape of deformation in body at different natural frequencies.

Frequency response function (FRF) Analysis

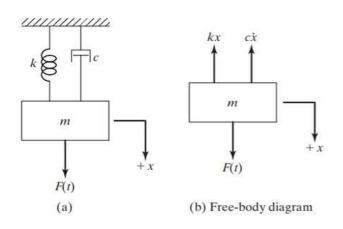
- Frequency response function (FRF) is a function used to quantity the response of a system to an excitation.
- Resonance is a condition when excitation frequency matches the natural frequency of the system.
- In FRF analysis we find out the response of a system over a range of given frequency.
- To get range of frequency, First perform modal analysis.

How to avoid Resonance

- 1. Changing the excitation frequency/loading
- 2. Changing the natural frequency of the system.

Excitation can be in form of Displacement, velocity and acceleration or force

Spring ,mass and Damper System

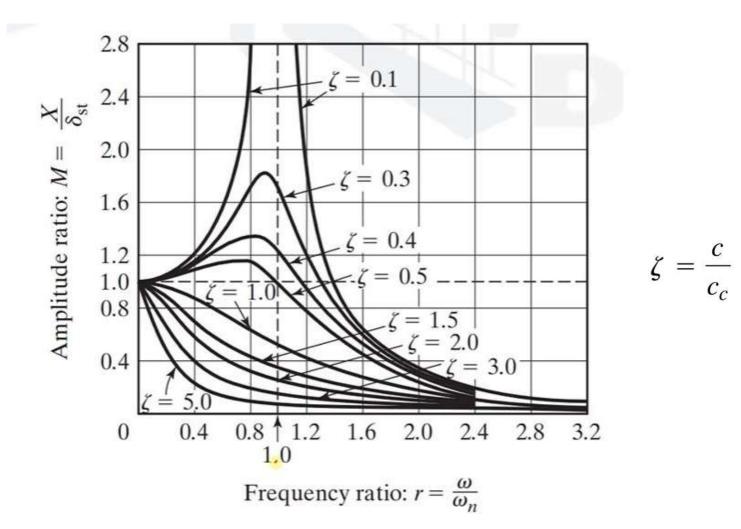


$$m\ddot{x} + c\dot{x} + kx = F(t)$$

$$\omega_n = \sqrt{\frac{k}{m}}$$

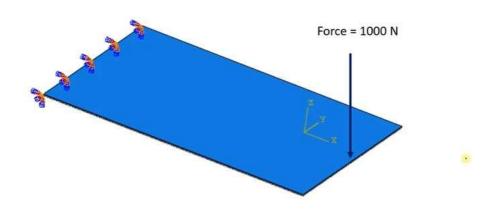
$$F(t) = F_0 \cos \omega t$$

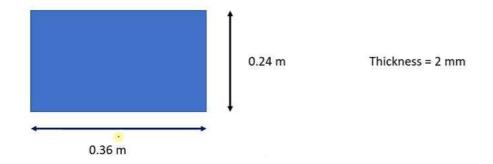
 ω_n = Natural frequency of System ω = Excitation Frequency



Variation of Amplitude ratio with respect to the Frequency ratio

 First we will perform the modal analysis, for Modal Analysis need not to apply the Loading. Once we have the natural frequency of the system we will perform FRF analysis of the system.

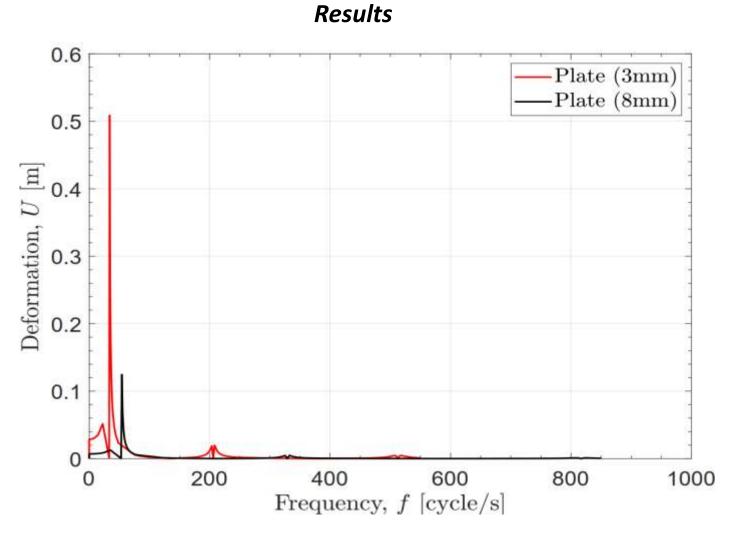




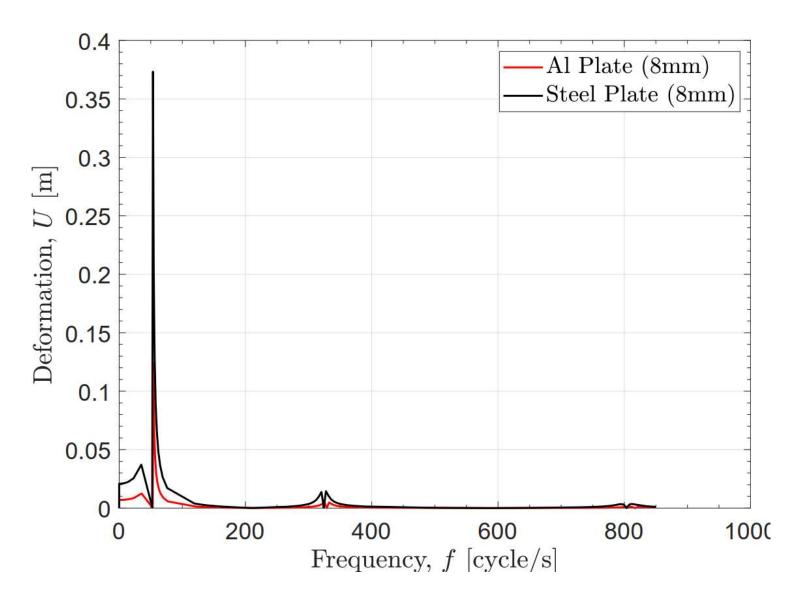
Material	Steel
Density	7850 kg/m3
Young's modulus	210 GPa
Poisson ration	0.3

Table 1. Consistent units.

Quantity	SI	SI (mm)	US Unit (ft)	US Unit (inch)
Length	m	mm	ft	in
Force	N	N	lbf	lbf
Mass	kg	tonne (10 ³ kg)	slug	lbf s ² /in
Time	s	s	s	s
Stress	Pa (N/m ²)	MPa (N/mm ²)	lbf/ft ²	psi (lbf/in ²)
Energy	J	mJ (10 ⁻³ J)	ft lbf	in lbf
Density	kg/m ³	tonne/mm ³	slug/ft ³	lbf s ² /in ⁴

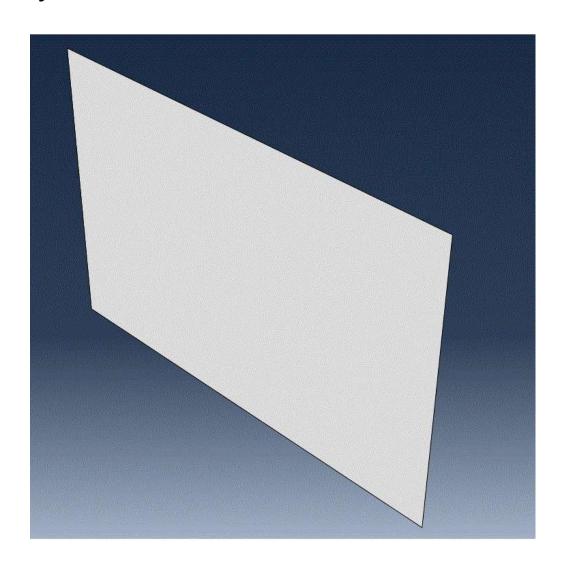


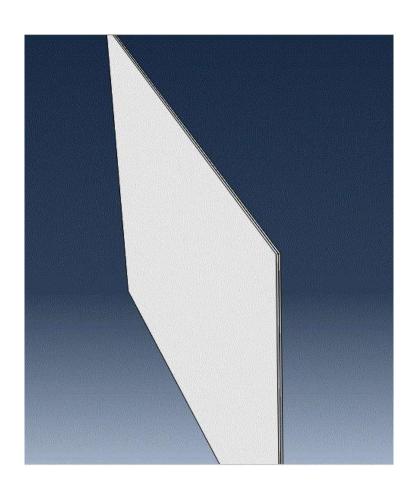
Results for Steel Plates with different thickness

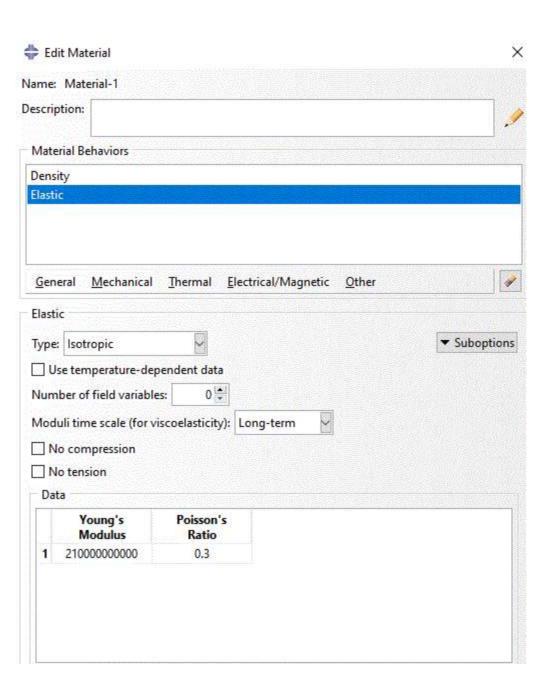


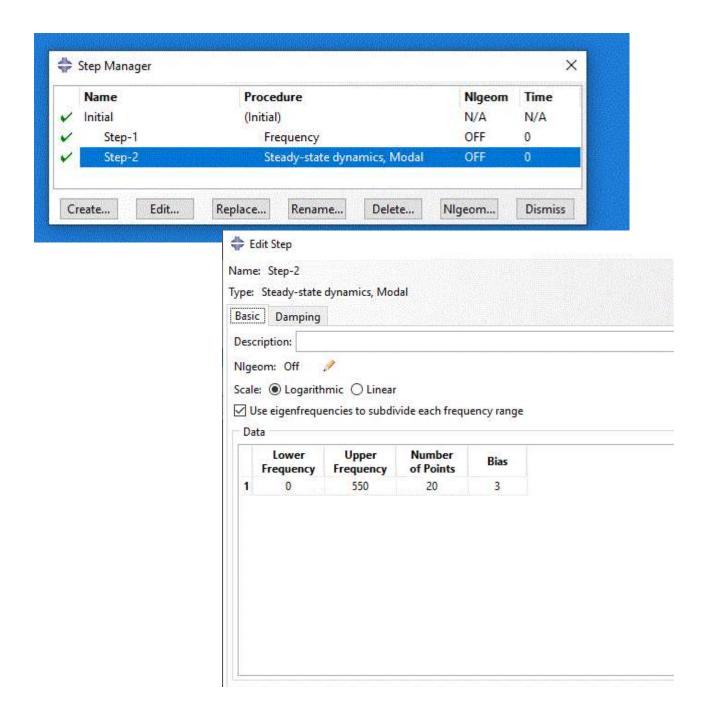
Results for Steel and Aluminium Plate with same thickness

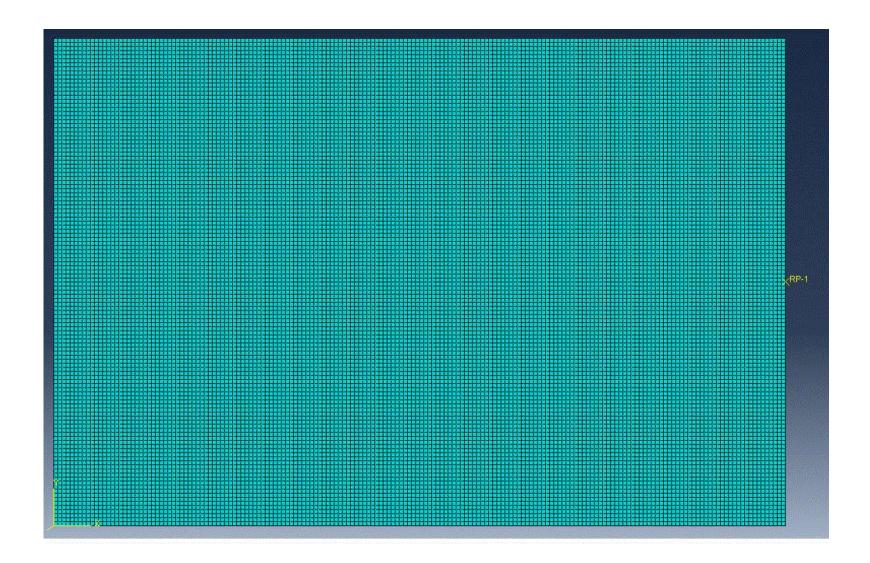
Extra Slides: Steps Taken to perform FRF Analysis
Of Plate











Total number of nodes: 21901 Total number of elements: 21600

21600 linear quadrilateral elements of type S4R

