VIBRATION ANALYSIS OF SANDWICH BEAM WITH FREE RADICAL POLYMERIZATION OF CHLOROPRENE AND FRP BASED CONSTRAINING LAYER

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ABSTRACT

In this paper, work on vibration analysis of a viscoelastic sandwich beam has been studied. Different specimens have been prepare by varying the core layers and face layers and studied under the simply supported and cantilever boundary conditions for modal analysis. The Natural frequencies are obtained for various specimen using different boundary conditions. The results obtained are compared with the theoretical approach and finite element based model results.

The viscoelastic material will be provided between the top and bottom layers to form the sandwich beam model. The material like Fiber reinforcement plastic, Neoprene, Natural rubber, steel, aluminum are taken for preparing the different specimen.

The experiment is conducted with help of 2 channels FFT analyzer on various specimens with different boundary condition like cantilever beam and simply supported beam condition

Keyword : - *Viscoelastic,vibration,damping Frequency,FRP,Rubber,Neoprene,SSB,cantilever Beam Condition*

1. Introduction

Vibration is very important issue in many structural cases. If vibration in system goes beyond the specific limit then there are chances of accident or system failure. So to damped the vibration, material should be selected for system or structure such that it, itself damped the vibration. Damping has a very high importance in structures and systems subjected to dynamic loading. Passive damping treatment is one of the methods to control the noise and vibration in structures. The airborne and structure borne noise and vibration occur more frequently in systems. The traditional passive control methods that include use of absorbers, barriers, mufflers, silencers, etc. are for airborne noise. The unwanted vibrations decreased with constant excitation frequency, modification of system's stiffness or mass as vibrations as these parameters amend the resonant frequencies. But in most cases, the isolation or dissipation of vibrations is done by using isolators or damping materials. Viscoelastic materials (damping material) exhibits both viscous fluid and elastic solid material characteristics.

Constrained layer and unconstrained layer or free layer treatment are the two types of treatment of viscoelastic material. In a sandwich structure generally the bending loads are carried by the force couple formed by the face sheets and the shear loads are carried by the lightweight core material

1.1 PRESENT CONSIDERATION

To study the constrained layer damping treatment vibration behavior in sandwich beams. The trial will be bonded between the top and bottom layers to form the sandwich beam model.

Top layer: Fiber Reinforced Polymer FRP (Nonmetallic), Metal like Steel and Aluminum
Core layer: Viscoelastic Material (Rubber, Neoprene)
Bottom layer: Fiber Reinforced Polymer FRP, Metallic

1.2 SANDWICH BEAM MATERIAL AND PROPERTIES

Table 1.1: Specification of Beam

Plate dimension	
Materials For Beam	1) Aluminum 2) Mild Steel 3) Rubber 4) Neoprene 5) FRP
Length of Beam	500 mm
Thickness (t)	4.5 mm.
Width	50 mm

Table 1.2: Material properties of sandwich beam for face and core layers

Type of material	Young's Modulus E (GPa)	Shear Modulus G (GPa)	Density in Kg/m^3	Poisson's Ratio
Aluminium	70	27.3	2766	0.33
Steel	200	80	7850	0.3
FRP	2	0.5	1700	0.3
Rubber	0.00154	0.005	950	0.45
Neoprene	0.0008154	0.000273	960	0.49

1.3 Specimens

Specimen 1: Aluminium – Rubber- Aluminium
Specimen 2: Steel- Rubber- Steel
Specimen 3: Aluminium- Neoprene – Aluminium
Specimen 4: Steel-Neoprene-Steel

Specimen 5: FRP-Neoprene-FRP
Specimen 6: FRP-Rubber-FRP
Specimen 7: Aluminium – Aluminium - Aluminium
Specimen 8: Steel- Steel- Steel

2 EXPERIMENTAL APPROACHES

The experimental setup consists of a cantilever beam or Simply supported Beam structure, transducers (strain gauge, accelerometer, laser vibrometer), a data-acquisition system and a computer with signal display and processing software (Fig. 2.1). Different types of beam materials and its properties are listed in 1.2. Different combinations of beam geometries for each of the beam material are summarized in Table 1.1.

Accelerometer is a sensing element (transducer) to measure the vibration response (i.e., acceleration, velocity and displacement). Data acquisition system takes vibration signal from the accelerometer, and encodes it in digital form. Computer acts as a data storage and analysis system. It takes encoded data from the data acquisition system and after processing (e.g., FFT), it displays on the computer screen by using analysis software.

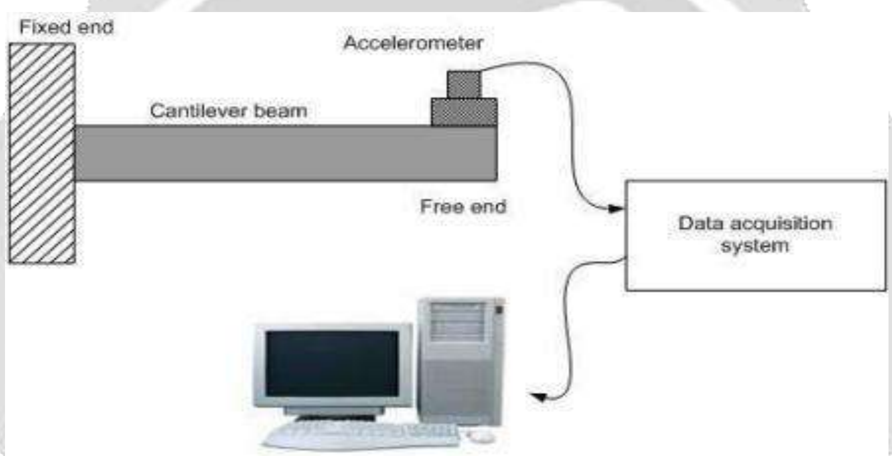
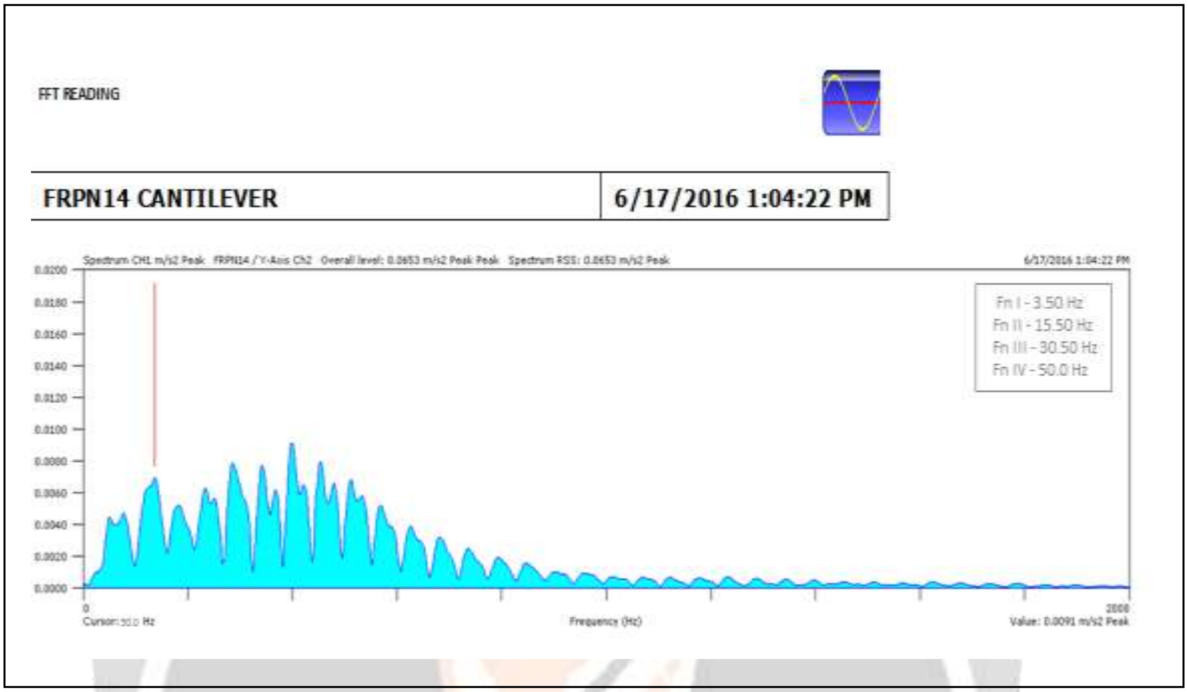


Fig. 2.1: An experimental setup for the free vibration of a cantilever beam

2.1 Experimental results

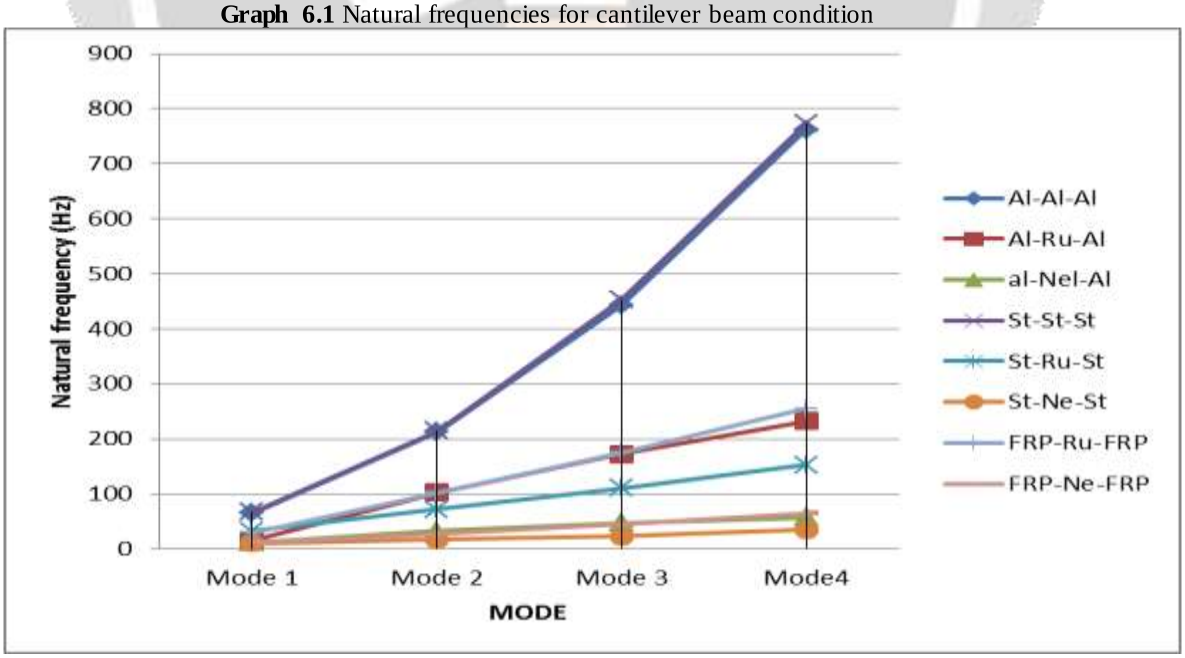
With the help of two channel FFT analyzer find out the free vibrational natural frequency for different mode. The various graphs of various specimens are obtained with the help of FFT analyzer, which shows behavior with free vibration.

Graph 2.1: FRP-NE-FRP specimen (Cantilever beam condition)

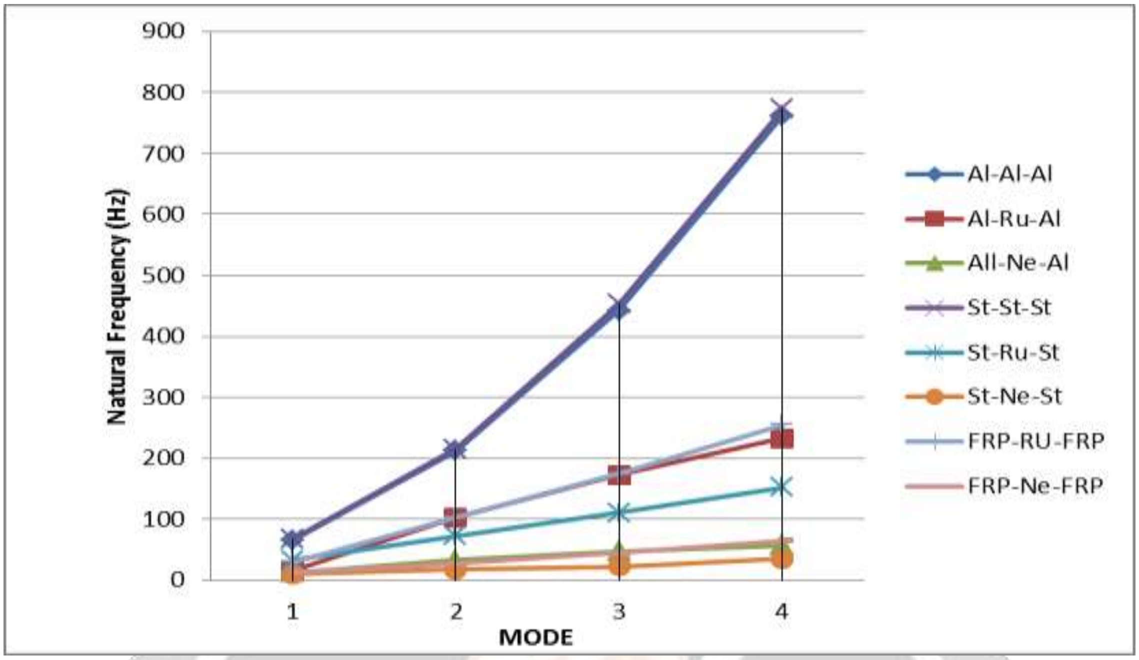


The following graphs show the natural frequencies for different specimen which is obtained experimentally. The graphs are plotted with Mode v/s natural frequencies in Hz.

Graph 6.1 Natural frequencies for cantilever beam condition

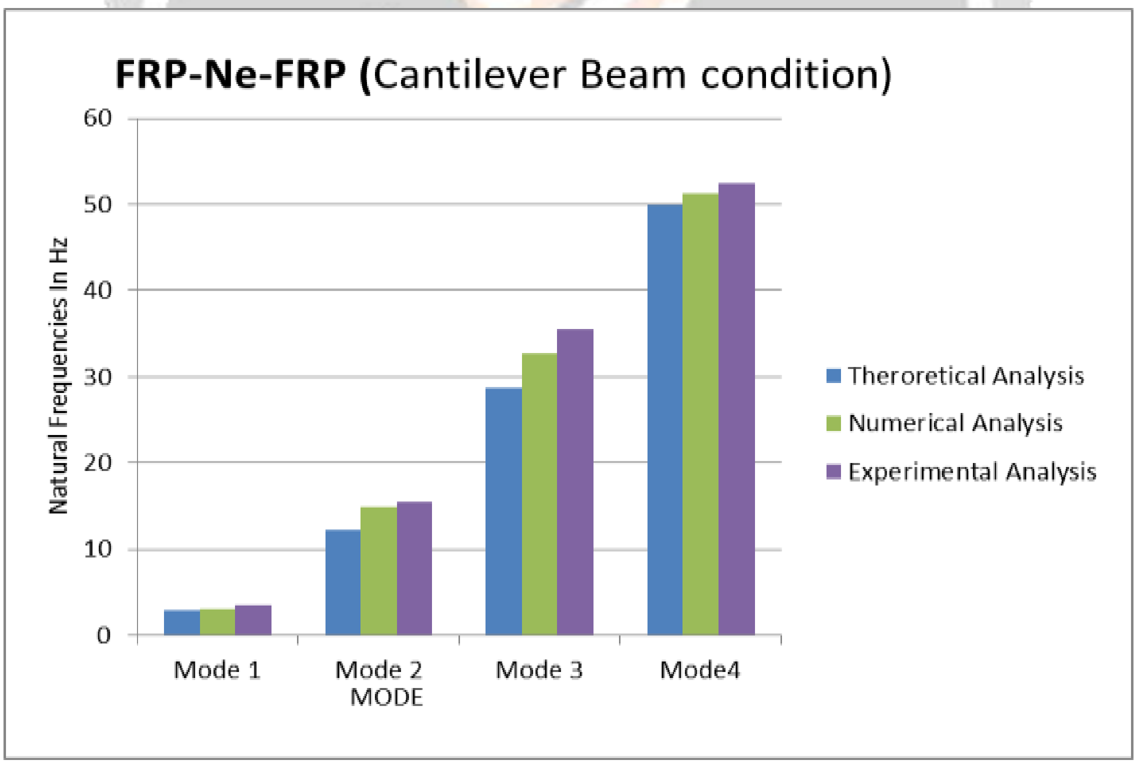


Graph 6.2 Natural frequencies for simply supported beam condition

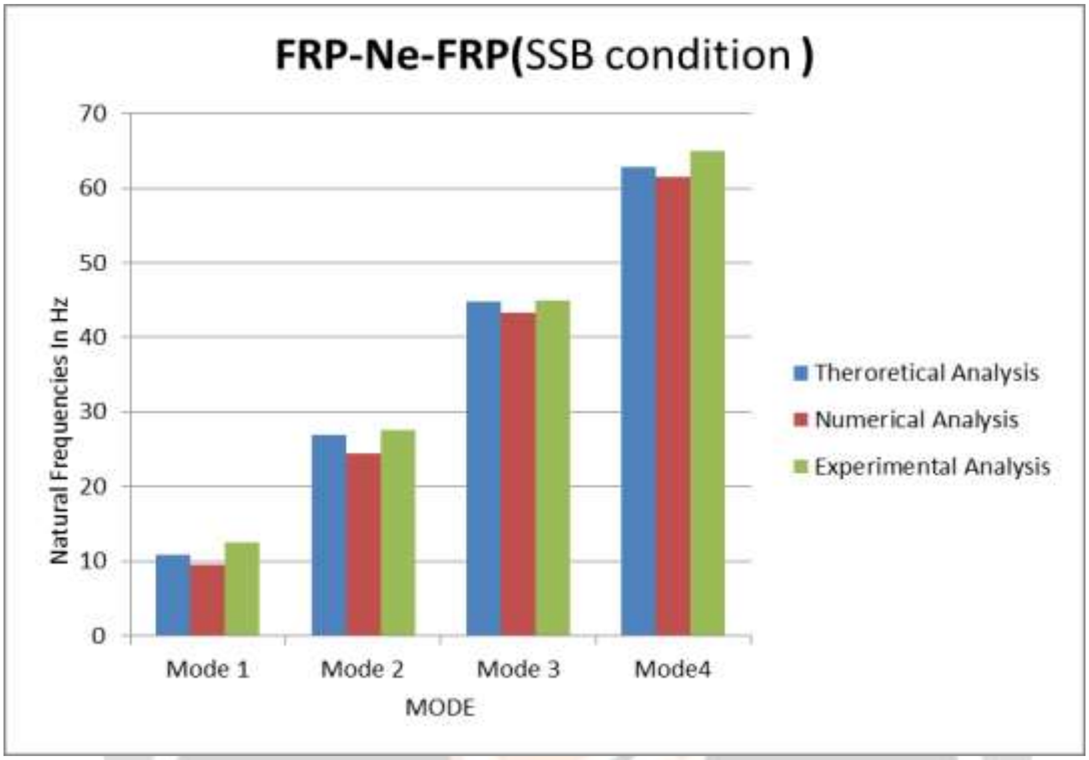


3. RESULTS ANALYSIS

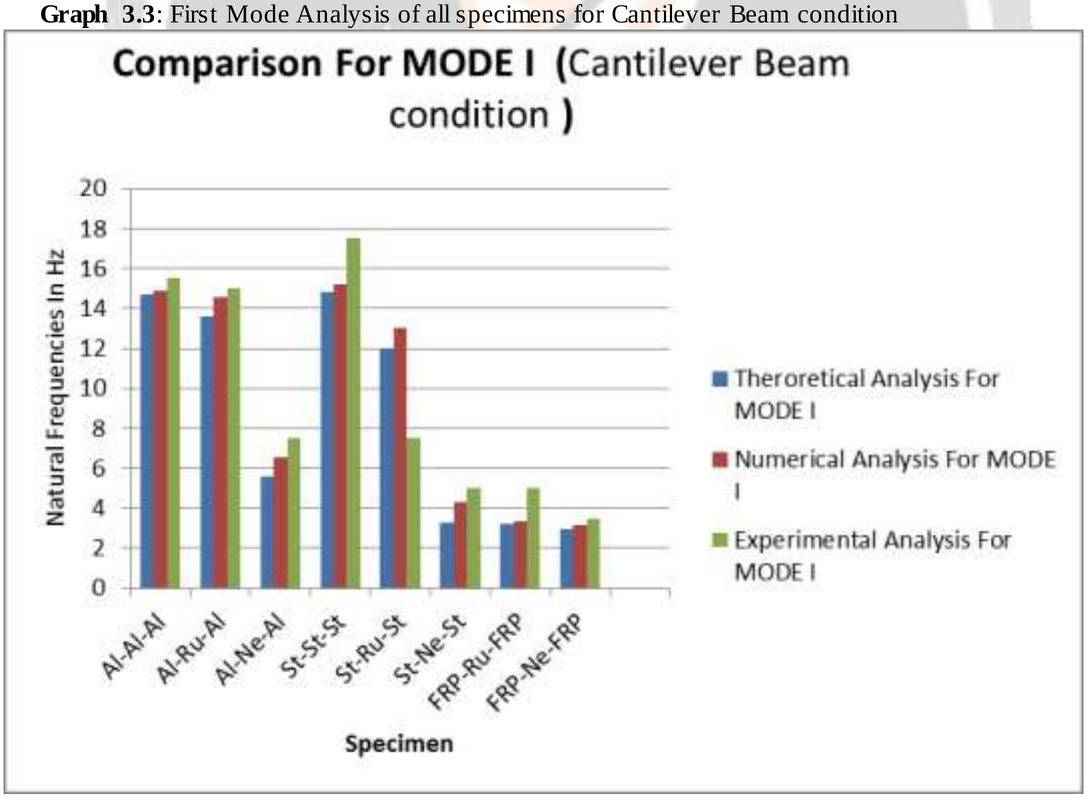
Graphs 3.1: Mode Analysis for FRP-Ne-FRP specimen for Cantilever Beam condition



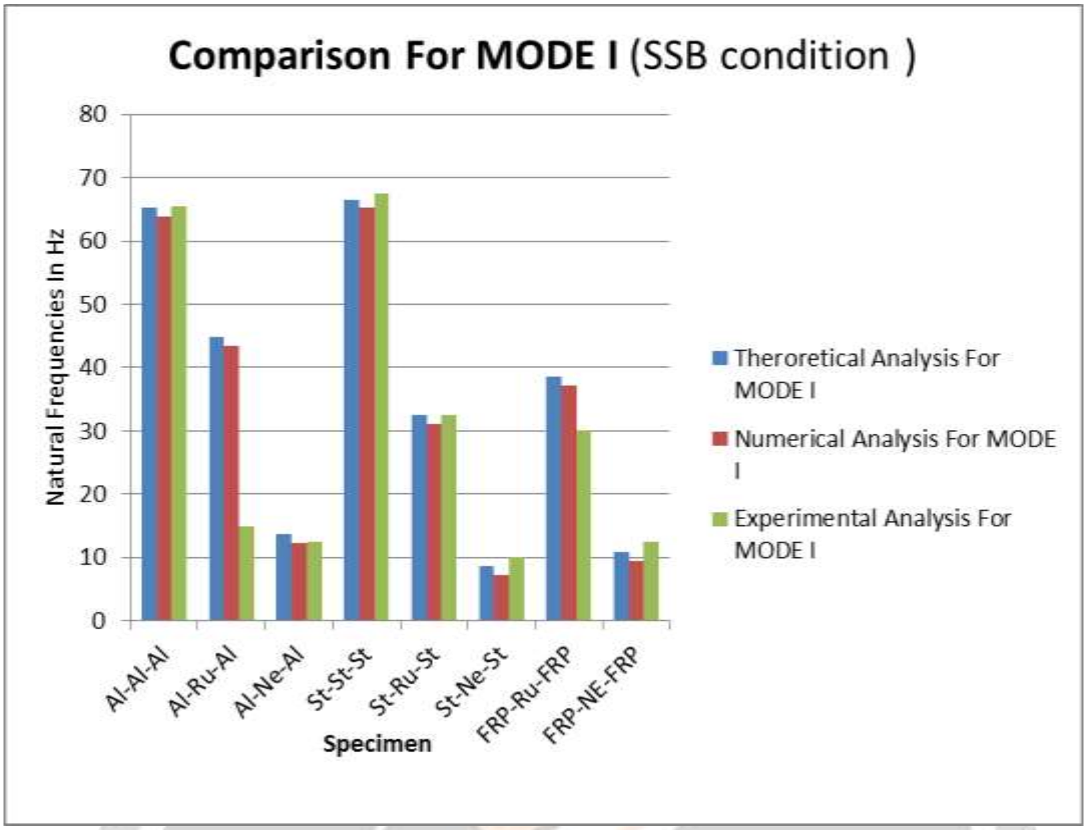
Graphs 3.2: Mode Analysis for FRP-Ne-FRP specimen for SSB condition



Graph 3.3: First Mode Analysis of all specimens for Cantilever Beam condition



Graph 3.4: First Mode Analysis of all specimens for SSB Beam condition



4. CONCLUSIONS

By comparing the all results, damping characteristics of neoprene viscoelastic material has best results in comparison with the rubber viscoelastic material. For controlling the vibration of structures like beams, plates the viscoelastic constrained layer damping treatment plays a vital role.

Also by considering fundamental mode (MODE I) result shows that FRP-Ne-FRP specimen having the best damping characteristics as compare to other specimen and St-Ne-St Specimen also shows good damping characteristics for other mode except mode I.

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