Chapter – 6 – CONCLUSIONS

This chapter is devoted to significant conclusions drawn from different aspects of composite panels investigated in this research work. Broadly these are as under:

- **Dynamic behavior** of composite panels has been an object of many studies. To investigate free vibrations of composite structures made of different fiber system both experimental and FEA approach have been exploited. It is a well established fact that the lowest vibration frequency of the beam belongs to the flexural bending mode, and this mode has been investigated thoroughly. It is also known that there exist other vibration modes that involve shear deformations.

- For the fabrication of composite laminates with different fiber system and with two different thicknesses 2mm & 4mm vacuum bagging – hand layup technique has been adopted. This manufacturing process has yielded specimens of good quality.

- A simple and low-cost vibration test fixture has been indigenously designed and fabricated to mount the specimens and to simulate different boundary conditions. This has greatly helped in successful experimentation and has helped in narrowing the gap between Experimentation and Finite Element Analysis.

- Physical and mechanical properties of composite laminates have been experimentally determined as per the relevant ASTM standards. These are required for a detailed analysis of stiffness, frequency and damping behavior of the composite panels. The properties calculated and the theoretical one are almost similar thereby validating the methodology adopted to prepare them.

- “Impulse” hammer technique has been adopted to extract the modal parameters such as natural frequency, damping and mode shapes for all the types of specimens tested. This technique can be suggested for smaller specimens.

- Three trials were tested for each of the specimens for consistent results and average results have been reported, which supports the quality of the research work.

- The Eigen frequency of the lowest flexural-bending mode significantly increases with the increase of the beam curvature when all edges of the
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specimen are clamped. When they are clamped on two edges, the frequency of the bending mode somewhat decreases with the increase of the beam curvature. Such a behavior completely complies with the known behavior of the homogeneous panels. At the same time, the Eigen frequencies of higher order modes increase slightly with more constraints which is in agreement with the theories available.

- The frequencies of the symmetric bending mode and the anti-symmetric mode of one order higher than the symmetric one may cross over for the beam with the clamped edges when the beam curvature increases.

- Finite Element Modal Analysis was also carried out for all the configurations and results tabulated and compared with experimental ones which found to be excellent agreement. SHELL 99 element chosen to model using FE tool yielded good results and comparable with experimental results.

- Increasing the Thickness of the specimen results in the increase in the natural frequency of the composite panel (which is directly proportional to the stiffness of the member).

- Change in the fiber material significantly changes the dynamics of the composite specimens, which were indicated in the results table.

- The boundary conditions also had a considerable effect on the natural frequency ofthe composite panel. This information can be effectively used to design composite panels accordingly.

- The use finite element package ANSYS to investigate the dynamic characteristics of laminated composite beams, is a successful tool which can be used by designers in industries.

- The use 4-channel FFT Analyzer to investigate the dynamic characteristics of laminated composite beams, is a successful experimental tool for such applications. Thereby the usage of FFT Analyzer in investigating the dynamic characteristics of laminated beams is validated. This again points to the importance of FFT Analyzer as a principal tool in vibrational analysis.

- This work addresses the dynamic behavior of five composite panels namely E-Glass/epoxy, S-Glass/epoxy, Carbon/epoxy, Graphite/epoxy, Kevlar/epoxy.

Finally, it is concluded that in this research work, a detailed dynamic analysis of composites specimens with different fiber system have been thoroughly studied and
results presented which may comprehend to designers’ of composites community in controlling of the vibration level.