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Analytical Study of Vibration on Composite Laminated Structures Using Matlab

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Abstract:
This paper investigates the Eigen values and Eigen vector of lamina and laminate of composite plates. Lamina plays a significant role in composite laminated structures; as a result, it's important to select an exact orientation lamina to avoid maximum amplitude. The structural stiffness and mass matrices were obtained from classical laminated plate theory and non conformal rectangular element theory. The Eigen values and Eigen vectors are derived based on vibration theory. The simply supported square plate element is designed analytically using above theories and computed in MATLAB, the variation of frequency and modes between lamina and laminate were studied for different orientation. Then the element assembled to global element level to study the changes in their vibration and compared. Finally, it also represents the first derivative frequency change with respect to fibre volume fraction and compared.

Keywords: *Vibration, Composite structures, finite element method, laminated plates.*

1. Introduction

Composite laminated structures acquire greater extent in aerospace, naval, automobile, and defense industries for the reason that it has interesting performance characteristics for instance high stiffness to weight ratio, high strength to weight ratio, greater fatigue properties and high corrosion resistance [1]. These composite laminated structures are frequently functioning in the vibration environments. Qimao Liu [2] investigated the sensitivity of the frequency and modes with respect to fibre volume fraction and orientations in a composite laminated structures using proposed analytical method. D.Ngo-cong [3] developed the effective radial basis function (RBF) collocation technique for free vibration analysis of laminated composite plates using first order shear deformation theory (FSDT). T. Kant [4] presented the analytical formulation and solutions to the natural frequency analysis of simply supported composite and sandwich plates. The linear statics and free vibration sensitivity problems of the composite sandwich plates were studied by D.H. Li [5]. Many works on vibration investigates the Eigen values and Eigen vectors in the laminate level with different boundary conditions. However, the literatures on vibration analysis for laminae level are very limited. This paper mainly studied how the sensitivity of natural frequencies and modes of the laminae changes when it's assembled to laminate composite structures. But also compared the first derivative frequency with respect to fibre volume fraction of laminae and laminated plates.

2. Methodology

The MATLAB coding performed in this paper used below theories as per the reference [1].In the local coordinate system each node has five degrees of freedom and totally 20 degrees of freedom. The global element was assembled to four elements and it has nine nodes with 45 degrees of freedom. The procedure followed for lamina as well as laminate.

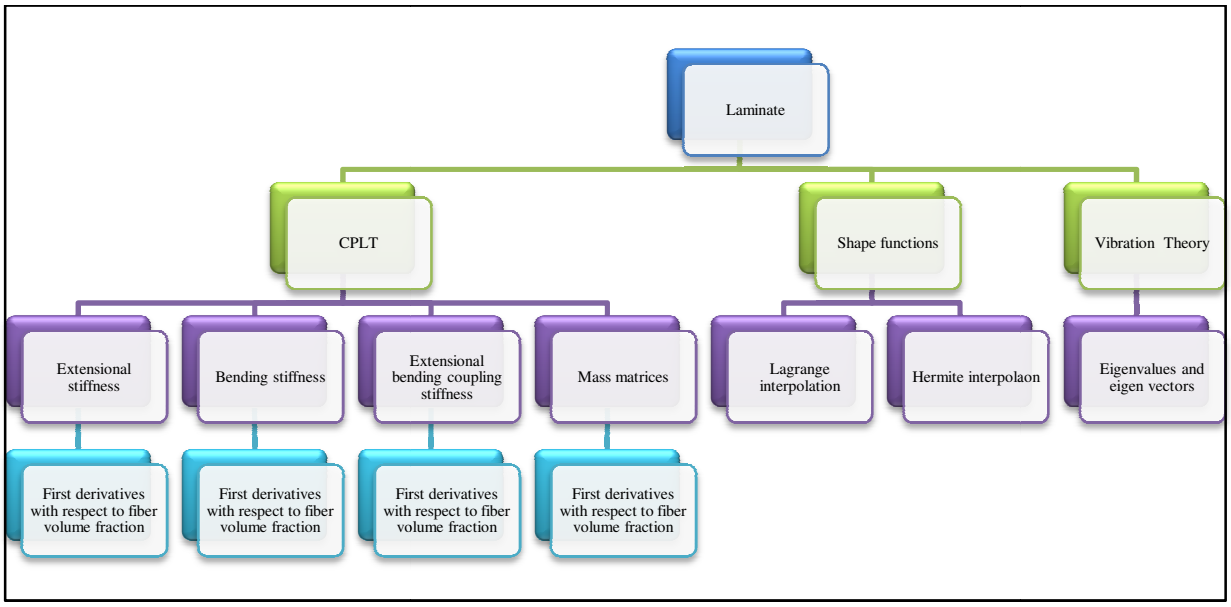

Figure 1

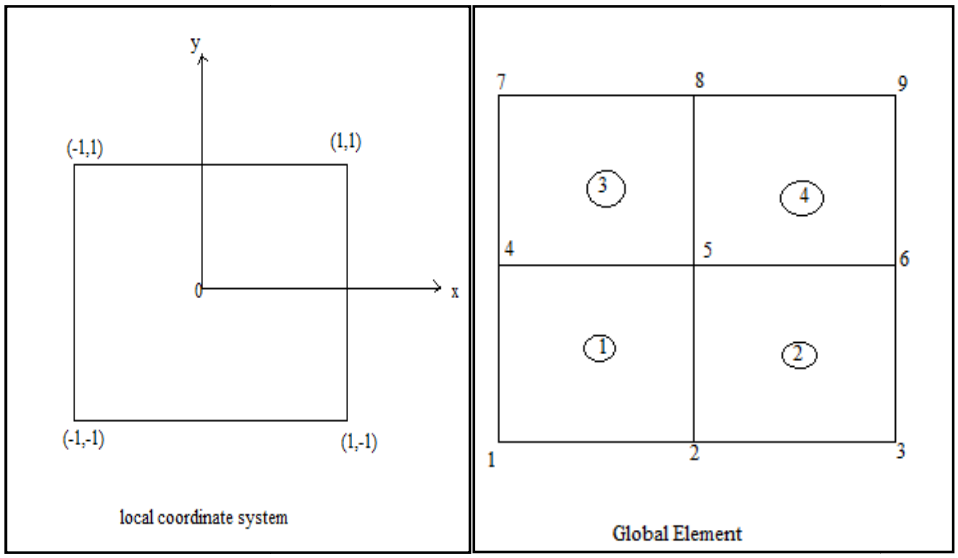

Figure 2

2.1. Materials Taken for Analysis

	Fibre material	Matrix material
Material	T1000G	Qy9511
Young's modulus	Ef = 294GPa,	Em = 4.2 GPa
Poisons ratio	vf = 0.22,	vm = 0.3
Density	ρf = 1800K g/m^3	ρm =1240Kg/m^3

Table 1

- The laminate code is [0/90/45/-45] s.
- The lamina thickness is 0.002m
- The laminate thickness is 0.016m
- Length l = 0.5m
- Breadth b = 0.5m

3. Results and Discussion

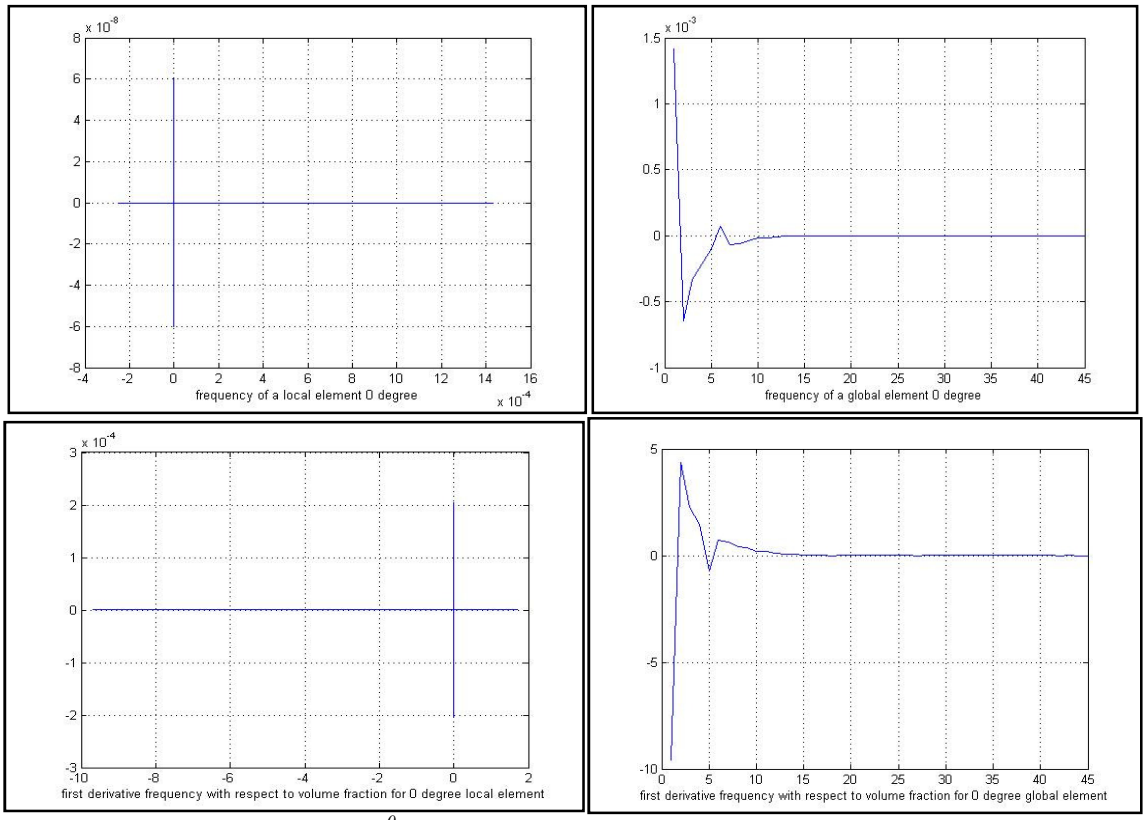

Figure 3: The frequency and modes of 0^0 angle lamina and its first derivative with respect to fibre volume fraction.

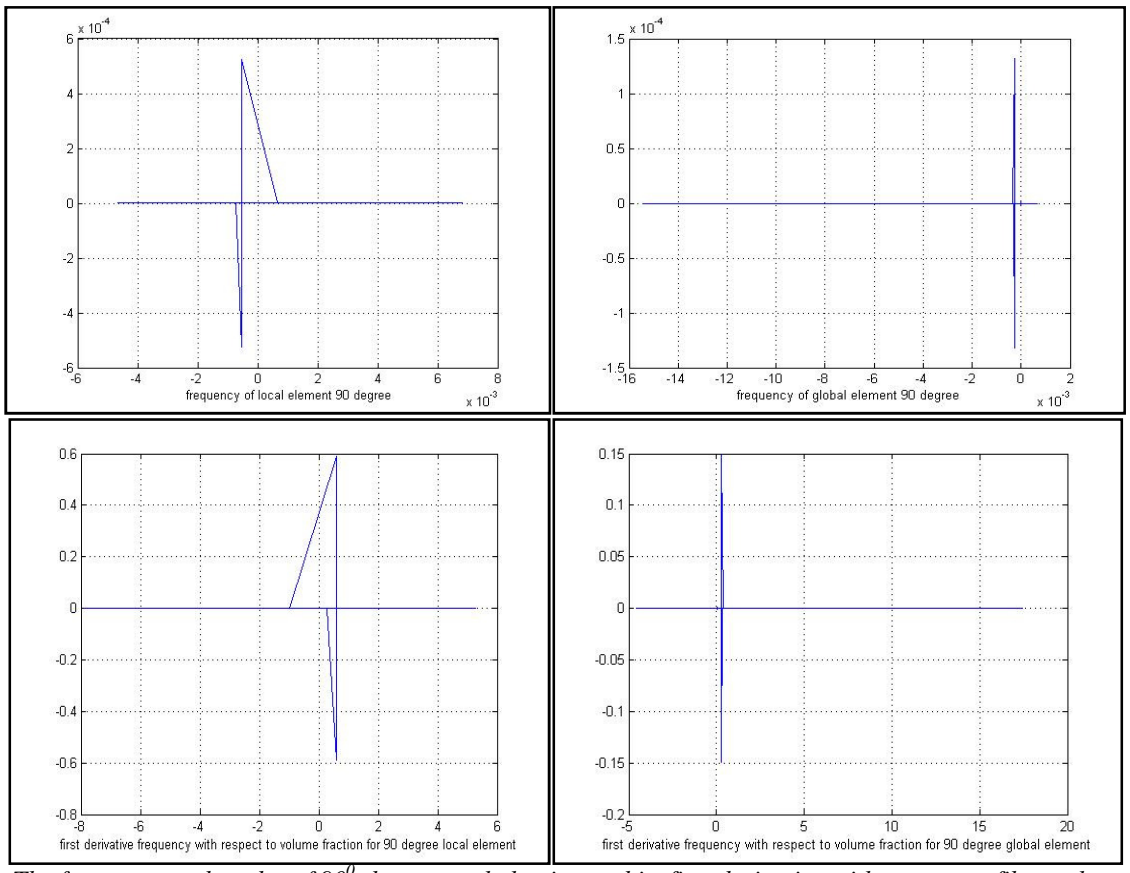

Figure 4: The frequency and modes of 90^0-degree angle lamina and its first derivative with respect to fibre volume fraction.

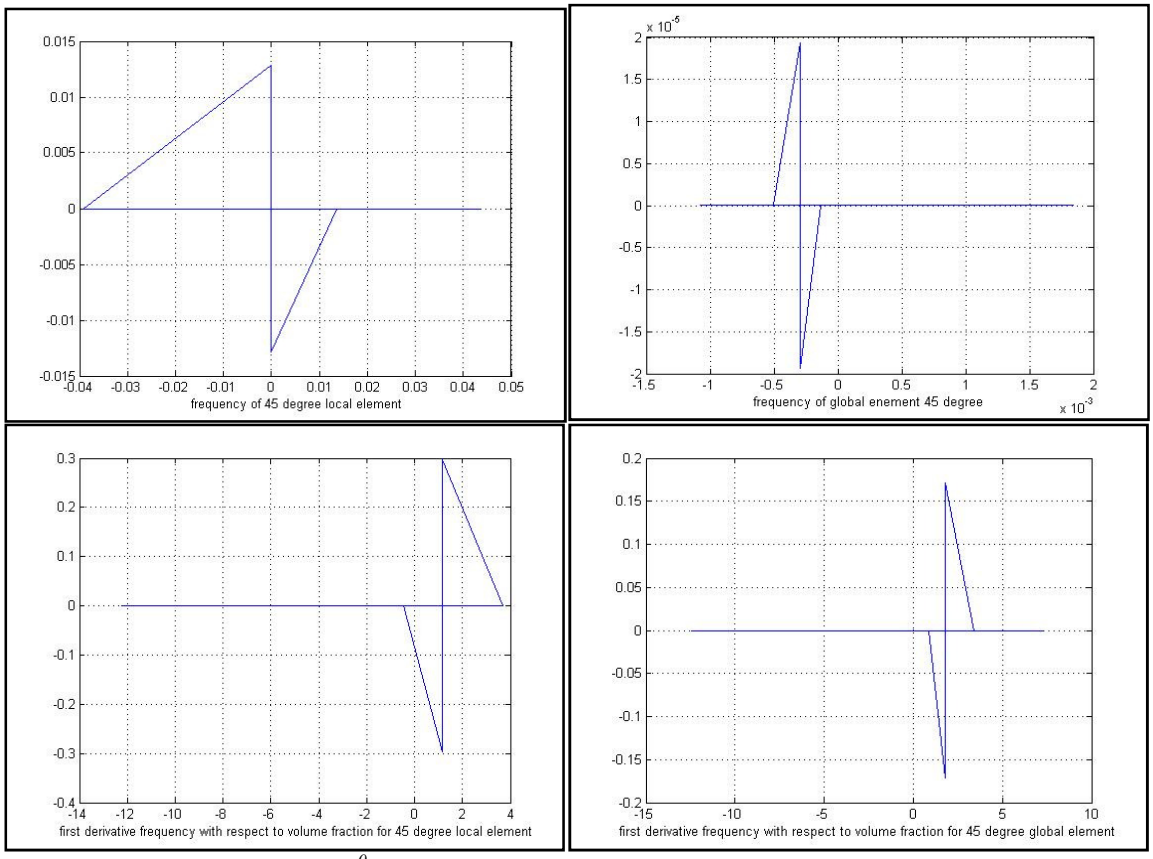

Figure 5: The frequency and modes of 45^0-degree angle lamina and its first derivative with respect to fibre volume fraction.

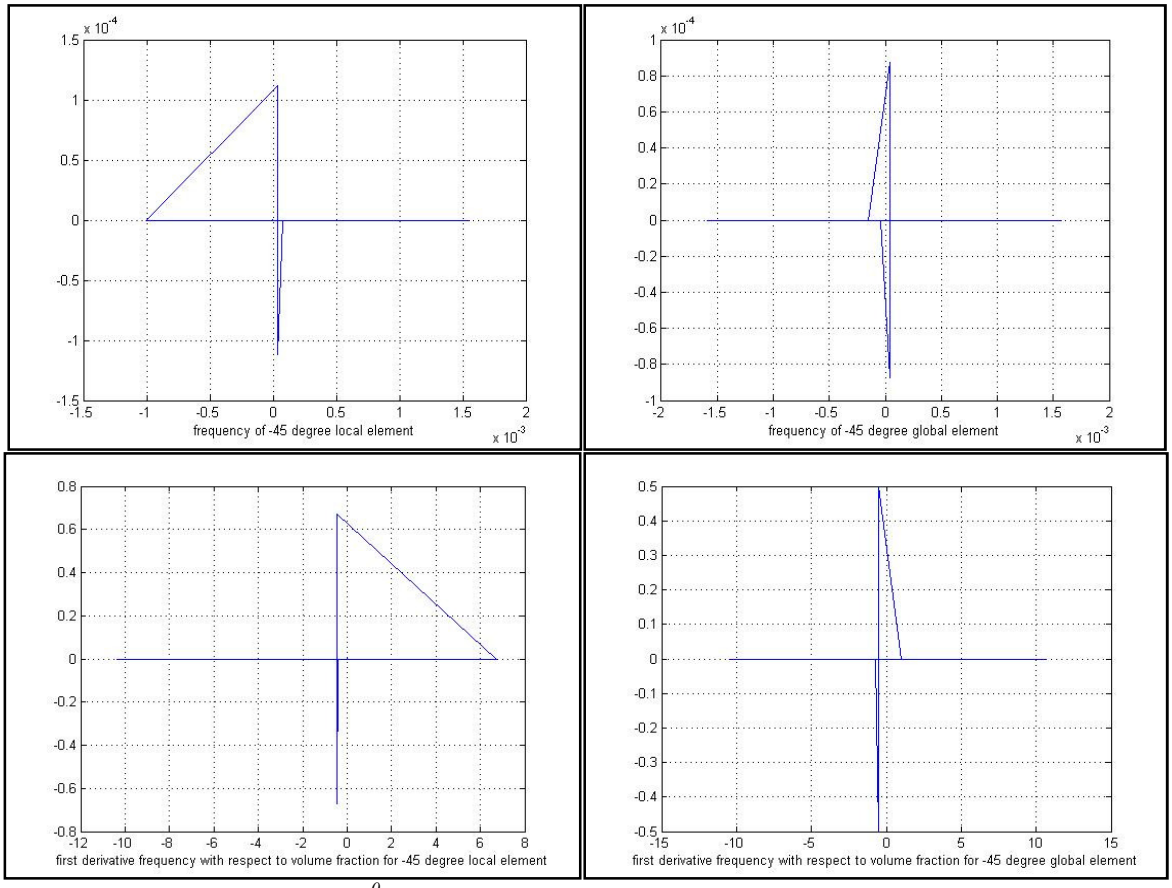

Figure 6: The frequency and modes of -45^0-degree angle lamina and its first derivative with respect to fibre volume fraction.

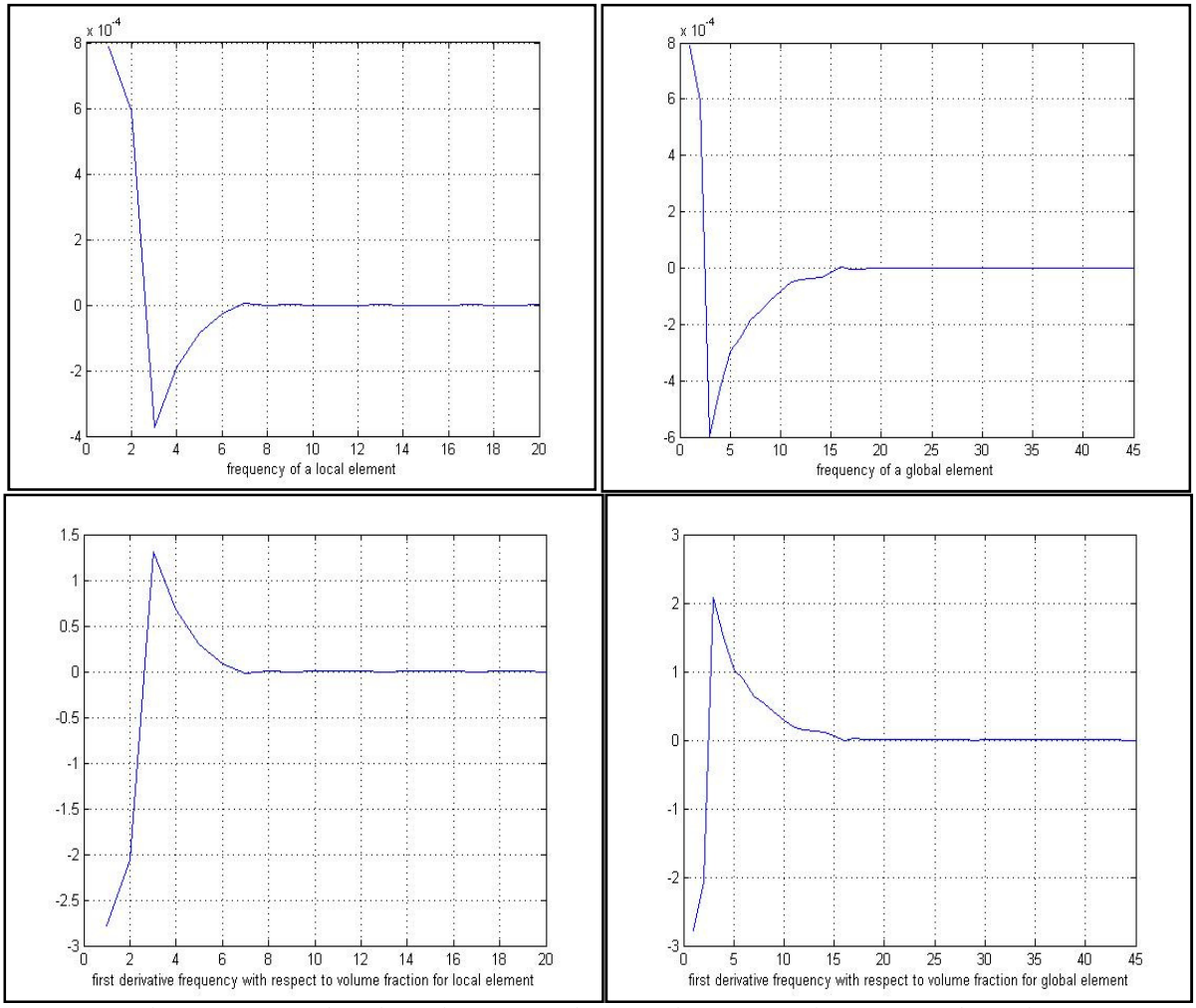

Figure 7: The frequency and modes of laminate and its first derivative with respect to fibre volume fraction.

4. Conclusion

Thus the above results show how the frequency and modes of lamina altering from the local element to the global element for different orientation, also its first derivative of frequency and modes changing with respect to fibre volume fraction. Finally, it also presents the difference in local and global laminate frequency and modes. If we increase the number of elements will get more Eigen values and Eigen vectors for convergence.

5. Acknowledgements

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6. References

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