European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 7, Issue 4, 2020

Improving Vibrant Property of Carbon Fiber Reinforced Polymer Compound using ANSYS Technique

Anas Islam[1], Rajat Yadav[1], Vikas Kumar Sharma[1]

[1]IET Department of Mechanical Engineering GLA University Mathura – 281406
Corresponding Author- anas.islam@gla.ac.in

Abstract: Present paper improves the dynamic properties of materials like mode shape natural frequency, fiber reinforced polymer compounds by which the material moist is studied with macro mechanical study by same micro mechanical study. For support of an engine, motor, pump or any other mechanical device must be used Structural elements. Here high damping and stiffness is not so easy for mechanical components over vibrated moist that depend on visco elastic nature of material for obtaining all categories of material combinations like damping rubber polymers. Present paper takes 2 compound plates that have a dimension of 140 X 170 mm. one which has a rubber sheet which has inserted in between two carbon fiber sheet layers and others who have only layers of carbon fiber. Modal analysis of two compound plates has performed in ANSYS 19 software to obtain mode shapes and respective natural frequencies of the structure.

Keywords: Dynamic Properties, Viscoelastic, Mode shapes, Fiber Reinforced Polymer, Damping, and Natural Frequency

1. Introduction

The compound material consists of a mixture of constituents and that constituents are often prepared by one or more irrelevant materials like a mixture of a minimum of two materials that are chemically distinct from each other with an interface separating the components compound equipment are further superior compounds as evaluated to conservative simple materials [1-3]. They have improved elasticity as evaluated to additional conservative materials the properties of these materials are different from their constituents. Compound materials are made by various methods some are mentioned that hand layup or chemical method [4-6]. Carbon compounds have carbon fiber reinforced in the matrix of carbon carbon-carbon compounds are make use of warm environments up to 6000 °f 3315°c and are 30 percentiles lighter than graphite fibers and also, it's 20 times stronger [7-9]. Their advantages include low density, good tensile as well as compressive strength, well thermal conductivity, high fatigue life, and a high coefficient of friction. One of the most advantages is it can withstand at high temperatures. Compound materials are those materials which include more than two materials which are synthetically made with dissimilar materials. It also includes chemically different than conventional materials, its properties are good than conventional [11]. The work of a reinforced matrix in a material is to give shape and protect the reinforcement to the environmental loads and toughness of the material, the main role of reinforcement in improving the properties of compound materials. Free vibration analysis was administered for identifying the natural frequencies [13].

2. Literature Review

Li Ma, Yun-Long Chen, Jin-Shui Yang, Xin-Tao Wang, Guo-Lin Ma, Rüdiger Schmidt, and Kai-Uwe Schröder, [1] has considered Auxetic materials and its structures as a class of fake materials that don't exist in nature that have been generally perused and evaluated for certain applications. This paper fixates on the creation and vibration damping of the carbon fiber compound auxetic twofold jolt furrowed sandwich sheets (DACSPs). The negative Poisson's extent effects of the compound auxetic DACSPs are indicatively analyzed reliant on essentialness method. 3D finite segment (FE) models got together with Modal Strain Energy (MSE) approach are made to investigate their vibration and damping characteristics. To support the mathematical models in the current examination, the compound auxetic DACSPs and such structures implanted with high damping layers are arranged and manufactured. Particular vibration and three-point bending tests are directed to inspect their vibration damping and bowing responses. The results show that the 3D FE models got together with the MSE approach are real to envision the particular properties of the compound auxetic DACSPs.

Jin-Shui Yang, [2] has concentrated in this exploration it presents the imperfections that can without much of a stretch show up in compound grid bracket center insert structure throughout the mind-boggling readiness process, which may essentially influence the auxiliary reaction and decline the heap conveying capacity. The reason for this paper is to examine the assembling imperfection affectability of modular vibration reactions of carbon fiber complex pyramidal bracket like center sandwich tube-shaped boards by modular trials and limited component examination. Deformities as well as deboning among face sheets and support centers (DFT), bracket missing (DTM), face sheet wrinkling (DFW), and hole strengthening (DGR) are brought into the present unblemished example misleadingly and modular testing is led to contemplate their dynamic conduct under without free limit circumstances.

Dai Gil Lee, Seung Hwan Chang, and Hyun Surk Kim, [3] has concentrated In request to get better the damping limit of the segment of an exactness reflect surface granulating machine instrument, a mixture section was produced by adhesively holding glass fiber fortified epoxy compound plates to a cast iron segment. To enhance the damping limit of the half and half-section, the damping limit of the mixture segment was determined as for the fiber direction and thickness of the compound overlay plate and contrasted with the deliberate damping limit. From tests, it was discovered that the damping limit of the half and half segment is 35% elevated by cast-iron section. Soggy out the trembling and commotion of equipment and structure, surface damping medications is broadly utilized since they are anything but difficult to actualize to different structures and is great damping limits with regards to wide recurrence and temperature ranges.

R. Chandra, S.P. Singh, and K. Gupta, [4] have concentrated fundamentally our category of research on damping in fiber- fortified compound resources and structures with an accentuation on polymer compound has been looked into in this document. As an initial step, compound damping instruments and philosophy pertinent to moist examination is portrayed. Further, the paper presents moist consider including large scale mechanical, micromechanical, and visco elastic (unwinding and creep) method; representation for entombing stage moist, damping, and harm in compounds. Some significant works identified with improved damping models for thick overlays development of cover damping and enhancement for moist in fiber fortified fiber strengthened compounds are as totally used as choices for regular materials essentially in light of their high explicit quality, explicit firmness, and tailor capable properties.

Jung Do Suh, Seung Hwan Chang, Dai Gil Lee, Jin Kyung Choi, and Bo Seon Park, [5] has concentrated In request to recover the shaking qualities of a shaft spread completed of 2 mm thick steel plate for fast mechanism apparatuses, the spread was fortified by carbon filament epoxy compound material. In view of the increasing circumstances and the shaking mode state of the shaft spread, the stacking succession and the width of the fortified compound overlay were resolved through a limited component examination. The connection among the misfortune factor and the stacking arrangement was likewise researched. The steel-compound cross breed axle spread was manufactured by co-fix holding in an autoclave and its dynamic attributes were tried.

3. Problem statement

It is commonly realized that an amazing damping limit is increasingly more critical for some engineering applications, for example, aviation, shipbuilding, and car enterprises with a prerequisite of vibration concealment and sound retention. The explanation behind high damping is essential because of inherent visco elastic conduct, interface contact, harm, and so forth of the improvement of materials science and innovation, the utilization of fiber strengthened sap framework compounds is continually expanded attributable to this high explicit quality and high explicit unbending nature, and high moist possessions as of late, that additionally push such kind of compound cell and sandwich structures forward

3.1 Methodology

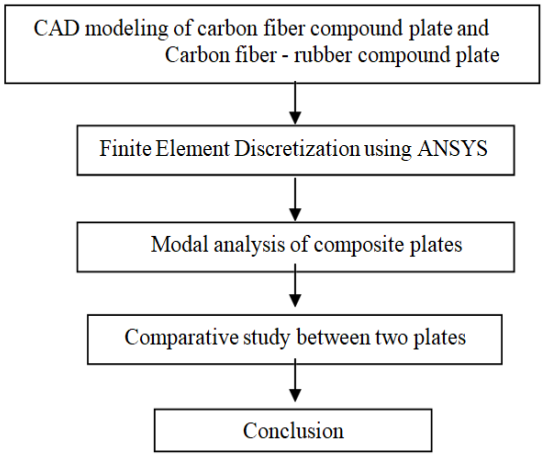

Figure.1. Implementation

3.2 Design of Compound Plates in Catia

The design of carbon fiber and carbon fiber- rubber compound plate has done in CATIA. Both plates are designed in such a way that they have equal in dimensions (its length and width) but Thickness varies. The thickness of the carbon fiber plate is 2 mm whereas the carbon fiber rubber plate is 3 mm.

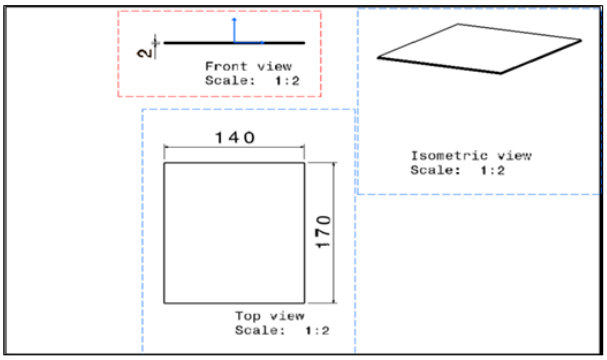

Figure.2. drafting of 2 mm plate

Fea Of Compound Plate in ANSYS

A. Carbon Fiber Compound plate

Material Properties:

Symbol	**Value**	**Property**
ρ	1490 Kg/m^3	Density
E_x	121 GPa	Young's Modulus X direction
E_y, E_z	8.6 GPa	Young's Modulus in Y and Z dir^n
υ_{xy}, υ_{xz}	0.27	Poisson's Ratio XY, XZ
υ_{yz}	0.4	Poisson's Ratio YZ
G_{xy}, G_{xz}	4.7 GPa	Shear Modulus XY, XZ
G_{yz}	3.1 GPa	Shear Modulus YZ

Table.1. Properties of carbon fiber compound material

Boundary condition

The boundary condition for the Structure is the giving of input known value at a node point, the known value either displacement or load. We can set one from these two but not both at a time. There are many types of loading in FEA analysis but the main type of loading is force pressure and temperature these can be applied at a node point or surface edge.

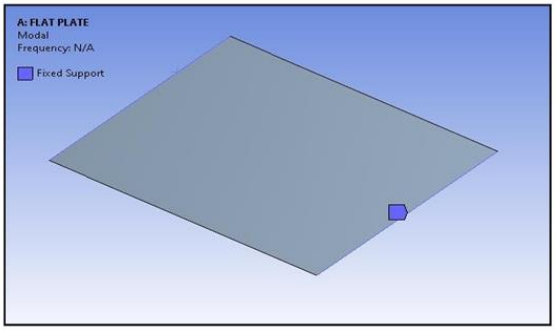

Figure.3. Applying Boundary condition on 2 mm plate

4. Results & Analysis

In the FEM, total deformation and directional deformation are two terms in which software used directional deformation because of the system displacement is vary to some axis or its depend on user-defined. Total deformation is nothing but a vector summation of all directional displacement in the system. Modal Analysis plays important role in vibrational structures in FEA analysis. It gives a better way to determine the natural frequency and mode shape of the system.

The Structures are vibrated under some specific frequency due to dynamic force or it's naturally. So the vibrations are investigated with the help of Experimental testing method (FFT analyzer) or some advanced techniques such as Analysis Software (Modal Analysis in ANSYS), Symbolic Software, and Mathematical methods (Galerkin Method, Ritz Method, etc.). By using all these methods we can compute the natural frequency of the vibrating structure.

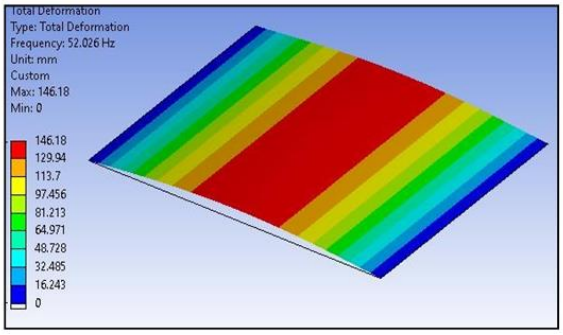

Fig. 4 Mode shape 1

The natural frequency of Compound structure 2mm thickness plate at mode shape 1 was 52.026 Hz.

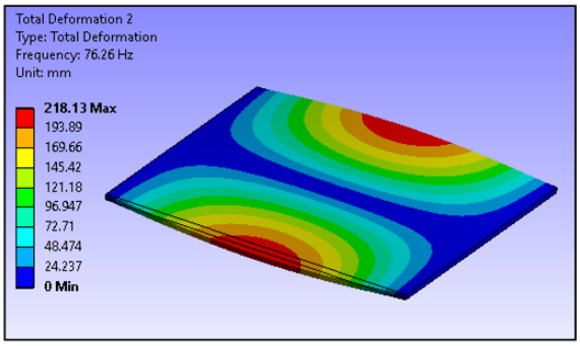

Fig. 5 Mode shape 2

The natural frequency of Compound structure 2mm thickness plate at mode shape 2 was 76.26Hz.

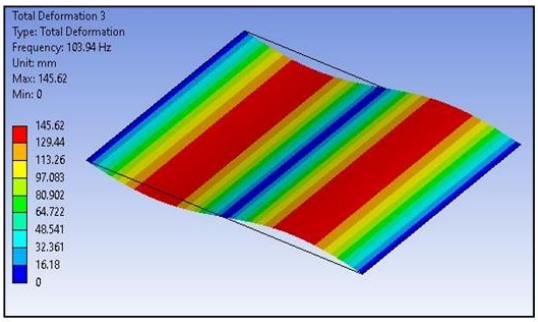

Fig. 6 Mode shape 3

The natural frequency of Compound structure 2mm thickness plate at mode shape 3 was 103.94 Hz.

Modal analysis result of carbon fiber compound plate in Tabular format:

Tabular Data

	Mode	Frequency [Hz]
1	1.	52.026
2	2.	76.26
3	3.	103.94
4	4.	121.22
5	5.	135.85

Table 2. The natural frequency of 2 mm plate with each mode of vibration

Carbon fiber Compound material with viscoelastic material

Material Properties:

Symbol	**Value**	**Property**
ρ	980 Kg/m^3	Density
E	0.45 MPa	Young's Modulus
υ	0.3	Poisson's Ratio
K	0.375 MPa	Bulk Modulus
G	0.17308 MPa	Shear Modulus

Table 3. Engineering material property of silicon

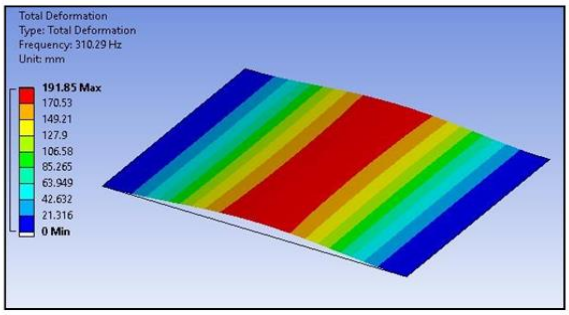

Fig. 7 Mode shape 1

The natural frequency of compound material with viscoelastic material structure 3 mm plate at mode shape 1 was 310.29Hz

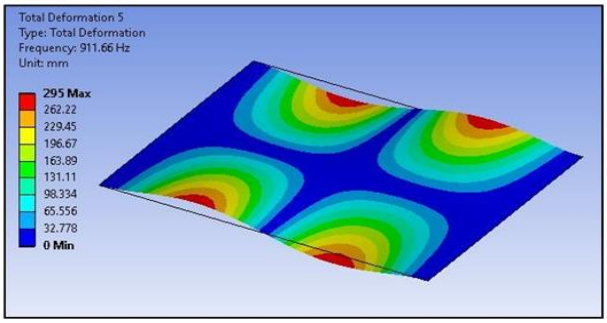

Fig. 8 Mode shape 5

The natural frequency of compound material with viscoelastic material structure 3 mm plate at mode shape 5 was 911.66Hz.

Modal Analysis Result of Carbon fiber- rubber compound plate in Tabular format:

Tabular Data

	Mode	Frequency [Hz]
1	1.	310.29
2	2.	350.81
3	3.	646.15
4	4.	856.34
5	5.	911.66

Table 4. The natural frequency of 3mm plate with each mode of vibration

5. Conclusions

In the present research two plates of a compound layer of ply orientation of [0 90] are used to perform the modal analysis and in the next attempt, viscoelastic material is inserted in between it to increase the damping and natural frequency.

Plates are vibrated at minimum natural frequencies it can be directly seen in the first carbon fiber compound plate.

Modal analysis has been done by using ANSYS 19 and getting results as expected. It is observed that in viscoelastic material as a layer in between plates increases the natural frequency.

References

[1] Li Ma, Yun-Long Chen, Jin-Shui Yang, Xin-Tao Wang, Guo-Lin Ma, Rüdiger Schmidt, and Kai-Uwe Schröder, Modal characteristics and damping enhancement of carbon fiber compound auxetic double-arrow corrugated sandwich panels, Compound Structures, Volume 203, November 2 018, pages 539-550.

[2] Sonia, P., et al., Effect of cryogenic treatment on mechanical properties and microstructure of aluminium 6082 alloy. Materials Today: Proceedings, 2020.

[3] Jin-Shui Yang, Influence of manufacturing defects on modal properties of compound pyramidal truss-like core sandwich cylindrical panels, Compound Science and Technology, [2017].

[4] Yadav, P. and K.K. Saxena, Effect of heat-treatment on microstructure and mechanical properties of Ti alloys: An overview. Materials Today: Proceedings, 2020.

[5] Dai Gil Lee, Seung Hwan Chang, and Hyun Surk Kim, Damping improvement of machine tool columns with polymer matrix fiber compound material, Compound Structures 43(1998) 155-163.

[6] Verma, S.K., N.K. Gupta, and D. Rakshit, A comprehensive analysis on advances in application of solar collectors considering design, process and working fluid parameters for solar to thermal conversion. Solar Energy, 2020. 208: p. 1114-1150.

[7] R. Chandra, S.P. Singh, and K. Gupta, Damping studies in fiber- reinforced compounds a review, Compound Structures, Volume 46, Issue 1, September 1999, Pages 41-51.

[8] Jung Do Suh, Seung Hwan Chang, Dai Gil Lee, Jin Kyung Choi, and Bo Seon Park, Damping characteristics of compound hybrid spindle covers for high speed machine tools, Journal of Processing Technology, Volume 113, Issues 1–3, 15 June 2001, Pages 178-183.

[9] Kumar, R., S.K. Verma, and V.K. Sharma, Performance enhancement analysis of triangular solar air heater coated with nanomaterial embedded in black paint. Materials Today: Proceedings, 2020.

[10] Mr. G. C. Mekalke and Mr. A. V. Sutar, Modal Analysis of Cantilever Beam for Various Cases and it's Analytical and FE Analysis, IJETMAS, February 2016, Volume 4, Issue 2, ISSN 2349-4476.

[11] Rathore, P.K.S., S.K. Shukla, and N.K. Gupta, Synthesis and characterization of the paraffin/expanded perlite loaded with graphene nanoparticles as a thermal energy storage material in buildings. Journal of Solar Energy Engineering, 2020. 142(4).

[12] Mohammad Vaziri, Ali Vaziri, and Prof. S.S. Kadam, Vibration Analysis of a cantilever Beam By Using F.F.T Analyzer, Vaziri, International Journal of Advanced Engineering Technology, Volume IV, Issue II, 2013.

[13] Rathore, P.K.S., S.K. Shukla, and N.K. Gupta, Yearly analysis of peak temperature, thermal amplitude, time lag and decrement factor of a building envelope in tropical climate. Journal of Building Engineering, 2020: p. 101459.

[14] J.P. Agrawal, "Compound Materials"Popular Science and technology series Published by DESIDOC,1990,pp54-86.