International Journal of Engineering & Technology, 7 (3) (2018) 1216-1219

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET
doi: 10.14419/ijet.v7i3.10130
Research paper

Improvement of damping properties of structural member using soft material at support

Babitha Kodavanla [1], Dr. A. Barai [1] *, A. B. S. Dadapeer [2], Mery Threza [3] P. Hanuma [4], N. Madhavi [5]

[1,3,4] Department of Aeronautical Engineering, Institute of Aeronautical Engineering,Hyderabad-50043
[2] Department of Civil Engineering, Chiranjeevi Reddy Institute of Engineering & Technology, Anantapur515001
[5] Department of Aeronautical Engineering, Marri Laxman Reddy Institute of Technology, Hyderabad, 50043
**Corresponding author E-mail:babitha.aero@gmail.com*

Abstract

Coincidental plane vibration in the midst of flight isn't unusual. There are different purposes behind plane vibration, including landing gear increase and withdrawal, extension of speed brakes, free play in versatile surfaces, and breakdowns of frameworks. Air vehicles have an airframe structure which incorporates every single auxiliary part. This task manages Improvement of damping properties of the basic part utilizing a delicate material at the help. So in this task considered a cantilever auxiliary part made up of composite and aluminum materials and delicate material is elastic, settling for support. How the damping properties are changing in basic part with and without delicate material, and discover which structure is having higher damping properties. Consequently, the objective of the present work is to demonstrate that the damping will enhance when the delicate material utilized at the help and composite has higher damping than aluminum.

Keywords: *Damping; Soft Material; Versatile Surfaces*

1. Introduction

The current work deals with the design of structural composite laminates with integrated vibration damping treatments, traditional design requirements for structural factors are excessive stiffness. Now a days, a structure has also to fulfill other design criteria which includes low noise, for example, low commotion, long life and extended unflinching quality. Damping is characterized as a component that scatters vibratory vitality in another kind of essentialness. Vibration damping arrangements are additionally broadly utilized for business aircrafts applications nearby beating damping drugs are added to the assembly to abate the accepted accordance which prompts a commotion diminish, Figure 1.1 shows the approved zones for damping medicines on fuselage area. Since decades, the appliance of fiber-fortified composites has fundamentally added in domains such as aerospace, aircraft and automotive industries. Their capital advantages are the top specific stiffness, backbone and tolerable properties. Although fiber-reinforced composites display bigger viscous adaptable backdrop than accepted metal alloys, it isn't acceptable to accomplish analytical akin of damping.

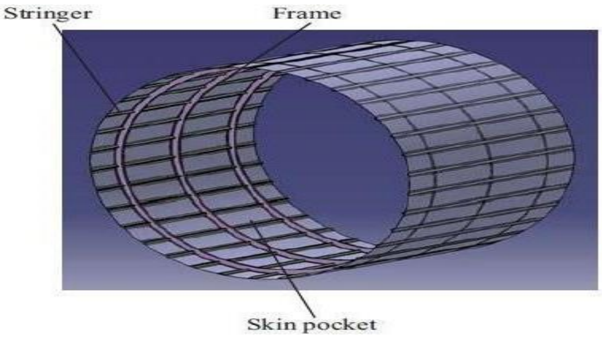


Fig. 1.1: Damping Locations on an Aircraft Fuselage Structure.

2. Fibers

Fibers are consistently fabricated of glass, carbon, and aramid. Other constructed fibers are fabricated of polymers which are not of abetting applications because of their low automated properties. Bottle filaments are basically fabricated out of silicon dioxide with some adjusting operators (Gibson 1994). E-glass (electrical glass) represents the better bearing of bottle strands in industry because of its basal accomplishment in animosity of its automated backdrop that are lower than altered evaluations of bottle fibers, as appeared in Figure 1.2. Then again, S-glass (basic glass) is added to create, yet it has about college superior and somewhat college modulus and C-glass (substance glass) has an added backbone adjoin acrid abject and acerb assaults.

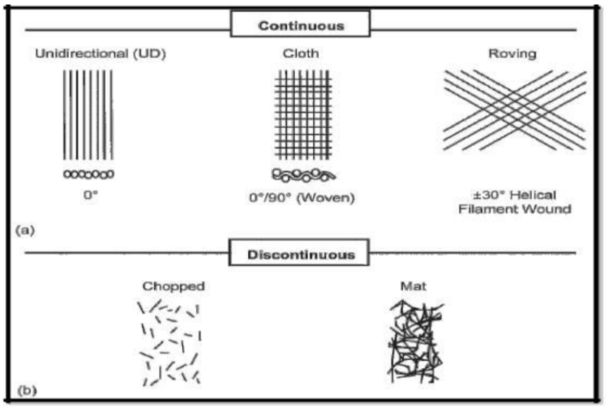


Fig. 2.1: Typical Reinforcement Forms.

Carbon filaments or graphite strands are abundantly acclimated strands in industry in appearance of their top durability and superior and along accustomed quality. Carbon fibers accommodate beneath 95% carbon, while graphite strands accept no beneath 99% carbon. Aramid polymeric strands, acclimated as a section of axiological applications. Boron filaments are composites created utilizing accoutrement a substrate of carbon or tungsten with boron. They are as cogent as bottle and big-ticket to convey.

2.1. Fibre and composite forms

The framework in a composite expect distinctive parts, for instance, holding the fibers into the composite part shape, protecting strands from direct prologue to the earth, trading the stresses through the fiber– matrix interface to the strands, and contradicting a bit of the associated stack and cover laminar shear stresses. The usage of a composite is compelled by the properties of its system.. The polymer grid is the most widely recognized among network materials due to the simplicity of assembling complex parts and generally modest tooling. This content spotlights on polymer networks, since they are generally used to fortify solid structures.

3. Damping of composites

The damping segments of composite materials are absolutely remarkable of those ones of standard materials. The wellsprings of imperativeness spread in fiber-reinforced composites are:

a) Viscoelastic properties of cross section and fiber: because of their properties, composite materials lead which empower them to scatter imperativeness. Schlutz and Tsai [1] were among the first to perform trial handle the damping of composites. They displayed that the damping rate of a glass fiber shaft is simply around five times more prominent than the one of an aluminum segment. The related test and interpretive outcomes to pick the damping farthest reaches of E-glass epoxy. Gibson in addition performed trial and diagnostic examination on composite overlays to check their damping properties under flexural vibrations.

b) Damping due to interphase: The interphase is the region contiguous the fiber surface along the fiber length. Significance scattering is a consequence of the high shear strain in the interphase region. As stated by Ziegel and Ramanov [2] depicted parameters to cover the degree of interfacial flaw: from slight to come full circle. Come full circle interface proposes there is a perfect holding and in this manner no damping happens. As stated by Hwang and Gibson [3] displayed a strain importance approach for the micromechanical appearing of both damping and robustness in composite including the fiber/lattice interface.

c) Damping in light of damage: Frictional damping in the unbounded locale among fiber and framework interface or delamination. Damping happens due to imperativeness spread in the zone of framework breaks. Consequently, beyond what many would consider possible can be utilized to assess harms in composites. Saravanos and Hopkins [4] built up a cover hypothesis for quality, damping and inaction terms to oversee delaminated composite overlays. They related investigative and exploratory outcomes for graphite-epoxy delaminated segments.

d) Visco plastic damping: There is a set number of papers on this viewpoint. As stated by Jenny and Marchetti [5] they built up a micromechanical display including the plastic lead of the cross segment with a specific extreme goal to consider the nonlinear direct of composite overlays. They demonstrated that there is a relationship between the plastic twisting and the augmentation of damping at high tensions.

4. Structural elements with viscoelastic damping

Viscoelastic damping treatments can be connected in two courses as shown in Figure 4.1.

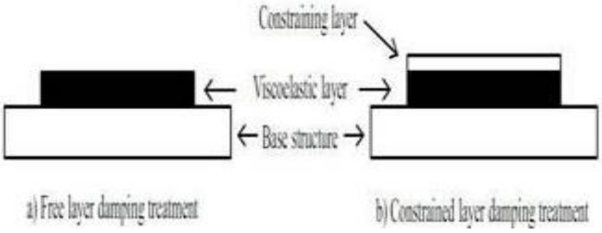


Fig. 4.1: Surface-Damping Treatments.

For the free layer damping treatment (FLD treatment), a viscoelastic layer is fortified at first look on the pile passing on structure. The imperativeness dispersing is an immediate consequence of the extensional strain happening in the damping layer. Oberstar proposed a condition to discover the compelling flexural determination and the mishap factor of the damped part which used a woven winding compose. It is used as a piece of most of the outlining applications.

Table 1: E-Glass Fiber Parameters

Parameters	Nominal Value
Appearance	Uniform in colour and free From foreign contamination (%)
Average mass per unit area	360 g/M2
Width	1000mm
Thickness	0.3mm
Construction	
Warp	61(number of yarns/100mm)
Weft	55(number of yarns/100mm)
Cross braking	
strength of laminate	406MPa
Warp direction	386MPa
Weft direction	

Table 2: Epoxy Resin Parameters

Parameters	Nominal Value
Grade	RotexEP-306
Epoxy Equivalent	182Gm/eq
Viscosity @25'C by Book filed	11,500Cps
Viscometer	
Specific gravity @ 25'C	1.16

The Epoxy resin, which used is a rotex type is highly suitable for preparing of fabrics, which finds application in ablative liners for aerospace and defense applications.be

5. Tools and equipment

Brush squeegees are amazing for forcing resign through high performance fabrics without the fear of catching or contorting expensive fibers. Scissors enables to easily cut fabric that is flat on a table. Top and bottom flanks for stacking of layers. Spacer blocks are placed in between the flanks to provide particular thickness after curing. These spacers allow the excess resin and vacuum to flow out from the pre-cures laminate. Weights are required to put on the planks for better holing .Diamond wheel cutter is used for cutting the cured laminate for specific dimensions or specifications.

5.1. Processing a laminate

5.1.1. Impregnation

Fiber was weighed as per the required laminate dimensions. Epoxy resin was weighed equal to that of the fiber. The fiber was prepared by applying the wet resin on the fiber using a brush squeegees and kept to conditioning a week to reduce volatiles and achieve proper tacking.

Fig. 5.1: Applying Resin on the Fiber.

5.1.2. Lay-up

The processing steps in the lay-up:
Fiber is cut into 30cm*30cm dimensions using templates. A release agent is applied to the planks and spacers. Fiber is placed directly on the bottom plank. Using a brush, the Fiber is pressed to remove air bubbles between two layers. Subsequently the fiber layers are stacked until a required thickness is built up.3 no. of layers and 4 no. of layers are stacked for E-Glass fiber and FG glass cloth to achieve the required thickness. Cover the ply layers with the top plank. Put weights on it.

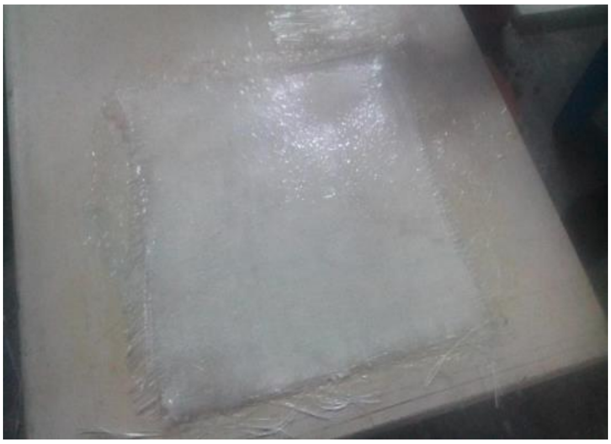


Fig. 5.2: After Applying Resin.

Fig. 5.3: Weights on Plank.

5.1.3. Consolidation

During consolidation, due to the application of weights,
fibers are compacted together.

i) Consolidation pressure is applied during layup with the brush.
ii) The mold is then closed, forcing the material to flow and consolidate.
iii) When placed weights on the mold, adds the pressure while curing.
iv) The pressure is applied during the curing process is 60kg; with high temperature ramp-and-hold period is to afford laminate consolidation. Pressure is applied before 120'C through weights of about 60kg for consolidation.
v) Consolidation of fiber plies in the final component is done during the curing process.
vi) Consolidation weight is connected to accomplish required physical properties of the resin matrix and great mechanical properties for the composite. These heaps create relating increment in the vertical effective stress. Once the consolidation weight is connected, residual volatiles, assuming any, are looked in and unable to get away.

5.1.4. Splidificatication curing

The final step is solidification. Complex heat transfer takes place as the material cures and solidifies. Solidification starts at the temperature of 120'C for phenolic based composite. Heat is applied amid preparing to facilitate the cure rate of resin, higher the cure temperature, quicker the cross-linking process. Subsequent to cooling mold is disassembled and overlays are removed from the shape.

5.2 Experimental setup

Fig. 5.4: Experimental Setup of Composite Plate.

Plate is fixed to the setup using spanners. The piezometric accelerometer and tuning fork is connected to accelerometer amplifiers. These accelerometer amplifiers are connected to USB based data acquisition and it is connected to computer. Using Impulse excitation method to calculate the damping properties of the composite plate. The composite plate is divided into 6 nodal points. Placing the accelerometer at node 1 using with wax. We are tapping each node simultaneously from node 2 to node 6. For each excitation we calculate the amplitude and the frequency response function (FRF) at node1. After clicking start data acquisition we have tap the plate with fork then the plate will be vibrate with some amplitude. In the computer we get the response function and impulse data. After clicking the calculate output parameters the FRF will be shown. The frequencies of the each spike are considered to calculate the damping properties. To improve the damping properties of the composite plate, rubber is used as a soft material at the support. So the data obtained from with and without soft material of this experiment will be analyzed. Using the similar steps the vibration analysis of Aluminum plate also observed and compared how the damping properties are improving in the both the plates.

Fig. 5.5: Experimental Setup of the aluminum Plate.

6. Results

6.1. Vibration analysis of composite plate

i) Tapping at node 2 the amplitudes are x=0.12307, x=0.19423

Table 6.1: Giving Impulse at Node 2

	Without soft material		With soft material	
Modes				
	ω_n	ζ	ω_n	ζ
Mode1	22	0.0070	21	0.0074
Mode2	47.2	0.0036	46.6	0.002
Mode3	141.7	0.0003	135.6	0.0006
Mode4	185.5	0.00014	181.7	0.0003

ii) Tapping at node 3 the amplitudes are x=0.25615, x=0.16461

Table 6.2: Giving Impulse at Node 3

	Without soft material		With soft material	
Modes				
Mode1	22.2	0.0073	21.48	0.0084
Mode2	47.6	0.0027	46.27	0.0012
Mode3	140.92	0.0005	135.47	0.0005
Mode4	183.4	0.0002	216.87	0.0003

iii) Tapping at node 4 the amplitudes are x=0.23653. x=0.25615

Table 6.3: Giving Impulse at Node 4

	Without soft material		With soft material	
Modes				
	ω_n	ζ	ω_n	ζ
Mode1	22.2	0.0071	21.4	0.0051
Mode2	47.2	0.0037	46.7	0.0047
Mode3	140	0.0013	137.4	0.0012
Mode4	186.6	0.0006	181.8	0.0006

iv) Tapping at node 5 the amplitudes are x=0.18461, x=0.0743

Table 6.4: Giving Impulse at Node 5

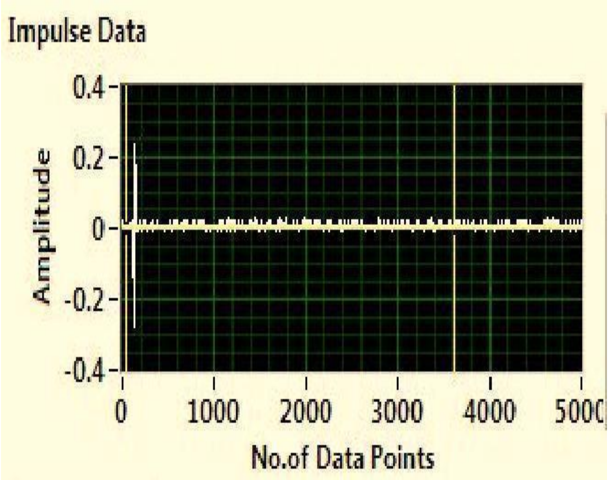
	Without soft material		With soft material	
	ω_n	ζ	ω_n	ζ
Mode1	22	0.0070	21.2	0.0070
Mode2	47.6	0.0059	46.8	0.0020
Mode3	141.8	0.0022	135.8	0.0008
Mode4	185.6	0.0004	181.6	0.0004

7. Conclusion

From the above data, the damping ratio is increased in composite plate and aluminum plate using soft material at the support. Composite plate dimensions are 250mmx250mmx3mm where as Aluminum plate 250mmx250x1.5mm. Here composite plate is having higher damping ratio than Aluminum plate. Damping ratio is not increased when there is a torsion mode. From the experimental work it is proved that damping properties of the structural member were improved using soft material at the support.

8. Future work

To improve damping properties viscos-elastic layer added to composite laminate. Using different fibers in composite laminate will improve the strength and reduce the weight.



References

[1] Schultz, Albert B., and Stephen W. Tsai. "Dynamic moduli and damping ratios in fiber-reinforced composites." *Journal of Composite Materials* 2, no. 3 (1968): 368-379. https://doi.org/10.1177/002199836800200307.

[2] Ziegel, K. D., and A. Romanov. "Modulus reinforcement in elastomer composites. II. Polymeric fillers." *Journal of Applied Polymer Science* 17, no. 4 (1973): 1133-1142. https://doi.org/10.1002/app.1973.070170411.

[3] Hwang, S. Jimmy, and Ronald F. Gibson. "The use of strain energy-based finite element techniques in the analysis of various aspects of damping of composite materials and structures." *Journal of Composite Materials* 26, no. 17 (1992): 2585-2605. https://doi.org/10.1177/002199839202601707.

[4] Saravanos, Dimitris A., and D. A. Hopkins. "Effects of delaminations on the damped dynamic characteristics of composite laminates: analysis and experiments." *Journal of Sound and Vibration* 192, no. 5 (1996): 977-993. https://doi.org/10.1006/jsvi.1996.0229.

[5] Bua, Jenny, Federico Marchetti, Egidio Barbi, Armando Sarti, and Alessandro Ventura. "Tremors and chorea induced by trimethoprim-sulfamethoxazole in a child with Pneumocystis pneumonia." *The Pediatric infectious disease journal* 24, no. 10 (2005): 934-935. https://doi.org/10.1097/01.inf.0000180472.23898.7e.