Investigation on Vibrational Behaviour of Laminated Hybrid Composites

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Abstract: *The aim of work is taken to study the vibrational behavior of epoxy polymer matrix composites of Kevlar and basalt by varying the orientation of the fiber ($0^0/0^0/0^0/0^0/0^0/0^0$), ($0^0/-30^0/+30^0/-30^0/+30^0/0^0$), ($0^0/-45^0/+45^0/-45^0/+45/0^0$), ($0^0/-60^0/+60^0/-60^0/+60^0/0^0$). The preparation of the samples is made by hand layup method. For the achievement of the above goal, experiment COCO-80 (FRF Analysis) setups with all necessary inputs were utilized. The variations in properties with respect to change in orientations were obtained and represented by graphs. The composite with, ($0^0/-45^0/+45^0/-45^0/+45/0^0$) fiber have shown improved performance of higher natural frequency at both ends fixed condition.*

Keywords: Composite beams, Kevlar& basalt fibre, vibration analysis.

Introduction: A composite material can be defined as a combination of a matrix and a reinforcement, which when combined gives properties superior to the properties of the individual components. Composite material applications are wide in the aerospace, civil, marine, and automotive industries due to their high specific stiffness and strength, excellent fatigue resistance, long durability and many other superior properties compared to ordinary composites [1] An attempt to study the influence on mechanical properties of the natural fiber and synthetic fiber reinforced composites. Tensile test revealed that the hybrid composite made of maximum natural fiber [2] A series of vibration tests were conducted to determine dynamic characteristics of the samples. Damping properties are calculated from logarithmic decrement method by using vibration response envelope curve [3]. Investigation of the various mechanical properties like tensile strength, flexural, strength of epoxy material using the materials used are basalt and Kevlar fibres as reinforcement is performed and compared with other composite materials like natural and artificial fibres [4].

Kevlar: Kevlar has many applications, ranging from bulletproof vests, drumheads because of its high tensile strength-to-weight ratio by this measure it is five times stronger than steel. It is also When used as a woven material, it is suitable for underwater applications.

Basalt: Basalt is an alternative raw material for fiber forming because of its relatively homogeneous chemical structure, its large- scale availability throughout the world. Low-cost high-performance fibers offer potential to solve the largest problem in the cement and concrete industry, cracking and structural failure of concrete.

Epoxy: Epoxy resins are the most commonly used resins. They are low molecular weight organic liquids containing epoxide groups, High strength, Low viscosity and low flow rates, which allow good wetting of fibers and prevent misalignment of fibers during processing.

Design and Fabrication: The composite beams are prepared by hand layup technique. The weight of fibers is 43.7% & epoxy was taken as 56.2%. The layers of Kevlar and basalt were placed at different orientations, outer most layers are made by Kevlar and inner layers are prepared by basalt. Composite plates are ($0^0/0^0/0^0/0^0/0^0/0^0$), ($0^0/-30^0/+30^0/-30^0/+30^0/0^0$), ($0^0/-45^0/+45^0/-45^0/+45/0^0$), ($0^0/60^0/+60^0/60^0/+60^0/0^0$) The processed wet composites are dried for 24hrs, and after drying the composite, the composite plate is cut into samples. The samples for vibration test are cut into required dimension as per ASTM standards.

Vibration Test:

The CoCo-80 (Coco) is a handheld data recorder, dynamic signal analyzer, and vibration data collector that is ideal for a wide range of industries including automotive, aviation, aerospace, electronics, and military applications that demand easy, quick, and accurate data recording and real-time processing in the field**.** The Coco hardware platform supports two different software working modes: Dynamic Signal Analyzer (**DSA**) and Vibration Data Collector (**VDC**). Each working mode has its own user interface and operation navigation structure. The test specimen for FRF test and equipment are shown in fig no: 1& 2.

Fig no:1 Specimens for FRF test

Fig no: 2 FRF vibration test setup.

Results

Vibration Test: The natural frequency of the composite beams at different orientations are analyzed by using the FRF analyzer. The natural frequency of the composite beam at different orientations, simply supporting condition by H function &COH function graphs obtained from FRF analyzer. The ASTM standards used are D175. The test results are represented in graphical & corresponding H and COH function values from tables 1 to 8 and fig no: 1 to 10.

SIG1779_H(ch2,ch1) at 0° on simply supported beam.

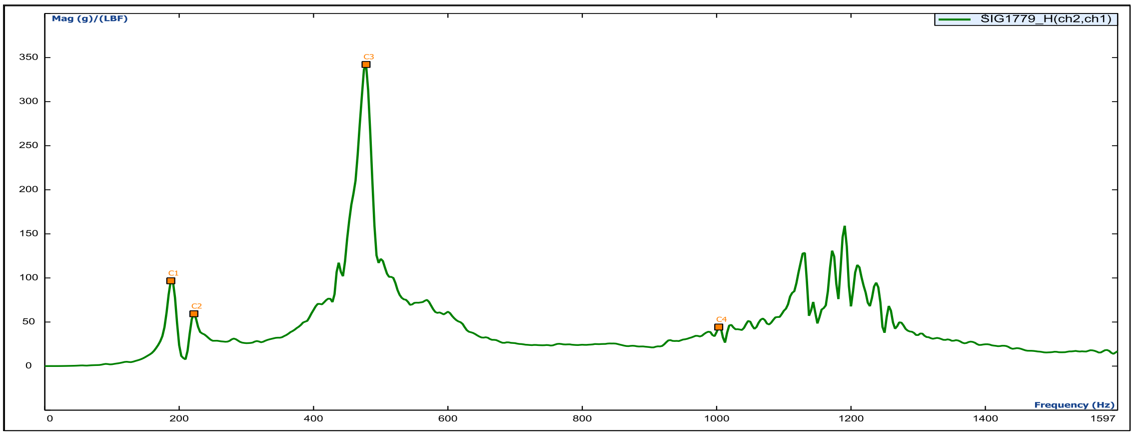

Fig No :3 Magnitude Vs Frequency In simply supported Condition

Table: 1 H Function Values

H (ch2, ch1)	X Frequency (Hz)	Y Mag (g)/(LBF)
C1	187.5000	96.7876
C2	221.8750	59.3914
C3	478.1250	342.1858

SIG1779_COH (ch2, ch1) at 0° on simply supported beam (coherence value).

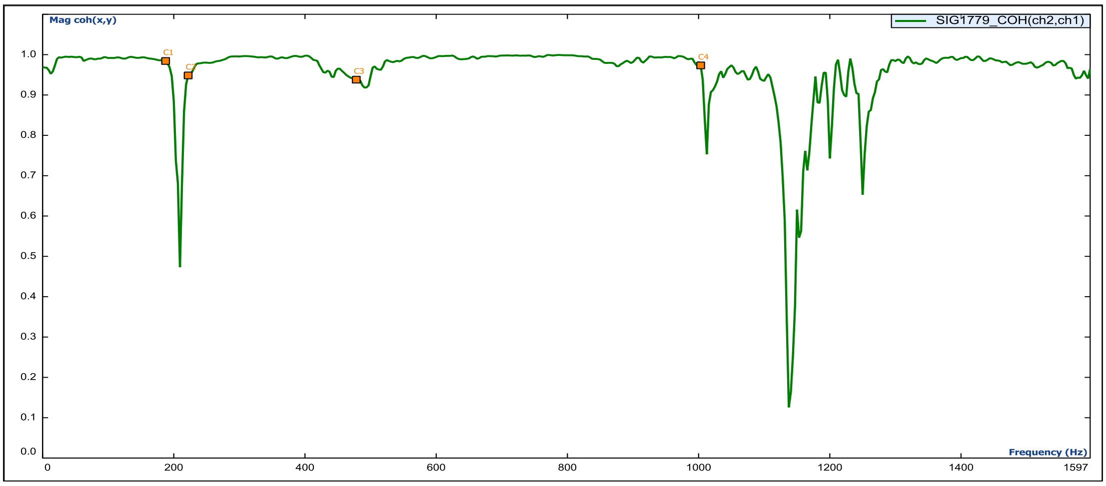

Fig No :4 Magnitude Vs Frequency In simply supported Condition

COH(ch2,ch1)	X Frequency (Hz)	Y Mag coh(x,y)
C1	187.5000	0.9843
C2	221.8750	0.9485
C3	478.1250	0.9380

Table: 2 COH Function Values

SIG1780_H(ch2,ch1) at 30° on simply supported beam

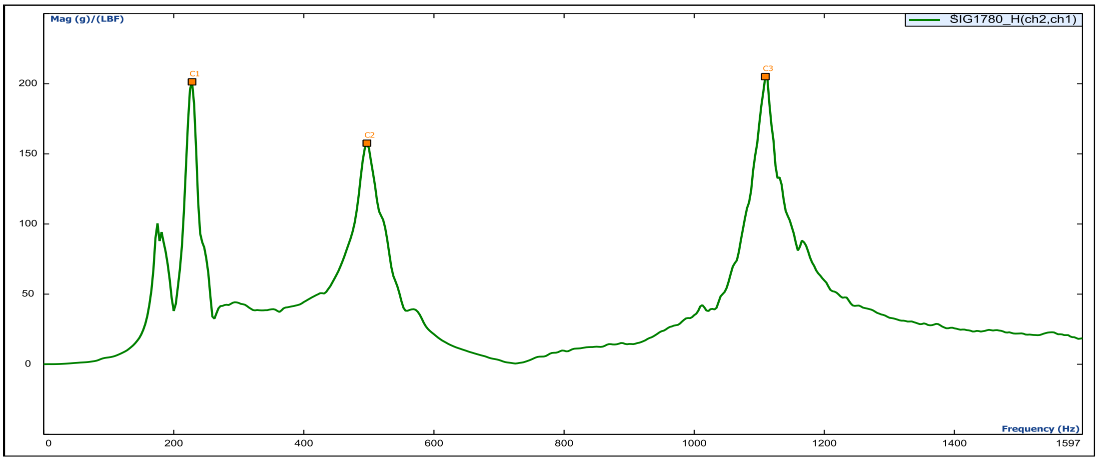

Fig No :5 Magnitude Vs Frequency In simply supported Condition

Table: 3 H Function Values

H(ch2,ch1)	X Frequency (Hz)	Y Mag (g)/(LBF)
C1	228.1250	201.3473
C2	496.8750	157.6138
C3	1109.3750	205.1040

SIG1780_COH(ch2,ch1) at 30° on simply supported beam (coherence values).

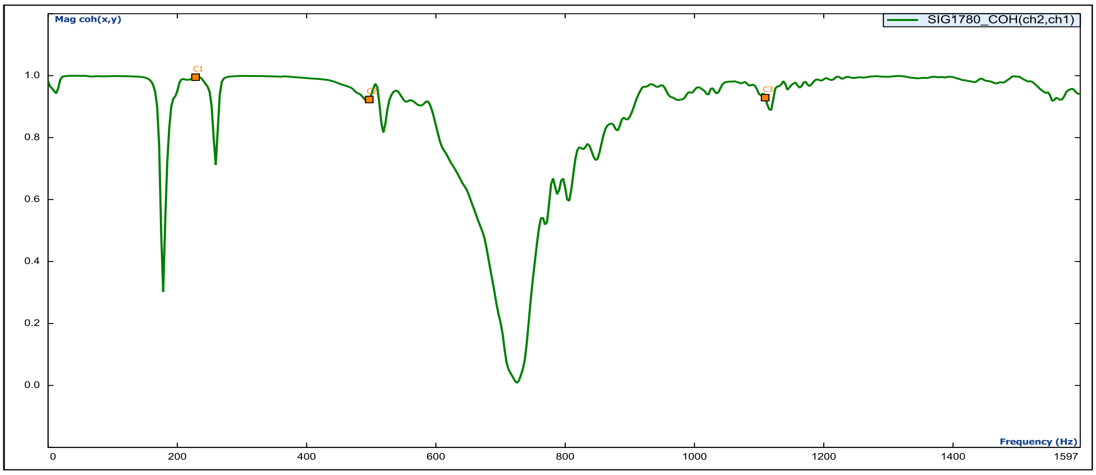

Fig No :6 Magnitude Vs Frequency In simply supported Condition

Table: 4 COH Function Values

COH(ch2,ch1)	X Frequency (Hz)	Y Mag coh(x,y)
C1	228.1250	0.9951
C2	496.8750	0.9230
C3	1109.3750	0.9290

(SIG1783_H(ch2,ch1)) at 45° on simply supported beam

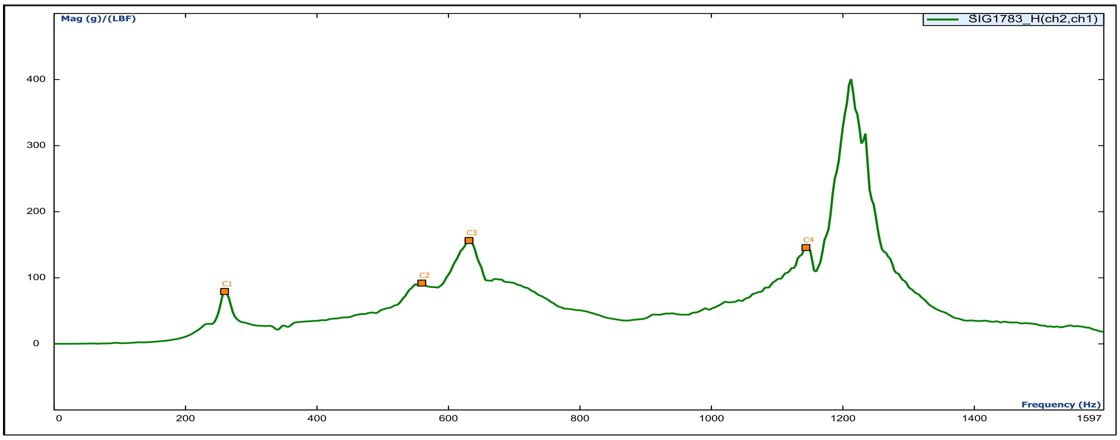

Fig No :7 Magnitude Vs Frequency In simply supported Condition

Table: 5 H Function Values

H(ch2,ch1)	X Frequency (Hz)	Y Mag (g)/(LBF)
C1	259.3750	79.2423
C2	559.3750	91.9486
C3	631.2500	156.4259

(SIG1783_COH(ch2,ch1))at 45° on simply supported beam (coherence values).

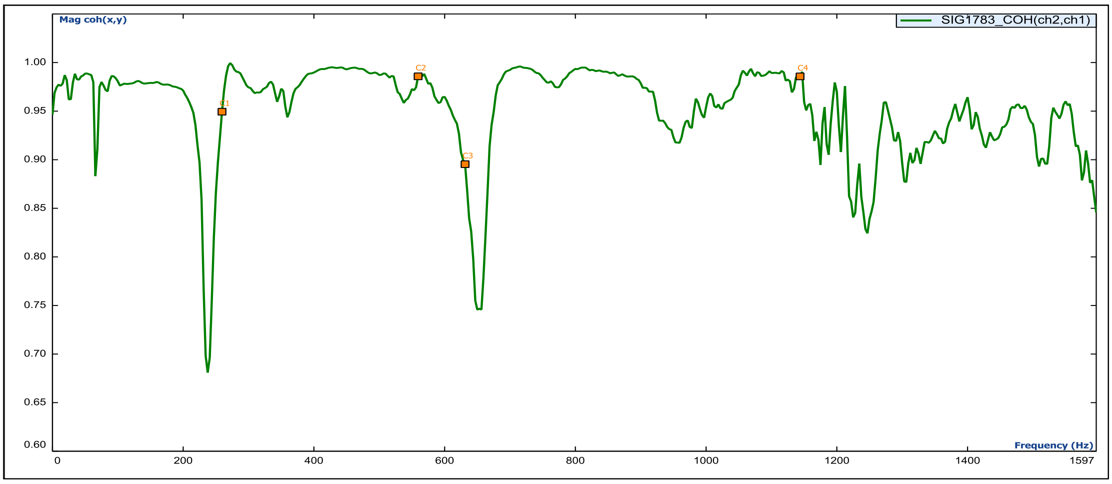

Fig No :8 Magnitude Vs Frequency In simply supported Condition

Table: 6 COH Function Values

COH(ch2,ch1)	X Frequency (Hz)	Y Mag coh(x,y)
C1	259.3750	0.9494
C2	559.3750	0.9858
C3	631.2500	0.8954

(SIG1785_H(ch2,ch1)) at 60° on simply supported beam

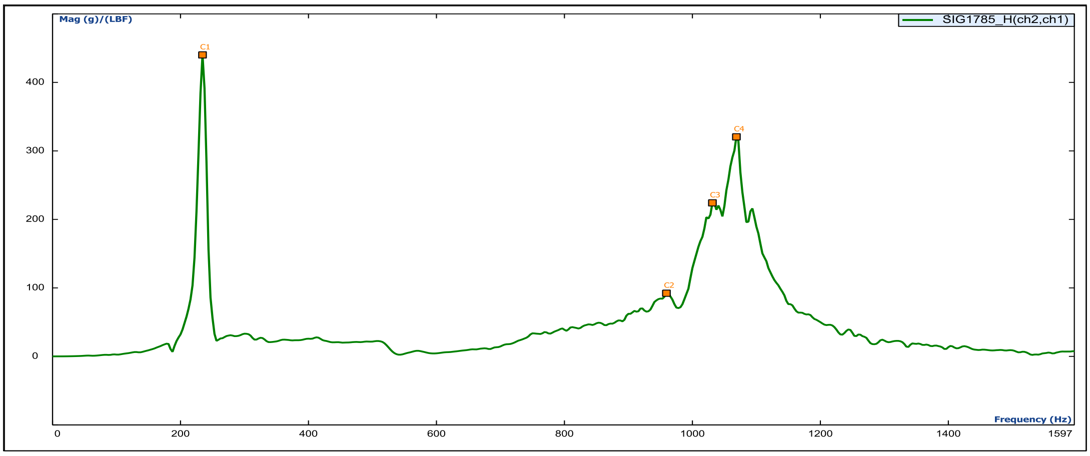

Fig No :9 Magnitude Vs Frequency In simply supported Condition

Table: 7 COH Function Values

H(ch2,ch1)	X Frequency (Hz)	Y Mag (g)/(LBF)
C1	234.3750	440.1418
C2	959.3750	92.2410
C3	1031.2500	224.1603

(SIG1785_COH(ch2,ch1)) at 60° on simply supported beam (coherence values).

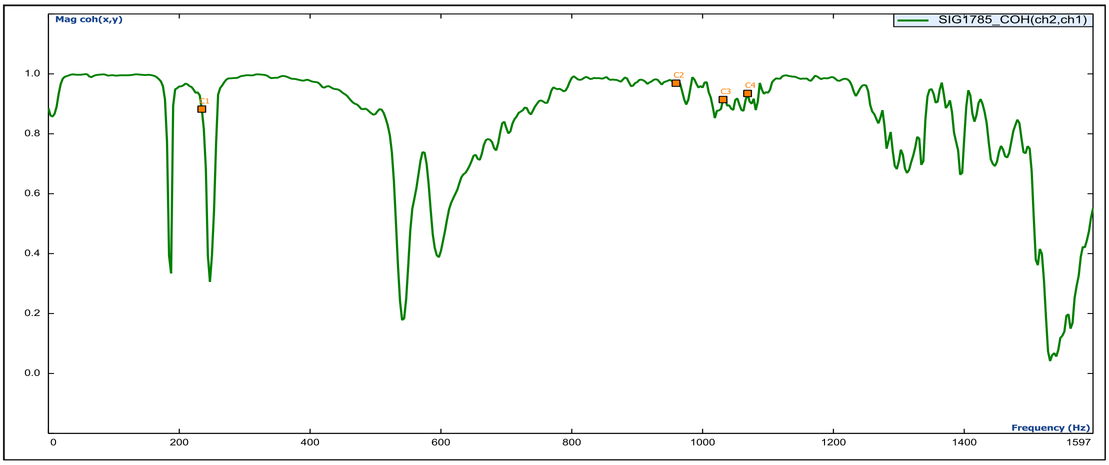

Fig No :10 Magnitude Vs Frequency In simply supported Condition

Conclusion: The present work experimentally evaluated, vibrational properties of fabricated epoxy polymer reinforced with Kevlar and basalt fibres at different orientations. The vibration test is carried out at different orientations. It is observed that the orientation (0°/-45°/45°/-45°/45°/0°) has highest values of natural frequencies at both end fixed condition.

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