Evaluation of Mechanical & Modal Analysis of Natural Fiber Composite Beams for Structural Building of Automotive

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Abstract -- Influence of fiber lengthand weight percentage on mechanical properties and free vibration characteristics are scrutinized with the use of natural fibers such as Coir fiber (CF) and Kenaf fiber (KF). The free vibrational characteristics and modal analysis are performed by using simulation technique.

I. INTRODUCTION

From decades, natural fibers in the form of reinforcements in polymer composites have been a test subject for scientists because of its growing familiarity and a wide range of applications [1]. Natural fiber is advantageous over synthetic fibers as they are renewable, eco-friendly, low in density, biodegradable and less abrasive [2]. The most commonly used plant fibers for polymer reinforcement are sisal, jute, banana, flax, coir, ramie, kenaf, hemp, Palmyra [3]. Fiber Reinforced Composite shaft (FRC) can offer an interesting mix of material abilities, which may incorporate low thickness, high quality, high solidness, and high damping esteems [4]. The most famous type of composite material is the fiber-reinforced epoxy composites, due to its high mechanical and thermal properties [5]. Coir fiber (CF) and Kenaf fiber (KF) are in good potential as reinforcement is epoxy composite [6]. Coir composites are created and their mechanical properties are assessed, at five distinctive volume divisions and lengths [7]. Coir fibers empower shear distortion system since purposes of maximum stress concentration create around the equators of such particles when the resin is focused on [8]. The % of elongation break and durability of coir fiber is higher than that of other natural fibers [9]. Coir has high microfibrillar point because of which it has low moduli and unsuitable in some viewpoint contrasted with other normal fiber as a result of its low cellulose content [10].

Kenaf fibers are reinforced with epoxy resin to frame fiber strengthened polymeric composites which enhance the mechanical strength of the composites [11]. KF are broadly considered as reasonable natural assets and a potential substitute for petroleum products and wood-pulps [12]. KF strengthened composite in seawater and watched the most astounding decrease rate in the pliable modulus [13]. KF displays numerous remarkable highlights like low feedstock and high biomass content [14]. KF showed enhanced and appealing properties in polymeric composites as support materials underneath flexural stacking conditions [15]. KF reinforcement is utilized to enhance epoxy resin performance and fiber weight proportion on the flexural properties [16]. From the brief review presented above, it can be concluded that the [17] proposed fiber is applied to enhance the mechanical properties and damping factor of the composite beam.

II. LITERATURE REVIEW

Had dissected Synergy of fiber length and substance on free vibration and damping behavior of natural fiber reinforced polyester composite shafts by (Senthil Kumar et al 2014) (Base Paper [18]). Impact of fiber length and weight rate on mechanical properties and free vibration qualities are examined. Characteristic frequencies and related modular damping estimations of the composite beam were gotten via completing the experimental modular investigation. It is discovered that an expansion in fiber content enhances the mechanical and damping properties. For SFPC, 3 mm fiber length and 50 wt% fiber content yielded better properties, though, for BFPC, 4 mm fiber length 50 wt% fiber content was the best proportion to yield better result.

Had exhibited the Effect of hardware vibration on chip arrangement and cutting powers in the machining of

fiber- reinforced polymer composites by (Weixing Xu et al 2016) [19]. This vibration effects were performed on both the Elliptic Vibration Assisted (EVA) and the customary cutting of unidirectional fiber-strengthened polymers with different fiber introductions. The fiber introduction essentially influences the chip development and cutting powers. Fiber break can happen either above or underneath the trimming way, yet that over the way rules chip arrangement. At the point when a fiber orientation is under 90°, chipping is principally through twisting initiated crack of fibers; when it is past 90°, be that as it may, chipping is for the most part by squashing the break of fibers. The EVA cutting, in any case, can limit the introduction impact by advancing more confined fiber crack.

Had exhibited the framework was described by stiffness and general reaction of un-dermonotonic and cyclic loads by (Rigoberto Burguenoet al 2001) [20]. Forced vibration testing was led as a major aspect of a level I non-dangerous evaluation. NDE) method at each of the test stages, including after disappointment. Experimental outcomes from the tests supposedly corresponded well with systematic outcomes for mode shapes and frequencies acquired through an Eigen value examination of a plane-grillage component display. It was demonstrated that both static portrayals of stiffness and assurance of mode shapes could be led with a sensible level of precision utilizing a grillage component model.

(Muruganet al 2016) [21]. had proposed Investigation on Mechanical Behavior as well as Vibration Characteristics of Thin-Walled Glass/Carbon Hybrid Composite Beams under Fixed Free Boundary Condition. The glass, carbon, and hybrid of glass/carbon overlays were created with two distinctive stacking successions by hand layup strategy and tried for assessing the mechanical properties with impressive trials. The vibration qualities of composite beams were tentatively concentrated by drive excitation procedure under settled free limit condition. The stacking cycle of beam impacts the mechanical properties and vibration qualities. Accordingly, this technique gives higher flexural quality and unbending nature of beam performs changed distortion attributes in free vibration.

Had proposed a logical examination of dynamic behavior of pultruded fiber- reinforced plastic (FRP) composite cantilever I- beams was exhibited by (PizhongQiao et al 2002) [22]. In light of a Vlasov-sort straight speculation, dynamic beam mass and stiffness coefficients, which represent both cross-area geometry and material anisotropy of the beam, were acquired. Both supernatural and polynomial shape capacities fulfilling the limit states of cantilever beams were utilized to portray the modular shapes. The impact of beam traverse length, orientation of fiber, and fiber volume division on regular frequencies was researched. Hence the systematic approach exhibited can be utilized as a proficient and flexible instrument with the expectation of free vibration investigation of FRP thin-walled structures.

Had proposed the Vibration control for a brilliant Carbon Fiber Reinforced Plastics (CFRP) composite beam impelled by piezoceramics (PZT) and Electro-Rheological Fluids (ERF) was researched by (Susumu Oda et al 2012) [23]. In this strategy, the time postponement of the reaction of the actuator was additionally contemplated. A controller for vibration concealment of the composite beam was outlined in view of the fuzzy model for ensuring its stability of the vibration control framework. This technique demonstrated the control exactness to be as higher if the time delays of input voltage as the reaction of actuators.

Had proposed free vibration and bending disappointment of overlaid solidified glass fiber/polyester composite plates with covered open segment and shut segment of stiffeners have been examined by FE (Finite Element) technique and investigated by (Tran IchThinhet al 2010) [24]. The stiffener component is a 3-noded isoperimetric beam component with 5 degrees of opportunity for every hub and the stiffeners can be situated anyplace inside the plate component. The regular frequencies of the overlaid solidified plates were resolved. This strategy demonstrated the common frequencies were in great concurrence with those computed by FE method.

Had investigated a sound absorption and vibration damping properties of flax fiber strengthened composites were portrayed and contrasted and the glass fiber reinforced composites by (Prabhakaranet al

2014) [25]. It was experimentally concluded that the sound absorption coefficient of flax fiber strengthened composites has 21.42% and 25% higher than that of glass fiber reinforced composites at higher recurrence level (2000 Hz) and lower recurrence level (100 Hz). From the vibration examine, that the flax fiber strengthened composites have 51.03% higher vibration damping than the glass fiber reinforced composites. The particular flexural quality and particular flexural modulus for flax fiber reinforced composites achieves good result. This outcome proposed that the flax fiber strengthened composites could be a viable possibility for applications which require great sound and vibration properties.

III. PROBLEM IDENTIFICATION

There are several drawbacks in the existing methods that can reduce the resistance capability, tensile strength, flexural strength and damping ratio. Some of the issues are:

- The use of polyester resin in fiber reinforced composite beam is very sensitive to UV degradation and also offers moderate mechanical and thermal properties compared to epoxy resin.
- In general, glass fiber causes some issues in combustion furnaces whereas, in natural fiber, thermal recycling is achievable [21].
- Some natural fibers have a few difficulties when utilized as reinforcements, such as lower impact strength, higher moisture absorption which leads to micro-cracking on the fiber used beams. [22, 25].
- In the existing paper, banana fiber composites showed the lowest mechanical strength compared to sisal fiber and water resistance property in sisal fiber is low [18]. Thus there is a need to understand the moisture absorption characteristics as well as mechanical characteristics of natural fibers. In order to overcome these issues and to develop optimized composite material paid the way to the proposed method.

IV. OBJECTIVES

- The main objective is to strengthen the fiber reinforced composite beam with the use of epoxy resin by using experimental and simulation analysis.
- Also, the free vibrational characteristics and modal analysis are performed for the proposed natural fiber reinforced composite such as CF & KF.
- Validation of experimental results with the hap of statistical tools and Optimizing the fiber to resin ratio for Mechanical properties.
- The performance measures of the proposed CF and KF are increased by using the Neural Network (NN) along with inspired optimization method.

V. PROPOSED METHODOLOGY

- The methodology investigates the mechanical strength and free vibrational characteristics of natural Fiber Reinforced Epoxy Composite Beam (FRECB). In the proposed work, natural fibers such as Coir Fiber (CF) and Kenaf Fiber (KF) are utilized to strengthen the reinforced epoxy composite beam.
- Initially, the developed fiber beam is subjected to impact hammer test i.e. an external force is applied to the composite beam, it tends to vibrate. This vibrational signal is measured by using the accelerometer which is attached to the end of the fiber composite beam.
- Based on the vibrational signal, free vibrational characteristics (such as damping factor, damping ratio, natural frequency response) and modal analysis are investigated for both coir and kenaf fiber reinforced epoxy composite beam.
- Then, for the mechanical strength analysis (tensile strength, flexural strength, and impact strength), the beam is developed with different fiber length and fiber content (weight %) proportion and then it is subjected to the experimental analysis.
- In order to validate the experimental data, machine learning technique is proposed, that is Neural Network (NN) along with inspired optimization method.

- The performance measures of the proposed coir and kenaf fiber increases by using the machine learning technique compared to existing fibers (Banana Fiber (BF) and Sisal Fiber (SF) reinforced polyester composite beam [18]). The proposed simulation approach is implemented in the MATLAB program.

VI. POSSIBLE OUTCOME

The proposed CF and KF fiber reinforced epoxy composite beam will give high tensile strength, flexural strength, impact strength and good resistance capability compared to the existing SF and BF fiber reinforced polyester composite beam. In addition, the proposed natural fiber offers higher damping ratio and maximum natural frequency response with the help of simulation technique.

VII. SUMMARY

Based on the experimental and simulation analysis, Coir fiber (CF) and Kenaf fiber (KF) were fabricated which give better results of proposed natural fibers in the Fiber Reinforced Epoxy Composite Beam (FRECB).

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