

Experimental and FEA analysis of Composite Leaf Spring for Natural Frequency by changing Fiber orientation

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Abstract: The work is carried out on composite leaf spring of a commercial vehicle. The purpose of this work is to carryout design and analysis of composite leaf spring with experimental design consideration and loading condition. The material of leaf spring is E-GFRC (Glass Fiber reinforced composite). The GFRC leaf springs are manufactured by hand lay-up method which were evaluated and study. The model of composite leaf spring is prepared and analyzed using ANSYS16.2 for the modal analysis under defined loading condition. The experimental and FEA result compared for validation.

Key Words: Composite Mono Leaf Spring, Vibration Analysis, FEA, FFT Analyzer.

I. Introduction

Vibration is the motion of a particle or a body or system of connected bodies displaced from a position of equilibrium. Most vibrations are undesirable in machines and structures because they produce increased stresses, energy losses, causes added wear, increase bearing loads, induce fatigue, create passenger discomfort in vehicles, and absorb energy from the system. Rotating machine parts need careful balancing in order to prevent damage from vibrations. Vibration occurs when a system is displaced from a position of stable equilibrium. The system tends to return to this equilibrium position under the action of restoring forces (such as the elastic forces, as for a mass attached to a spring, or gravitational forces, as for a simple pendulum). The system keeps moving back and forth across its position of equilibrium. A system is a combination of elements intended to act together to accomplish an objective. For example, an automobile is a system whose elements are the wheels, suspension, car body, and so forth. A static element is one whose output at any given time depends only on the input at that time while a dynamic element is one whose present output depends on past inputs. In the same way we also speak of static and dynamic systems. A static system contains all elements while a dynamic system contains at least one dynamic element. [1]

A physical system undergoing a time-varying interchange or dissipation of energy among or within its elementary storage or dissipative devices is said to be in a dynamic state. All of the elements in general are called passive, i.e., they are incapable of generating net energy. A dynamic system composed of a finite number of storage elements is said to be lumped or discrete, while a system containing elements, which are dense in physical space, is called continuous. [1]

II. Methodology

2.1 Material

The material used for leaf springs is usually a plain carbon steel having 0.90 to 1.0% carbon. The leaves are heat treated after the forming process. The heat treatment of spring steel products greater strength and therefore greater load capacity, greater range of deflection and better fatigue properties. [8]

A. Carbon Fibers: Their advantages include high specific strength and modulus, low coefficient of thermal expansion and high fatigue strength. Graphite, when used alone has low impact resistance. Its drawbacks include high cost, low impact resistance and high electrical conductivity. [8]

B. Glass Fibers: The main advantage of Glass fiber over others is its low cost. It has high strength, high chemical resistance and good insulating properties. The disadvantages are low elastic modulus poor adhesion to polymers, low fatigue strength and high density, which increase leaf spring weight and size. Also crack detection becomes difficult. [8]

2.2 Selection of Fiber

Table-1. Properties of fiber

Sr.No.	Type of Fiber	Properties
1	Glass Fiber	-
a)	E-glass	High Stiffness, high buckling, weak in shear, low cost.
b)	S-glass	High Stiffness, high buckling, weak in shear, high cost.
2	Carbon fiber	High strength, high modulus, low density, high temperature resistance, considerably high cost.
3	Ceramic	High temperature resistance, low thermal conductivity.

From the above table we have selected the E-glass fiber and resin epoxy for fabrication of composite leaf spring.



Fig. 1- Fabricated composite Leaf Spring

III. 3. Result And Discussion

3.1 Finite Element Analysis (FEA)

FEA analysis is done by changing the fiber orientation.

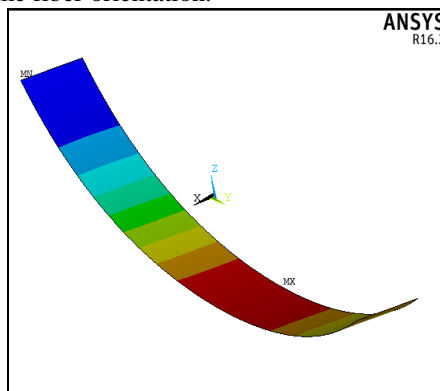


Fig.2. First mode shape of 0-90 configuration @ 31.05 Hz

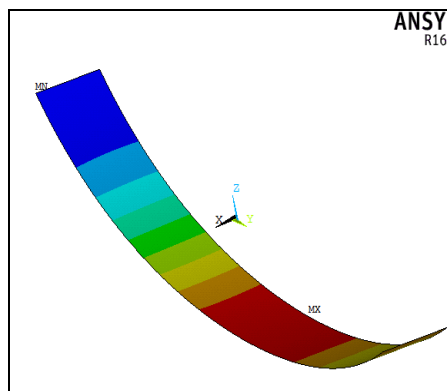


Fig.3. First mode shape of 0- 45 configurations @ 29.18 Hz

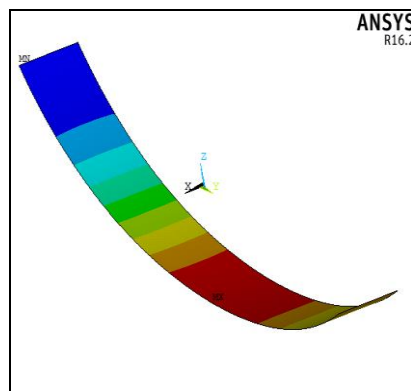


Fig.4. First mode shape of 45- 45 configuration @ 25.41 Hz

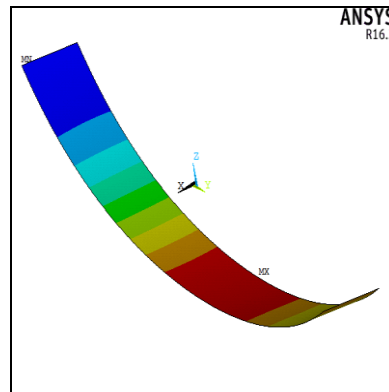


Fig.5. First mode shape of 30-60 configuration @ 26.27Hz

Table 2: Results of Natural Frequency of Glass Fiber Epoxy Composite Leaf Spring.

Fibre Orientation	Natural Frequency of First Mode in Hz
0-90	31.05
0-45	29.18
45-45	25.41
30-60	26.72

3.2 Experimental Analysis



Fig. 6. Experimental setup

Experimental analysis of the leaf spring is done on FFT analyzer.

Experimental Results of average Natural Frequency of Glass Fiber Epoxy Composite Leaf Spring is 28.17 Hz.

IV. Conclusion

1. Composite leaf spring has greater vibration absorbing capacity than conventional leaf spring
2. The natural frequency is higher for 0-90 fiber orientation and minimum for 45-45 fiber orientation.

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