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#### “A REVIEW ON LEAF SPRING FAILURE ”

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#### ABSTRACT

*We know that the spring plays very essential part of every automobile for suspension point of view. Leaf spring is the main type of suspension system which is used in many light and heavy vehicles.. Reducing weight while increasing or maintaining strength of products is getting to be highly important research issue in this modern world. When the rear wheel comes across a bump or pit on the road, it is subjected to vertical forces, tensile or compressive depending upon the nature of the road irregularity. These are absorbed by the elastic compression, shear, bending or twisting of the spring. The mode of spring resistance depends upon the type and material of the spring used. Further when the front wheel strikes a bump it starts vibrating. Composite materials are one of the material families which are attracting researchers and being solutions of such issue.*

**Key Words:** Leaf spring failure, fracture mechanism, failure modes, composites, failure analysis.

#### I. INTRODUCTION

##### 1.1. Leaf Springs

A leaf spring is the simple form of spring commonly used for the suspension in wheeled vehicles. Leaf spring is mainly made up of steel, but due to issue of weight today most of the automobile companies used composite materials for the manufacturing of leaf springs. The composite materials used like E-Glass/Epoxy, Graphite/Epoxy, and Carbon/Epoxy etc. The classification of leaf spring included as Elliptical, Semi Elliptical, Three quarter Elliptical, Quarter Elliptical, and Teraservers. The leaf spring mainly consists of different parts like Master leaf, Center bolt, central clamp, Eye, and Rebound clip. So, here in this paper we try to review all these previous journals for better understanding the work done. In previous researchers the analytics and software's determine the load carrying capacity. Material based study is used for light weight transformation of vehicles at various loading conditions used for working and checking of load durability. The paper also included the study and work which held in past and gives the brief study about the work performed by researchers in previous journals. The details of my study on previous papers are present in the next section (Literature survey). II. LITERATURE REVIEW The section here shows the review of previous journals based on study and analysis of leaf spring. The study in this section is subdivided into number of categories on the basic of work done in past. A. Analysis of Leaf Spring on the Basis of Material and Its Compositions. Shishay Amare Gebremeskel et.al [1] material plays very important role in every manufacturing process. The paper also describes and solves the major issues of vehicles weight through use of composite material E-Glass/Epoxy composite shown in Fig. 1. Their work focuses on constant cross section design, weight reduction, and design. The result shows that shear stress is much less than the shear strength ( $\tau = 3\text{mpa}$ ) and the design is safe even for flexural failure. They focus on their work for design of leaf spring used in three wheelers.



Fig.1 leaf spring

## II. LITERATURE REVIEW

**Senthil kumar et. al [2007]** has present leaf spring ingests the vehicles vibrations, shocks and thump loads(induced due to road variations from the norm) by technique for spring shirkings, with the goal that the potential essentialness is taken care of in the leaf spring and after that recollected continuously. The estimations of existing customary steel leaf springs of a light business vehicle are taken and are checked by plan estimations. Static examination of 2-D model of common leaf spring is in like manner performed using ANSYS 7.1 and differentiated and preliminary comes about [1].

**Shiva Shankar et al. [2006]** Gives introduction of composite materials made it possible to diminish the weight of the leaf spring with no decreasing on the pile passing on breaking point and strength. Studies were coordinated on the utilization of composite structures for vehicle suspension system [2].

**Malaga. Anil Kumar et al [2012].** Depicts the three different composite materials have been used for examination of mono composite leaf spring. They are E-glass/epoxy, Graphite/epoxy and carbon/epoxy. E-glass/epoxy composite leaf spring can be suggested for replacing the steel leaf spring both from solidness and empasize point of view. A comparable report has been made in steel and composite leaf spring with respect to quality and weight [3].

**H.A. Al-Qureshi [2001]** Described a single leaf, variable thickness spring of glass fiber strengthened plastic (GFRP) with near mechanical and geometrical properties to the multi leaf spring, was illustrated, made and attempted. Glass fiber sustained plastic (GFRP) presents positive conditions over graphite/epoxy, for instance, lower affectability to parts, impact and wear hurt. The leaf spring model was believed to be a figuratively diminished, steady width shaft passing on an engaged burden and thought to be even with different line lengths for the two limbs of the spring. A restricted part program is used to show the direct of leaf spring. [4].

**M. Raghavendra et al.[2012]** Portrays plan and examination of secured composite mono leaf spring. Weight decline is as of now the central issue in vehicle organizations. In the current work, the estimations of a current mono steel leaf spring of a light vehicle is taken for showing and examination of secured composite mono leaf spring with three differing composite materials to be explicit, E-glass/Epoxy, S-glass/Epoxy and Carbon/Epoxy exposed to a similar burden as that of a steel spring. Appeared differently in relation to mono steel leaf spring the secured composite mono leaf spring is found to have 47% lesser problems, 25%~65% higher robustness, 27%~67% higher repeat and weight reducing of 73%~80% is cultivated [5].

**Smita C. Saddu, et. al [2014]** has delineate the assessment of steel and composite material leaf spring. By then these results are differentiated and that of the exploratory outcomes. The results is deduced that nerves made in the composite material leaf spring is less as differentiated and that of the steel material leaf spring, so it exhibits that composite material is more remarkable and mild than the customary leaf spring with relative framework assurance. The assessment is done through CATIA V5R19 [6].

**M. Venkatesan et. al [2012]** Described the arrangement and exploratory examination of composite leaf spring made of glass fiber invigorated polymer. The objective was to take a gander at the store passing on cutoff, solidness and

weight hold assets of composite leaf spring with that of steel leaf spring. A weight decreasing of 76.4% was cultivated by using upgraded composite leaf spring [7].

**Pankaj Saini [2013] et al.** the composite material were they used was glass fiber fortified polymer (E-glass/epoxy), carbon epoxy and graphite epoxy is used against customary spring. The arrangement boundaries were picked and analyzed with the objective of limiting of the composite leaf spring when stood out from the steel leaf spring [8].

**Shishay Amare Gebremeskel et. al [2012]** In this a singular E-glass/Epoxy leaf spring is illustrated and reenacted taking after the arrangement norms of the composite materials considering static stacking figuratively speaking. It is exhibited that the resulting framework and propagation bothers are much underneath the quality properties of the material, satisfying the most outrageous push dissatisfaction establishment. The arranged composite leaf spring has moreover achieved its palatable fatigue life. This particular arrangement is made especially for light weight three wheeler vehicles [9].

**M. M. Patunkar et. al [2011]** they have done examination Design, collecting, testing and examination of mono composite leaf spring under static stacking condition. The material decided for the investigation was glass fiber strengthened plastics. A spring with consistent width and thickness was made by hand layup framework .The examinations were driven on load testing machine (in various burden condition) and numerical assessment was finished by methods for (FEA) using ANSYS programming. Come about shows that, the tensions and shirking of legitimate data will cut down when differentiate and manufacturing and examined data [10].

**Amrita Srivastava et. al [2002]** Comparative assessment between steel leaf spring and Jute/E glass braced Epoxy leaf spring. The cross variety composite leaf spring is found to have lesser weight, lesser cost, lesser weights and higher strength. The CAD models of Leaf spring are masterminded in Unigraphics NX6 and imported in static fundamental assessment workbench of Ansys 14.5 where restricted part examination (FEA) is performed. The arrangement objectives are nerves and preoccupations [11].

**Aggrwal M.L et. al [2007]** The exhaustion nature of 65Si7 spring steel has been evaluated likely as a segment of shot peening boundaries for the application in vehicle vehicles [12].

**M.L. Aggrawal et al. [2005]** Fatigue nature of shot peening leaf spring from research office trial of EN45 steel spring is determined. An impressive proportion of examination has been done to upgrade weariness nature of material by making compressive waiting push field in there surfaces through shot peening [13].

**B. Vijaya Lakshmi, et. al [2006]** are consider the stack passing on breaking point, robustness and weight venture assets of composite leaf spring with that of steel leaf spring.. The estimations of a current conventional steel leaf spring of a Heavy business vehicle are taken Same estimations of routine leaf spring are used to make a composite multi leaf spring using E-GLASS/EPOXY, C-GLASS/EPOXY, S-GLASS/EPOXY unidirectional spreads. Master/Engineer writing computer programs is used for showing and COSMOS is used for assessment. Static and Dynamic examination of Leaf spring is performed using COSMOS [14].

**Ashish V. Amrute et al. [2007 ]** Oversees replacement of standard steel (65si7) leaf spring of a light business vehicle with composite leaf spring using E-glass/Epoxy. Estimations of the composite leaf spring are to be taken as same estimations of the conventional leaf spring. The objective is to take a gander at the load passing on breaking point, bothers and weight save assets of composite leaf spring with that of steel leaf spring. The restricted segment showing and assessment of a multi leaf spring has been finished. The CAE examination of the multi leaf spring is performed for the shirking and tensions under portrayed stacking conditions. The theoretical and CAE results are dissected for endorsement [15].

**Minoru Iwata et al. [2009]** Presented curved and rotationally blocked structure into polyimide chain using unbalanced dianhydride and got as of late made polyimide having a not too bad thermo malleability. For the appraisal of the as of late made polyimide on radiation quality, they lit the polyimide with proton bar, evaluated its sturdiness by using mechanical properties, and differentiated and routine business polyimide. From the preliminary comes to fruition, they could assert the high radiation resistivity of as of late made thermoplastic polyimide [16].

**Parkhe Ravindra et. al [2014]** Describes plan and examination of composite mono leaf spring with Carbon/Epoxy composite materials is shown and exposed to a similar burden as that of a steel spring. The diagram necessities were bothers and redirections. The composite mono leaf springs have been shown by thinking about Varying cross-section, with unidirectional [17].

**Prof.A.V.Javir1 et al [2016]** both are concentrates on leaf spring in which springs are one of the most established suspension segments they are still every now and again utilized, particularly in business vehicles. The previous writing study shows that leaf springs are planned as summed up power components where the position, speed and direction of the pivot mounting gives the response powers in the body connection positions. Another part must be engaged, is the vehicle business has demonstrated expanded enthusiasm for the supplanting of steel spring with composite leaf spring because of high solidarity to weight proportion. Accordingly, investigation of the composite material turns out to be similarly essential to consider the conduct of Composite Leaf Spring. The target of this report is to introduce demonstrating and examination of composite mono leaf spring (GFRP) and think about its outcomes. Displaying is finished utilizing Pro-E 5.0 and Analysis is done by utilizing ANSYS 13.0 software.[18]

**K.Ashwini et. al. [2018]** This audit is intended to be a far reaching hotspot for planning a leaf spring utilizing different composites as the Automobile businesses are demonstrating distinct fascination for supplanting steel leaf spring with that of a composite leaf spring to acquire decrease in weight, which is a powerful measure for vitality protection as it diminishes by and large fuel utilization of the vehicle [19].

**Mayur D. Teli et. al [ 2019]** In electric vehicle portion it is altogether seen that the overabundance weight of batteries (>10% of in general weight) lessens the movement scope of electric vehicle. This abundance weight of the batteries causes higher pressure of the springs and likewise decrease the space accessible for suspension travel which lessens the life of suspension and solace to the traveler. To conquer these issues, suspension should be reconfigured as far as geometry and material of the suspension. Considering above changes in suspension framework,, which is semi-curved covered sort. The CAD model was made in CATIA and imported to ANSYS. Investigative, Experimental and Finite Element Analysis were done on composite model. Weight enhancement of 67.70% for GFRP is seen in contrast with EN 46 material. For avoidance 3.93%, for solidness 4.06%, for vitality ingested 3.94% and for normal recurrence is 5.25% contrast is watched. [20]

### III. RESEARCH GAP

Weight decrease is currently the principle issue in car ventures. To decreasing load of the vehicle business has been demonstrating enthusiasm for the supplanting of customary steel spring with composite leaf spring because of high quality and weight proportion at a similar burden over the composite leaf spring and furthermore lessening the erosion obstruction, commotion creation and confine street incited vibration for comfort riding condition. The composite materials acquaint with defeat all these condition and gives better driving comfort. It is found in the writing overview there are heaps of examination work has done by the analysts to less with the customary Steel leaf spring. The limited component strategy was utilized by analyst to investigate the outcomes were it utilized in genuine condition. In present work nine composite materials were utilized as composite material as an option of traditional leaf spring. The most extreme pressure, avoidance and weight decrease were determined from utilizing limited component examination.

### IV. PROBLEM STATEMENT

As weight assumes a significant job in choosing the effectiveness of a car. The leaf spring utilized for the most part is made of steel which are very cumbersome and one of the expected things for weight decrease in cars since it accounts 10-20% spring weight conveyed by its own. To keep away from this hindrance and solace riding characteristics an endeavor is to be made in supplanting the material with cutting edge materials like composite materials. This work is predominantly centered around the usage of Thermoplastic polyimide with 30% carbon fiber fortified (composite material) by supplanting steel En 45 in traditional leaf springs of a suspension framework to lessen item weight, improving the security, solace and solidness.

## V. METHODOLOGY

ANSYS is broadly useful limited component examination (FEA) programming bundle. Limited Element Analysis is a numerical technique for deconstructing an unpredictable framework into little bits (of client assigned size) called components. The product actualizes conditions that administer the conduct of these components and illuminates them all; making a thorough clarification of how the framework goes about in general. These outcomes at that point can be introduced in classified, or graphical structures. This kind of investigation is ordinarily utilized for the structure and improvement of a framework excessively complex to break down by hand. Frameworks that may fit into this classification are excessively mind boggling because of their geometry, scale, or administering conditions.

ANSYS is the standard FEA showing device inside the Mechanical Engineering Department at numerous schools. ANSYS is likewise utilized in Civil and Electrical Engineering, just as the Physics and Chemistry offices.

ANSYS gives a practical method to investigate the exhibition of items or procedures in a virtual situation. This kind of item advancement is named virtual prototyping.

With virtual prototyping methods, clients can repeat different situations to improve the item some time before the assembling is begun. This empowers a decrease in the degree of hazard, and in the expense of inadequate plans. The multifaceted idea of ANSYS likewise gives a way to guarantee that clients can see the impact of a plan all in all conduct of the item, be it electromagnetic, warm, mechanical and so forth.

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