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A Review Paper on "Stress Analysis of Leaf Spring by Using Photo Elasticity Technique"

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Abstract - *The point of this survey paper is to speak to a general report on the plan, examination of leaf spring. The suspension framework in a vehicle altogether influences the conduct of vehicle, i.e. vibration qualities including ride comfort, solidness and so on. Leaf springs are regularly utilized as a part of the vehicle suspension framework and are subjected to a huge number of differing pressure cycles prompting exhaustion disappointment. A great deal of research has been improved the situation enhancing the execution of leaf spring. Presently the car business has demonstrated enthusiasm for the supplanting of steel spring with composite leaf spring. When all is said in done, it is discovered that fiberglass material has better quality trademark and lighter in weight as contrast with steel for leaf spring. In this paper there is surveyed a few papers on t he plan and examination leaf spring execution and weariness life forecast of leaf spring. There is additionally the investigation of disappointment in leaf spring. Additionally the investigation of leaf spring with ANSYS is finished. The automakers can diminish item advancement cost and time while enhancing the security, solace, and solidness of the vehicles they create. The prescient capacity of CAE instruments has advanced to the point where a significant part of the outline confirmation is currently done utilizing PC reenactment as opposed to physical model testing.*

Key Words: Finite Element Analysis, Finite Element Method, CAE tool, Leaf spring.

1. INTRODUCTION:

Photoelasticity is a nondestructive, entire field realistic pressure examination strategy in view of an optomechanical property called birefringence, controlled by numerous straightforward polymers. Joined with other optical components and lit up with a common light source, a stacked photoelastic example (or photoelastic covering connected to a standard example) displays periphery designs that are identified with the distinction between the essential worries in a plane ordinary to the light engendering course. The strategy is utilized principally to analyze two dimensional plane issues, which is the accentuation in these notes. A strategy called pressure solidifying enables the technique to be reached out to three dimensional issues. Photoelastic coatings are utilized to examine surface worries in assemblages of complex geometry.

The photoelastic technique depends on a novel property of some straightforward materials, specifically, certain plastics. At the point when the model is pushed and a beam of light enters along one of the headings of foremost pressure, the light is separated into two segment waves, each with its plane of vibration (plane of polarization) parallel to one of the staying two Principal (planes on which shear pressure is zero). Moreover, the light goes along these two ways with various speeds, which rely on the extents of the staying two main worries in the material. The episode light is settled into parts having planes of vibration parallel to the headings of the chief anxieties. Since these waves navigate the body with various speeds, the waves develop with another stage relationship, or relative impediment. In particular, the relative hindrance is the distinction between the quantities of wave cycles experienced by the two beams going inside the body. This wonder is called twofold refraction or birefringence, and is the same as displayed by certain optical precious stones — however in photoelasticity the twofold refraction is fake, being controlled by the condition of pressure or resist each point in the body. The two waves are united in the photoelastic polariscope, and allowed to come into optical impedance. In the classification of optical obstruction, the dim and light groups acquired are called borders, and the periphery arranges is characterized as the estimation of N along the band under thought.

Photoelasticity is a test strategy for anxiety investigation that is especially valuable for individuals having muddled geometry, confounded stacking conditions, or both. For such cases, investigative strategies (that is, entirely scientific techniques) might be awkward or unimaginable, and examination by a test approach possibly more proper. While the ideals of exploratory arrangement of static, versatile, two-dimensional issues are presently to a great extent eclipsed by logical strategies, issues including three-dimensional geometry, numerous segment congregations, dynamic stacking and inelastic material conduct are normally more amiable to trial investigation.

The name photoelasticity mirrors the idea of this test strategy: photograph suggests the utilization of light beams and optical methods, while versatility delineates the investigation of stresses and distortions in flexible bodies. Through the photoelastic-covering strategy, its space has stretched out to inelastic bodies, as well. Photoelastic examination is generally utilized for issues in which stress or strain data is required for expanded areas of the structure. It gives quantitative confirmation of exceptionally focused on

territories and pinnacle worries at surface and inside purposes of the structure and regularly similarly vital, it recognizes zones of low feeling of anxiety where basic material is used wastefully.

1.1 Four Basic Technique of Photoelasicity:

1. Two dimensional photoelasticity: - A two dimensional model is studied.
2. Three dimensional photoelasticity: - A three dimensional model is made and stresses are frozen in this model.
3. Photoelastic coating analysis: - thin coating of double refracting plastic is cemented to the surface of the model and only surface can be obtained.
4. Digital photoelasticity: - new technique wherein the fringes are calibrated in a digital polariscope to minimize human error.

1.2 Commonly Used Photoelastic Material:

1. Epoxy resin
2. Araldite CT 200 (RESIN) / HT901(HARDENER)
3. Araldite CY230 (RESIN) /HY951 (HARDENER)
4. Polycarbonate
5. Glass
6. Celluloid
7. Urethane rubber
8. Catalin
9. Colombia resin CR-39
10. Homalite

1.3 Polariscope:

The optical instrument used in photoelastic stress analysis is called polariscope. The observations are in the form of optical fringes called Isoclinics and Isochromatics, which are formed when the photoelastic model is placed in its field and loaded.

Stresses are produced as a result of mastication forces imposed on a structure. The distribution or pattern of these stresses is a result of the angle of the load and the geometry of the object. Photoelastic stress analysis involves applying a given stress rate to a model and utilizing the induced Brief ringence of the material to examine the stress distribution within the model. The magnitude and direction of stress at any point can be determined by examining the fringe pattern. In this study photoelastic analysis was carried out to obtain a more authentic result.

1.4 Relevance:

Leaf springs are mainly used in suspension systems to absorb shock loads in automobiles like light motor vehicles, heavy duty trucks and in rail systems. The advantage of leaf spring over helical spring is that the ends of the spring may be guided along a definite path as it deflects to act as a structural member in addition to energy absorbing device. It carries lateral loads, brake torque, driving torque in addition to shock absorbing makes leaf spring a valuable design tool. Leaf spring is an excellent example of how absorb shock loads in automobiles this principle is put to use to control vehicle motion.

1.5 Input information of Mono Leaf Spring:

Component	Mono Leaf Spring
Vehicle Model	Mahindra Jeep
Suspension	Rear Leaf
Span Length	700 mm
Width	40 mm
Thickness	4 mm
Vehicle weight at rear axle	1700 kg.

2. LITERATURE REVIEW:

1) **Malaga. Anil Kumar, T.N.Charyulu, Ch.Ramesh** had examined that, car industry has demonstrated expanded enthusiasm for the supplanting of steel spring with composite leaf spring because of high quality to weight proportion. This work manages the substitution of multi - leaf steel spring with mono composite leaf spring. Suspension framework in a car decides the riding solace of travelers and the measure of harm to the vehicle. The fundamental capacity of leaf spring get together as suspension component isn't just to help vertical load, yet additionally to disconnect street prompted vibrations. The goal of his paper is to supplant the multi-leaf steel spring by mono composite leaf spring for a similar load conveying limit and firmness. Since the composite materials have more flexible strain vitality stockpiling limit and high quality to - weight proportion when contrasted with those of steel. It is conceivable to lessen the heaviness of the leaf spring with no diminishment on stack conveying limit and solidness. The outline requirements were restricting burdens and relocation. Mode ling and investigation of both the steel and composite leaf springs have been finished utilizing ANSYS programming.

2) **Baviskar A. C., Bhamre V. G., Sarode S. S.** spoken to a general report on the outline, examination of leaf spring. The suspension framework in a vehicle fundamentally influences the conduct of vehicle, i.e. vibration qualities including ride comfort, soundness and so forth. Leaf springs are regularly utilized as a part of the vehicle suspension framework and are subjected to a large number of fluctuating pressure cycles prompting exhaustion disappointment. A ton of research has been improved the situation enhancing the execution of leaf spring.. In this paper there is checked on a few papers on the plan and examination leaf spring execution and weariness life expectation of leaf spring. There is additionally the investigation of disappointment in leaf

spring. Likewise the investigation of leaf spring with ansys is finished. The automakers can diminish item advancement cost and time while enhancing the wellbeing, solace, and strength of the vehicles they deliver. The prescient ability of CAE devices has advanced to the point where a significant part of the plan confirmation is currently done utilizing PC reenactment instead of physical model testing.

3) **M.Venkatesan, D.Helmen Devaraj** Described plan and trial investigation of composite leaf spring made of glass fiber fortified polymer. The goal is to analyze the heap conveying limit, firmness and weight reserve funds of composite leaf spring with that of steel leaf spring. The outline requirements are stresses and diversions. The measurements of a current regular steel leaf spring of a light business vehicle are taken. Same measurements of traditional leaf spring are utilized to create a composite multi leaf spring utilizing E-glass/Epoxy unidirectional covers. Static examination of 2-D model of customary leaf spring is additionally performed utilizing ANSYS 10 and contrasted and test comes about. Limited component investigation with full load on 3-D model of composite multi leaf spring is finished utilizing ANSYS 10 and the diagnostic outcomes are contrasted and exploratory outcomes. Contrasted with steel spring, the composite leaf spring is found to have 67.35% lesser pressure, 64.95% higher solidness and 126.98% higher characteristic recurrence than that of existing steel leaf spring. A weight lessening of 76.4% is accomplished by utilizing advanced composite leaf spring.

4) **S. Kanakambara Rao** had demonstrated that, a two dimensional photograph flexible model investigation has been embraced to break down the stone work infill conduct in an in-filled edge against racking burden. The pressure dispersion is examined for the relative firmness of the casing and infill, equivalent to 3.5.The model tried is composite, created utilizing Aluminum for outline and araldite AY103 with hardener HY 951 as the infill material. Perceptions of the model put in the photo– flexible seat uncovered the noticeable picture of edges over the entire zone of the infill from which the pressure circulation is precisely clear anytime for both the course and greatness. The outcomes show that the photograph versatile technique can be viably used to think about the flexible conduct of in-filled edges.

5) **José L.F. Freire** had contemplated exploratory systems that utilization properties of light spreading through stacked or twisted parts to decide and investigate the relative relocations in the material with a specific end goal to set up their strain and stress fields. Photoelasticity is a branch of Photomechanics. It utilizes models developed from materials straightforward to the light being utilized. These materials show birefringence under connected pressure and are seen under polar ized light utilizing an instrument called a polariscope. The photoelastic reaction comprises of two groups of edges – isochromatic and isoclinic – which are seen in the polariscope. Photoelasticity might be connected to models in the research center or to models in the field, and in addition to 2D or 3D thinks about. Along these lines, it is an entire field strategy. In spite of the fact that the optical reaction demonstrates pressure circulations over a moderately expansive spatial measurement, it all things considered takes into account an exact assurance of stress states in restricted territories or at particular purposes of a segment. Therefore, photoelasticity shows not just the most stacked zones of the watched part, yet can likewise give precise pressure esteems at any basic point.

3. PROPOSED WORK:

3.1 Problem Statement:

The photoelasticity techniques will be used to study stresses and stress distribution in three dimensional models subjected to static loading conditions. However, the calculation of maximum bending stress of leaf spring is three dimensional problems. The accurate evaluation of stress state and distribution of stress is complex task. Thus we have to analyze the stress pattern by using 3D Photoelasticity techniques. So it is decided to find the stresses & deformation in leaf spring by using 3D photoelastic technique. Also, the stresses and stress distribution in spring can be determined with the finite element method.

3.2 Methodology:

Phase I- Analytical Method

This includes theoretical calculations of leaf spring i.e. calculations of forces and bending strength using mathematical equations.

Phase II- Experimental Method

- Three dimensional photoelastic models of a leaf spring of araldite resin and hardener mixture will be prepared.
- Suitable loading frame will be designed and fabricated to show the actual working conditions.
- The loaded models will be kept in stress freezing oven to undergo stress freezing cycle.
- Slicing of the models will be done by using a properly designed slicing plan to get maximum information about Stresses. For this purpose, various directions of slicing planes will be carefully selected.
- Stress distribution in leaf spring will be carried out by using polariscope.

Phase III –Finite Element Method

FE analysis will be carried out by using following steps.

- Modeling of Leaf spring using CATIA V5 software.
- Selection of proper element for meshing.
- Specifying material properties like modulus of elasticity, poissions ratio, etc.
- Applying boundary conditions and constraint.
- Applying the forces.
- Post processing and result summery.

Phase IV –Comparison of the results

Finally the results obtained experimentally and those obtained by Finite Element method will be compared, interpreted and conclusions will be drawn.

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