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Design and Fabrication of Solar Dryer Using Waste Metal Cans

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Abstract*: The methods for heat transfer augmentation are relevant to several engineering applications. In recent years, the high cost of energy as well as material has resulted in an increased effort and aimed at producing more efficient heat exchange equipment. There is a necessity for minimization of a heat exchanger in specific applications, such as aerospace application, through an augmentation of heat transfer. For this purpose a pipe in pipe heat exchanger is used to improving the methods of heat exchange between two fluids which are at different temperatures.*

In order to improve heat exchanger performance in a better way a twisted tape is inserted into the inner pipe. These types of twisted tape inserted heat exchangers useful in both overhead condensers and compression inter stage coolers etc. The main objective of the project is to create turbulence in the hot fluid tunnel with the help of twisted tape inserts so that an increase in the heat transfer coefficient can be identified.

Keywords: *Twisted tape, Turbulence, Heat exchanger*

I. Introduction

The suspension of leaf spring is one of the potential items for weight reduction in automobile as it accounts for ten to twenty percent of the unsprung weight. The introduction of composite materials has made it possible to reduce the weight of the leaf spring without any reduction on load carrying capacity and stiffness. Energy conservation is one of the most important objectives in any vehicle design and reduction of weight is one of the most effective measures for energy conservation as it reduces overall fuel consumption of the vehicle. Because of composite material's high elastic strain energy storage capacity and high strength-to-weight ratio compared with those of steel. FRP springs also have excellent fatigue resistance and durability. But the weight reduction of the leaf spring is achieved not only by material replacement but also by design optimization. The leaf spring should absorb vertical vibrations, shocks and bump loads by means of spring deflection so that the potential energy is stored in the leaf spring as strain energy and then released slowly. The specific elastic strain energy is inversely proportional to the density and young's modulus. The automobile industry has shown increased interest in the replacement of steel leaf spring with fiber glass composite leaf spring because FRP composites possess lower young's modulus, lower density and lesser weight as compared to steel. Recently natural fibers have been receiving considerable attention as substitutes for synthetic fiber reinforcements such as glass in plastics due to their low cost, low density, acceptable specific strength, fairly good mechanical properties, eco-friendly and biodegradability characteristics.

In actual practice, the load rate and fatigue life under specified range are determined experimentally. The process of experimental fatigue life prediction of leaf springs is a time consuming process, that is, for the fatigue life 100000 cycles, the experimental procedure will consume approximately 2-3 days. For the assessment of experimental fatigue life, a full scale leaf spring testing machine is required. The leaf spring is mounted in the machines the condition of the vehicle, the fatigue test stroke is determined, and the leaf spring is tested from maximum stress to minimum or initial stress. As there are a number of factors responsible for fatigue life enhancement like material processing, loading, surface, size, and environmental factor, it is mandatory that the fatigue life should be determined by considering these factors. The engineers working in the field of leaf springs design are facing a challenge to devise a fatigue life assessment method which is reliable and consumes less time. Although the analytical or simulation techniques provide an approximate fatigue life, the validation of these results through experimental testing is mandatory.

II. Methods

For achieving the objective of the paper a flow chart is prepared which shows various steps taken into consideration. The flow chart is shown in figure.

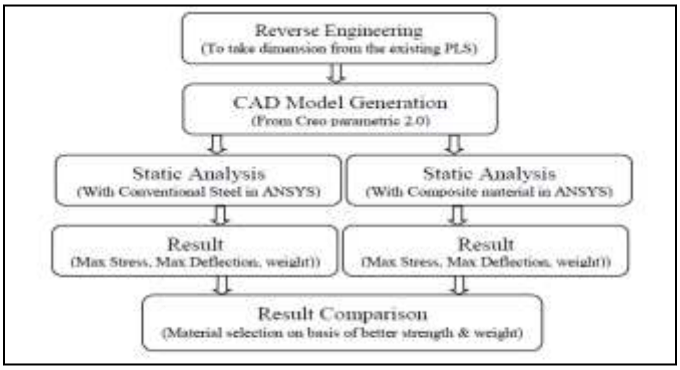

Fig.1: Methodology

III. Design And Analysis

Procedure to be followed:

- Selection of Vehicle (Tata Ace).
- Measurement of Parameters of present leaf spring.

Analysis of different leaf in ANSYS 14

- Manufacturing the composite leaf spring.
- Testing of different leaf on the fatigue testing machine.

Components to Be Design:

a) Master leaf
b) Graduated leaf

For the purpose of analysis, the leaves are divided into two groups namely, master leaf along with graduated-length leaves forming one group and extra full-length leaves forming the other. The following notations are used in the analysis.

t = Thickness of Leaves.
b = Width of Each Leaf.
N = No of Leaves.
W = Maximum Load.
L = Length of Cantilever or half the length of semi-elliptic spring (mm)
E = Modulus of Elasticity of Material.
W.L = Maximum Bending Moment in the Centre (M)
n_f = Number of full length leaves.
n_g = Number of graduated leaves.
n = Total number of leaves (Full length leaves + Graduated leaves)
P = Force applied at the end of the spring (N)
P_f = Portion of P taken by the extra full-length leaves (N)
P_g = Portion of P taken by the graduated-length leaves (N)

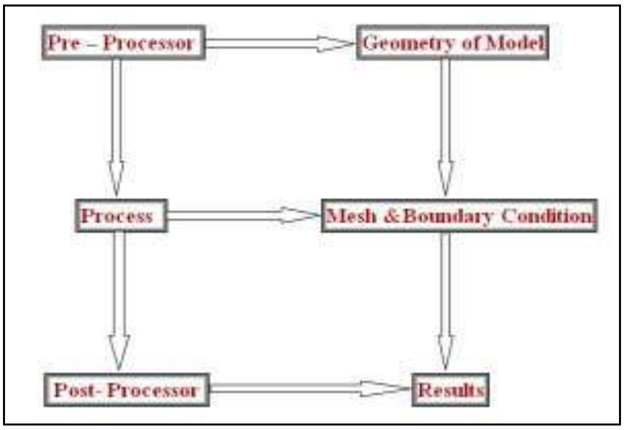

Fig.2 Block Diagram of the Proposed System

IV. Optimization

Optimum Design Procedure for Normal Specifications:

1. Select independent geometrical parameters: Select independent geometrical parameters for the mechanical element which uniquely define the geometry of the mechanical element. If the choice exists select the geometrical parameters which are either specified or limited.
2. Decide objective of optimum design: Design the objective of optimum design.
3. Write P.D.E: Write the P.D.E. which expresses the quantity to be optimized. If possible, write this equation in terms of groups of functional requirement parameters, material parameters and geometrical parameters.
4. Write S.D.Es and limit equations: Write all subsidiary design equations, which express the functional requirements and undesirable effects other than the quantity to be optimized. Write all limit equations, for functional requirements parameters, undesirable effect parameters, materials parameters and geometrical parameters. Indicate loose limits if any.
5. Classify parameters: Classify all parameters included in P.D.E., S.D.E. and limit equations.
6. Combine S.D.Es with P.D.E: Combine all subsidiary design equations with P.D.E. by eliminating only unspecified and unlimited parameters. Generally one unspecified and unlimited common parameter is eliminated from P.D.E for each S.D.E.
7. Determination of variation of optimum design quality: Determine the variation of optimum design quality with respect to each independent parameter or independent parameter group in the developed P.D.E.
8. Impose limit equations on P.D.E.: Using limit equations, determine and substitute the optimum value for each independent parameter in developed P.D.E .
9. Write final P.D.E. in terms of parameter groups: Write the P.D.E. in terms of groups of functional requirement parameters including undesirable effects, material parameters and geometrical parameters. This is known as final P.D.E.
10. Select optimum material: From the final P.D.E. using the material parameters group, select the optimum material. This material parameter group is known as material selections factor and its value will determine the optimum available material.
11. Determine optimum values of geometrical parameters: The optimum values for the eliminated geometrical parameters are obtained by solving the original subsidiary design equations.

V. Results

From the results of static analysis of steel leaf spring, it is seen the displacement of leaf spring is 30.745 mm which is well below the camber length of leaf spring. It is seen that the maximum bending stress is about 422 MPa, which is less than the yield strength of the material. The FEA results are compared with the theoretical results and found that the theoretical result and FEA result are nearer to each other.

Material	Load	Theoretical Deflection (mm)	FEA Deflection (mm)
65Si7	3801	36.61	30.745
E-glass/Epoxy	3801	40.4696	33.987
/Carbon/Epoxy	3801	45.23	36.485
Graphite/Epoxy	3801	26.15	21.976

Table 1: Comparison between Theoretical and FEA Results

After that the multi leaf spring with different composite material is analyzed in ANSYS-14 with same dimension and same boundary condition as that of conventional leaf spring, showing bending stress and deflection under same load. The comparison between steel leaf spring and composite leaf spring for deflection and bending stress results from the ANSYS is shown in the Table.

Material	Load(N)	Deflection(mm)	Stress(N/mm^2)	Strain Energy(mJ)
65Si7	3801	30.745	421.1	619.03
E-glass/Epoxy	3801	33.987	422	685.64
Carbon/Epoxy	3801	36.485	422.45	736.73
Graphite/Epoxy	3801	21.976	424.19	445.54

Table.2 Comparison of FEA Results for Different Materials

Fig.3: Analysis Of Carbon/Epoxy leaf spring

Fig.4 shows the comparative explanation about the weight, cost, stiffness and deformation of the conventional steel leaf spring, glass fiber leaf spring and sandwich of glass and carbon fiber leaf spring.

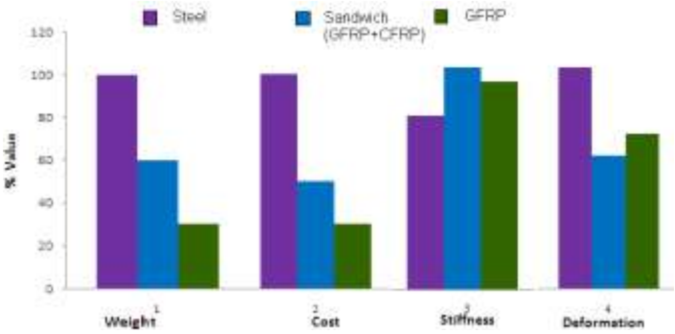

Fig.4 Comparision between conventional and composite material.

VI. Conclusion & Research Challenges

- A semi-elliptical multi leaf spring is designed for a four wheel automobile and replaced with a composite multi leaf spring made of E-glass/epoxy composites.
- Under the same static load conditions the stresses and the deflection in leaf springs are found with great difference. Stresses and deflection in composite leaf springs is found out to be less as compared to the conventional steel leaf springs.
- All the FEA results are compared with the theoretical results and it is found that they are within the allowable limits and nearly equal to the theoretical results.
- E-glass/epoxy composite leaf spring can be suggested for replacing the steel leaf spring both from stiffness and stress point of view.

Totally it is found that the composite leaf spring is the better that of steel leaf spring. Therefore, it is concluded that composite multi leaf spring is an effective replacement for the existing steel leaf spring in vehicles.

For future work, we anticipate that the further reduction in weight is possible by means of applying the modern shape optimization techniques to achieve an effective shape of the leaf spring. Based on these investigations will be further performed and in future the shape optimization can lead us to a proper shape of the composite leaf spring.

- Now a day there is need of weight reduction in Light Utility Vehicle, So by using composite leaf spring in these vehicles we will get sophisticated design.
- By modifying the properties of material and design parameters composite leaf spring can be use in the Heavy Duty Vehicle also.
- Nowadays composite leaf spring is convenient to use only on expressways vehicles. After improving the quality of roads it can be used in rural area's vehicle also.
- This world is now replacing conventional accessories by deriving new composites and nano material in metallurgical research.
- With tremendous improvement in all the accessories of vehicle, new generation of automotives will be capable to reach customer's satisfaction.

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