

## Article Info

Received: 07 Jan 2021 | Revised Submission: 28 Apr 2021 | Accepted: 05 May 2021 | Available Online: 15 Jun 2021

## Designing and Analyses of Leaf Spring Suspension System using Creo Parametric 2.0

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### ABSTRACT

This paper presents various aspects of Leaf Spring suspension system, its Analysis and Design. A suspension system isolates the vehicle from wheel and road vibration and absorbs most of the shock. In this paper a design as well as analysis has been done of a Leaf spring suspension system. For the research, designing has been done in Creo Parametric 2.0 software. Different design parameters have been reviewed and optimization of the major parameters is shown as given by research that affects suspension over Creo Parametric 2.0 Software. At last, the results have been displayed with various graphs.

**Keywords:** Leaf spring; Suspension system; Strain energy; Creo parametric.

### 1.0 Introduction

A suspension system of an automobile is a spring, which expands and regains its original space when load is applied on it. Leaf spring suspension system is a type of suspension system which acts as a spring in an automobile. A Suspension of an automobile acts in absorbing shocks, vibrations, and hence acts as a damper. Suspension systems have ability to absorb and store energy (strain energy) to make ride more comfortable.

Leaf spring suspension system is most widely used in heavy automobile vehicles due to its high load bearing capacity. A leaf spring suspension system comprises of various steps known as blades.

The top most leaf is known as master leaf it is the longest one and it has eyes at its ends. The remaining leaves supporting the master leaf are known as graduated leaves.

#### 1.1 Types of leaf spring

- Semi-elliptical spring
- Quarter-elliptical spring
- Three-quarter elliptical spring
- Transverse spring
- Full elliptical spring
- Platform type spring

### 2.0 Principle behind Working of Leaf Spring Suspension

This suspension system consists of some leaf springs which combines together and acts as a suspension body in an automobile. Further advancement introduced composites, which are helpful in designing a suspension having better ride quality without increasing cost. In the designing of suspension system strain energy is considered.

$$U = \sigma^2 / pE \quad \dots(1)$$

Here,  $\sigma$  is known as strength, E is known as Young's Modulus of the spring material and p is known as density.

#### 2.1 Advantages of leaf spring

The advantages of leaf spring are that the Leaf spring gives large amount of support between the vehicle's chassis and the wheel. Leaf spring suspension can bear huge load due to their tight knit structure, that's why heavy-duty vehicles use them.

### 3.0 Designing of Leaf Spring

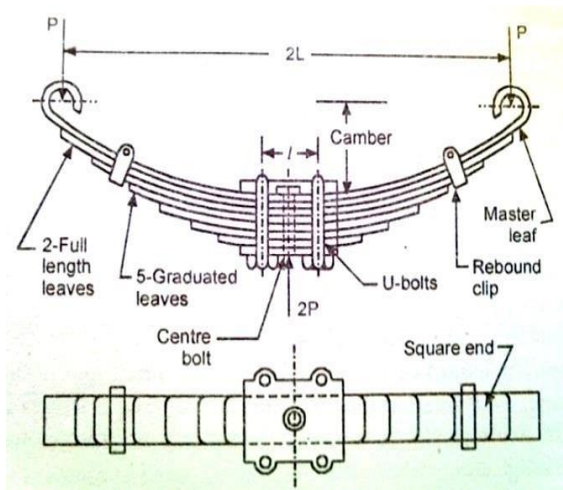
Leaf springs are oldest suspension systems that are used in commercial vehicles. Leaf spring is one of the key components of vehicle suspension

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system. According to recent advancement and innovations in automobile sector older products are replacing new technologies and advanced. As the leaf spring suspensions are known for their high load bearing capacity so it's very important to make an economical design and use light-weight materials to reduce overall cost and weight of the vehicle.

**Figure 1: Systematic Diagram of Leaf Spring**



A balance of comfort, riding quality and economical design are the things a manufacturer must take under consideration while designing multi leaf spring suspension system. Leaf spring suspension system is the name which comes in mind whenever we talk about heavy vehicles (trucks, cargos, commercial vehicles, buses, SUV's etc.). The widely used elements to manufacture leaf spring are silico-manganese spring steel, EN45A, 60si spring steel, chrome-vanadium based steel, and spring steel shell (50CrVA) etc. All these materials have high yield strength and composed of silica gel with good elastic property.

The concept of composite materials is introduced in order to reduce the weight of the leaf spring suspension system without compromising the characteristics of it. Creo Parametric 2.0 is used to create 3D model to do analysis of Stress and Deformation response when subjected to vertical loads.

### 3.1 Contribution of various researchers

Prakash Kumar Sen et al. [1] investigated on Components, Principal and Classification of Suspension System and gave review it. The

conclusion of this research is that the suspension of an vehicle provide desired height and cushioning to vehicle in order to absorb the bumps in the road and provide better riding quality to the passengers.

Khatavkar et al. [2] investigated on Electromagnetic Suspension System and gave review it. The conclusion of this research is that the semi active suspension system have better ride quality and output as compared to passive suspensions and electromagnetic suspension, it has high bandwidth and efficient solutions for improving handling and comfort.

Chaudhari Mahendra M [3] investigated on Indian automobile suspension system and gave review it. They concluded that the suspension used by Indian automobile manufacturers are very useful in passenger automobiles as they provide better ride quality, Right desired height and better performance. As a result of using these suspensions the maintenance is very less as the vibrations are very well damped in these vehicles. Yousef Abdulhammed et al. [4] investigated on New Automotive Active Suspension System and gave review it. They concluded that the suspensions' containing hydraulic actuator requires an electric motor to run. Ajat Sudrajat et al. [5] investigated on active suspension system and gave review it. They concluded that the advancement in suspensions can reduce the cost of using active suspensions with electromagnetic actuators.

SF Youness et al. [6] investigated on functions of active suspensions in two different control system cases—one is without network and second is with network. They used LQR and PID control systems for controlling the travel of suspension. Abhishek Goyal et al. [7] investigated on active suspension control mechanisms and approaches. They concluded that flexibility and handling provided by active suspensions are enhanced but there use is limited due to higher power requirements

### 3.3 Problem formulations

Multi-Leaf Spring for commercial vehicle needs to be of high strength as it used to carry heavy loads, and also maintaining factor of safety. The main objective of this work is:

- To develop structural modelling of Multi-Leaf Spring using Creo Parametric 2.0 software.

- Static structural and Harmonic response analysis of Multi-Leaf Spring using Creo Parametric 2.0
- Analysis of steel- Multi-Leaf spring in terms of deformation and von-Mises stress curves.

**3.4 Material properties**

**Table 1: Properties of Material used for Analysis**

Material Steel	
Property	Value
Structural Type	Isotropic
Density	7.82707e-09(tonne/mm <sup>3</sup> )
Young’s Modulus	199948 MPa
Poisson’s Ratio	0.27
Shear Stiffness	78719.7 Mpa
Failure Criteria	None
Thermal Expansion	1.17e-5/°C
Thermal Type	Isotropic
Conductivity	43.0125 mW/mm°C
Specific heat	4.73341e8 mm <sup>2</sup> /sec <sup>2</sup> °C

**3.5 Geometrical parameters of multi-leaf spring**

Older leaf springs are replaced by new innovation known as parabolic leaf spring – It has lesser number of leafs in which thickness of leafs varies from the master leaf to the outer graduated.

Parabolic Leaf spring suspension has high load carrying capacities as compared to the older ones. In the present work multi-leaf spring of commercial vehicles is considered for analysis. The geometrical parameters are shown in table for the 3D model we have designed In Creo Parametric.

**Table 2: Dimensions of the Designed 3D Model**

Parameters	Value (all dimensions are in mm)
Distance between eyes	1291
Thickness of all leaves	10
Width of leaves	60
Total number of leaves	7 leaves
Free Camber	150

**4.0 Analysis of Leaf Spring in Creo Parametric 2.0**

Creo is a 3D designing Software used to design, Stimulate, and analyze any 3D model.

**4.1 Generic steps to do analysis in creo 2.0**

- Build Geometry. Create a 3D model representing the objects dimensions.
- Define Material Properties. Select the material you want to assign from the library.
- Apply Constraints. Apply the load, direction of force and moment from the ribbon menu
- Run the analysis. Now run the analysis by clicking on the analysis and studies in ribbon menu.
- Viewing the results. After successfully implementing all these steps you are able to see the detailed study about your structural design.

**4.2 Specific capabilities of creo 2.0**

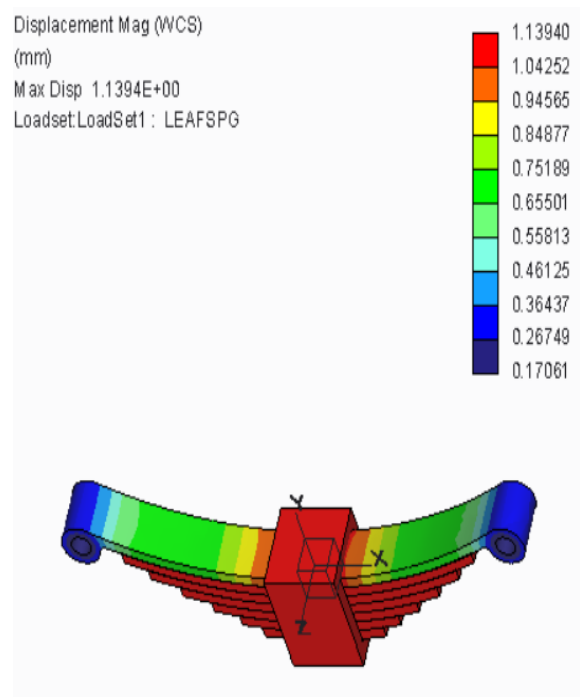
- Geometry analysis
- Sketcher Analyses
- Manikin
- Mechanism
- Simulate

**4.3 Analysis results**

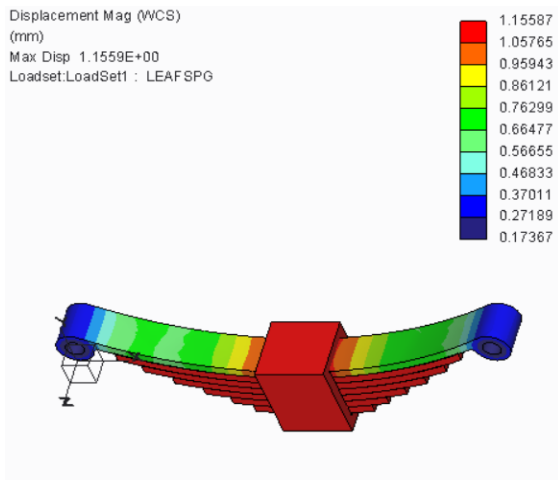
**4.3.1 Simulated results**

Here are the out comes after applying several loads on the designed leaf spring suspension.

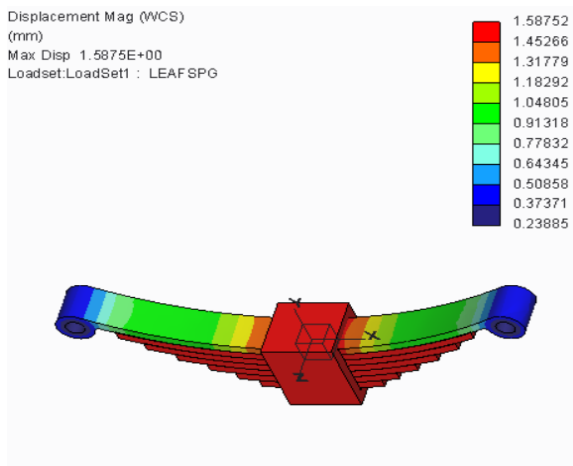
**Figure 2: Stress Shown Against Load 3000N**



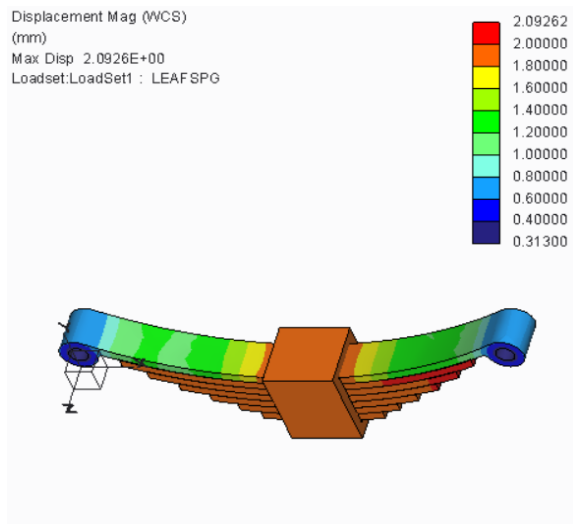
**Figure 3: Stress Shown Against Load 5000N**



**Figure 4: Stress Shown Against Load 7000N**



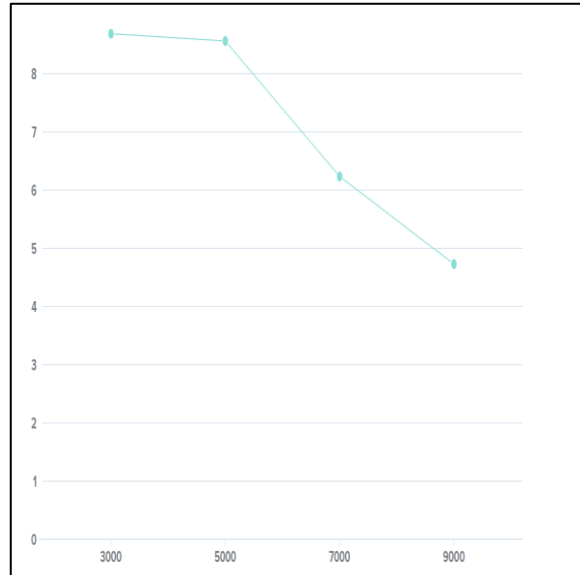
**Figure 5: Stress Shown Against Load 9000N**



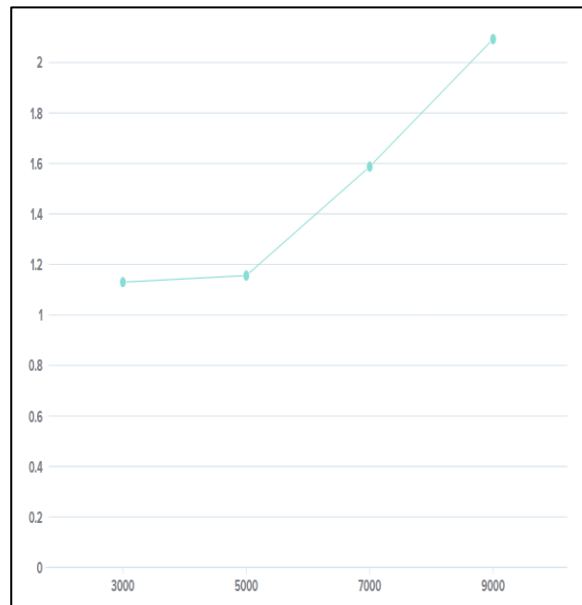
**4.3.2 Graphical analysis**

After doing stimulation to computed all the results and made some graphical representation.

**Figure 6: Stress Von Mises VS Load**



**Figure 7: Displcement Mag vs Load**



The deformed and un-deformed shape of the leaf spring is shown in Figure and the graph gives the Von-Mises stress and deformation at various loads. Within this analysis, Creo Parametric 2.0 has been used to create a model to analyze strength of leaf spring.

## 5.0 Conclusions

Thus, suspensions are important part to consider while designing a car. Suspensions are used for connecting car chassis with the wheels and provide cushion and comfort to the passengers. It acts like a sanitizer which protects us from various viruses and diseases; suspension system protects us from the bumps and irregularities of roads, hence they give us damped riding quality and cushioning effect.

A suspension of a vehicle which enhance the ride pleasure, comfort, and safety. It also transfers the force/load between the vehicle body and the road surface. By giving the suitable/desired height to the vehicle it acts as safety member for the vehicle as it reduces the bumping action which protects the hitting of tires and wheel arches.

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