Development of Leaf Spring Testing Machine

Mr. Satish Chandbodhale[1]Prof. C.C Handa[2]
[1]MTech Student [2]Professor
[1,2]Department of Mechanical Engineering
[1,2]KDK College of Engineering, Nagpur, Maharashtra, India

Abstract—*A basic way of testing springs is through Universal testing machine. A hydraulic unit is used to apply load on the spring (compressive or tensile) which results in deflection of spring. A motor supplies an incompressible fluid to hydraulic unit which applies pressure on spring. Hydraulic unit is attached to upper plate whereas lower plate is fix to a base. These plates apply force on any material kept between these two plates. This is an advanced machine which is connected to a computer which takes input as force in Newton and after deflection produces results in a form of graph i.e. stress strain graph. Same concept is applied in developing the spring testing machine for leaf springs. For the suspension of carry-load vehicles many types of arrangements may be used depending on the type of the vehicle and the occurring operating loads. One advantageous type of suspension systems is the leaf-springs system, which needs less additional components than other suspension systems, thereby leading to lighter and lower-coststructures. Leaf springs are made up of beams of uniform strength and are normally used in automobiles to absorb the shock and vibrations produced by the road undulations, thereby providing comfort to passengers. The load test verifies that all the component parts of leaf springs including materials, base-fixings are fit for task and loading it is designed for. Take a look as the springs are bent to the max to make sure that they're just right before being sent out to the eventual customers. For the design of serial leaf-springs, specific requirements regarding the dimensions of the vehicle configuration and the allowable developed stresses that occur under specific operating loading conditions should take into account. Various leaf spring testing machines are available in the market and details collected through net search are discussed in short below.*

Keywords—Development, Leaf Spring, Testing Machine

I. AIM & OBJECTIVES

Aim of project is to design and analyze Leaf spring testing machine

- To study the existing spring testing machine available
- The mechanism used to test the important parameters/ properties of leaf spring
- For the predefined force value, what is the displacement of spring.
- For the predefined displacement, what is the force on spring.
- To determine the strength of the spring under given load.

II. LITERATURE RESEARCH

A. A Review on Testing of Steel Leaf Spring by Mr. Ajay D. Dighe[1]:

Static Load Test: In the experimental analysis, the comparative testing of different steel leaf springs will help for drawing the conclusions. The steel and steel leaf springs are tested by using leaf spring test rig. The deflection or bending tests of selected spring for comparative study is taken on the universal testing machine. The spring is loaded from zero to the prescribed maximum deflection and back to zero. The load is applied at the center of spring. In the testing, firstly move the plunger up to desired height so that we can fix the fixture and leaf spring for test. Fix the position of fixture. On the fixture place the specimen. Set the universal testing machine. Apply the loads in steps of 20 kg gradually. The vertical deflection of the spring center is recorded in the load interval of 20 Kg. The noted deflection readings will help for comparative study of steel springs.

Fatigue load Test: A fatigue analysis is carried out with the help of hydraulic-fatigue testing machine. The designed and fabricated composite leaf spring is mounted on testing machine and the limit switches are fixed at a span of 50 mm in the vertical direction. This is the amplitude of loading cycle, which is considerably high amplitude. The frequency of one cycle is 66-80 mHz, which is considered to be very low. This leads to high amplitude low frequency fatigue test. During the test the value of strain at location 1 is recorded. The maximum and minimum stresses value is obtained at the first cycle of the composite leaf spring are 299 MPa and 202 MPa respectively. As the number of cycles goes on increasing, the fluctuation in the stress are continuing to a certain level then settling takes place. Under this condition, the maximum and minimum operating stress values are found to be 310 MPa and 208 MPa, respectively. Since, the fatigue (tensile) strength of the composite material is considered as 900 MPa, the stress level obtained from operating stress is 0.33, which is very low and safe. Due to high amplitude and low frequency fatigue analysis, the experimental analysis does not provide final results in the short period. The test is conducted for 100 to complete 25,000 cycles.

Features:

1) Different steel leaf spring is tested.
2) Universal testing machine used for fatigue test
3) Load is applied in steps of 20Kg gradually

Fig. 1:

B. Investigation of Stresses and Deflection in Multi Stage Leaf Spring of Heavy DutyVehicle by FEM and Its Experimental Verification by Ruchik Tank and SrinivasKurna[2]:

The aim of this study is to establish correlation between FEA simulation and Rig test data for Multi-stage semi-ellipticalsuspension leaf spring. This method would then be used to predict durability and other suspension characteristics likestiffness from the leaf geometry at design stage itself. The rates predicted can then be used in multi-body dynamic modelsor full vehicle Noise, Vibration and Harshness (NVH) models. This methodology would reduce product development time &cost significantly. The main objective of this paper is to correlate CAE results with Rig test. Correlation between Test and Virtual will help in reducing product design time and cost of Rig Test. This FEA based correlation methodology will help in variable ratesuspension design whose stiffness characteristics are more complicated than single rate suspension. Correlating thisproblem in FEA with Rig Test is challenging task as static and dynamic friction will play key role in simulation.Test rig setup (Figure) should be modeled similar to the vehicle assembly condition. In order to model this setup, one halfof the Axle-spring assembly is taken. A leaf spring type suspension consists of leaf spring panels, a center bolt, a U-bolt,and a bushing. Multiple leaf spring panels are fixed by the center bolt and the U-bolt. The frame can be considered rigid asno frame deformation between the two mounting locations of the leaf springs is observed on the vehicle while in action.Thus, the leaf spring suspension brackets are rigidly connected to the base of the test rig for the simulation.

Features:

1) Correlation study of FEA and Test Rig data for leaf spring

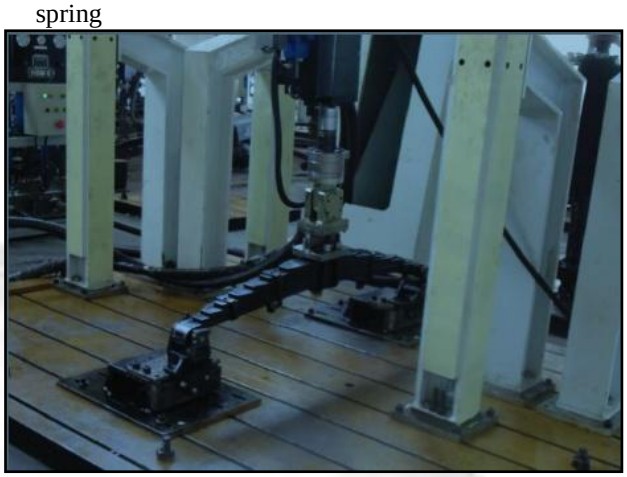

Fig. 2:

C. Investigation of Stresses in Master Leaf of Leaf Spring by Fem and its Experimental Verification [3]:

In experimental analysis, actual prototype is considered under static loading condition. The stress analysis ofleaf spring is carried out by using the strain gauge technique. The instrumentation is developed for this work.Instrumentation measures only the change in resistance i.e. ΔR. This change in resistance is very small having amagnitude of few milli volts. So it is necessary to convert this small resistance into an equivalent voltage with thehelp of instrumentation techniques. The instrumentation consist of Strain Gauges, Wheatstone bridge circuit andDigitalmultimeter.

Features:

1) Static loading consditions
2) Wheatstone bridge circuit and Digital multimeter is used.

Fig. 3:

III. DEVELOPMENT SETUP

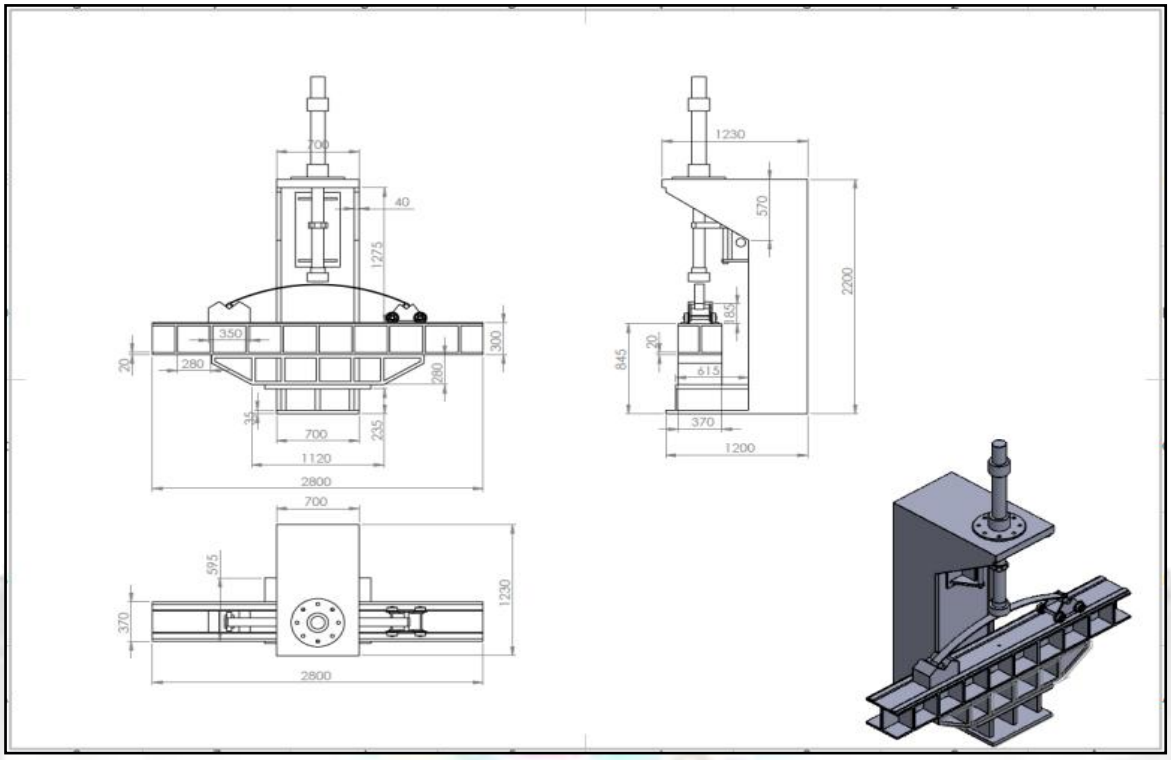

Fig. 4: 2D Detailingof leaf spring testing machine

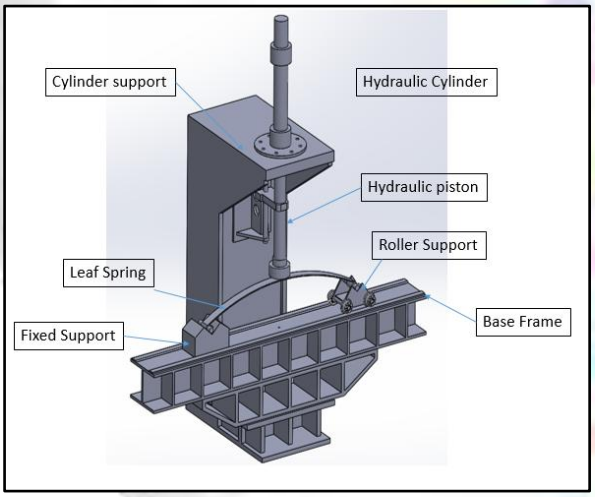

Fig. 5: 3D detailing of leaf spring testing machine

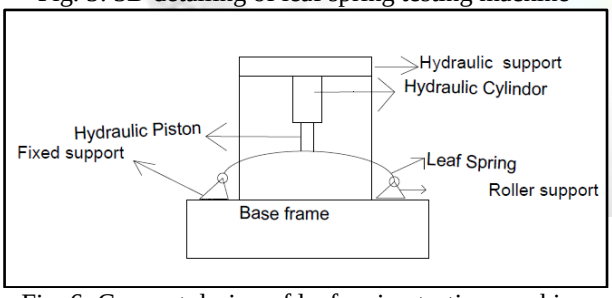

Fig. 6: Concept design of leaf spring testing machine

IV. WORKING

Spring to be tested is fixed between the Piston and the base. Base is has the rails mounted on it to guide the roller support. There are two supports over which spring can be placed one is fixed and other roller support. Hydraulic Cylinder mounted on the vertical member exerts pressure on the piston, by this application of force piston moves

Downward and applies the pressure on leaf spring. This results in the sideward movement of the roller support. When a spring is kept between piston and the base, the spring gets deflected due to downward motion. Sensors can monitor the load applied and deflections on the spring respectively.

V. CONCLUSION

This research article reveals the way setups are developed. A machine is developed to perform testing of leaf springs by applying maximum load capacity of 50 ton, this study can help design engineers interest in development of leaf spring testing machine.

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