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Design and Development of Leaf Spring Fatigue Testing Machine

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ABSTRACT: In today's automobile industry, leaf springs are commonly use in heavy-duty vehicles. A leaf spring is a simple form of spring commonly used as a suspension in wheeled vehicles. Fatigue is responsible for 90% of the failures that occur in an industry. Fatigue testing equipment is used to determine the fatigue life or fatigue strength of a material. Mechanical Engineering students are having a hard time visualizing on how manufacturers determine the fatigue strength of a leaf spring. This is because the professors only teach the concepts and theories about leaf spring, and there is no actual representation on how the testing of leaf spring really works. So are tried to develop prototype leaf spring fatigue testing machine using pneumatic cylinder and microcontroller. With the help of this machine, we can measure fatigue life cycle of testing leaf spring.

KEYWORDS: Leaf Springs, Pneumatic Cylinder, Arduino, Leaf Spring Fatigue Testing Machine.

I. INTRODUCTION

In actual practice, the load rate and fatigue life (under specified stress 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 of 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 simulating 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. RELATED WORK

According to Keresia Gudukeya, Tawanda Mushiri, Charles Mbohwa. [1], In this research a fatigue endurance testing system is designed. It is used in testing fatigue endurance of a leaf spring as the last stage in the production line. The system incorporates a fluid system which utilizes gravity to increase head, and uses less electrical energy, than the current system. This kind of development such as the use of less electricity is a welcome move towards greener manufacturing and machines are able to run on less electricity supplies.

Mouleeswaran SENTHIL KUMAR , Sabapathy VIJAYARANGAN [2] introduced a static and fatigue analysis of steel leaf spring and composite multi leaf spring made up of glass fibre reinforced polymer using life data analysis. The dimensions of an existing conventional steel leaf spring of a light commercial vehicle are taken and are verified by design calculations. Studies were conducted on the application of composite structures for automobile suspension system [1, 2]. A double tapered beam for automotive suspension leaf spring has been designed and optimized [3]. Composite mono leaf spring has also been analyzed and optimized [4], Mr. Ajay D. Dighe [3] studied gives a brief idea about fabrication and testing procedure of steel leaf spring. The efforts have been taken for sequential analysis of leaf spring. It includes static test, fatigue test, macroscopic inspection and metallographic analysis of leaf spring. leaf

Leaf springs are still used widely in a variety of automobiles. Leaf spring made of composite materials made it possible to reduce the weight without any increase in load carrying capacity and stiffness of the leaf spring. Therefore, analysis of composite material leaf springs has become essential in showing the comparative results with conventional leaf springs.

S. V. Kumbhar, A. M. Takale, A. H. Badiwale, A. D. Gawali and B. S. Bhanase.. [5] focused is to design a spring stiffness testing machine with stepper motor by using computer control, which emphasizes to measure a stiffness of helical compression springs for I.C. Engines valves for the various fluctuating load.

III. PRINCIPLES AND WORKING

A. Concept of the Project:

Since the failure by fatigue fracture is the most common failure in automotive components such as crankshaft as well as those involving spring on trucks. In addition to, leaf spring especially as automotive components often experience over load and vibration that occur due to the unevenness of the road. So So are tried to develop prototype leaf spring fatigue testing machine using pneumatic cylinder and microcontroller. With the help of this machine, we can measure fatigue life cycle of testing leaf spring.

B. Need of the Project:

Since the failure by fatigue fracture is the most common failure in automotive components such as crankshaft as well as those involving spring on trucks. In addition to, leaf spring especially as automotive components often experience over load and vibration that occur due to the unevenness of the road. So So are tried to develop prototype leaf spring fatigue testing machine using pneumatic cylinder and microcontroller. With the help of this machine we can measure fatigue life cycle of testing leaf spring. For the assessment of experimental fatigue life, a full-scale leaf spring testing machine is required. The leaf spring is mounted in the machines simulating 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.

C. Objective of the Project:

Main aim of this project work is to design and fabrication of Fatigue Testing Machine which is capable of testing the fatigue life of leaf springs for Automobile application.

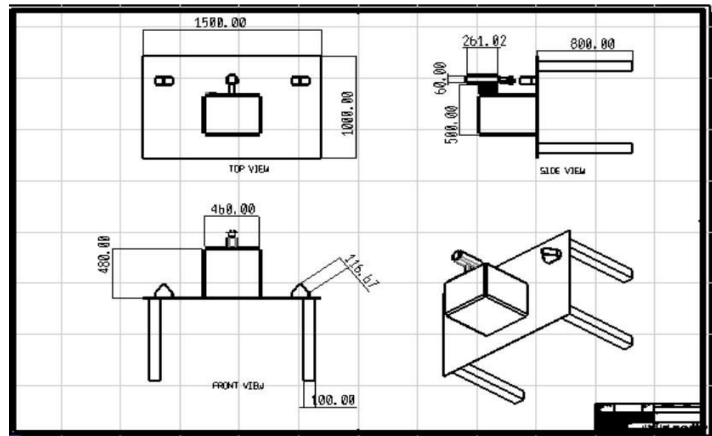
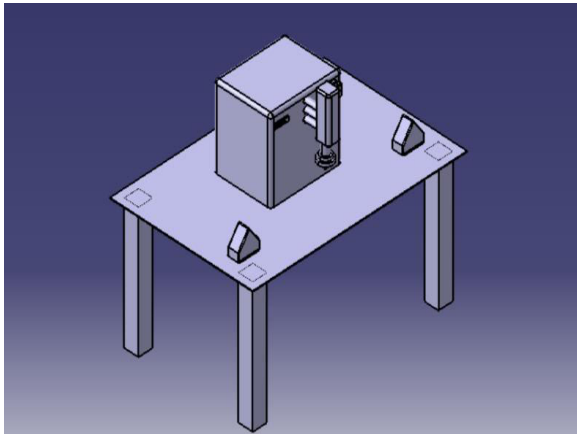
- To design the fatigue tester and its components
- To fabricate the fatigue testing machine.

The scope of this project gives us many advantages to learn new processes for making this product.

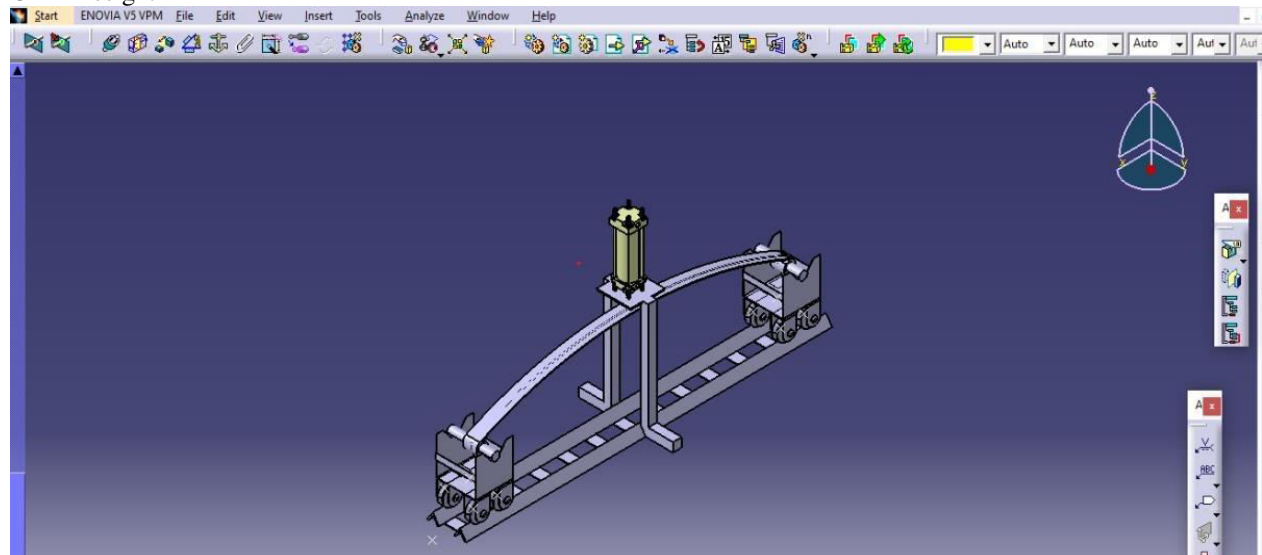
IV. PROPOSED SYSTEM

A. CAD Model ad Design:

Computer-aided design (CAD) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. The term CADD (for Computer Aided Design and Drafting) is also used. Its use in designing electronic systems is known as electronic design automation (EDA). In mechanical design, it is known as mechanical design automation (MDA) or computer-aided drafting (CAD), which includes the process of creating a technical drawing with the use of computer software. CAD software for mechanical design uses either vector-based graphics to depict the objects of traditional drafting, or may also produce raster graphics showing the overall appearance of designed objects. However, it involves more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions.



CAD Design:



B. PNEUMATIC CYLINDER DOUBLE ACTING 50mm BORE x 100mm STROKE PROFILE

A pneumatic cylinder is a mechanical device that converts compressed air energy into a reciprocating linear motion. A double-acting cylinder uses compressed air to move a piston in and out, while a single-acting cylinder uses compressed air for one-way movement and a return spring for the other.

Specification:

- End Caps: Aluminium Die Cast, Seals: Polyurethane
- Barrel: Aluminium Profile Barrel, Non-Corrosive, Light Weight.
- Piston Rod: SS.410 Roller Burnished.

The force exerted by a double acting pneumatic cylinder on outstroke can be expressed as (1). The force exerted on instroke can be expressed as

$$F = p \pi (d1^2 - d2^2) / 4 \tag{2}$$

where d1 = full bore piston diameter (m) d2 = piston rod diameter (m)

Double Acting Cylinder Calculator - Input Stroke (pressure = 2 bar)

$$= (2 \times 10^5 \text{ N/m}^2) \pi [(0.050 \text{ m})^2 - (0.01 \text{ m})^2] / 4$$

$$= 376.99 \text{ N}$$

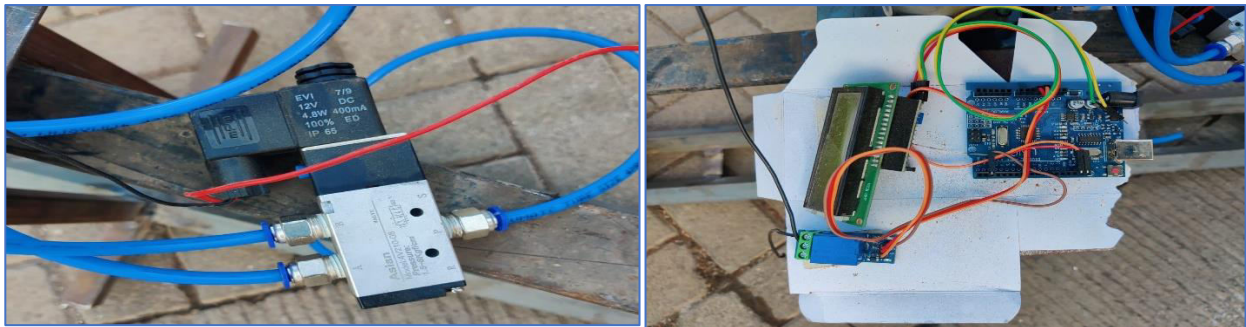
C. Arduino:

Nowadays, with Microcontrollers being relatively cheap and readily available in the market, making a purchase decision on a suitable one to pick might a hard task to handle. However, there’s one particular model that’s good to start with for users. That model is the ATmega328p, an 8-bit AVR microcontroller.

ATmega328P is a high performance yet low power consumption 8-bit AVR microcontroller that's able to achieve the most single clock cycle execution of 131 powerful instructions thanks to its advanced RISC architecture. It can commonly be found as a processor in Arduino boards such as Arduino Fio and Arduino Uno

V. RESULTS

Throughout the project, careful consideration was given to the selection and integration of the pneumatic cylinder as the primary actuator. The pneumatic system offers several advantages, including rapid and precise control over the loading and unloading cycles, allowing for accurate simulation of real-world conditions experienced by leaf springs. The pneumatic cylinder's adjustable pressure and stroke length provide flexibility in generating a wide range of loading profiles, enabling comprehensive fatigue testing.



VI. CONCLUSION

In conclusion, the design and development of the leaf spring fatigue testing machine project utilizing a pneumatic cylinder has resulted in an efficient and reliable testing apparatus for evaluating the fatigue characteristics of leaf springs. the design and development of the leaf spring fatigue testing machine utilizing a pneumatic cylinder has provided a valuable tool for the automotive industry. It allows engineers and researchers to effectively evaluate the durability and performance of leaf springs, leading to improved design and manufacturing processes. Ultimately, this project contributes to enhancing the safety, reliability, and longevity of leaf springs in various applications, benefiting the automotive sector.

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