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Design and Fabrication of Fatigue Testing Machine of Cantilever Type

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Abstract: This project is centered on the design of a low–cost cantilever loading rotating bending fatigue testing machine using locally sourced materials. The design principle was based on the adaptation of the technical theory of bending of elastic beams. Design drawings were produced and components/materials selections were based on functionality, durability, cost and local availability. The major parts of the machine: the machine main frame, the rotating shaft, the bearing and the bearing housing, the specimen clamping system, weight hanger, revolution counter, sensors ,electric motor, and dead weights; were fabricated and then assembled following the design specifications. The machine performance was evaluated using test specimens which were machined in conformity with standard procedures. It was observed that the machine has he potentials of generating reliable bending stress – number of cycles data; and the cost of design was lower in comparison to that of rotating bending machines from abroad. Also the machine has the advantages of ease of operation and maintenance, and is safe for use.

Keywords: Fatigue, failure analysis, machine, design.

I INTRODUCTION

Fatigue testing machine is used to determine the fatigue life or fatigue strength of a material. An overlook to the broken parts in most of the scrap will show that almost all failures occur at stresses below the yield strength of the material. This complex phenomenon is known as “Fatigue”. Fatigue is responsible for 90% of the failures that occur in an industry. In the 19th century, it was considered mysterious since a fatigue fracture did not exhibit any visible plastic deformation, this lead to the belief that fatigue was an engineering problem. A major breakthrough in the understanding of the process of fatigue failure happened in the 20th century with the help of more powerful tools such as computer, powerful microscopic instrument, after which fatigue was not considered as an engineering problem but as both material and design phenomenon. The idea behind this work is not to provide answers to the unanswered questions, but to solve the difficulty in answering them from a different perspective. This involves defining the unpredictable nature of fatigue failure by conducting tests on various specimens and explains the known techniques of fatigue testing. In the science of materials, fatigue is a phenomenon of weakening of a material caused by repeated application of loads. It is the progressive, unpredictable and structural damage that take place when a material is subjected to cyclic loading. The nominal maximum stress values that actually cause the material to fail may be much lower than the strength of the material typically quoted as the yield strength or ultimate strength. If the applied loads are greater than a certain threshold value, then microscopic cracks will begin to form at the stress concentrated areas such as grain interface or where there are surface defects. Eventually a crack will reach a critical size, the crack will expand at a faster rate, and the structure will fail.

Fatigue failures generally involve three stages:

- Crack initiation
- Crack Propagation
- Final fracture

II LITERATURE SURVEY

In order to assess the trend and level of research work done till date, in the area of titled work, an exhaustive literature has been reviewed. A gist of some of the most relevant research work is presented in this chapter under various classified headings. The work on fatigue goes back to 1837, when Wilhelm Albert established a correlation between applied loads and durability in the context of chains used in mines. Around 1839, Jean-Victor Poncelet, who designed cast iron axles for mill wheels, described metals being “tired” in his lectures at the military school at Metz. The phenomenon of fatigue was widely observed in 17th century during the failure of railway structures that claimed many lives, as reported by Gray and Smith Rankine investigated the fatigue failure of railway axles and suggested that the axles should be forged with a hub of enlarged diameter and large radii, so as to reduce the cutting of grain flows during machining, which would improve the fatigue life of axles. Wöhler was also the first to arrive at the modern terms of

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"fatigue life" and "scatter" in the context of design for fatigue life. The low cycle fatigue analysis has been successfully applied to structures subjected to small number of fatigue cycles during their lifetime, viz. electrical equipment subjected to thermal stresses. Around the same time, Neumann developed the slip-plane model of crack initiation, while Schijve and Brock investigated the factors affecting crack propagation in aircraft structures, which were subjected to variable amplitude or gust-spectrum loading. Subsequently, Schijve developed detailed model of fatigue crack growth and published a series of lectures on the topic. The developments during twentieth century are comprehensively covered in a review article by Schijve. Subsequent researchers further extended the concepts developed by pioneers, as mentioned above. The prominent names among them include Brechet et al. for extension of Coffin-Manson law, Toth and Krasowsky for damage process analysis on the basis of Paris law and Coffin-Manson equation.

III OBJECTIVES OF THE PROJECT

- The objective of present work aims at constructing a cantilever type fatigue testing machine.
- The machine is capable of testing the fatigue life of various samples of specimen of different minimum diameters and subjected to fatigue load.
- The endurance limit of the material can be predicted with the test results. The machine is also capable of testing specimens of varying cross section.

IV PHYSICAL MODEL

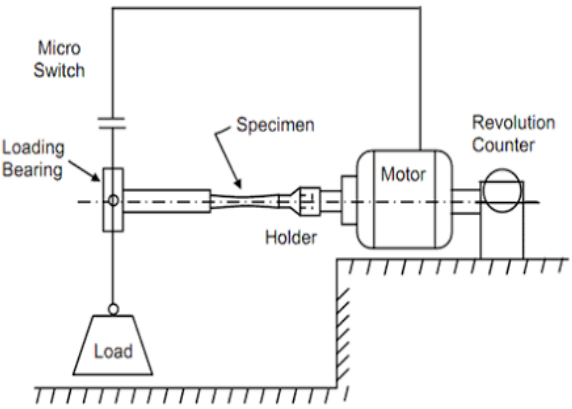

Fig 1

V WORKING PRINCIPLE

The fatigue-testing machine is of the cantilever beam type. The specimen functions as a single beam which is loaded at single point. When rotated one-half revolution the stress in the fibres originally above the neutral axis of the specimen are reversed from compression to tension for equal intensity. Upon completing the revolution, the stresses are again reversed, so that during one complete revolution the test specimen passes through a complete cycle flexural stress.

VI STANDARD FATIGUE TESTING SPECIMEN

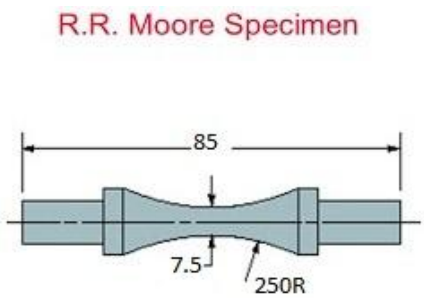

Fig 2 R. R. Moore Specimen

VII COMPONENTS

- A.C Induction motor,
- Bearing and its housing assembly
- Weight hanger assembly
- Dead weight
- Bearing spindling
- Digital counter
- Switch,
- Specimen
- Drill chucks,
- The metal desk.

VIII TECHNICAL DETAILS

- Revolution Counter: A 6 digit digital counter is used for recording the number of stress cycles a specimen undergoes during testing.
- Motor: An electric motor uses electric energy to produce mechanical energy .The electric motor used is 0.25HP that is designed to rotate at 1500 rpm.
- Standard Test Specimen: Standard test specimen made of different materials are used of 6mm to 8mm.
- Bearing: Bearing are used to constrain loads which are applied.
- Shaft: Shaft is a rotating machine element, which is used to transmit power from one part to another.
- Nut: A nut is type of fastener with a threaded hole. Nuts are used along with bolts to fasten two or more parts.

IX. CONCLUSION

After successfully performing the experiment is given that in the starting in initial condition at normal motor speed there is no breakdown in the component, But after some time if we apply some load to the cantilever type loading hanger of the component then crack is initiated which propagates over a period of time and at certain point and time there is sudden breakage in component.

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