Design and Fabrication of Tension Creep Testing Machine

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Abstract

This experiment uses existing mechanically operated tensile and creep testing was modified to a low cost, electro-mechanically operated creep testing machine capable of determining the creep properties of aluminium and thermoplastic materials as a function of applied stress, time and temperature. The modification of the testing machine was necessitated by having an electro-mechanically operated creep testing machine as a demonstration model ideal for use and laboratory demonstrations, which will provide an economical means of performing standard creep experiment. Creep is a slow extension of a material in response to a comparatively low stress. Under a constant load, extension of the material results in a reduction in cross section, so stress increases under constant load. The higher the stress, the higher the creep rate until failure finally occurs. In metal, creep can occur at any temperature higher than approximately half the absolute melting point (Celsius melting point + 273). Thus, creep is not a problem for common metals used at ordinary temperature. The aim of this experiment is to study the effect of uniaxial loading on creep deformation by characterizing the study-state creep behaviour of any material at room temperature.

Keywords: Creep, stress, temperature, time, load, laboratory experiment.

Objectives of Project: The objective of this project is to design and fabricate a Creep test apparatus which can be used in laboratory also to demonstrate creep as a phenomenon in metal equipment, without using expensive furnaces or equipment..

Introduction

Success in today's market plays requires improvements in efficiency, quality and accuracy of testing facilities and testing equipments. Testing is an essential part of any engineering activity, it is necessary at any point in the engineering process. Aluminium, Iron, Steel and their alloys are the metals that are mostly used for production of appliances, devices and buildings. Recent developments associated with an innovative view of thermoplastics in structural applications demand accurate engineering data. More specifically the assessment of structural performance requires data that spans appropriate ranges of stress, time, and temperature and strain rate. Creep testing machine are predominantly used to measure how a given material perform under constant load, at elevated temperature. The primary use of creep testing machine is to enable students generate values for creep time curve.At high temperature, stresses imposed on metal components produce a continuously increasing strain even if they are below yield point ,and results in a phenomenon is known as Creep.

Stages of Creep:-

- Primary Creep: - In this stage the deformation occurs and resistance to creep increases until the next stage.
- Secondary Creep: - In this stage the ratio between strain and time is constant.
- Tertiary Creep: - In this stage a reduction in cross sectional area occurs.

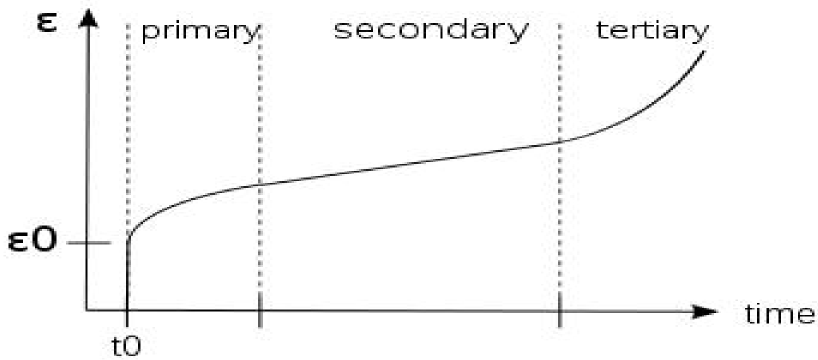


Fig.1. Stages of Creep

Fig. 2 Existing Creep Tension Machine

Existing Technology

The existing machine (Fig 2.) works on lever arm loading principle. In this, load is applied one side of a lever arm and the sample material which is to be tested is attached to the other end of the lever arm.
However, lever arm itself maintains constant tensile load to the sample material based on the lever ratio.

Design of Machine Components:

Base plate

Fig 3(a) shows, the base plate which is designed with double "I" beam structure to sustain the whole load of machine over it. The base plate is made up of cast iron and its dimensions are 300×125×65mm.The base plate is connected with the two T-slotted columns by the application of welding and also one furnace is placed in the centre of it.

Column
Top plate

Top plate is flat plate with the dimension 300×50×5mm as illustrate in Fig 3(e). It is connected with the two columns from bottom by welding. Also a half rounded pulley is connected in the centre of it. Top plate has acut exactly in the centre for the passage of nylon wire rope to roll over pulley.

Furnace

Fig 3(b) shows, column used are of T-shape which connectsthe base plate and top plate with the application of welding. The length of column is 770mm.The columns are made up of cast iron which makes the design more robust and sturdy.

Grips

The work of grips is to fix the specimen tightly in furnace. In this design the grips used are "Clevis Couplings" which is used for the fixation of flat rectangular specimens as shown in Fig 3(c). One grip is internally fixed at the base plate while other is adjustable to height which will be connected to the hot pull rods.

Pulley

The pulley used in this design is half round pulley as shown in Fig 3(d) whose work is to provide support and rolling motion and to support the rope which is connected to the turn buckle.In this design two pulleys are used. One is connected to the centre of the top plate and the other pulley is offset to the top plate by 135mm. As shown in Fig 3(f), furnace is the heart of this tension creep testing apparatus. It provides heating to the specimen. The furnace has a cuboid structure placed over base plate,between the two columns. The outer length, breadth and height of the furnace are 152mm, 128mm and 224mm respectively. The inner length, breadth and height of furnace are 124mm, 115mm and 200mm respectively. Bison sheet is used as refractory material having thickness of 12 mm in all sides. The furnace is attaining a maximum temperature of 200 degree Celsius. The furnace has a hole in the centre at the top of the furnace to pass the hot pull rod. Furnace is designed to load and unload specimen easily.

Spring

In this simplified design of tensile creep testing machine, a tension spring as shown in Fig 3(g) is used to compensate the slack generated by the nylon wire because of increment in the length of specimen. The wire diameter of spring is 1 mm and coil diameter is 10 mm with 44 numbers of active turns.

Digital Temperature Controller

Fig 3(h) shows digital temperature controller is an electronic operated device which is used to control the temperature of furnace for various time spans. This digital controller is placed at the left side of one column.

Load Cell

Fig 3(i) shows, load cell is an electronic device placed in the creep testing apparatus after the spring. It indicates the applied force on the specimen by a digital meter which is placed with digital temperature controller. This device is used to indicate the precise load applied on the specimen. In this apparatus the load cell can show up to 40 kg load precisely. The load cell is connected to approximately 20.5 cm above the base plate to the column.

Turn Buckle

Turn buckle is a device connected to a wire rope and spring in creep test apparatus to apply the desired force on the specimen at constant high temperature. Turn buckle has two ends, one end is left hand thread and the second has right hand thread. The centre part of the turn buckle is called as coupler. As the coupler rotates, the rods are either pulled together or pushed apart depending upon the direction of rotation of coupler as illustrate in Fig 3(j).

Test Specimens:-

Test specimens for Tensile Creep TestingMachine could be either Tin/lead or Teflon. The standard test specimen should be in the form of “I” Section

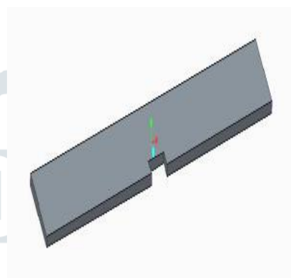
Table1. Selected materials for fabrication of creep testing machine

Top Plate	Mild Steel
Base Plate	Mild Steel
Column	Mild Steel
Spring	SAE 6145(oil Quenched)
Grips	Mild Steel
Pulley	Stainless Steel
Turn Buckle	Stainless steel (316 grade)

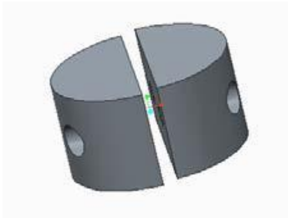
(a)

(d)

(b)



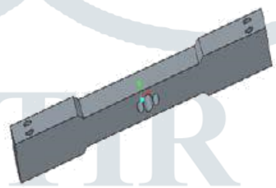
(e)



(c)

(f)

(g)



(i)

(h)

(j)

Fig 3. ComponentsofCreepTesting Machine (a) Base plate (b) Column (c) Grip for I shape specimen (d) Pulley (e) Top plate (f) Furnace (g) Spring (h) Digital temperature controller (i) Load cell (J) Turn buckle.

Complete Assembled Model

Basic approach for the assembly of creep testing machine elements was carried out in CREO 3.0 version. Firstly all components were designed and made individually and then these were assembled to form complete creep testing machine as shown in Fig 4.

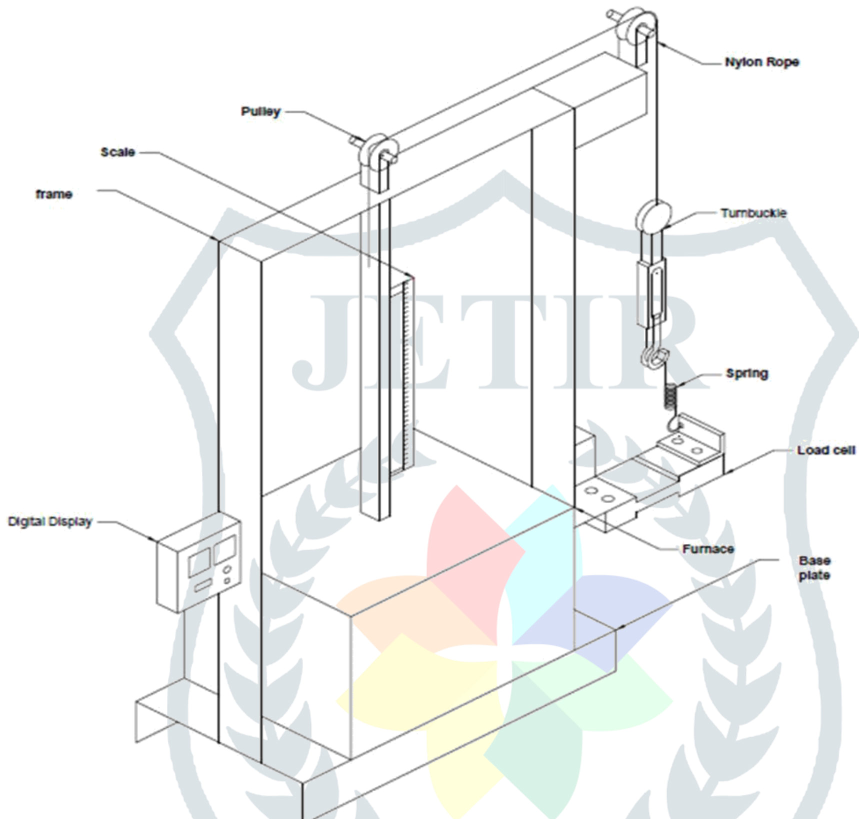


Fig 4. Complete Assembled Model of Creep Testing machine.

Methodology

In the tension creep testing machine we are varying temperature, load and time for obtaining the creep phenomenon at various temperature, load and time. In this apparatus, first we have to load the specimen into the grips and there we have to set the required temperature and time by the digital temperature controller. After setting the time and temperature we have to apply the desired load by twisting the coupler of turn buckle , and in return turn buckle is connected to the specimen via a nylon wire with a hot pull rod.Hot pull rod connected to the furnace and its length is up to10cm above the furnace. After some time, because of high temperature and high applied load, increment in the length of specimen takes place and also the tension in the nylon wire decrease. Hence, to compensate the applied tension ,a tension spring is fixed after the turnbuckle. This tension spring compresses itself and by compression it pulls the nylon wire to regain the applied load. A load cell is also connected to the spring above the base plate to indicate the load applied by turn buckle.

Conclusion

The purpose of this project was to design and fabricate a creep test apparatus which can be used in laboratory to demonstrate creep behaviour of engineering material. The project involve a new mechanism which replace lever arm mechanism. With a connecting metal wire and turnbuckle. Also a tensile helical spring was used to maintain a comstant load on the material.

Acknowledgment

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