Analysis of Creep Behaviour of Shape Memory Alloy

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***Abstract*- The Analysis for a creep behavior of SMA National wire is presented along with material used is Nitinol alloy for increasing temperature tensile tests for constant load. The main characteristics, which appear in SMA, are the effect of shape memory and super elastic property. This paper discusses about the behavior of SMA Nitinol wire and its properties shown in tensile testing machine. In this analysis, we have used the parameter like strain, temperature, time; load to obtain the required result and plot the graph. Due to distinct properties of nitinol, it has variety of application in automobile, heat engine, etc. While performing loading under consistent rate of pressure per unit area temperature increments because of stress actuated in martensitic change. The deformation properties are vital because the deviation of SMA elements can change under consistent stress in the model of SMAelement.**

***Index terms*- SMA, Creep, Super elasticity, Sub-loop, Nitinol.**

1. INTRODUCTION

The distinct properties and application of SMA in various industries has gained more attention of researchers. Accomplishment in the present commercial center requires improvement in effectiveness, quality and exactness of testing offices and testing hardware. Testing is a fundamental of all designing action. It is essential anytime in the designing procedure (2). It has wide variety of application from aerospace to biomedical devices due to its distinct properties. Due to regaining its original shape before deformation by increasing the temperature to a certain level has make SMA a desirable material for a damping and actuation.[3] SMA may be found in two phases particularly austenite and martensite. Austenite is the parent Phase in which martensite softer product phase occurs from transformation process. [4]

On the martensitic transformation the practical properties of SMA dependent on and the misshaping properties of martensitic change are complexes because of the nature of martensitic transformation which is delicate to the variety in temperature and stress to their hysteresis. [5] On the basis of constitutive models that are available we can predict the behavior of SMA which could take into consideration while applied on specific material. There are many applications of SMA, which can be further used in other devices for betterment of advancement in technology.

In this analysis, we are predicting and obtaining the behavior of Nitinol wire, which can be used for further research by plotting the curves as a result to the research on the basis of tests. The test carried out is done by keeping the load constant and increasing the temperature. The economic side of choosing a material of Nitinol was taken in account to find out the material best performance under practical conditions to minimize cost in current technology and providing a better solution to it.

Creep is defined as the behavior of materials to deform at elevated temperature range and at constant load. To determine how much strain (load) a body can deal with in order to determine which material to use for a specific application creep is important. Creep is progressively extreme in materials that are exposed to warm surrounding for extensive duration so that large increments are seen as they come close to their melting points. Creep deformation does not happen immediately due to supply of pressure. In this way, Creeps "Period sub ordinate “deformation. It

Works on the principle of Hooke's law (stress is straight comparative corresponding to the strain).

In the first stage, or transient drag, the strain rate is relatively high, but decreases with expanding time and strain because of procedure closely resembling to repetitive plastic deformation at lower temperature.

The second stage alluded to as "consistent state creep" is the most comprehended. The microstructure is invariant during this stage, which implies that recuperation impacts are concurrent with deformation.

In tertiary stage, the strain rate exponentially increments with stress in view of necking aspects or inner splits or voids diminishes the functional field of sample. The firmness or quality is immediately lost in this stage while the materials is for all time changed. The increasing speed of creep distortion in the tertiary stage in the long run prompts material break.

2. LITERATURE SURVEY

In paper [1] K.Takeda, H. Tobushi and E. Pieczyska research different sub-circle practices including creep and creep recuperation related with overly flexible miss happening of a TiNi SMA tape dependent on proof of neighborhood temperature varieties as estimated by thermograph and on surface perceptions of SIMT groups made with a movement examination magnifying lens during pressure tests.

In paper [2] J.L. Chukwaneke, P.C. Okolie, D.C. Ugwuegbu and J.E. Sinebe, structuring and building a ductile wet blanket testing machine that would be utilized to perform straightforward killjoy tests. Tests led with this machine were discovered dependable and the outcomes didn't stray such a great amount from standard outcomes.

In review paper [3] P.S. lobo, J.Almeida, L. Guerreiro, focuses on the portrayal of SMA's and models for forecast of the reaction of these metals. It was inferred that remaining strain may be of pertinent in genuine structure ventures.

In paper [4] Zoherh Karlaschi, Using SMA's in the structure of new gadgets particularly in mechanical technology, robotization, clinical can prompt creating gadgets, which were difficult to make utilizing regular metals, for example, hardened steels. Picking legitimate change temperatures can be significant in the improvement of the gadget. For gadgets, for example, various inserts, controlling the change Temperature to be as per the internal heat level is of a significance.

3. METHODOLOGY

a) CONSTRUCTION OF MACHINE

A radiant ceramic heater works by using electricity to warm a ceramic plate, which then radiates heat into the chamber. The heating coil plate has a diameter of 160 mm and has thickness of 20 mm. The coil is fixed with bolts. For insulation of the chamber, we have used glass wool. Typical thermal conductivity values for glass wools are between 0.023 and 0.040W/make Glass wool work just by having an enormous number of gas-filled pockets, which prevent large-scale convection causing rapid decrease in heat transfer coefficient. The inner and outer casing of the chamber is of mild steel with 0.5 mm thickness.

A thermostat is a provided for sensing the temperature of chamber and perform action so that the chambers temperature is maintained near a desired set point 200°c. A advanced temperature indicator is utilized for observing temperature. Hooks are provided for fixing the wire. The lower hook is welded with hanger, which is a rod with a disc at bottom for arrangement of load. The specimen used for testing is shape memory alloy Nitinol wire with 0.5mm diameter. It is an alloy of Nickel (Ni) (%)– 55.08 And Titanium (Ti) (%) – 44.81.

b) CAD MODEL

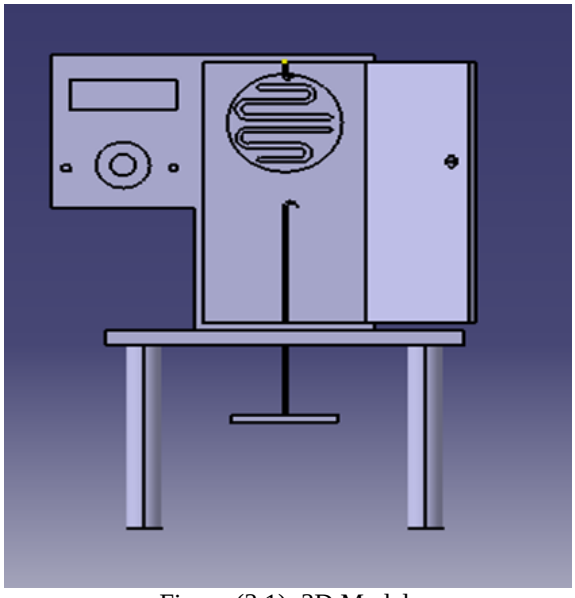


Figure (3.1): 3D Model

Figure (3.2): Fabrication Model

4. WORKING PROCEDURE

- The Specimen wire is fixed between two hooks.
- Then we add load to the hanger for obtaining the behavior of wire.
- Then we start the switch of heating oil and temperature indicator.
- Then we heat wire up to 200°C and then maintain it constant under constant loading then we wait for certain period of time for observing behavior of wire reading.
- As soon as the specimen performs change in length then we take that reading and observe for certain time of around 10minutes.
- At the end of 10 minutes we take the final reading that how much change in length is performed in wire and that reading is noted.
- The reading is taken under constant observation and the graph of strain vs. time is plotted. Then we further do same procedure for obtaining the result for different loads.

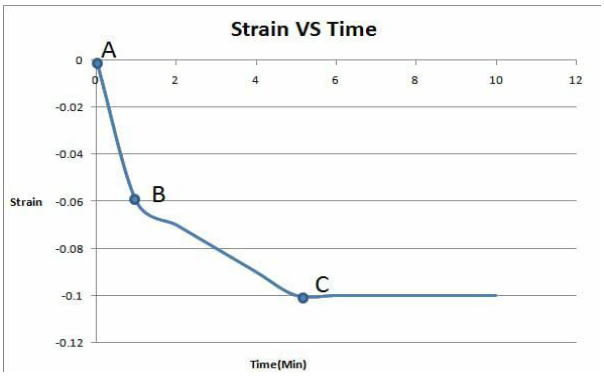
5. RESULT

a) Observation Table

Reading on scale	Strain	Time (in minute)
12.6	0	0
12	-0.06	1
11.9	-0.07	2
11.8	-0.08	3
11.6	-0.09	4
11.5	-0.1	5
11.5	-0.1	6
11.5	-0.1	7
11.5	-0.1	8
11.5	-0.1	9
11.5	-0.1	10

Table (5.1): observation table

b) Graph



Graph(5.1): Stain Vs Time

A –Shows wire is at room temperature
B –shows maximum contraction in wire of 6 mm
B to C –Between B to C we get 1 mm contraction at each minute for 4 minute time duration
C –After this point wire does not obtain any contraction, we get constant line

6. CONCLUSION

We have plotted the result of behavior of SMA wire and gave the foundation that can undergo the further research. On the basis of the experimental analysis, we interpreted the behavior of SMA Nitinol wire at increasing temperature up to 200°C and then maintaining it constant under different constant load. The results we have found out are based on above procedure and they are validating in a particular amount i.e. the nitinol wire have performed compression or contraction. It shows change in length lying in between length of 0 mm to 10 mm. The analysis done by we are carried out in low cost and we can further extend or modify according to requirement in future research.

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