To study the creep deformation in metals.

Apparatus:

Metal specimen in wire form, weights traveling microscope, marker.

Theory:

When a material is subjected to a load, deformation follows loading almost instantaneously. Under certain conditions, however, and particularly at high temperature, of the applied load is retained for long periods, considerable additional deformation may occur. The material may gradually deform plastically and ultimately even fracture at a stress that is well below the ultimate tensile strength as determined by short time tensile testing. This continuous slow extension under a constant stress is known as creep.

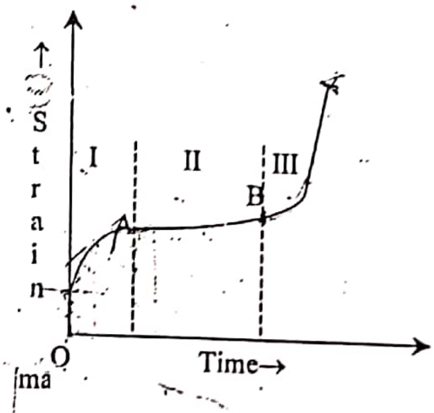

Figure 1

The standard creep test measures the strain are elongation of a loaded sample as a function of time at a constant temperature. If a constant load is used, the stress will not, of course, remain constant since the sample will undergo elongation. However, constant loading case merits investigation, as it is more representative of service condition. Under optimum condition, one can observe three distinct stages of elongation during creep deformation in metals. These are known as:

(i) Primary creep
(ii) Secondary creep
(iii). Tertiary creep

At low temperatures and stresses most metals show only primary creep. During the primary creep period the rate of extension decreases with time. It remains steady during the secondary creep stage. Tertiary creep is characterized by accelerating creep rate eventually

1 cm = 20 div

1 div = 1/20th cm

Value of 1 M.S.D = 0.05 cm

Div. on the vernier = 50

$$L.C. = \frac{\text{Value of 1 M.S.D}}{\text{No. of div.s on the vernier}}$$

$$= \frac{0.05}{50}$$

$$= 0.001 \text{ cm}$$

M.S. Reading	V.S. coinciding	Total Reading MSR + (VSC × LC)

1.05 .. 1.10 .

results in fracture. The contribution of various stages to total creep deformation depends on the nature of materials and the condition of temperature and stress prevailing during the test. The creep curves for any material are sensitive to both stress and temperature. For metals the functional form of extension vs. time for primary and secondary stage is given by

$$l = l_o(1 + Bt^{1/3})e^{kt} \qquad (1)$$

Where

L is the length at any time t,

l_o is the length immediately after applying the load,

B and k are constants for any given stress and temperature in order to verify equation (1), an experiment is to be performed the determination. In this experiment, we shall subject a thin copper wire to a constant tensile load (~10 N) and measure time variation in extension with the help of traveling microscope.

Procedure

Arrange the copper wire provided to you as per figure 2. Suspend a weight of about 1 kg and mark any point (at about 80 cms from the fixed end) on the wire. Focus the crosswire of the microscope on the mark and note down the initial position on the horizontal Vernier scale. Now add a weight of about ½ kg on the hook and start the stopwatch. It is seen that there is a measurable change in elongation. Give support to the weights from below (by hand or jack) after about ten seconds and note down the change in length on the horizontal scale. Giving support to load "freezes" extension enabling us to record the changes in length after small intervals of time of active load application. Repeat the process after every ten seconds of load application recording the observation up to, say sixty seconds. During this period, the elongation is considerable and represents the primary creep. Beyond this region the elongation slows down. Now take the observations of the extension after every one-minute. Observed secondary creep for 10/15m.

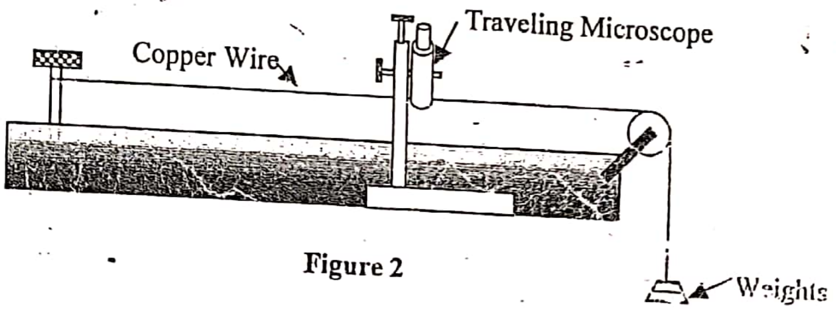

Figure 2

Plot a graph between the elongation and time. The characteristics correspond to a general equation (1), which is the sum of the exponential curve (OA) and the linear one (AB).

Calculations

A) Determination of *B*

B in equation (1), is a constant and denotes transient flow. Thus in the primary creep region OA, the variation of time is very small. Thus $e^{kt} \to 1$ in equation (1)

$$\frac{l-l_o}{l_o} = Bt^{1/3} \qquad (2)$$

corresponding to each data compute $(\text{strain})^3$ and time. The slope of the curve would give B^3.

B) Determination of *k*

The constant k can be evaluated from the region AB, for which the product $Bt^{1/3} << 1$. Therefore, equation (1) for region AB can be approximated as:

$$l = l_o e^{kt} \qquad (3)$$

The plot between log *l* and time is a linear one. Determine the value of *k* from it is known as the rate of strain for the secondary region.

Arrange your extension vs. time data symmetrically. Show graphical plot mentioned before and gives the resulting values of *B* and *k* (in proper units).

Observations

For Determination of *B*

S.No.	Load (Kg)	Time (Sec)	Microscope Reading (cm)	Extension Δl (cm)	Strain $(\Delta l/l)$	$(\text{Strain})^3 \times 10^{-12}$