Studies on Prevention of Creep in Concrete

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Abstract* -- *A concrete element when kept under sustained load presents progressive strain over time, which is associated with the creep phenomenon. The creep characteristic of high strength concrete assumes importance in the back drop of increase in prestressed concrete constructions. The loss in prestress and long-term deflection depend on creep strain of high strength concrete. Even in case of RC columns, such creep induced deformations cause the stress increase in the reinforcement and may induce the material to undergo yielding. An experimental study is conducted to determine the time induced creep strain of high strength concrete using creep rig of capacity 1000 kN. Creep strains are measured at regular time intervals. M50 concrete is designed for mix proportions and its properties like compressive strength and elastic modulus are determined. Three cylindrical specimens are mounted in the creep rig and are subject to a sustained load which is about 30% of ultimate compressive strength. Measurement of creep strain over time period is done with the help of a digital D'Mec gauge. The data is mathematically modelled as a time dependent phenomenon using correlation technique. The modelling will help to generate the creep strain over any given time duration. The goodness-of-fit of a model to the observed data is decided by the coefficient of correlation. The developed model will assist in predicting the time-dependent behaviour of RC columns in compression and uniaxial bending. Also, it will help to obtain comprehensive creep deformation for the prediction of long-term lateral deflection and instability. The model can be used in the development and calibration of a theoretical equation for the prediction of creep deflection and buckling under sustained load.

***Indexed Terms:* High Strength concrete, compressive strength, modulus of elasticity, creep**

I. INTRODUCTION

When load is applied on a concrete specimen, shows an instantaneous deformation followed by slow increase of deformation is called concrete creep. Creep is a time-dependent permanent (plastic) deformation under a certain applied load. Generally, creep occurs at high temperature (thermal creep) but can also happen at room temperature depending on the material (e.g. lead or glass), although this happens at a much slower rate.

As a result, the material undergoes a time-dependent increase in length, which could become quite dangerous while in use. The rate of deformation is called the creep rate. It is the slope of the line in a creep strain vs. time curve (see below).

II. REVIEW

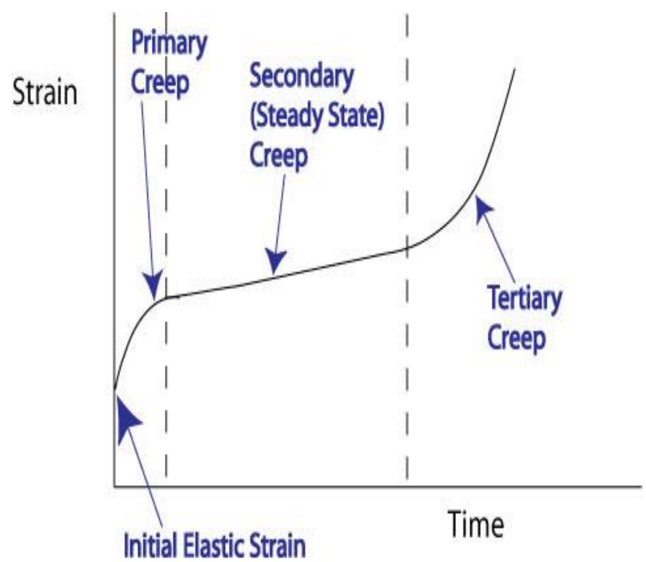
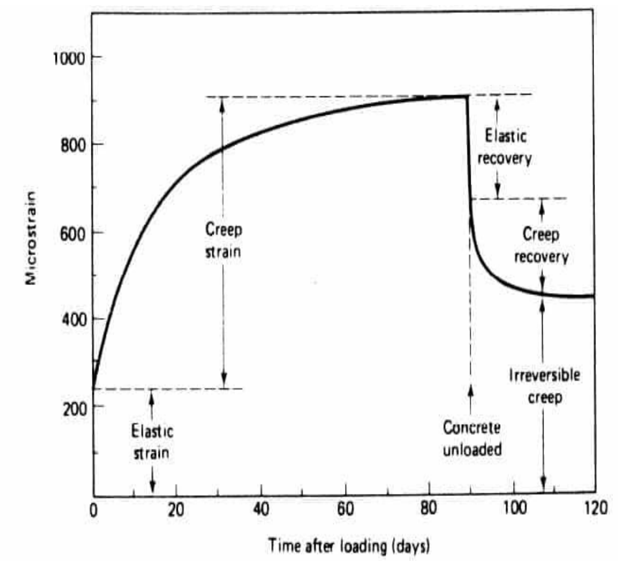


Fig 1: Creep Strain vs. Time Curve

Creep deformation has three stages; Primary creep starts rapidly and slows down with time. Secondary creep progresses at a relatively uniform rate. Tertiary creep has an accelerated rate of deformation which terminates when the material fails (breaks or ruptures). It is associated with both necking and the formation of grain boundary voids. There are several design strategies that can be adopted to avoid creeping in materials:

1. Reduce the effect of grain boundaries (use single crystal material with large grains).
2. Add solid solutions to fill the voids in the material.

3. Use materials with high melting temperatures.
4. Consult creep test data during materials selection.



III. METHODOLOGY

When a load is applied on a concrete specimen. the specimen first shows an instantaneous deformation which is then followed by slow further increase of deformation. This slow increase of deformation, discovered in 1907 by Hatt, is called creep. There is always strain associated with applied stresses to any material. ASTM E 6-03 defines creep as “the time-dependent increase in strain in a solid resulting from force.” To define creep, one must consider two identical specimens subjected to the same environmental histories, one specimen being loaded and the other load-free (companion specimen). The difference of the deformation of these two specimens defines the instantaneous deformation plus creep.

MacGregor and Wight explain that when a load is applied to concrete, it experiences an instantaneous elastic strain which develops into creep strain if the load is sustained. The magnitude of this creep strain is one to three times the value of the instantaneous elastic strain, it is proportional to cement-paste content and, thus, inversely proportional to aggregate volumetric content. Creep can thus be defined as the increase in strain under a sustained stress; and since this increase can be several times as large as the strain on loading, creep is of considerable importance in structural mechanics.

IV. RESULTS AND DISCUSSION

Under normal conditions of loading, the instantaneous strain recorded depends on the speed of application of the load and thus includes not only the elastic strain but also some creep. It is difficult to differentiate accurately between the immediate elastic strain and early creep, but this is not of practical importance as it is the total strain induced by the application of load that matters.

V. CONCLUSIONS

It was also found that basic creep was much higher than drying creep for all these concretes. They attributed the reduction of creep in the LWC with pre-wetted aggregate to three mechanisms: enhanced cement hydration, expansion of microstructure, and water seepage inhibition due to the internally stored water in LWA.

Comparing the results from these three concretes, they concluded that a higher compressive strength did not necessarily ensure lower creep because compressive strength and creep did not depend on the same factors to the same extent.

REFERENCES

[1] Shetty, M. S. *"Concrete Technology Theory & Practice, Published by S."* CHAND & Company, Ram Nagar, New Delh (2005).

[2] Punmia, B. C., Ashok Kr Jain, and Arun Kr Jain. Reinforced concrete structures. Vol. 1. Firewall Media, 1992.

[3] IS CODE 456 :2000 AND IS CODE 800 :2007