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An Experimental Study on Creep Characteristics of HSC

*Lavanya C.N[1],S.Tejaswi[2]
[1]*mvjce, vtu,Bangalore* ,[2]*mvjce, vtu,Bangalore*
*Corresponding Author: *Lavanya C.N*

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 helps 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.

Keywords:- High Strength concrete, compressive strength, modulus of elasticity, creep

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I. INTRODUCTION

Concrete is generally classified as normal strength concrete, high strength concrete (hsc) and ultra high strength concrete. concrete whose compressive strength is more than 50 to 60mpa is known as high strength concrete. The use of high strength concrete for bridges and high rise buildings is well known. High strength concrete can be obtained by using chemical admixture. The concrete having super plasticizer decreases the water/cement ratio and increases the workability. The behaviour of columns with high strength under sustained loading is of considerable importance.

1.1creep of concrete

The state of stresses due to sustained load promotes strains in concrete members which progresses over time, characterizing the phenomenon known as creep. creep is the tendency of a solid material to move slowly or deform permanently under the influence of mechanical stresses. it can occur as a result of long term exposure to high levels of stress. creep is more severe in materials that are subjected to heat for long periods. creep deformation does not occur suddenly upon the application of stress but strain accumulates as a result of long term stress. therefore, creep is a "time dependent" deformation. the creep deformations are more pronounced in the first months of the structure lifetime, when develop under higher rates. it can be extend for periods of time up to ten years, in more advanced stages it evolves over modest rates. the mechanism of creep depends on temperature and stress. in the initial stage, the strain rate is relatively high but slows with increasing time.creep depends for the given concrete mixture mainly on the loading history and applied stress. the important characteristic is that concrete element at an early age undergoes great creep deformation than when older concrete is loaded.

1.2Scope of work

1.To design mix proportions for achieving M50 concrete.
2.To establish mechanical properties of M50 concrete like compressive strength and elastic modulus.
3.To study the behavior of M50 concrete under sustained load.

1.3Objective

The basic objective is to understand the creep behaviour of high strength concrete under normal conditions. As high strength concrete is being increasingly used in present day constructions the main objective is to capture the creep phenomenon.

II. METHODOLOGY

Creep behaviour of high strength concrete is studied. Concrete of M50 grades is selected and the mix design is prepared based on the target strength and workability. Creep rig of 1000 kN capacity is employed. The sustain load is applied for 36 days. Creep strain is measured with help of a digital D'Mec gauge. Creep behaviour which is a time dependant property of concrete is mathematically modelled.

2.1Mix design

The concrete mix is used with nominal 28 day compressive strength of 50N/mm^2.

Table 1.Mix design quantities for 1m^3 of concrete

Compressive strength	50N/mm^2
Cement	450kg/m^3
Water	160 kg/m^3
Fine aggregate	540 kg/m^3
Coarse aggregate	1080 kg/m^3
super plasticizer	3.6 kg/m^3

The high strength concrete is attained by using a low water cement ratio of 0.35 with a high range water reducing agent of 0.8% by mass of cement to maintain workability.

III. EXPERIMENTAL WORK

3.1Compressive strength of concrete:

The compressive strength of concrete i.e. ultimate strength of concrete is defined as the load which causes failure of the specimen divided by the area of the cross section in uni-axial compression, under a given rate of loading the compression strength is calculated using the formula.

Compressive strength = (Load/Area) N/mm^2

The cubes and cylinders were tested after a curing period of 7days respectively. These were tested in 1000KN capacity compressive testing machine to get the compressive strength of concrete.

3.2 Stress – strain behaviour and modulus of elasticity

The stress strain behaviour of concrete cylinders is investigated. The direction of loading is perpendicular to the longitudinal axis of the cylinder specimen. A 200mm digital De'mec gauge is mounted against these studs for measuring longitudinal strains. De'mec gauge readings representing the longitudinal deformation are noted, leading to stress and the corresponding longitudinal strains. From the stress – strain relationship, modulus of elasticity of the concrete is evaluated.

3.3Measurement of creep

Creep of HSC specimen is investigated using the creep rig which is having 1000 kN capacity. The specimen is loaded up to 30 to 40 percent of the ultimate strength of concrete and the sustained load is applied for 36 days. Creep strain is measured with the help of a digital D'mec gauge.

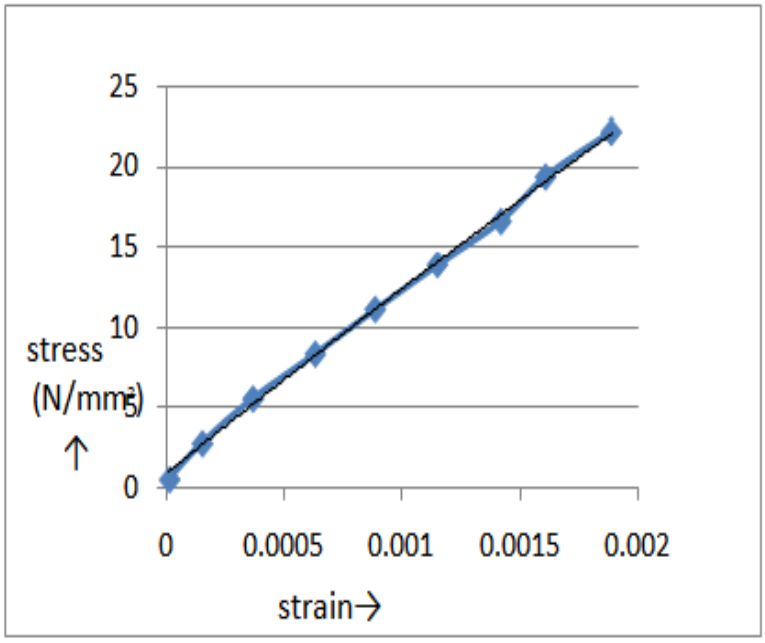
4. Experimental results

4.1Stress – strain behaviour and modulus of elasticity:

The concrete cylinders ware tested under compression parallel to the longitudinal axis of the specimens.

Table 2. Stress Strain Values of HSC

Stress (N/mm^2)	**Strain**
0.00001	0.555
0.00015	2.78
0.000365	5.55
0.00063	8.33
0.000885	11.1
0.00115	13.88
0.00142	16.65
0.00161	19.43
0.00189	22.21



4.2Creep behaviour of concrete

The creep strain versus time is measured. The sustained load corresponds to about 30% of the ultimate compressive strength. Instantaneous elastic strain is noted. The experimental data is presented.

Table3. Creep strain and time values

Time(days)	Strain
0	0
1	0.00027
2	0.000325
3	0.000335
4	0.000345
5	0.00035
6	0.000355
7	0.00036
8	0.000365
9	0.00037
10	0.00038
11	0.000385
12	0.00039
13	0.0004
14	0.000405
15	0.00041
16	0.000415
17	0.00042
18	0.000425
19	0.000425
20	0.00043
21	0.00043
22	0.00043
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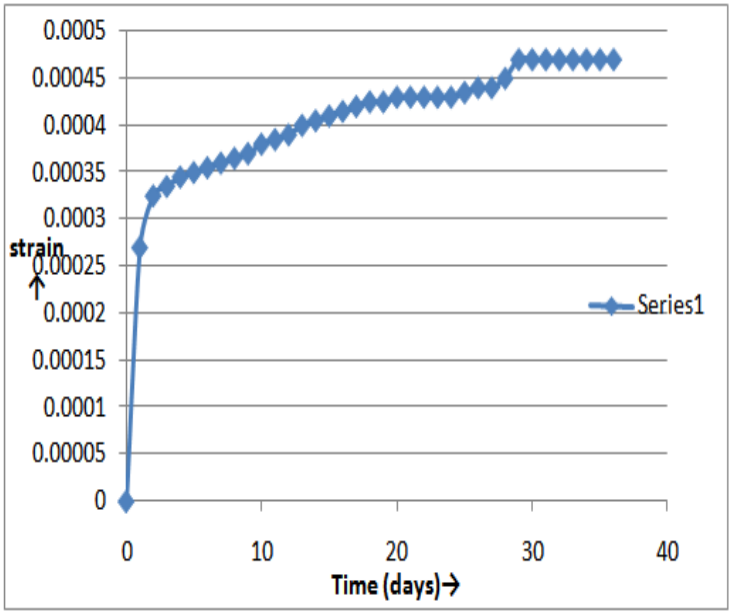

Creep coefficient

Generally the effect of creep is indicated in terms of creep coefficient which is defined as the ratio of ultimate creep strain to elastic strain at the time of loading. The values are presented.

The creep coefficients given in IS1343-1980 are irrespective of grade of concrete. It may be observed that the creep coefficient on 7 days is on the higher side whereas that on 28 days agrees with the value obtained in the present investigation.

Age at loading	**Creep coefficient As per IS 1343-1980**	**Creep coefficient obtained**
7days	2.2	1.33
28days	1.6	1.6

IV. CONCLUSIONS

Within the limited scope of the present work, following conclusions are drawn. Measurement of creep is necessary to predict the long term behavior of structural members made of HSC. The creep has a exponentially decreasing trend with time. The elastic modulus can be predicted by the stress-strain equation by taking first derivative which is same as measuring the slope of the tangent at the origin.

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