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CREEP OF CONCRETE

R.Sakthivel[1], S.Ramakrishnan[2]
[1,2]Structural Engineering, Bannari Amman Institute of Technology

Abstract- Creep is defined as the plastic deformation under sustain load. Creep strain depends primarily on the duration of sustained loading. It has been widely acknowledged that creep of concrete is greatly influenced by the surrounding ambient. Creep induces the deflection of the structural member with time. Hence the study on creep of concrete is necessary to prevent failure. A concrete cylinder is casted for two different grades and the load of 40% of its compressive strength is applied constantly. Creep is measured with time. A time - dependent creep is provided in a graph showing its variation.
Keywords-Creep, Durability, Loading, Demechreading, compressive strength

I. INTRODUCTION

Concrete is a composite material which has wider application in construction industry because of strength and durability. The properties of concrete can measured in various stages such as fresh and hardened stage. The several tests can be conducted on concrete to find its properties. The characteristics of fresh concrete such as workability and compactability are studied by conducting slump test, Vee Bee test, compacting factor test, etc. Similarly hardened concrete properties were studied by performing compressive strength test, split tensile strength test, flexural strength test, durability studies etc. Durability of concrete is the ability of concrete to resist weathering action, chemical attack, and abrasion while maintaining its desired engineering properties. Creep of concrete is one of the important durability study.

Different concretes require different degrees of durability depending on the exposure environment and properties desired. Concrete ingredients, their proportioning, interactions between them, placing and curing practices, and the service environment determine the ultimate durability and life of concrete. Hence creep of concrete for different grades of concrete has been found out in this experiment.

II. LITERATURE SURVEY

2.1 FLEXURAL CREEP OF STEEL FIBER REINFORCED CONCRETE IN THE CRACKED STATE

S. ARANGO; et al, This paper aims at assessing the effect of a number of variables on flexural creep of steel fiber reinforced concrete in its cracked state, namely: fiber geometry (slenderness and length), fiber content, concrete compressive strength, maximum aggregate size, and flexural load. Notched prismatic specimens have been subjected to sustained flexural loads for 90 days following a test setup and methodology developed by the authors. Several experimental outputs have been measured: initial crack width, crack width at 90 days, and crack opening rates and creep coefficients at 14, 30, and 90 days. Multiple linear regression has been applied to relate these creep parameters to the variables considered. Semi-empirical equations have been obtained for these parameters. Statistical inference has been applied to identify the variables that have a statistically significant effect on SFRC flexural creep response. Fiber slenderness and fiber content have been found to significantly modify the effect that load ratio has on flexural creep response of SFRC.

2.2 CONCRETE BASIC CREEP PREDI CTION BASED ON TIME–TEMPERATURE EQUIVALENCE RELATION AND SHORT-TERM TESTS

O.R. BARANI; et al, Using temperature as an accelerator of reactions in short-term tests for the prediction of concrete creep is the main idea of this paper. The application of a time-temperature equivalence relation is examined with reference to creep in concrete under constant moisture conditions. A mathematical model is developed which uses short-term tests to predict long-term creep deformation of concrete under constant moisture conditions, taking into account aging of concrete and the influence of temperature. The thermal activation is assumed to be governed by the Arrhenius principle, and the activation energy of the viscosity of water is found to be applicable in the analysis of the experimental data. The proposed model has been verified using selected experimental data, and its satisfactory agreement with experimental observations is illustrated. Finally, the proposed model is compared mathematically with Bazant and Panula's model.

2.3 CREEP AND CREEP RECOVERY PROPERTIES OF POLYSTYRENE AGGREGATE CONCRETE

W.C TANG; et al, The present study aims to characterize the creep behaviour of Polystyrene Aggregate Concrete (PAC). The creep and creep recovery of PAC were determined experimentally and compared with normal weight concrete. The parameters studied include polystyrene aggregate (PA) content, curing and storage conditions. The ultimate creep strains for the polystyrene aggregate concrete were estimated using a hyperbolic expression and compared to the other common prediction models for normal weight concrete. The experimental results showed that creep of polystyrene aggregate concrete increased with the increase of PA content in the mix. The ratios of creep recovery to creep strains decreased slightly with an increase in PA content. The curing and storage conditions showed remarkable influences on the creep of PAC, but not for its creep recovery. Besides, the creep prediction results were compared against the prediction models given by ACI and CEB-FIP.

2.4EFFECT OF AGGREGATE TO BINDER RATIO ON SHRINKAGE AND CREEP OF HIGH PERFORMANCE LIGHTWEIGHT CONCRETE

Jafa'ar S. Al-Sakini; et al, High performance lightweight concrete, HPLC, could be considered as a combination between high performance concrete and structural lightweight concrete. In the present work, HPLC was produced from totally local materials (Metakaolin and Porcelinite). An experimental part had carried out to investigate the effect of increasing lightweight aggregate volume on time dependent deformations of high performance lightweight concrete. The tests included in this work were: 28-day oven dry density, compressive strength, shrinkage strain, and creep strain in compression. The test period for shrinkage and creep was extended to 364 days. It was concluded that using higher Porcelinite to binder ratios had always negative effect on shrinkage of HPLC. Mix M20 (with 20% increase in P/B ratio) showed the lowest shrinkage magnitude and rate. No significant decrease was observed in specific creep of the tested mixes when adopting higher P/B ratios**.**

2.5 PRACTICAL PREDICTION OF CREEP AND SHRINKAGE OF HIGH STRENGTH CONCRETE

ZDENEK P.BAZANT; et al, Model for practical prediction of creep and shrinkage of normal strength concrete, developed previously, is extended to high strength concrete. It is found that only a minor adjustment for the concrete strength effect is needed in the formulas for drying creep. The formulas for basic creep and shrinkage need no adjustment. The prediction model is compared with test data for creep and shrinkage obtained recently by Ngab, Nilson and Slate, and by Colle pardi, Corradi and Valente, and a satisfactory agreement is demonstrated. The coefficientof variation of the deviations from test data is not larger than that for the normal strength range. However, the existing data are rather limited and further testing is desirable.

2.6 STUDY OF EARLY-AGE CREEP AND SHRINKAGE OF CONCRETE CONTAINING IRANIAN POZZOLANS: AN EXPERIMENTAL COMPARATIVE STUDY

M.H.Afshar; et al, This paper presents an experimental study on prediction of the early-age creep and shrinkage of concrete with and without silica fumes, trass, ground-granulated blast-furnace slag, combinations thereof, and inuences of the proposed Iranian pozzolans. Experiments were carried out under a controlled ambient condition at a temperature of 40_C and a relative humidity (RH) of 50%, and a laboratory ambient condition at a temperature of 20_C and a relative humidity (RH) of 30% in order to collect the required data. Comparisons are made between ACI209-92, BS8110-1986 and CEB1970 prediction models, and an estimation model, based on 28-day results (short-term test method), using the same experimental data to predict the creep and shrinkage of the specimens at the ages of 120 and 200 days after curing. The results show that the above-mentioned models are not accurate enough for predicting the creep and shrinkage of concrete containing local Iranian pozzolans. It was also observed that the prediction, based on short-term results, would lead to more accurate creep and shrinkage predictions.

2.7 SHORT-TERM TENSILE CREEP AND SHRINKAGE OF ULTRA-HIGH PERFORMANCE CONCRETE

Victor Y. Garas; et al, The tensile creep and free shrinkage deformations of ultra-high performance concrete UHPC) were examined through short-term testing to assess the influences of stress/strength ratio, steel fiber reinforcement, and thermal treatment. The use of fibers and the application of thermal treatment decreased 14-day drying shrinkage by more than 57% and by 82%, respectively. Increasing the stress-to-strength ratio from 40% to 60% increased the tensile creep coefficient by 44% and the specific creep by 11%, at 14 days of loading. Incorporating short steel fibers at 2% by volume decreased the tensile creep coefficient by 10% and the specific creep by 40%, at 14 days. Also, subjecting UHPC to a 48-h thermal treatment at 90 _C, after initial curing, decreased its tensile creep coefficient by 73% and the specific creep by 77% at 7 days, as compared to ordinarily cured companion mixes. Comparison of tensile creep behaviour to published reports on compressive creep in UHPC reveal that these phenomena differ fundamentally and that further evaluation is necessary to better understand the underlying mechanisms of tensile creep in UHPC. Results from this study also showed that the effects of both thermal treatment and fibre reinforcement were more pronounced in tensile creep behaviour than tensile strength results of different UHPC mixes. This emphasizes the importance of conducting tensile creep testing to predict long-term tensile performance

III. CREEP OF CONCRETE

Creep may be defined as the slow deformation of a material over an extended period of time while under sustained load. The strain which is produced in the course of a creep test at the end of loading may be three or four times the initial elastic strain. Therefore creep is of considerable importance in structural mechanics. Besides that, creep may also be viewed from another standpoint, to be known as a form of relaxation of material. This occurs when the restraints are such that a stressed concrete specimen is subjected to a constant strain; creep will manifest itself as a progressive decrease in stress with time. However in most cases, the detrimental effect of creep prevails.

The occurrence of creep is based on the viscous component in the concrete as well as hygrometric and hydrometric condition of the material. Creep strain can be defined into several different components with basic creep and drying creep being the two most recognized forms. In addition to that, the classification also comprises of transitional creep strains that causes a magnification of creep rate. These transient phenomena can be considered as the result of local reductions in rigidity at the site of phase changes occurring in the cement paste due to interaction with the environment. The details of the different types of creep strain are discussed here.

3.1. Basic Creep :

Basic creep is creep deformation that occurs under a constant compression at hygrometric equilibrium, without the event of moisture exchange between the ambient and the medium.

3.2. Drying Creep

Drying creep, also known as the Pickett effect is the additional creep strain in excess changes in its environment. The magnitude of creep obtained is mainly due to drying creep as water movement in concrete induced higher stress. The strain is expressed in millimetres per millimetre, resulting in a dimensionless pure number. If the moisture content increases, wetting creep will result. Both wetting and drying creep are considered as transitional hygral creep strains**.**

3.3 Transitional Thermal Creep

The term transitional thermal creep is used to describe the additional strain that occurs when the temperature of concrete changes while under load . The temperature changes can be due to the influence of the surrounding ambient or due to the heat development of cement paste hydration.

TEST SET UP

Load the creep specimens to the lower load plate. In placing creep specimens in the frame, take care in aligning the specimens to avoid eccentric loading. when cylinders are staked and external gauges are used, it may be helpful to apply small preload, such that the resultant stress does not exceed 40N. The strain variation around each specimen should be noted, after which, the load may be removed and the specimens realigned for greater strain uniformity.

TEST SPECIMENS

Specimen Size

The diameter of each specimen shall be 150± 1.5 mm], and the length shall be at least 290 mm. When the ends of the specimen are in contact with steel bearing plates, the specimen length shall be at least equal to the gauge length of the strain-measuring apparatus plus the diameter of the specimen. When the ends of the specimen are in contact with other concrete specimens similar to the test specimen, the specimen length shall be at least equal to the gauge length of the strain-measuring apparatus plus 40 mm. Between the test specimen and the steel bearing plate at each end of a stack, a supplementary non instrumented cylinder whose diameter is equal to that of the test cylinders and whose length is at least half its diameter shall be installed.

APPLICATION OF LOAD:

Immediately before loading the creep specimens, determine the compressive strength of the strength specimens. At the time unsealed creep specimens are placed in the loading frame, cover the ends of the control cylinders to prevent loss of moisture. Load the specimens at an intensity of not more than 40 % of the compressive strength at the age of loading. Tae strain readings immediately before and after loading, 2 to 6 h later, then daily for 1 week, weekly until the end of 1 month, and monthly until the end of 1 year. Before taking each strain reading, measure the load. If the load varies more than 2 % from the correct value, it must be adjusted. Tae strain readings on the control specimens on the same schedule as the loaded specimens.

IV. RESULTS

Compressive strength test results for M20 and M40 for 28 days grade of concrete cylinder

S. No.	Mix	Age at testing (days)	Specimen	Weight (g)	Load (N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	M20	28	E1	12.7	431	24.42	24.41
2			E2	13.2	412	23.31	
3			E3	12.4	451	25.5	
4	M40	28	F1	13.5	520	28.86	28.13
5			F2	13.3	490	27.20	
6			F3	13.1	510	28.31	

Creep of concrete in compression test results M20 for 28 days grade of concrete:

Date of testing	:	8-11-14
Weight of specimen	:	13.13Kg
Static ultimate load	:	431.3kN
Applied creep load	:	202.2kN
Gauge length	:	170
Least count of demech reading	:	0.002mm

			DEMECH READING			
S.NO	TIME	LOAD(N)	SIDE 1	SIDE 2	AVERAGE	STRAIN(MICRONS)
1	0	0	520	525	522.5	0
2	10	170	485	480	482.5	533
3	20	170	478	480	479	580
4	30	170	475	478	476.5	613
5	40	170	470	475	472.5	667
6	50	170	460	465	462.5	800
7	60	170	455	463	459	847
8	70	170	455	463	459	847
9	80	170	455	460	457.5	867
10	90	170	455	455	455	900
11	100	170	450	440	445	1033
12	110	170	440	440	440	1100
13	120	170	440	440	440	1100
14	130	170	440	435	437.5	1133
15	140	170	440	435	437.5	1133
16	150	170	440	435	437.5	1133
17	160	170	440	435	437.5	1133
18	170	170	435	435	435	1167
19	180	170	435	435	435	1167
20	190	170	435	435	435	1167
21	200	170	425	430	427.5	1267
22	210	170	425	430	427.5	1267
23	220	170	425	430	427.5	1267
24	230	170	425	430	427.5	1267
25	240	170	425	430	427.5	1267
26	250	170	425	430	427.5	1267
27	260	170	425	430	427.5	1267
28	270	170	425	430	427.5	1267
29	280	170	425	430	427.5	1267
30	290	170	425	430	427.5	1267
31	300	170	425	430	427.5	1267

32	310	170	424	425	424.5	1307
33	320	170	424	425	424.5	1307
34	330	170	424	425	424.5	1307
35	340	170	424	425	424.5	1307
36	350	170	424	425	424.5	1307
37	360	170	424	425	424.5	1307
38	370	170	424	425	424.5	1307
39	380	170	424	425	424.5	1307
40	390	170	424	425	424.5	1307
41	400	170	424	425	424.5	1307
42	410	170	424	425	424.5	1307
43	420	170	424	425	424.5	1307
44	430	170	424	425	424.5	1307
45	440	170	424	425	424.5	1307
46	450	170	424	425	424.5	1307
47	460	170	424	425	424.5	1307
48	470	170	424	425	424.5	1307
49	480	170	424	425	424.5	1307
50	490	170	424	425	424.5	1307

Creep of concrete in compression test results M40 for 28 days grade of concrete

Date of casting : 13-10-14

Date of testing : 11-11-14

Size of specimen : 150mmx300mm

Weight of specimen : 13.30Kg

Static ultimate load : 506.67

Applied creep load : 202.67

Gauge length : 150mm

Least count of demech reading : 0.002mm

S.NO	TIME	LOAD(N)	DEMECH READING		AVERAGE	STRAIN(MICRONS)
			SIDE 1	SIDE 2		
1	0	0	525	538	531.5	0
2	10	210	485	515	500	420
3	20	210	480	500	490	553.33
4	30	210	480	495	487.5	586.67
5	40	210	480	490	485	620
6	50	210	480	480	480	686.67
7	60	210	475	480	477.5	720
8	70	210	475	480	477.5	720

9	80	210	473	475	474	766.67
10	90	210	473	475	474	766.67
11	100	210	473	473	473	780
12	110	210	472	470	471	806.67
13	120	210	470	470	470	820
14	130	210	467	470	468.5	840
15	140	210	467	465	466	873.33
16	150	210	465	460	462.5	920
17	160	210	465	460	462.5	920
18	170	210	465	460	462.5	920
19	180	210	460	460	460	953.33
20	190	210	460	455	457.5	986.67
21	200	210	460	455	457.5	986.67
22	210	210	460	455	457.5	986.67
23	220	210	460	455	457.5	986.67
24	230	210	460	455	457.5	986.67
25	240	210	460	455	457.5	986.67
26	250	210	460	455	457.5	986.67
27	260	210	460	455	457.5	986.67
28	270	210	460	455	457.5	986.67
29	280	210	460	455	457.5	986.67
30	290	210	460	455	457.5	986.67
31	300	210	460	455	457.5	986.67
32	310	210	460	455	457.5	986.67
33	320	210	460	455	457.5	986.67
34	330	210	460	455	457.5	986.67
35	340	210	460	455	457.5	986.67
36	350	210	460	455	457.5	986.67
37	360	210	460	455	457.5	986.67
38	370	210	460	455	457.5	986.67
39	380	210	460	455	457.5	986.67
40	390	210	460	455	457.5	986.67
41	400	210	460	455	457.5	986.67
42	410	210	460	455	457.5	986.67
43	420	210	460	455	457.5	986.67
44	430	210	460	455	457.5	986.67
45	440	210	460	455	457.5	986.67
46	450	210	460	455	457.5	986.67
47	460	210	460	455	457.5	986.67
48	470	210	460	455	457.5	986.67
49	480	210	460	455	457.5	986.67
50	490	210	460	455	457.5	986.67

V. CONCLUSION

I

In this Investigation, totally 12 cylinders and 6 cubes were casted for M20 and M40 grades of concrete and tested for creep. The following could be concluded from the test results.

1. Maximum Strain value is obtained at the initial stage of loading (nearly within 30 mins from the time of application of load) for both M20 and M40 grades of concrete.

2. After 6 hours, the rate of increase in strain value is very much reduced for both M20 and M40 grades of concrete.

3. Results obtained for every 10 mins shows that, M40 grade of concrete has lesser strain value than M20 grade of concrete.

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