INTERNAL CURING ON HIGH PERFORMANCE CONCRETE WITH PRE-SOAKED LIGHT WEIGHT AGGREGATE TO PREVENT SHRINKAGE

A. Baskar[1], G. Arunvignesh[2]

[1] *Assistant Professor, Department of Civil Engineering, Gnanamani college of Technology Namakkal.*
[2] *ME Structural Engineering, Department of Civil Engineering, Gnanamani college of Engineering, Namakkal*

ABSTRACT - In our fast growing world use of low water cement ratio concrete mixtures are highly promoted because of their strength and durability. But low w/c structure tends to early age shrinkage cracks. To reduce shrinkage cracking, a method named as internal curing is developed. In this method internal curing agents by means of LWA added to balance the reduction of water content. Hence LWA plays a major role in internal curing. And at the same time fabrication of heavy structure needs high strength concrete to hold the structure without failure.so my project investigates the properties of HPC specimens are cast with replacement of cement with 12% of silica fume and addition of 6%,12%,20% of LWA in internal curing method.

1. INTRODUCTIONS

1.1 INTERNAL CURING

Internal curing(IC) refers to the time-dependent improvement of concrete strength due to the gradual release of water from aggregate, in which it was absorbed before mixing, to the cement particle to allow continued hydration.

1.2 HIGH PERFORMANCE CONCRETE

High performance concrete (HPC) has been defined as concrete that possesses high workability, high strength and high durability. ACI also defines a high-strength concrete as concrete that has a specified compressive strength for design of 6,000 psi (41 MPa) or greater.

1.3 MATERIALS USED

The following materials are used for making the concrete as high performance one and ensuring internal curing inside the concrete.

- silica fume
- Super plasticizers
- light weight aggregate
    - Vermiculite
    - Saw dust

2 EXPERIMENTAL INVESTIGATIONS

2.1 FINE AGGREGATE

The fine aggregate used in this investigation is clean river sand passing through 4.75 mm sieve and conforming to grading zone II. The fine aggregates were tested as per Indian standard specifications IS 383-1970.

2.2 COARSE AGGREGATE

Locally available coarse aggregates having the maximum size of 10 to 20mm was used in this present work

2.3 CEMENT

The cement used in this study is 53 grade OPC manufactured by chettinad cements.

2.4 WATER

The portable water available in the college campus has been used.

2.5 SUPER PLASTICIZER

To improve the workability of the fresh light weight concrete, CONPLAST SP 430 super plasticizer, has been used.

2.6 DESCRIPTION OF SPECIMEN

Specimen details	% replacement of LWA				
	Vermiculite %	Saw dust%	SF	SP	w/c
S_1					0.36
S_2	6		12	1.2	0.34
S_3	12		12	1.2	0.32
S_4	20		12	1.2	0.30
S_5		6	12	1.2	0.34
S_6		12	12	1.2	0.32
S_7		20	12	1.2	0.30

3 RESULTS AND DISCUSSION

3.1 COMPRESSIVE STRENGTH

The concrete cube specimens are made as light weight concrete in high performance one by adding silica fume and super plasticizer.

Fig 3.1 Tests on Cube

3.1.1 DISCUSSION ON COMPRESSIVE STRENGTH

The compressive strength at an age of 3, 7 and 28 days of different mix proportions are observed that the mix with 6% vermiculite and saw dust are the optimum levels and the prism and beams are cast with this optimum replacement level.

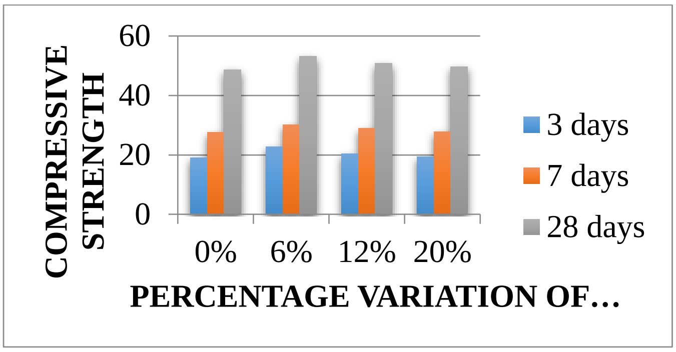

Fig 3.2 Compressive Strength of Vermiculite in HPC

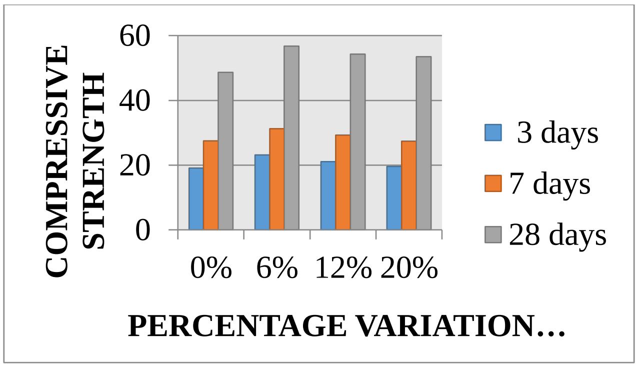

Fig 3.3 Compressive Strength of Saw Dust in HPC

3.2 SHRINKAGE BEHAVIOR

In order to predict the early age shrinkage the prisms were cast and tested in 1, 3, 7 and 28 days. The optimum percentage is found as 6% from the compressive strength result. This percentage replacement of light weight aggregate sand is taken for preparing the prism specimen. At least 3 samples are prepared for one mix proportion..

Fig 3.4 Shrinkage Tests on Pris

3.2.1 DISCUSSION ON SHRINKAGE PRISM

The shrinkage measurements were made on 4 x 4 x 11.25 inches (100 x 100 x 286 mm) prism specimens. Measurements were started at 1-days age and were continued to 3, 14 and 28-days age. Based on the results and observations, it is observed that the artificial light weight aggregate provides better result than that of natural light weight aggregate. It was observed that, in mixtures without the water saturated lightweight aggregate; there is a strong dependency on the size and shape of the concrete member undergoing this plastic shrinkage. It is noted that any effects that the paste composition had on shrinkage was completely over-ruled by the presence of the moisture in the LWA. The value of normal concrete in length comparator at 28 days is 0.034 and the values of light weight aggregate such as saw dust and vermiculite is 0.028 and 0.023. The percentage reduction of saw dust and vermiculite is 6% and 11% respectively compared to normal concrete.

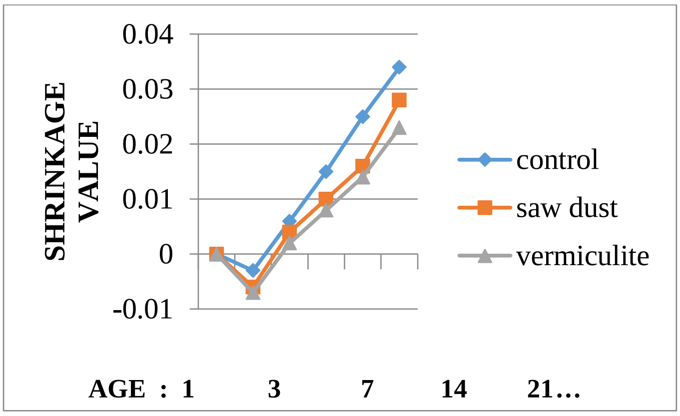

Fig 3.5 Shrinkage Values

3.3 TESTING OF BEAMS

The current experimental program includes 6 beams. S1, S3, S5 are the beams kept under water curing and S2, S4, S6 are the beams kept under internal curing condition. For each proportion of mix one beam has been casted.

3.3.1 REBOUND HAMMER TEST

The results of rebound hammer test are shown in table 4.3.

Table 3.3 Rebound Hammer Test Results

SI.NO	Beam designation	Compressive strength (N/mm^2)
1	S1	46.1
2	S2	40.8
3	S3	48.6
4	S4	44.1
5	S5	46.2
6	S6	58.1

3.3.2 FLEXURE TEST

Table 3.4 Test Result on Beam Specimens

S.N	specimen	Ultimate load(KN)	First crack load(KN)	Mode of failure
1	S1	48.96	12	UR
2	S2	40.99	12	UR
3	S3	50.76	10	UR
4	S4	48.98	14	UR
5	S5	60.78	18	UR
6	S6	54.5	14	UR

The behavior of specimens in terms of crack development, the failure mode and the ultimate load were observed during the test. The compressive and tensile strains were recorded. The observations of each beam were presented in below tables.

Fig 3.6 Testing of Beam Specimen

3.4 LOAD VS DEFLECTION

The flexural strength of internal curing specimens is nearly same that of water curing specimens and the deflection values of internal curing specimens is less compared to the water curing specimens. The deflection goes on increasing towards the mid span of the beam.

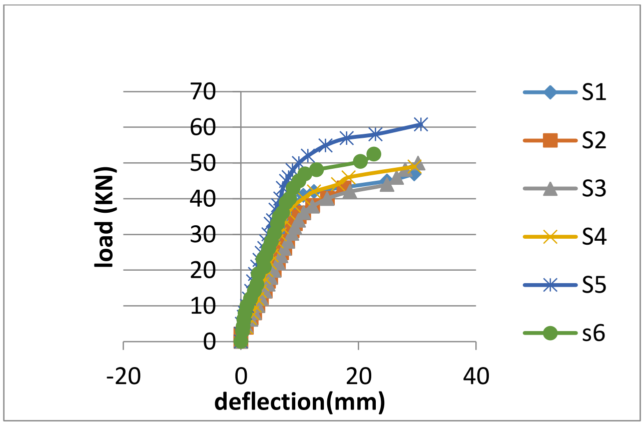

Fig 3.7 Comparison Chart for Load Deflection Curve at L/2

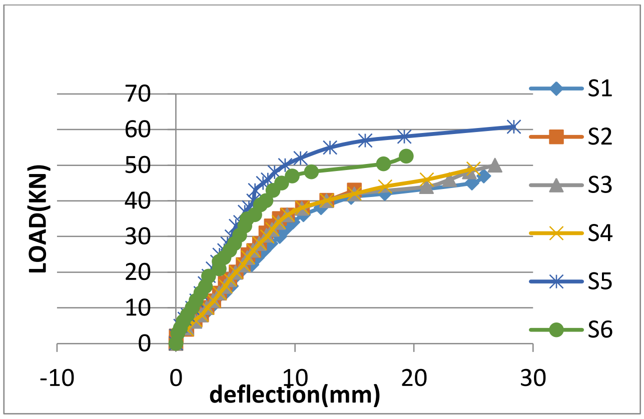

Fig 3.8 Comparison Chart for Load Deflection Curve at L/3

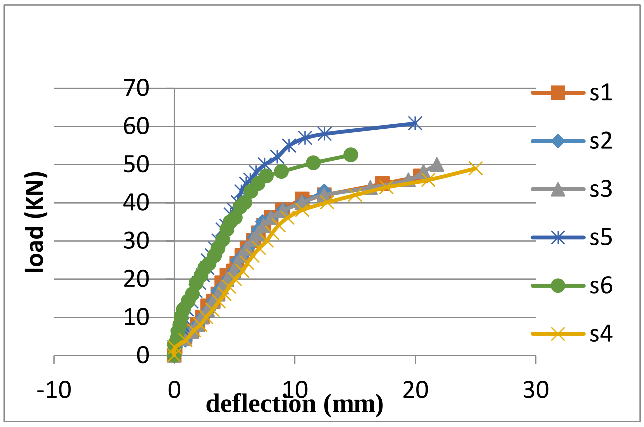

Fig 3.9 Comparison Chart for Load Deflection Curve at L/4

The load Vs mid span deflection of the beam is shown in figure 4.7. It can be seen that S1 & S5 specimens suffers maximum deflection under the load. The specimen S1 suffered a maximum deflection of 24.52 next to the specimen of S5 suffered maximum deflection of 24.03.The specimens S4 & S6 were undergone small deflections compared to S1 & S4.

The load Vs one third span deflection of the beam is shown in figure 4.8. It can be seen that S1 & S5 specimens suffers maximum deflection under the load. The specimen S1 suffered a maximum deflection of 20.48 next to the specimen of S5 suffered maximum deflection of 22.41.The specimens S4 & S6 were undergone small deflections compared to S2 & S3.

The load Vs one fourth span deflection of the beam is shown in figure 4.9. It can be seen that S5 & S4 specimens suffers maximum deflection under the load. The specimen S4 suffered a maximum deflection of 19.13 next to the specimen of S5 suffered maximum deflection of 20.The specimens S2 & S6 were undergone small deflections compared to S1 & S3.

3.5 STRESS STRAIN BEHAVIOUR – WATER CURING

The stress strain plot of specimens S1, S3, S5 is shown in figure 4.10. From the plot it is clear that the rate of strain exhibited by the concrete in compression zone is nearly same for S1, S3 and S6 specimens. As specimen with saw dust which has been kept under water (S5) is in high strength group, it shows a stress strain plot with higher stress strain values.

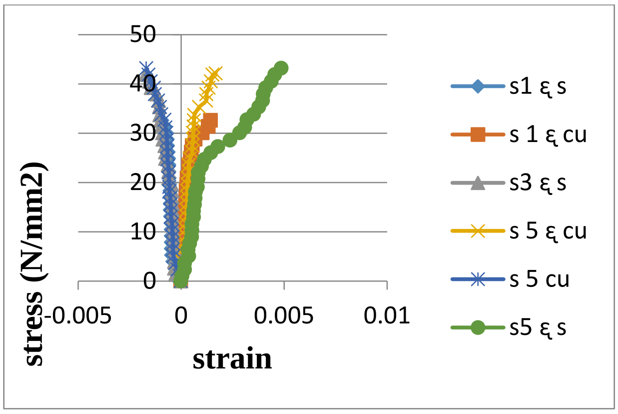

Fig 3.10 Stress Strain Curve for Specimen S1, S3, S5

The tensile strains exhibited by the above specimens, shows a linear behavior due to the presence of reinforcement till major cracking takes place. Among the specimens, S5 has the highest strain value with low level of strain and longest elastic region. Whereas the control specimen kept under internal curing has the lowest stress value.

3.6 STRESS STRAIN BEHAVIOUR – INTERNAL CURING

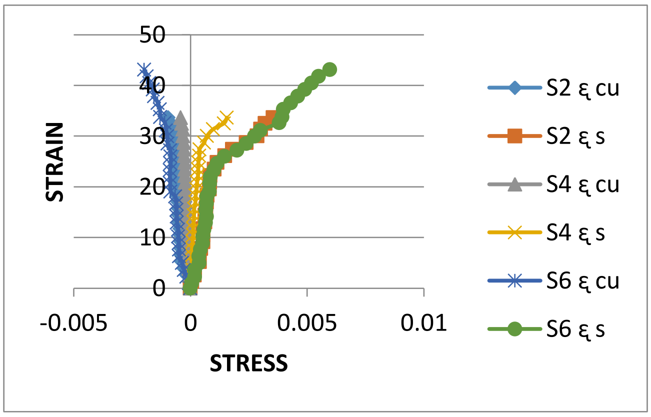

Fig 3.11 Stress Strain Curve for Specimen S2, S 4, S6

The stress strain plot of specimens S2, S4 and S6 is shown in figure 6.11. From the plot it is clear that the rate of strain exhibited by the concrete in compression zone is nearly same for S4 and S2 specimens. The specimen with saw dust as an internal curing agent it exhibits a clear stress strain plot with higher stresses value.

The tensile strain exhibited by the above specimens, shows a linear behavior due to the presence of reinforcement till major cracking takes place. Among the specimens S5 has the highest strain value with low level of strain and longest elastic region. Whereas the control specimen has the lowest stress value.

The stress and strain characteristics of both water and internal curing conditions are more or less exhibit same behavior.

4. CONCLUSION

The following are the conclusions based on the experimental work carried out.

The physical and mechanical properties of vermiculite, saw dust and silica fume have been found to be favorable for the use in cement concrete as indicates by the compressive strength of concrete specimens tested.

- The load corresponds to cracking is nominally more in all beams compared to that of control beam both in terms of water curing and in terms of internal curing. The flexural strength is not affected due to internal curing. The maximum load resisted by 6% replacement of saw dust is more than that of control specimen.

- The provision of internal curing resulted in a substantial reduction in the measured shrinkage for the prism specimens. From the length comparator reading, it is observed that the 6% of vermiculite gives the less shrinkage than that of specimens made of saw dust. The percentage reduction of saw dust and vermiculite is 6% and 11% respectively compared to normal concrete.

- The replacement of Lightweight sand by saw dust and vermiculite was absorbed as more effective at internal curing. Lightweight aggregate reduced the shrinkage significantly and prolonged the net-time to cracking considerably.

- High performance Concrete is more homogeneous than normal concrete. Initial flaws like pores, cracks and interfacial delimitation in High performance Concrete are smaller and less numerous than in normal concrete.

- Wet LWA, in the amount of 6% of total sand, provided enough internal curing water to the hydrating cement in order to eliminate shrinkage.

- Ductility index, stiffness of internal curing specimens are more than that of water curing specimens

- By considering the overall performance it is concluded that the specimens subjected to internal curing are having the capacity of reducing shrinkage cracks.

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