Self Curing And Moist Curing Analysis on Fly-Ash Replacement In Concrete

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Abstract- *CO2 fixation in the form of inorganic carbonates, commonly known as mineral carbonation, is an intriguing approach for carbon dioxide removal from diverse gas streams. The acquired CO2 is reacted with metal-oxide containing materials, which are often minerals. Alkaline industrial waste, such as flyash, may also be used as a calcium or magnesium source. The solubility of flyash from traditional pulverised hard coal fired boilers with and without desulphurization products, as well as flyash from lignite fluidised bed combustion, produced by Polish power plants, was investigated in this research. The primary goal was to evaluate the potential of flyash as a reactant in the mineral carbonation process. Experiments were carried out in a 1 dm3 reactor with a heating jacket and a stirrer. At different temperatures (20 – 80oC), waste-to-solvent ratios (1:100 – 1:4), and stirrer speeds (300 – 1100 min-1) the rate of dissolution in water and acid solutions was determined. The results clearly reveal that fluidised lignite flyash has the best potential for carbonation owing to its high free CaO concentration and quick dissolution kinetics, and may be used in mineral carbonation of CO2.*

Keywords- flyash,self curing, moist curing

I. INTRODUCTION

Curing concrete is the process of maintaining a satisfactory moisture content in concrete during its early stages in order for the desired properties to develop. However, in many cases, good curing is not always practical. Several investigators inquired about the possibility of self-curing concrete. As a result, the need to develop self-curing agents drew the attention of several researchers. The idea behind self-curing agents is to reduce water evaporation from concrete and thus increase the concrete's water retention capacity when compared to conventional concrete. Water-soluble polymers have been discovered to be effective self-curing agents in concrete.

Self-curing agents in concrete will be a new trend in concrete construction in the new millennium. Curing concrete helps to develop the microstructure and pore structure of the concrete, which improves its durability and performance. The idea behind self-curing agents is to reduce water evaporation from concrete and thus increase the concrete's water retention capacity when compared to conventional concrete.

1.1 Self-Curing

Curing concrete is the process of keeping an acceptable moisture content in concrete during its early stages in order for the necessary qualities to develop. However, proper curing is not always feasible and is often overlooked in many circumstances. Several scientists inquired about the possibility of self-curing concrete. As a result, the necessity to produce self-curing chemicals drew the attention of various researchers. The idea of self-curing chemicals is to minimize water evaporation from concrete and hence enhance the concrete's water retention capacity when compared to traditional concrete. Water soluble alcohols have been shown to be effective self-curing agents in concrete. The usage of self-curing admixtures is critical since water resources are becoming more precious (i.e. each 1m3 of concrete requires about 3m3 of water for construction most of which is for curing). The advantage of self-curing admixtures is especially apparent in desert settings (for example, Rajasthan), where water is scarce.

1.2 Advantages of Self Curing:

- Reduces permeability,
- Protects reinforcing steel,
- Increases mortar strength,
- Increases early age strength sufficient to withstand strain,
- Provides greater durability,
- Lower turnaround time,
- Improved rheology
- Greater utilization of cement,
- Lower maintenance,
- Reduces autogenous cracking,

1.3 Scope

This test method is used to determine the rate of absorption (sorptivity) of water by hydraulic cement concrete by measuring the increase in the mass of a specimen resulting from absorption of water as a function of time when only one surface of the specimen is exposed to water. The exposed surface of the specimen is immersed in water and water ingress of unsaturated concrete dominated by capillary suction during initial contact with water.The values stated in SI units are to be regarded as the standard.

II. LITERATURE REVIEW

Nagesh Tatoba Suryawanshi. This Paper reports an experimental investigation into the usage of water-soluble polyvinyl alcohol as a self-curing agent The compressive and tensile strength of self-curing concrete for 7 and 28 days is determined in this research and compared to conventional concrete of same mix design. The endurance of self-curing concrete is tested by exposing concrete cubes to a chloride environment and determining the impact of the same on cube strength by determining cube compressive strength. The weight loss with time findings showed that water retention for self-curing agent-containing concrete mixes is greater than for traditional concrete mixes. The results also revealed that self-curing concrete has stronger compressive, tensile, and flexural strength than traditional concrete.

A.S. El-Dieb. In this paper The water retention of self-curing concrete is explored. Concrete weight loss and internal relative humidity measurements were taken over time to assess the water retention of self-curing concrete. To assess hydration, non-evaporable water of various ages was tested. Water transport through concrete is assessed by calculating absorption percentages, permeable void percentages, water sorptivity, and water permeability. Water transfer through self-curing concrete is assessed as it ages. The influence of concrete mix proportions, such as cement content and w/c ratio, on the performance of self-curing concrete was explored.

Mateusz Wyrzykowski. Conclusion of this paper isThe mobility of water in hardening cement paste is critical in terms of internal curing efficacy. For the examination of water migration kinetics from internal curing agents [superabsorbent polymers (SAP)] into hydrating cement pastes with a low water-to-cement ratio, a mechanistic-type numerical model of cementitious materials is used. It is shown that releasing curing water at an early age (i.e., on the first day of hydration) allows for a uniform and nearly immediate distribution of water throughout the whole volume of cured paste, even when the distances for water migration are as great as 2–3 mm. The development of permeability as a consequence of the hydration process has been found to have a significant influence on water mobility in the cement paste. Water movement may be significantly hampered by capillary porosity depercolation. The research demonstrates that a portion of the water initially collected by the paste in the vicinity of the SAP may be subsequently redistributed to a huge volume of hardening paste, even after the permeability has become very low.

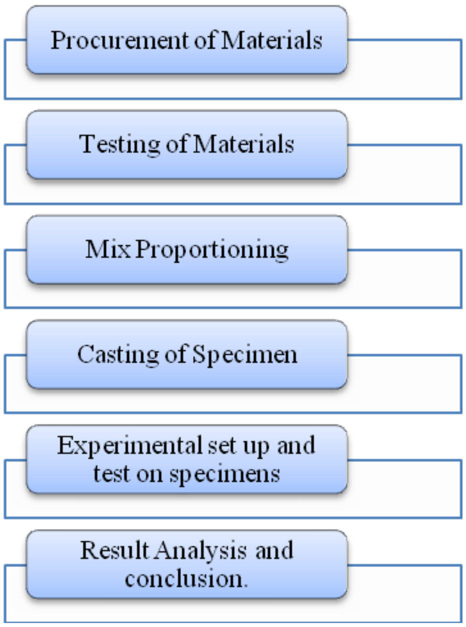
Glory Joseph and K. Ramamurthy. In this paper The autogenous curing behaviour of cold-bonded fly-ash-aggregate concrete is investigated for a variety of cement and aggregate contents by submitting the concrete to three distinct curing regimes: mist curing, sealed condition, and air curing. The moisture transport from aggregate to concrete is evaluated and connected to the paste-aggregate proximity at different ages. Nonevaporable water content is used to determine the degree of hydration. Thermal gravimetric analysis (TGA) has been used to correlate hydration products with concrete age. According to the findings, the degree of hydration and strength of cold-bonded aggregate concrete are almost indifferent to curing conditions.

Benjamin E. Byard et al. Cracking in bridge decks at a young age is a big problem that could shorten the bridge's useful life. Using cracking-frame testing, the effect of lightweight fine aggregate on how likely concrete bridge decks are to crack was looked at. For internal curing, prewetted absorptive lightweight aggregate (LWA) is mixed into the mixture during batching. This adds water to the mix. As hydration goes on, the LWA loses the water it has taken in. This happens early on. The release of the internal curing water makes the cementing material more watery and reduces the capillary stress that comes from the cement drying out on its own. Cracking frames measure how stresses build up due to thermal and self-shrinkage effects from the time the material is set until it starts to crack. To find out how stress builds up due to self-shrinkage, concrete samples were tested at temperatures that matched those of a bridge deck that was already in place and under isothermal curing conditions.

Gaston Espinoza-Hijazin et al. This paper concluded Natural pozzolans (NP) have been shown to be a good supplementary cementitious material. However, replacing ordinary portland cement (OPC) with NP could make concrete shrink more when it dries and when it shrinks naturally. Internal curing (IC), which can speed up the pozzolanic reactions and reduce shrinkage, could be a big help when using NP. The goal of this study is to find out what happens when IC is mixed with NP in concrete. The results show that replacing 39% of the OPC with NP decreased the compressive strength by 15%, decreased the chloride ion permeability by

66%, and increased the natural shrinkage by 40%. The compressive strength or permeability of IC with prewetted lightweight aggregate didn't change much, but autogenous shrinkage was cut by up to 58%. In this study, NP had a higher chemical shrinkage than OPC, which made IC less effective as the amount of NP went up.

III. METHODOLOGY



3.1 Materials

3.1.1 Cement

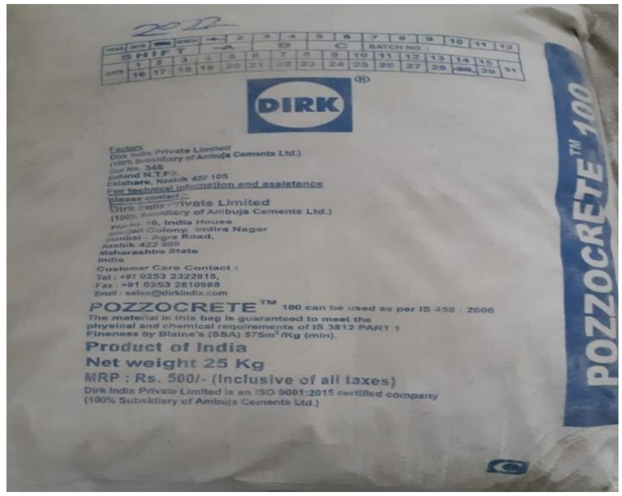
Ultra Tech 53 grades Ordinary Portland cement is used for this study. This cement is the most widely used one in the construction industry in India

3.1.2 Course and fine aggregates

Maximum size of Coarse aggregates is 20 mm used for this study which taken from Mhasrul-Nashik, Maharashtra, and natural sand of river bed is used confirming to grading Zone –II of table 4 of IS 383 were procured from Maharashtra.

3.1.3 Fly Ash

Fly Ashis obtained from DIRK- INDIA COMPANY, Nashik city in Maharashtra.



3.1.4 Water

Drinking water is used for casting and currying of the concrete blocks.

3.1.5 Self Curing Compound.

Emcoril white are membrane forming curing compound to be brushed or sprayed on the fresh concrete only once at very initial stages which is in critical hardening of the concrete.

DETAILS	SAMPLE-1	SAMPLE-2
Weight of empty pychnometer with cap (m1)	**458 gm**	**458 gm**
Weight of pychnometer with 1/3rd of fly ash (m2)	**587 gm**	**583 gm**
Weight of pychnometer with fly ash and water (m3)	**1315**	**1316**
Weight of pychnometer filled with water (m4)	**1252 gm**	**1252 gm**

Product name	Emcoril White
Type	Membrane forming Curing Compound as per ASTM C309
Colour	White
Curing Efficiency	80%
Consumption	150-250 g/m2
Coverage	approx. 4.5 to 6.5 m2 /kg

Specific Gravity Test - Sand.

The results are listed below: -

DETAILS	SAMPLE-1	SAMPLE-2
weight of empty pychnometer with cap (m_1)	458 gm	458 gm
weight of pychnometer with 1/3rd of sand (m_2)	580 gm	578 gm
weight of pychnometer with sand and water (m_3)	1331gm	1329 gm
weight of pychnometer filled with water (m_4)	1252 gm	1250gm

FORMULA

$G = M_2\text{-}M_1 / [(M_2\text{-}M_1)\text{-}(M_3\text{-}M_4)]$
=2.8

CALCULATIONS

1) G1= 2.8
2) G2=2.92
3)

MEAN= 2.86

RESULT:

The specific gravity of sand was found to be **2.86**

3.2 Specific Gravity - Fly Ash.

The results are listed below

FORMULA:

G = M2-M1 / ((M2-M1)-(M3-M4))

CALCULATIONS:

1) G1= 1.95
2) G2=2.04

MEAN= **1.995**

RESULT

The specific gravity of FLY ASH was found to be **1.995**

3.3 Concrete Mix Design

B-1 Stipulations for Proportioning

a) Grade designation	M20
b) Type of cement	OPC 53 grade of cement
c) Maximum nominal size of aggregate	20 mm
d) Minimum cement contentment	300 kg/m3
e) Maximum w/c ratio	0.35
f) Workability	100 mm (slump)
g) Exposure condition	severe (for reinforced concrete)
h) Degree of supervision	good
i) Type of aggregates	crushed angular aggregate
j) Maximum cement content	450 kg/m3

B- 2 Test Data forMaterials

a) Cement used	OPC 53 grade conforming to IS 8112
b) Specific gravity of cement	3.15
c) Fly ash :	conforming to IS 3812
d) specific gravity of Fly ash :	1.995

B-3 Target Strength for Mix Proportion

STEP I:

$f'_{ck} = f_{ck} + 1.65 \times s$
$= 20 + 1.65 \times 4$
$= 26.60$ N/mm^2

STEP II:

W/c ratio = 0.35

STEP III:

Selection of water content:
For 20mm Maximum Water Content = 186 Liter For 25 To 50 Mm Slump
Estimated water content for 100 mm slump = 186 + (6/ 100) × 186
= 197.16 liter

STEP IV:

Calculation of Cement And Fly ash Content Content:
W/C ratio =0.35
Cementations material (cement + Fly ash) = (197.6 / 0.35) = 563 kg/m^3
From table 5 of IS 456, minimum cement content for moderate exposure = 300 kg / m^3
395.2 kg/ m3 > 300 kg / m^3……………………………….. Ok
Cementations material content =395.2 x 1.10 = 434.72 kg / m^3
Water content = 197.16 lit.
W.C. ratio = 0.35
Fly ash about 20% of total cementitrious material content = 563 x 0.2
= 113 = Kg / m^3
Cement (OPC) = 563-113 = 450 kg / m^3
Fly ash being utilized = 113 kg / m^3

STEP V:

proportion of volume of coarse aggregates and fine aggregates content

From the table 3, of IS 10262- 2009; the volume of coarse aggregates corresponding to 20 mm size aggregates and fine aggregates conforming to zone II ; and for w /c ratio of 0.5 to 0.62
In this case w /c ratio is taken as 0.5
As w/c ratio lowered by 0.10; the proportion of volume of coarse aggregates is increased by 0.02[at the rate of± 0.01 for every ± 0.05 changing in w/c ratio] Therefore, Corrected volume of coarse aggregates for water cement ratio 0.5=0.62
Therefore, volume of coarse aggregate = 0.62
Volume of fine aggregates content 1- 0.62=0.38

STEP VI:

Mix calculations:

A)Volume of concrete = 1 m^3

B) Volume of cement = (mass of cement / specific gravity of cement) × (1/1000)
= (450 /3.15) X (1/1000)
= 0.1428 m^3

C) Volume of Fly ash = (mass of Fly ash / specific gravity of Fly ash) × (1/1000)
= (113 /1.995) X (1/1000)
= 0.0566 m^3

D) Volume of water = (mass of water/ specific gravity of cement) × (1/1000)
= (197.6 / 1) × (1/1000)
= 0.1976 m^3

E) Volume of all in aggregates
= [A – (B + C +D)]
= [1 – (0.1428+0.0566+0.1976)]
= 0.5836 m^3

F) Mass of coarse aggregates
volume of coarse aggregates × specific gravity of coarse aggregates × 1000]
= 0.5836 X 0.62 X 2.726 × 1000
= 1008 kg

G) Mass of fine aggregates
= [(E) × volume of fine aggregates × specific gravity of fine aggregates × 1000
= 0.5836 X 0.38 X 2.86 × 1000
= 634 kg

Mix proportion for trial number 1(fly ash =20%): -

Cement: 450 Kg/M3
Fly ash: 113 kg/ M3
Water: 197.16 kg/M3
Fine Aggregate: 634 Kg/M3
Coarse Aggregate: 1008 Kg/M3
Water-Cement Ratio: 0.35

Mix design proportions:(Fly Ash 20%)-2.1M &2.1S

water	Cement+ fly ash	Fine aggregates	Coarse aggregates
197.16	450 + 113	634	1008
0.35	1	1.12	1.79

Mix design proportions :(Fly ash 25%)- 2.2 M &2.2S

water	Cement+ fly ash	Fine aggregates	Coarse aggregates
197.16	423 + 140	628	1000
0.35	1	1.11	1.77

Mix design proportions :(Fly ash 30%)-2.3 M &2.3S

water	Cement+ fly ash	Fine aggregates	Coarse aggregates
197.16	394 +169	623	990
0.35	1	1.11	1.76

Mix design proportions:(Fly ash 20%)-2.4 M &2.4S

water	Cement+ fly ash	Fine aggregates	Coarse aggregates
197.16	351 + 87	682	1084
0.45	1	1.94	3.08

Mix design proportions :(Fly ash 25%)-2.5 M &2.5S

water	Cement+ fly ash	Fine aggregates	Coarse aggregates
197.16	328 + 110	677	1077
0.45	1	2.06	3.28

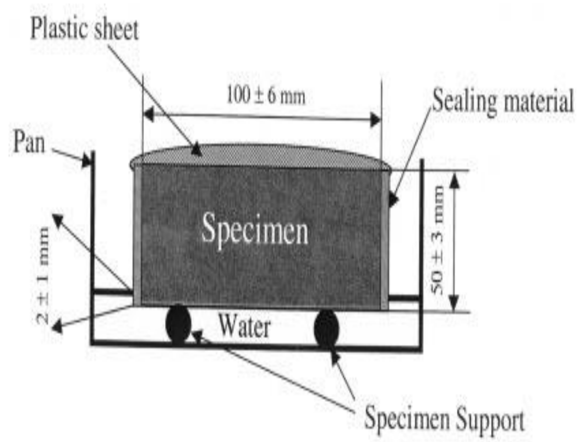
Mix design proportions :(Fly ash 30%)-2.6 M &2.6S

water	Cement+ fly ash	Fine aggregates	Coarse aggregates
197.16	307 +131	674	1072
0.45	1	2.19	3.49

IV. EXPERIMENTAL SET UP

4.1 Procedure

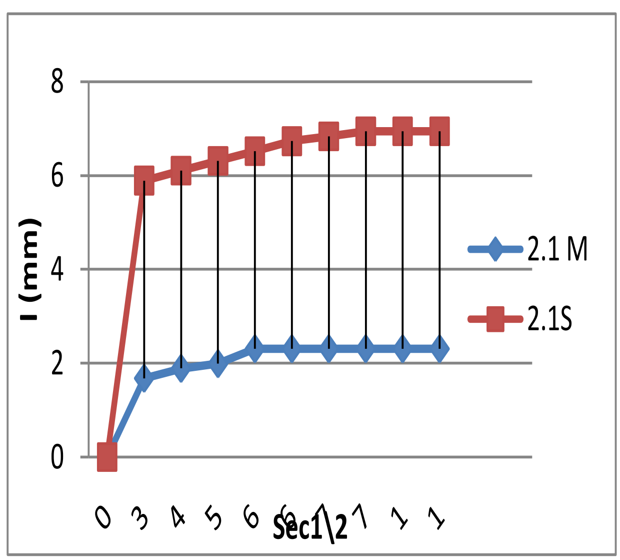
1. Remove the specimen from the storage container and record the mass of the conditioned specimen to the nearest 0.01 g before sealing of side surfaces.
2. Measure at least four diameters of the specimen at the surface to be exposed to water. Measure the diameters to the nearest 0.1 mm and calculate the average diameter to the nearest 0.1 mm.
3. Seal the side surface of each specimen with a suitable sealing material. Seal the end of the specimen that will not be exposed to water using a loosely attached plastic sheet The plastic sheet can be secured using an elastic band or other equivalent system .
4. Use the procedure below to determine water absorption as a function of time. Conduct the absorption procedure at 23 + 2°C with tap water conditioned to the same temperature.
5. Seal the side of each specimen with the right kind of sealant. Use a loosely attached plastic sheet to seal the end of the specimen that will not be in water. The plastic sheet can be held in place with an elastic band or something similar.



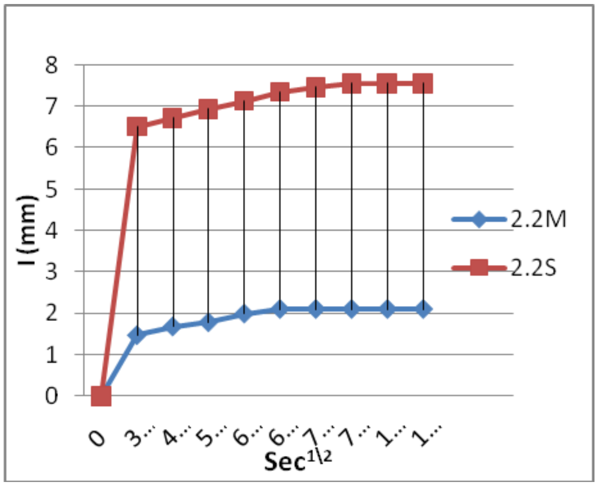
Schematic of the Procedure

V. RESULT ANALYSIS

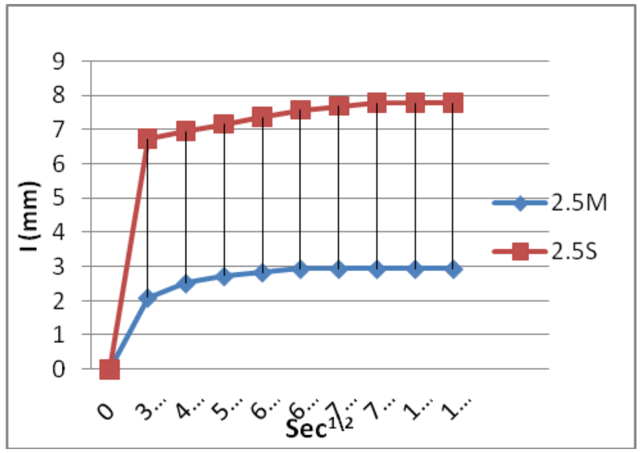
Graph showing comparison between moisture curing concrete and self-curing concrete



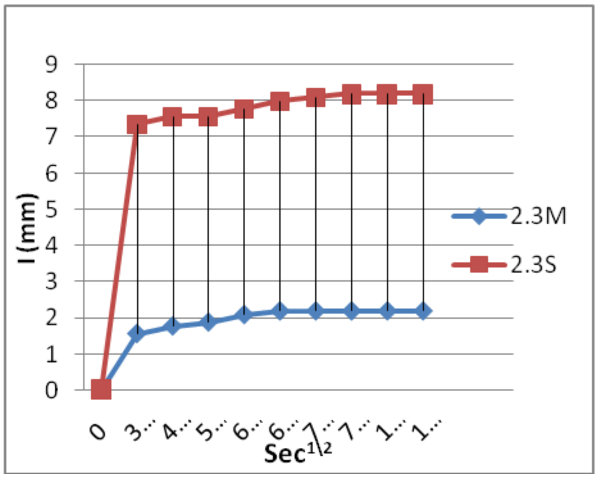
GRAPH 1



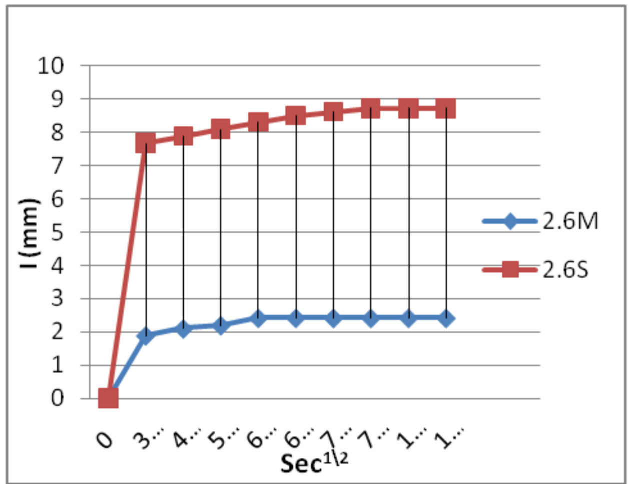
GRAPH 2



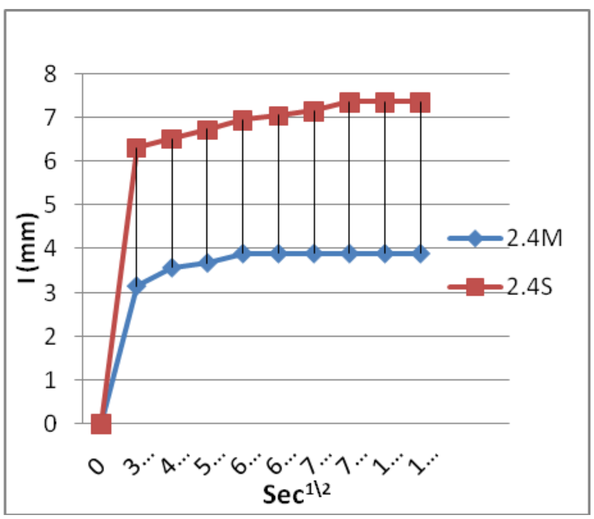
GRAPH 5



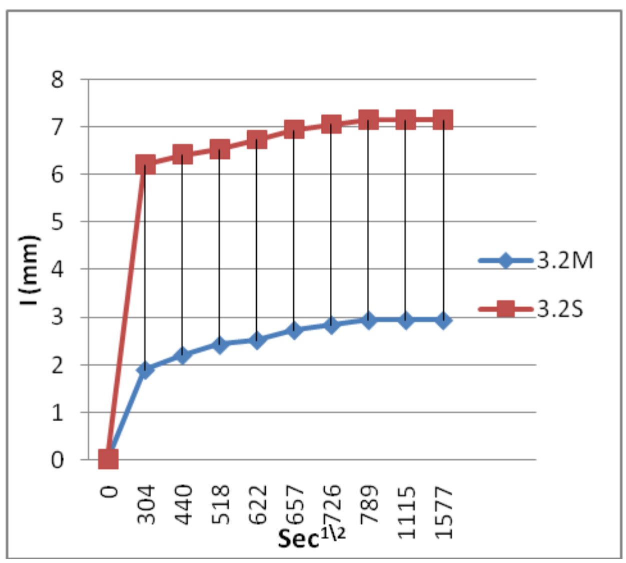
GRAPH 3



GRAPH 6



GRAPH 4



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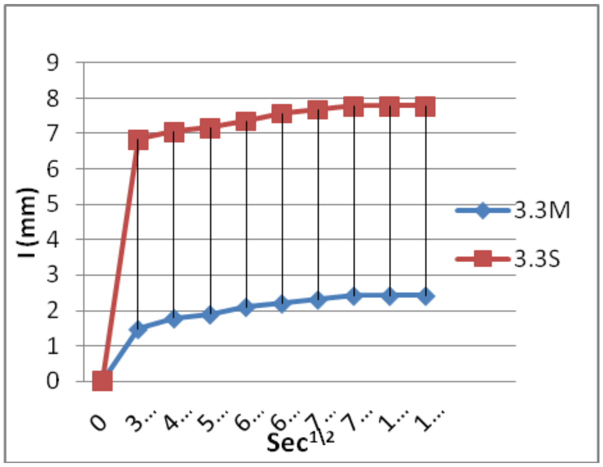

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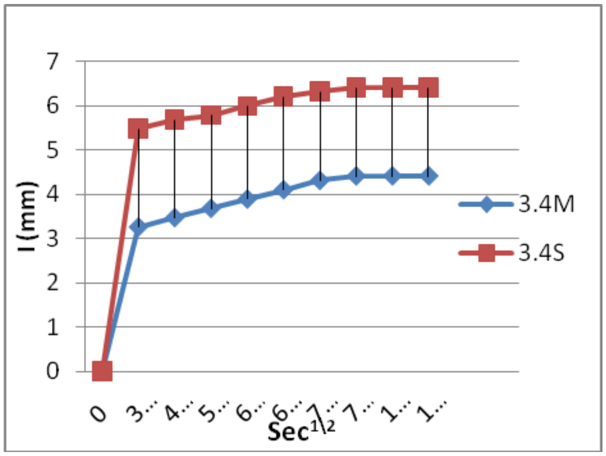
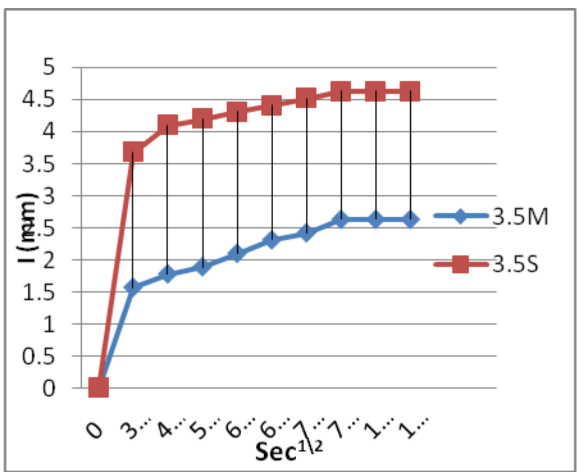
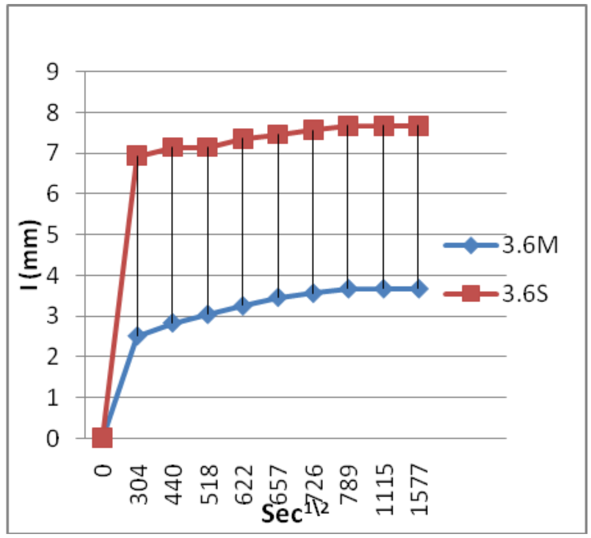


GRAPH 9



GRAPH 10



GRAPH 11

VI. CONCLUSIONS

The following could be concluded from the results obtained in this study in spite of the scattering of test results:

1. 1.The water sorptivity was measured at 1,2,3,4,5,6,7,8,14 and 28 days of age, in order to study the effect of self-curing on the development of the capillary pores, and the capillary water suction of the concrete. Graph shows the water sorptivity for the self-curing and the conventional concrete with different fly ash contents and at different water cement ratios with time. For the M20 and M30 concrete mix, the water sorptivity values at both ages were not significantly reduced when w/c ratio was reduced from 0.45 to 0.35. From graphs we can conclude that rate of absorption of self curing concrete is larger than moisture curing concrete.
2. Rate of absorption increases with increase in fly ash content.
3. Rate of absorption was not changing significantly with change in water cement ratio from 0.45 to 0.35.
4. Rate of absorption is reduces with time. It is very higher for first 24 hours and reduces on further days.
5. We can say that as capillary pores in self curing concrete are higher than that of moisture cured concrete the strength gained by self curing concrete is definitely less than moisture cured concrete, but it saves plenty of water required for curing i.e. it only requires water for concreting, no further curing required.
6. Use of self curing concrete saves approx. 66% of water which is required for curing.
7. As there is reduction in water resources day by day in india, very much need of water saving self curing

concrete can be a solution.1 m^3 of concrete requires 3 m^3 of water, most of them is for curing. In desert areas this technique is very much effective.

Also, the following conclusions could be considered for further research:

- Performance of the self-curing agent is affected by the mix proportions, mainly the cement content and the w/c ratio.
- Effect of the self-curing agent on the microstructure and the pore size distribution of the self-curing concrete require additional study.
- Durability of self-curing concrete to sulphate salts and chloride induced corrosion is needed to be evaluated.
- The effect of using higher w/c ratios, different cement types, and supplementary cementing materials (SCM), such as silica fume fly ash and ground granulated blast slag on water retention, hydration and moisture transport of the self-curing concrete needs further investigations

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