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Experimental Investigations on Effects of Millenium 21 Admixture (Internal Curing) On Durability and Strength Parameters of Concrete

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Abstract: *As per the previous studies of various internal compounds, the durability and strength of the internally cured specimens is much greater than the conventionally cured specimens. Millenium21 is new product in market and thus is used as internal curing compound in this experimental study. The quality of structure does not solely depend upon strength gain only. Thus the durability has to be studied. In this experimental study the effects of Millenium21 were studied on strength and durability of concrete. Internal curing compound is used in concrete which will acquire uniform curing using minimal amount of water which is not possible with conventional curing techniques that in turn leads to improper curing and development of cracks. Therefore Millenium 21 is mixed in concrete to gain long term durability access.*

Keywords: *Carbonation, Durability, Internal curing, Millenium 21, Strength.*

I. Introduction

The ACI-308 Code states that "internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing Water."[1]
Conventionally, curing concrete means creating and maintaining moisture conditions over the surface of concrete. Contrary, Internal curing happens from inside the concrete by internal curing compound. Internal curing is not a substitute for external curing. Moisture loss must still be prevented using conventional external measures.

Since decades curing of concrete on site has been a great problem to deal with. The conventional methods used for curing on site are not up to the mark and does not meet the required standards which in turn leads to cracking, shrinkage, reinforcement corrosion, creep, spalling and honeycombing which affects the durability of concrete. To achieve good curing, excessive evaporation of water from a freshly cast concrete surface should be prevented and if it fails then it will lead to the lowering of degree of cement hydration and thus the concrete casted is of undesirable properties. Due to improper curing on construction sites the required moisture content and temperature in concrete is not satisfactory and the desired strength of concrete is not developed, thus resulting in reduced life of the structure.

Also conventional curing technique requires enormous quantity of water. It is difficult to create and maintain moist conditions in dry regions having scarcity of water. Thus proper curing is not achievable which in turn affects the strength and durability of concrete structures.

Nowadays, new developments are made in construction industry. One of the major developments in achieving proper curing is done by making the use of internal curing compounds such as Millenium21 that prevent the loss of water and promote moist curing conditions. Internal curing provides a positive contribution in increasing the sustainability of infrastructure.

Proper curing of concrete structures is important to ensure that they meet their intended performance and durability requirements. Internal curing by Millenium21 is a very promising technique that can provide additional moisture in concrete for more effective hydration of the cement and reduced self desiccation, shrinkage, cracking, chloride permeability. Also, it has been found that the use of Millenium21 rapidly cures the concrete within 3 days whereas conventional method requires minimum 7 days of curing. Curing significantly influences the durability of reinforced concrete structures. Carbonation test and water absorption test on concrete were carried out to study the durability. Also the compressive strength test was performed for comparing strength of conventionally and internally cured concrete.

II. Experimental Investigations

2.1 Materials

Properties of materials used for the experimental study are as follows:

2.1.1 Cement

Ordinary Portland cement (Jaypee cement) of 53 grade having specific gravity 3.10.[2]

2.1.2 Aggregates (FA and CA):

FA of size less than 4.75 and CA of size 20mm is used.

Table 1: Properties Of Aggregate

Properties	Source	Zone	Specific Gravity	Fineness Modulus	Colour
FA	Mula River	Zone I	2.53	3.30	Black
CA	Khadi Machine	Zone I	2.91	-	Greyish Black

2.1.3 Water

Water is an important ingredient of concrete as it actually participates in the Chemical reaction with cement. water having pH range 7.0 - 8.0 was used in the mixture.

2.1.4 Curing Compound

Millenium 21 (Fig.1) is used as internal curing compound in the experimental investigation. For M20 grade, 100ml of compound/bag of cement is used.

Colour: Milky White

pH: 10

Nature: Basic in nature.

Density: 0.98

Fig. 1: millenium 21 admixture

2.2 Casting of concrete

Concrete blocks of grade M20 for 3,7,28,120 days age were casted for both conventionally and internally cured concrete specimens of size 150mm x 150mm x 150mm as per given specifications[3]. These specimens were casted separately for each experimental study i.e. Compressive strength test, Carbonation Test and Water Absorption test. The specimens were removed from the mould and subjected to curing for different period for conventionally and internally cured concrete.

2.3 Compressive Strength test

Compressive strength test were carried out on 3,7,28,120 days age of concrete specimens. The test was carried out on an Universal testing machine having capacity of 1000 kN. The testing machine complies in all respects with the requirements of IS : 516 – 1959.[4]

2.4 Durability tests

Durability tests carried out in this study are carbonation test and water absorption test. Durability tests were done at the age of 7,28 and 120 days.

2.4.1 Carbonation test

The phenolphthalein indicator is an acid base indicator and was applied to a fresh fractured surface of concrete. Part of concrete where the indicator turns purple, the pH is above 8.6. Where the solution remains

colourless, the pH of the concrete is below 8.6, suggesting carbonation. A fully-carbonated paste has a pH of about 8.4.[5]

2.4.2 Water Absorption test

The water absorption test on hardened concrete is performed as per ASTM C642-81[6].The specimens are cured for different curing period and dried in an oven at 105^{o} C for 24 hrs. The dry specimens are then cooled to room temperature (25 ^{o}C) and weighed accurately as dry weight. Dried specimen were immersed in water for 24 hours and then weighed accurately as wet weight.The percentage increase in weight is calculated as the percentage of water absorbed.

III. Results And Discussion

3.1 Compression test

Compressive strength test was performed and the following results were obtained:

The compressive strength test results in Table 2 reveals that initially 3days strength is lower in internally cured concrete specimens as compared to conventionally cured specimens. But the results show that the strength at 7,28,120 days age is higher in internally cured specimens as compared to conventionally cured specimens.

Table 2: Compression Test Results

WITHOUT ADMIXTURE				WITH ADMIXTURE(Millenium21)		
SAMPLE	DAYS	STRENGTH		SAMPLE	DAYS	STRENGTH
1	120	38.27		1	120	43.8
2		31.21		2		42.13
3		30.25		3		41.31
Average		33.24		Average		42.41
1	28	28.19		1	28	30.85
2		23.8		2		30.37
3		20.35		3		30.77
Average		24.11		Average		30.66
1	7	22.48		1	7	23.9
2		22.78		2		25.33
3		25.34		3		24.71
Average		23.53		Average		24.65
1	3	17.08		1	3	15.16
2		16.45		2		15.58
3		18.24		3		17.2
Average		17.26		Average		15.98

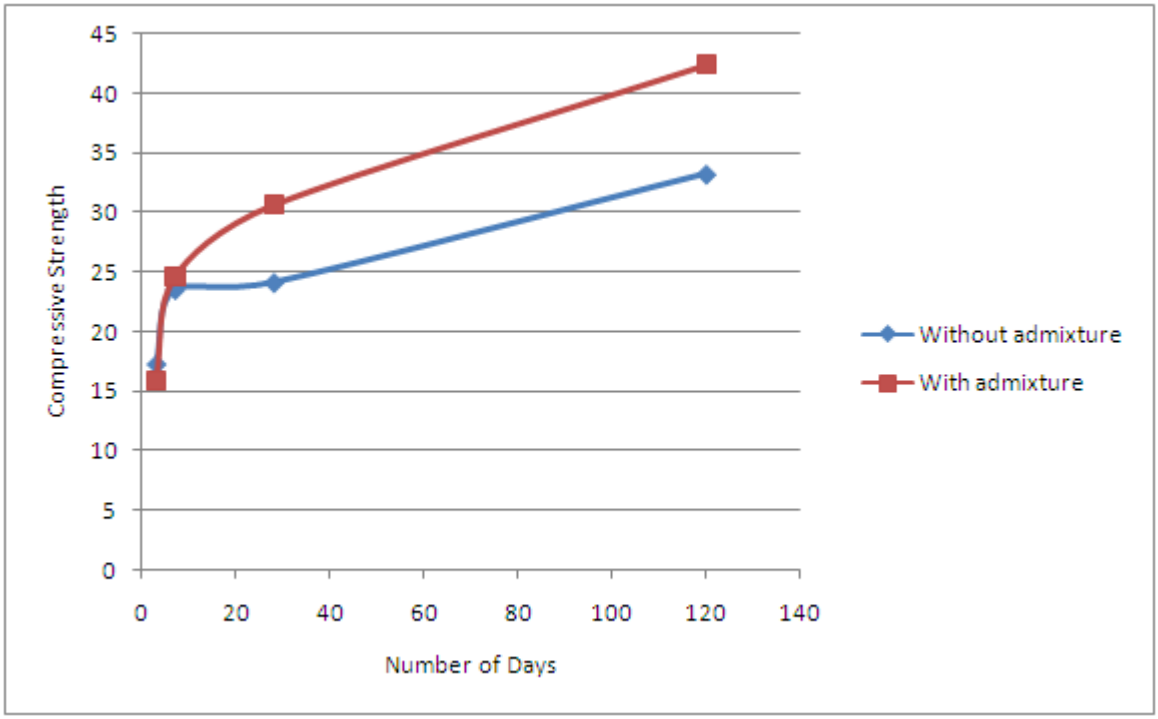

Fig. 2 Average Strength comparison for 3, 7, 28, 120 days

3.2 Carbonation test

Carbonation test was performed and the results show that there is negligible carbonation depth at early age of concrete. The carbonation depth is observed only after long term exposure to environment. Thus the results are observed in only 120 days age concrete which are shown in below table.

Table 3: Carbonation Test Results

DAYS	SAMPLE NO.	CARBONATION DEPTH (in mm)	
		WITHOUT ADMIXTURE	WITH ADMIXTURE
120	1	5	2
	2	4	3
	3	4	2
28	1	1	NIL
	2	NIL	NIL
	3	NIL	NIL
7	1,2,3	NIL	NIL

Fig 3 : Carbonation test using phenolphthalein indicator.

3.3 Water Absorption test

The test results show a reduced water absorption in internally cured specimens as compared to conventionally cured specimens. The internal curing compound reduces the voids which in turn reduces the water permeability and increases the density of concrete specimens.

Table 4: Water Absorption Test Results

No. of Days	Description	Sample No.	wt. of dry block (W1)	wt of wet block (W2)	Percentage	Average
120	With Admixture	1	8.385	8.575	2.26	2.22
		2	8.45	8.65	2.36	
		3	8.34	8.51	2.04	
	Without Admixture	1	8.395	8.62	2.68	2.75
		2	8.48	8.72	2.83	
		3	8.385	8.615	2.74	
28	With Admixture	1	8.385	8.485	1.19	1.09
		2	8.555	8.635	0.93	
		3	8.625	8.725	1.16	
	Without Admixture	1	8.48	8.71	2.71	2.82
		2	8.305	8.565	3.13	
		3	8.43	8.65	2.61	
7	With Admixture	1	8.65	8.77	1.39	1.20

		2	8.585	8.685	1.16	
		3	8.415	8.505	1.07	
	Without Admixture	1	8.375	8.555	2.14	2.44
		2	8.575	8.785	2.44	
		3	8.34	8.57	2.76	

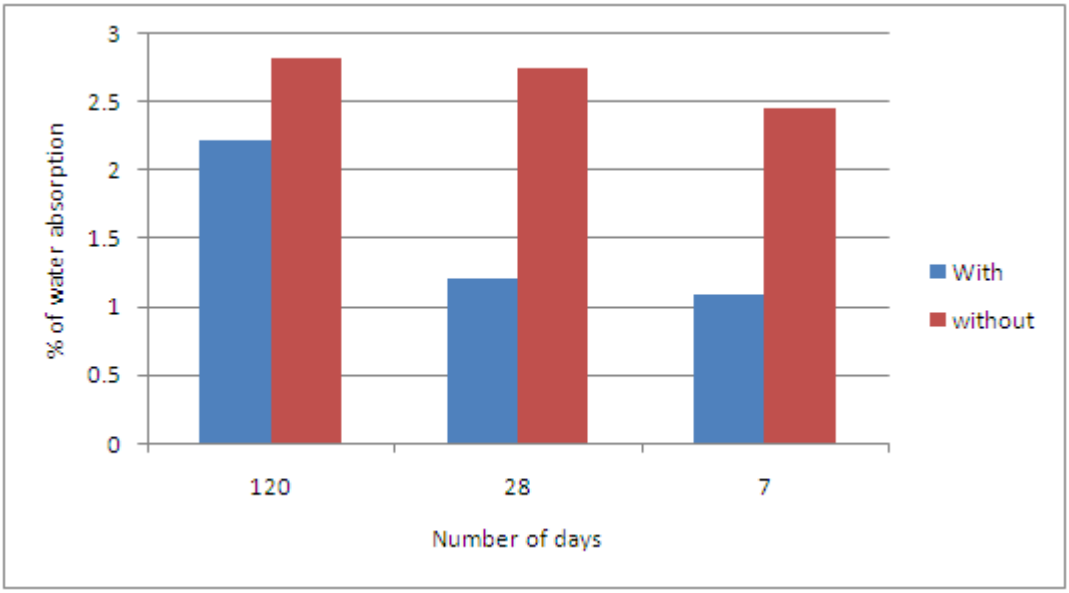

Fig. 4 Average Percentage of Water Absorption

IV. Conclusions

- The internally cured specimens were proved to be better than conventionally cured specimens in terms of strength and durability.
- The addition of internal curing compound increases the degree of hydration.
- Conventionally cured specimens showed better strength initially but the long term strength of internally cured specimens was higher.
- The carbonation test results showed that the depth of carbonation is less in internally cured specimens compared to conventionally cured specimens.
- The experimental study showed that the percentage of water absorption is less in internally cured specimens.
- The use of internal curing compound Millenium21 can be helpful in achieving sustainability of water in areas having scarcity of water.

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