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Effect of Different Water Curing Duration on Properties of Concrete

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ABSTRACT: In the construction business, it is required that concrete structures be cured in accordance with established norms in order to meet strength and durability criteria during the structure's service life. Curing concrete is an empirical procedure predicated on adding water to the hydration process of cement and controlling the migration of moisture away from the concrete structure. In consideration of this requirement, a research effort investigating the difference in mechanical characteristics of concrete with and without curing has been initiated. For this experiment, grade M30 concrete was employed, and two mixes were considered: one with regular Portland cement (OPC) and another with GGBS as a mineral additive partially replacing OPC. Twenty-four cube specimens were cast for each mix, with nine cubes undergoing 28-day curing, nine cubes undergoing partial curing, and nine cubes undergoing no curing. The results of the experiment were compared and conclusions were reached.

KEYWORDS: Fully curing, Partial curing, No curing, Compressive strength.

I. INTRODUCTION

In the construction business, it is required that concrete structures be cured in accordance with established norms in order to meet strength and durability criteria during the structure's service life. Curing concrete is an empirical procedure predicated on adding water to the hydration process of cement and controlling the migration of moisture away from the concrete structure. Curing is the process of regulating the rate and magnitude of concrete's moisture loss during cement hydration. When Portland cement and water are combined, a chemical process known as hydration occurs. The degree to which this reaction is completed affects the concrete's strength and durability. Normally, freshly-mixed concrete includes more water than is necessary for the hydration of the cement; however, excessive water loss by evaporation might delay or prevent sufficient hydration. The curing duration might vary based on the needed qualities of the concrete, its intended use, and the ambient circumstances, i.e. the temperature and relative humidity of the surrounding environment. For concrete to attain the necessary strength and durability, curing must begin as soon as feasible after installation and finishing and continue for a reasonable amount of time as specified by the applicable standards. Curing may be applied in a variety of methods, and the most suitable procedure may be decided by the construction location or technique. Also, uniform temperature must be maintained throughout the depth of the concrete to prevent thermal shrinkage fractures. Also necessary for preventing plastic shrinkage cracks are preventative measures to reduce moisture loss from the concrete surface.

II. LITERATURE REVIEW

Most of the researches have worked in publishing their work in comparison of different curing method on the compressive strength of concrete. The observation, methodology, conclusions and further scope of work are used to finalise the objectives of present work. The available literature of review is as follows:

A.S.Thakare(2016) this paper presents the comparison between the Self Cured Concrete and Conventionally Cured Concrete. This work includes the Designing, Casting and Testing of Cubes, Beams, and Cylinders of various grade of concrete [M20 to M40]. Now a day's most of the

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region are facing scarcity of water, lack of good workmanship. There are various method of curing in whichwater is the necessary thing for curing, but due to deficiency of available water this type of water curing method are not favorable for arid region mostly, this methods are also Uneconomicalas various point of view. The aim of this paper is to apply another method of curing to overcome mentioned problems and after applying such method we used to compare the result. The various set of Cube, Beam and Cylinder was cast for different grades, water curing method and self-curing method by using plastic sheet we use to take different grades, after done all this procedure we used to compare results for both. The result reveals that Self Cured Concrete maintained higher strength till 14 days as compared to Conventionally Cure Concrete but after 28 days both results are reached up to their Target Strength.

Obam (2016) Different methods are usually adopted to cure concrete. Concrete strength partly depends on the method and duration of curing. The structural use of concrete depends largely on its strength, especially compressive strength. This study uses three curing methods to determine their effects on the compressive strength and density of concrete. These methods are immersion of concrete cubes in curing tank (Ponding), covering of cubes with wet rug (Continuous wetting) and the use of polythene sheet (Waterbarrier). Laboratory experimental procedures were adopted. A total of sixty (60) cubes were cast with 1:2:4 mix ratios. The cubes were cured in the laboratory at room temperature. The results showed that the average compressive strength values for 28-day curing vary with curing methods. The cubes cured by immersion have an average compressive strength of 29.7 N/mm2 while the ones cured by wet rug and polythene sheet have average compressive strength of 26.8 and 24.7 N/mm2 respectively. The traditional curing by immersion appeared to be the best method to achieve desired concrete strength.

B.MOHAN (2016) In this study strength parameters of self-compacting concrete, self-curing concrete, Self-compacted selfcuring concrete M20 and M25 grade are compared with Conventional Concrete. Mechanical properties of the concrete specimens such as compressive strength, and flexural strength are to be performed. Self-compacting concrete describes concrete with the ability to compact itself by means of its own weight the requirement for vibration. It is proved to fill all recesses reinforcement spaces and voids even in highly reinforced concrete members. Self-compacting concrete incorporating self-compacting agents have been studied and tests are performed using self-compacting agents. The Self-curing of concrete is for maintaining satisfactory moisture content in concrete during its early stages in order to develop the desired properties. The concept of self-curing agents is to reduce the water evaporation from concrete and hence increase the water retention capacity of the concrete compared to conventional concrete. The chemical admixtures used in this study are complots SP-430 for self-compacting concrete and polyethylene glycols (PEG) 600 as selfcuring agents. The mechanical properties are found by testing the casted specimens such as cubes and beams of standard sizes for varying proportions. The parameters that very are fly-ash as 10%, 20% and 30%. The percentage of conplast SP-430 and self-curing agents is kept constant as (0.9%)with reference to literature studies. The objective of this study is to compare the mechanical properties of self-compacting concrete, self-curing concrete, self-compacted self-curing with conventional concrete. A self-curing concrete is provided to absorb water from atmosphere from air to achieve better hydration of cement in concrete. It solves the problem that the degree of cement hydration is lowered due to no curing or improper curing, and thus unsatisfactory properties of concrete. The self-curing agent can absorb moisture from atmosphere and then release it to concrete. The self-curing concrete means that no curing is required for concrete, or even no any external supplied water is required after placing. The properties of this self-cured concrete of this invention are at least comparable to and even better than those of concrete with traditional curing.

Mr. Ram Lohar(2016) Self-curing is done in order to fulfill the water requirements of concrete whereas self-compacting concrete is prepared so that it can be placed in difficult positions and congested reinforcements. This investigation is aimed to utilize the benefits of both self-curing as well as self-compacting. The present investigation involves the use of self-curing agent viz., polyethylene glycol (PEG) of molecular weight 400 (PEG 400) for dosages ranging between 0.1 to 1% by weight of cement added to mixing water. Comparative studies were carried out for compressive strength for conventional SCC and self-cured SCC. The optimum dosage of PEG-400 for maximum strength was observed to be 1%. It were observed that increase in dosage of PEG shows that also increases strength of SCC.

The results obtained showed that the average compressive strength values for 7, 14, 21 and 28 days, vary with curing methods. The results show that ponding had the highest compressive strength

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and density, followed by wet covering, sprinkling, then uncured for two days, with the totally uncured cubes having the least compressive strength and density as well as highest shrinkage limit. Ponding method of curing was recommended to be the best of all the curing methods.

III. MATERIALS AND METHODOLOGY

Cement: Ordinary Portland Cement of 43 Grade was used for casting of all the specimens. It is tested as per IS 12269:1987 Recommendation.

Fine Aggregate (FA): Manufactured sand with specific gravity 2.7 and fineness modulus 3.245 confirming to Zone- II is used.

Coarse Aggregate (CA) - Locally available angular crushed aggregates as per IS 383-1970 is used in this experimental work of study. Specific gravity of 2.69 coarse aggregate is determined using the method confirming to Indian Standard 2386.

Water: The purpose of use of water is for both mixing and curing and it shall be clean and free from the any of the detrimental materials such as acidic compounds, alkaline, salt substances, sugar compounds, organic materials or other substances that may be harmful to concrete structure potable water which is used for drinking purpose is in general suitable in mixing and for curing of concrete. It is tested as per IS 10500:2012 Recommendation, details are shown in table.1.

Table 1: Properties of Water

S. No	Characteristics	Water Sample (mg/l)	Permissible Limit (mg/l)
1	pH	7.2	6.5 to 8.5
2	Colour	clear	
3	Taste	Agreeable	-
4	Odour	Unobjectionable	-
5	Total Acidity (as mg/L of CaCO3)	10	-
6	Total Alkalinity (as mg/L of CaCO3)	240	250- 600 mg/L
7	Chlorides	44.99	200-1000 mg/L
8	a. Total Hardness	180	200-600 mg/L
	b. Calcium Hardness	110	-
	c. Magnesium Hardness	70	-
9	a. Total solids	640	-
	b. Total dissolved solids	160	500- 2000 mg/L
	c. Total suspended Solids	480	-
	d. Inorganic solids	520	-
	e. Organic solids(mg/L)	120	-
10	Turbidity	2	10 NTU

Chemical admixture (Superplasticizer) - LaGreen S20 is a low range modified polycarboxylic ether based Superplasticizer for pumpable concrete. The properties of Superplasticizer S20 are tabulated in Table. 2.

Table 2: Properties of Superplasticizer

Type	Polycarboxylic based ethers
Form	Liquid
Colour	Light Brown
Relative Density	1.1 20°C
pH	6.6
Specific gravity	1.1

Ground Granulated Blast Furnace (GGBS): Blast furnace slag is a by-product of iron manufacture. When quenched rapidly with water to a glassy state and fines ground, it develops the property of latest hydraulicity. The proportions of GGBS to be used in concrete depend upon the job requirements, the usual proportions vary from 10 to 50% by weight of cement. GGBS is a cement replacement basis however, if the purpose is to enhance some aspect of concrete durability. Physical Composition of GGBS is shown in Table. 3

Table 3: Physical Composition of GGBS

Parameter	Specifications
Colour	Light grey
Specific gravity	2.85 to 2.95 (2.32)
Specific surface	450 m2/kg

Table 4: Details of test specimens prepared

Designation	Concrete Matrices
CS (M30)	Cement Concrete Specimen
CGS(M30)	Cement + 30%GGBS Concrete Specimen

Mix Design -

Mix Design is one of the process by means of which suitable ingredients in the concrete are selected and in order to determine their relative quantity with object of producing concrete possessing minimum desirable properties like workability in fresh state minimum desirable strength and durability in hardened state. Mix proportion obtained by after mix design is tabulated below.

Table 5: Mix proportion for CS(M30)

Water	Cement	Fine aggregate	Coarse aggregate	Super Plasticizer**
157.6 ltr /m^3	366.511 kg/m^3	778.780 kg/m^3	1232.877 kg/m^3	1.8325 kg/m^3
w/c 0.43	1	2.124	3.363	0.005

Table 6: Mix proportion for CG(M30)

Water	Cement	GGBS	Fine aggregate	Coarse aggregate	Super Plasticizer**
157.6 ltr /m^3	282.214 kg/m^3	120.948 kg/m^3	762.405 kg/m^3	1206.983 kg/m^3	1.4110 kg/m^3
w/c 0.39	1		1.891	2.993	0.005

IV. EXPERIMENTAL PROGRAMME

Test specimen and testing procedures for compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast. In this study M30 grade of concrete which are often used for buildings and infrastructure construction are considered. The total experimental program consists of the concrete Specimens were subjected under three curing conditions namely fully cured (FC), Partially Cured (PC) and Not- Cured (NC). In FC the specimens were cured for 3 days, 7 days and 28 days, in PC the specimens were cured for 3 days in water and later left for air curing and 7day in water and later left for air curing and in NC the specimen after demoulding on next day were left for air curing. Cubes were tested on compression testing machine as per I.S. 516-1959. In each category three cubes were tested and their average value is reported.

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Figure 1: Compressive strength test

V. RESULTS AND DISCUSSION

The hardened concrete test was done as per IS 516:1959. The results of cube for compressive strength at different ages under three curing conditions (Fully cured, Partial cured, Not-cured) are summarized in below table.

Details of Cube specimens, Standard.	Fully Cured, FC			Partially Cured, PC			Not-Cured, NC		
	3 days	7 days	28 days	3 days	7 days	28 days	3 days	7 days	28 days
CS	14.96	22.84	31.85	19.10	24.59	31.85	9.32	11.38	13.32
CGS	13.62	22.21	32.73	18.51	22.96	32.73	9.18	11.40	13.32

The Fig. 2, 3 & 4 shows Cubes Compressive Strength of CS at different ages under three curing conditions (Fully cured, Not-cured & Partial cured). Fig. 4 shows shows the Percentage variation of Cubes Compressive Strength of CS(NC) with respect to CS(FC).

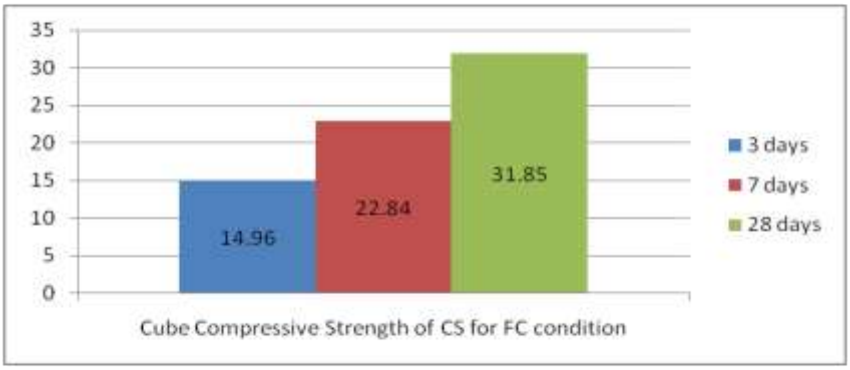

Figure 2: Cube Compressive Strength of CS for FC condition.

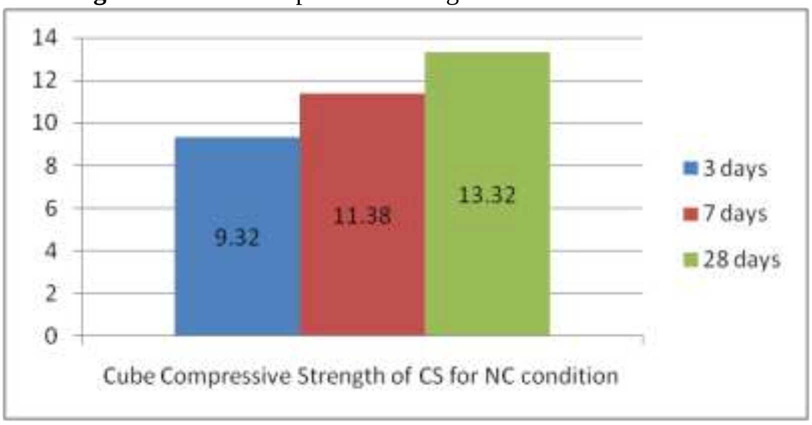

Figure 3: Cube Compressive Strength of CS for NC condition.

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The reduced compressive strength under NC conditions specimens is compared with FC condition specimen for CS (M30), the average percentage cube strength reduction for 3 days , 7 days and 28 days is 37.71%, 50.17% and 58.17% respectively.

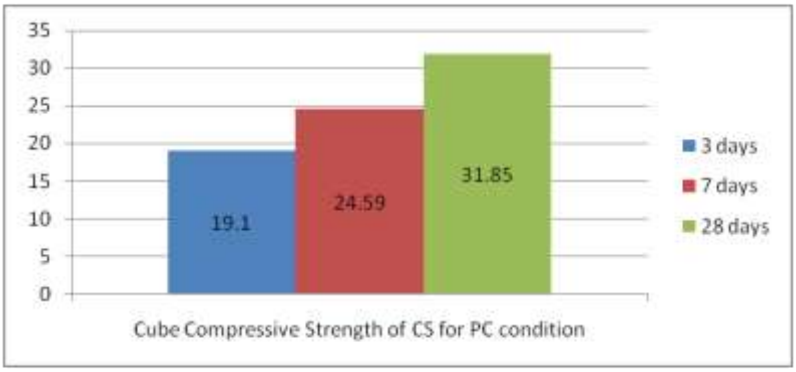

Figure 4: Cube Compressive Strength of CS for PC condition

The Fig. 5, shows Cubes Compressive Strength of CGS at different ages under three curing conditions (Fully cured, Not-cured & Partial cured). Fig. 10 shows the Percentage variation of Cubes Compressive Strength of CGS(NC) with respect to CGS(FC)

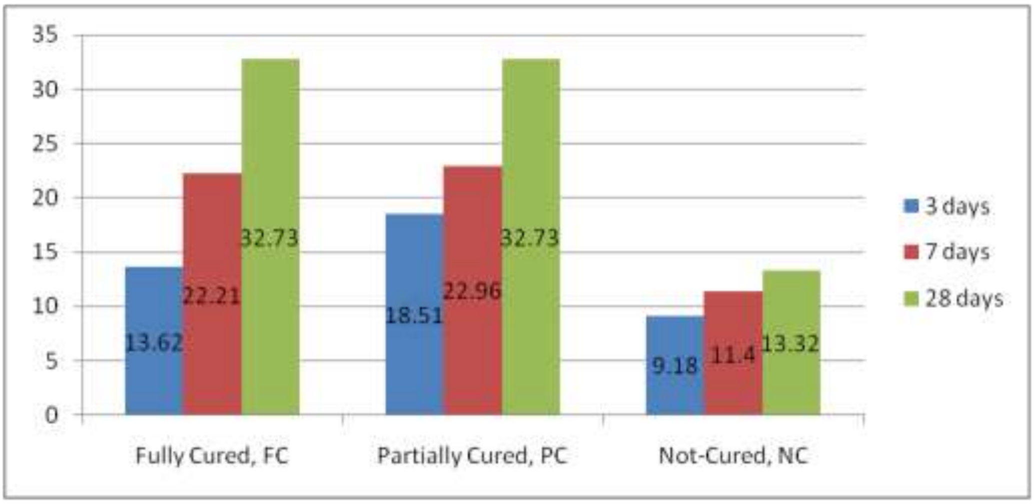

Figure 5: Cube Compressive Strength of CGS for FC PC & NC condition

VI. CONCLUSION

Based on the above experimental results it can be concluded that the compressive strength of cube specimens for not cured condition and compressive strength of cube specimens for fully cured condition shows so much variation which is not desirable. It can also be concluded that the there is no much change in the strength due the replacement of GGBS by cement. Even though the compressive strength of cube specimens for partially cured condition compared with 28 days compressive strength of cube specimen for fully cured condition shows less variation than that of not cured condition the desirable strength is not achieved. The cube compressive strength curves helps to estimate the strength of CS and CGS specimens for a known water curing duration, which would be useful in construction field to evaluate actual strength of concrete.

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