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Outcome of compressive strength and hydration in Concrete with curing techniques

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ABSTRACT

Within this experimental study normal concrete was prepared by using water-cement ratio of 0.55. Cube specimens were prepared for testing the compressive strength at 7 and 28 days of curing correspondingly utilising two curing methods namely Laboratory(by immersion) say water curing, and by covering with Plastic sheet, for curing specimens till testing day. Test results points out that laboratory curing method by immersing the specimens in water type of curing provided much better results than covering the concrete with plastic sheets, method of curing. Drying rate was noteworthy when the specimens were subjected to Plastic sheeting method of curing. Therefore, hindering hydration process and consequently affect the compressive strength of hardened concrete. The outcome of this study advocates that concrete is to be cured by water curing in order to get better compressive strength.

INTRODUCTION

For complete and proper strength developments, the loss of water in concrete from evaporation should be prevented, and the water consumed in hydration should be replenished. This the concrete continues gaining strength with time provided sufficient moisture is available for the hydration of cement which can be assured only by creation of favourable conditions of temperature and humidity. This process of creation of an environment during a relatively short period immediately after the placing and compaction of the concrete, favourable to the setting and the hardening of concrete is termed curing (1). Concrete curing is one of the most important and final steps in concrete construction though it is also one of the most neglected and misunderstood procedures. It is the treatment of newly placed concrete during the period in which it is hardening so that it retain enough moisture to immunize shrinkage and resist cracking (2). Curing of concrete is a pre requisite for the hydration of the cement content. For a given concrete, the amount and rate of hydration and furthermore the physical make-up of the hydration products are dependent on the time-moisture-temperature history (3). The necessity for curing arises from the fact that hydration of cement can take place only in water-filled capillaries. This is why loss water must be prevented. Furthermore, water lost internally by self-dedication has to be replaced by water from outside, i.e.ingress of water into the concrete must take place. (4). A proper curing maintains a properly warm, moist environment for formation of hydration products, so reduces porosity in hydrated paste of cement and raise the microstructure density in concrete. Therefore hydration products widen from surfaces of cement grains, hence volume of pores decline due to proper curing in appropriate temperature, moisture . Right curing very much contributes to decrease the porosity and also drying shrinkage within concrete, and therefore for achieving the better strength and larger resistance to chemical or physical attacks in hard line environments. So, a suitable curing method such as water ponding (immersion), spraying or sprinkling of water, or covering with polythene sheet material is essential us order to produce strong and durable concrete. (5) The study present the effect of various curing methods on the concretes compressive strength, by using Pozalona portland cement and finally identifies the most effective curing process for normal concrete.

METHODS AND MATERIALS

Nearby available crushed black basalt stones and fine aggregate (quartzite sand) of Shahpur of Gulbarga district, were used as coarse and fine aggregate respectively. The fractions of different sizes of crushed basalt stone and fine aggregates, as shown in Table 1. Pozalona Portland cement (PPC) was used as the main binder. Locally available Drinking portable water was used for preparing the concrete. It was also used for curing purposes. The major properties of the constituent materials are given in Table 2.

Table 1: Gradation crushed basalt stone and Shahpur(Gulbarga) sand

SIEVE SIZE	% FINER BY MASS	
	Crushed basalt stone (Fineness Modulus: 4:81)	Shahpur (Gulbarga) Sand (Fineness Modulus:4.23)
28.00mm	100	
20.00mm	85.91	
14.00mm	19.86	
10.00mm	10.82	
6.30mm	1.28	
5.00mm	0.29	99.48
3.35mm	-	99.21
2.00mm	-	98.47
1.18mm	-	93.60
850µm	-	86.97
600µm	-	75.40
425µm	-	56.62
300µm	-	43.66
150µm	-	13.53
75µm	-	10.03
Pan	-	0.00

Table 2: Properties of the constituent materials of concrete.

Materials	Properties
Crushed Basalt Stone	Max. size:20mm,unitweight: 432.50kg/m^3 Specific gravity: 2.68, Absorption:0.72%, Moisture content: or 13%, void ratio: 0.45, Porosity: 9.26%
Fine Aggregate	Max. size:5mm, unit weight: 517.70kg/m^3, Specific gravity: 2.76, Absorption:2.27%, Moisture content:4.70%, void ratio: 0.45, Porosity: 0.07%
Pozalona Portland Cement	Specific Gravity: 3.15, unit weight: 1440kg/m^3
Drinking water	Density: 1000kg/m^3, PH = 6.9

Mix Proportions of Concrete.

The concrete was made based on water cement ratio of 0.55 and a cement content of 340kg/m^3 for getting the compressive strength more than 20N/mm^2 at 28 days (laboratory method of curing). Shahpur sand was utilised with a quantity of 33.33% of total aggregates by weight. The concrete mixture was proportioned to cover a minimum slump of 48mm and also a minimum compacting factor or 0.94. The concrete mixture was assumed to be fully compacted and the proportions of the materials were determined on the basis of absolute volume of the constituents. The details of mixture proportions are given in the following lines

Table 3: Mix Proportions of Concrete
Crushed granite stone – 1360 Kg/m^3
Fine aggregate – 680 Kg/m^3
Ordinary Portland Cement – 340 Kg/m^3
Portable Borehole Water- 170 Kg/m^3

Fresh Concrete testing
The fresh concrete was prepared by utilising manual method of mixing in the concrete laboratory of KCT Engineering college Gulbarga. Immediately after mixing, the fresh concrete was tested for slump and compacting factor. The slump and compacting factor tests were determined.

Preparation of Test Specimens
A total of 32 cubes having dimensions 150mm x 150mm x 150mm each were cast. The specimens were molded in moulds using three layers of filling and each layer tamped 25 times to expel the entrapped air. The tops of the cubes were marked after a while for identification purpose. Immediately after this, the specimens were kept in a cool place in the laboratory. The specimens were removed from the metallic moulds at the age of 24+ – 2 hours.

Curing Methods
The test specimens were cured under two types of curing until the day of testing. These were Laboratory method of curing that is also known as immersion method of curing where concrete blocks were immersed in water and second method is by wrapping with plastic sheeting. In laboratory curing method, the specimens were weighed and immersed in water. Portable borehole water was used in water curing. In water. In plastic sheeting, the specimens were weighed and wrapped in flexible plastic sheets until the testing date. At least 3 layers of wrapping were used to prevent moisture movement from concrete surface. The curing temperature was maintained at 27 + 2ºC in all the curing methods.

Hardened concrete Testing.
The compressive strength of the test cubes were determined by crushing the cubes under the compression machine at KCT Engineering college Gulbarga. A total of 32 cubes were tested, of these 16 cubes were for laboratory method, while the last 16 cubes were for sheeting method of curing. The length of curing dates considered was7 and28 days respectively.

RESULT AND DISCUSSIONS
Fresh Properties:
The slump and compacting factor of the concrete were 48mm and 0.94 respectively indicating that the concrete mix has adequate mobility and stability i.e the mix fall within the range of medium workability. The average result of 0.94 obtained as the compacting factor indicated that the concrete can be manually compacted.

COMPRESSIVE STRENGTH

Table 4: Compressive strength of cubes cured for 7 days using immersion method of curing. www.engineeringcivil.com

Identification Mark	Age of Curing (days)	Wt of Cube (KG)	Dimension of the Cube (mm x mm x mm	Density of Cube (Kg/m^3)	Area of Cube (mm^2)	Failure Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
F11	7	7.96	150 X 150 X 150	2358.52	22500	330.67	14.70	
F12	7	7.68	150 X 150 X 150	2275.56	22500	328.00	14.58	
F13	7	7.65	150 X 150 X 150	2266.67	22500	294.67	13.10	
F14	7	7.53	150 X 150 X 150	2231.11	22500	346.67	15.41	13.56
F15	7	7.90	150 X 150 X 150	2340.74	22500	310.67	13.81	
F16	7	7.84	150 X 150 X 150	2322.96	22500	273.33	12.15	
F17	7	8.04	150 X 150 X 150	2382.22	22500	280.00	12.44	
F18	7	7.79	150 X 150 X 150	2308.15	22500	276.67	12.30	

Table 8: Compressive strength of cubes cured for 7 days using the Membrane Method (Plastic Sheeting). engineeringcivil.com

Identification Mark	Age of Curing (days)	Wt of Cube (KG)	Dimension of the Cube (mm x mm x mm	Density of Cube (Kg/m^3)	Area of Cube (mm^2)	Failure Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
P11	7	8.44	150 X 150 X 150	2500.74	150 X 150	264	11.76	
P12	7	8.24	150 X 150 X 150	2441.48	150 X 150	272	12.12	
P13	7	8.18	150 X 150 X 150	2423.70	150 X 150	266	11.85	
P14	7	7.94	150 X 150 X 150	2532.59	150 X 150	257	11.44	11.67
P15	7	7.90	150 X 150 X 150	2340.74	150 X 150	273	12.15	
P16	7	7.83	150 X 150 X 150	2320.00	150 X 150	252	11.20	
P17	7	7.68	150 X 150 X 150	2269.63	150 X 150	254	11.29	
P18	7	7.60	150 X 150 X 150	2278.52	150 X 150	260	11.56	

Table 5: Compressive strength of cubes cured for 28 days using immersion method of curing engineeringcivil.com

Identification Mark	Age of Curing (days)	Wt of Cube (KG)	Dimension of the Cube (mm x mm x mm	Density of Cube (Kg/m^3)	Area of Cube (mm^2)	Failure Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
F21	28	7.52	150 X 150 X 150	2228.15	150 X 150	496	22.04	
F22	28	7.60	150 X 150 X 150	2251.85	150 X 150	492	21.87	
F23	28	7.92	150 X 150 X 150	2346.67	150 X 150	442	19.64	
F24	28	7.94	150 X 150 X 150	2352.59	150 X 150	520	23.11	20.34
F25	28	7.96	150 X 150 X 150	2358.52	150 X 150	466	20.71	
F26	28	7.83	150 X 150 X 150	2320.00	150 X 150	410	18.22	
F27	28	7.80	150 X 150 X 150	2311.11	150 X 150	420	18.67	
F28	28	8.19	150 X 150 X 150	2426.67	150 X 150	415	18.44	

Table 9: Compressive strength of cubes cured for 28 days using the Membrane Method (Plastic Sheeting).

Identification Mark	Age of Curing (days)	Wt of Cube (KG)	Dimension of the Cube (mm x mm x mm	Density of Cube (Kg/m^3)	Area of Cube (mm^2)	Failure Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
P21	28	8.80	150 X 150 X 150	2607.41	150 X 150	397	17.64	
P22	28	8.51	150 X 150 X 150	2521.48	150 X 150	409	17.64	
P23	28	8.31	150 X 150 X 150	2462.22	150 X 150	400	17.78	
P24	28	8.20	150 X 150 X 150	2429.62	150 X 150	386	17.16	17.42
P25	28	7.93	150 X 150 X 150	2349.63	150 X 150	410	18.22	
P26	28	7.72	150 X 150 X 150	2287.41	150 X 150	378	16.80	
P27	28	7.69	150 X 150 X 150	2278.52	150 X 150	381	16.93	
P28	28	7.67	150 X 150 X 150	2272.59	150 X 150	375	16.67	

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The results of compressive strength have been presented in tables 4-5and in tables 8-9. In both the curing methods, the compressive strength of the concrete raise with age. The highest compressive strength at all ages was produced by laboratory method of curing I;e by immersing the blocks inside the water. The average compressive strength of water cured concrete was 13.56w/mm^2 and 20.34 N/mm^2 at 7 and 28 days respectively. The development of higher compressive strength in immersion (Water) curing is accredited to suffice moisture content and appropriate vapour pressure, which were maintained to continue the hydration of cement. Plastic sheeting method of curing produced the lowest compressive strength at all ages. It caused a reduction in compressive strength of 1.89N/mm^2 and 2.92N/mm^2 at 7 and 28 days, respectively, as compared to laboratory method of curing. The early drying of concrete stopped the cement hydration before the pores were blocked by adequate calcium silicate hydrate.

CONCLUSIONS
1. Laboratory method of curing was the most efficient method of curing. It produced higher compressive strength. This is due to improve pore structure and lower porosity resulting from greater degree of cement hydration reaction without any loss of moisture from the concrete specimens.
2. Plastic sheeting method of curing produces lowest level of compressive strength. This is because the moisture movement from the concrete specimen is higher in plastic sheeting method, which did not provide and any protection against early drying out of concrete. Hence hydration of cement reaction was abated.
3. The extent of moisture movement was greatly dependent of the method of curing. Greater moisture movement occurs under plastic sheeting (membrane) method, and it signifi-

cantly affected the strength property of the concrete.

5. Normal concrete should be cured by water curing (immersion) method in order to achieve good hardened properties. Water curing produces no loss of moisture, and therefore enhances cement hydration reaction. In case of water shortage, sprinkling curing can be adopted instead of wrapped (plastic sheeting) curing.

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