Experimental Study on Curing Methods of Concrete

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***Abstract* -This paper is directed to evaluate effectiveness of different curing methods and study the persuade of climate on the strength properties of concrete. Normal concrete was prepared with a water-cement ratio of 0.45. The specimens were cast for testing the compressive strength at 7, 14 and 28 days of curing respectively using seven curing methods namely Ponding, Air Drying, Immersion, Oven curing, calcium chloride (miscellaneous), Membrane curing and Pack (Plastic sheeting) curing to cure the specimens until the day of testing. Test results indicates that water curing (WAC) Immersion , Ponding as well as Membrane curing provide much better results than Plastic Sheeting method of curing. The rate of drying was important when the specimens were subjected to Oven method of curing. The overall finding of this paper suggests that concrete should be cured by water curing to attain a better compressive strength.**

Keywords - Ponding, Air Drying, Immersion, Oven curing, Membrane curing, Plastic Sheeting method, compressive strength.

I. INTRODUCTION

A. General

Concrete is mainly used as the construction material; it is generally related with Portland cement as the chief component for production of concrete. Ordinary Portland cement (OPC) is usually used as the primary binder to make concrete. When OPC is mixed with water, a chemical reaction called hydration takes place. The extent to which this effect is completed influences the durability and strength of the concrete. Freshly mixed concrete normally contains extra water it required for hydration of the cement. Though, extreme loss of water by evaporation can delay or prevent adequate hydration.

Curing is the maintenance of a satisfactory moisture content and temperature in concrete for a period of time immediately placing and finishing so that the desired properties may develop during hydration. In order to attain good quality concrete, a suitable mix must be followed by curing in a suitable environment during the early stages of hardening. Curing must be undertaken for a useful period of time if concrete is to attain its potential strength and durability. Curing is necessary if concrete is to achieve its intended function over the design life of the structure whereas. Curing can be done in a number of methods while the most suitable means of curing may be dictated by the site conditions or the construction method. The need for adequate curing of concrete cannot be overemphasized. Proper curing will increase durability, volume stability, strength, water tightness, abrasion resistance, and resistance to freezing and thawing and deicers. Exposed slab surface are particularly sensitive to curing as strength development and freeze-thaw resistance of the top surface of a slab can be reduced considerably when curing is defective. If temperatures are favorable, hydration is relatively rapid the first few days after concrete is placed.

B. Significance of curing

When the mineral admixtures react entirely in a blended cement system, their demand for curing water can be much superior to that in a conventional ordinary Portland cement concrete. When this water is not readily offered, significant deformation and early age cracking may cause. Due to the chemical shrinkage occurring during cement hydration, empty pores are formed within the cement paste, leading to a decrease in its internal relative humidity and also to shrinkage which may affect early age cracking.

II. METHODS OF CURING CONCRETE

A. *Air Curing*

Generally this type of curing done when atmospheric air contains 90% of moisture content. After removal of mould, casted cubes were immersed in water for maximum of 24±1.5hours. And the specimen was kept out in the open atmosphere until tested for 7, 14 and 28 days.

B. *Calcium chloride ($CaCl_2$)*

Calcium chloride is used as surface coating or as an admixture. It has been used adequately as a curing medium. These methods are based on that calcium chloride being a salt show affinity for moisture. The salt not only absorbs the moisture content from atmosphere but also retain it at the surface. This moisture held at the surface prevents the mixing water from evaporation and keeps the concrete wet for a long time to support hydration. After removal of mould, cubes were immersed in water for 24±1.5hours .And the specimen coated with $CaCl_2$ solution on its surface and kept uninterrupted till testing on 7, 14 and 28 days.

C. *Pack curing*

Pack curing done by covering the specimen with plastic sheet over the wet saw dust on surface of concrete cubes. After removal of casted mould, Cubes were immersed in water for maximum of 24±1.5hours and test specimen were covered with fine wet sawdust as a pack over surface of concrete cube. Later whole specimen enclosed with plastic film to avoid evaporation of water.

Sawdust: Natural material which has property of excellent absorbing water and maintaining moisture for long time.

D. Membrane curing

Burlaps, cotton mats, and rugs and other covering of permeable material which hold water on the surface whether horizontal or vertical. Burlap should be carefully rinsed in water to make it more absorbent. Cotton mats and rugs hold water longer than burlap with less jeopardy of drying out. They are handled the same as burlap except that due to their greater mass application to a freshly finished surface must wait until the concrete has hardened to greater degree than for burlap. Two or three coats may be required for effective sealing of the surface to prevent the evaporation of water.

E. Pond curing

Ponding on flat surfaces, such as pavements and floors, concrete can be cured by ponding. Earth or sand dikes around the border of the concrete surface can retain a pond of water. It is suitable for curing horizontal surfaces such as floors, roof slabs, and road and air field pavements. The horizontal top surfaces of beams can also be ponded. After placing the concrete, its exposed surface is first covered with moist canvas. After 24 hours, these covers are removed and small ponds of clay or sand are built across the beam. The area is divided into a number of rectangles. The water is filled between the ponds. The filling of water in these ponds is done twice or thrice a day, depending upon the atmospheric conditions. Though this method is very efficient.

F. Immersion curing

Immersion curing with water consists of total immersion of the hardened concrete element. This method is commonly used in the laboratory for curing the concrete specimens.

This method of curing satisfies all the requirements of curing, namely, promotion of hydration, elimination of shrinkage and absorption of heat of hydration. It is pointed out that if the membrane method is adopted, it is enviable that a certain extent of water curing is done before the concrete is covered with membranes. The precast concrete items are normally immersed in curing tanks for certain period. In some cases, wet coverings such as wet gunny bags, hessian cloth, jute matting are wrapped to vertical surface for keeping the concrete wet.

G. Oven curing

Generally oven curing happening after immersing the remolded specimen in water for at least 24±1.5 hours. For oven curing, the specimens were cured in the oven at 80^{o} C for 1.5hrs±2mints. After curing in oven the test specimens were kept without interruption until for at least six hours in order to avoid a radical modify in the environmental conditions .This specimens were gone to air-dry followed by sprinkling in the laboratory awaiting the day of test.

III. EXPERIMENTAL PROGRAM

A. Material properties

Ordinary Portland Cement of 53grade confirming to IS 12269-1987 was used . River sand confirming to grading zone II of IS 383-1970 was used as a fine aggregate. Well graded coarse aggregate passing through 20mm sieve according to IS 383-1970 was used. Saw dust was obtained from sawmill used for covering the specimen.

Table 1 Physical Properties of Cement

S.NO	Description	Test Values
1.	Specific gravity	3.15
2.	Initial Setting Time	30 min
3.	Final Setting Time	350min
4.	Fineness Modulus	3.2%
5.	Slumpvalue	65 mm
6.	Compaction Factor	0.95

Table 2 Physical Properties of Fine Aggregate

S.NO	Description	Fine aggregate
1.	Specific gravity	2.75
2.	Water Absorption	1%
3.	Fineness Modulus	2.83

Table 3 Physical Properties of Coarse aggregate

S.NO	Description	Coarseaggregate

1.	Specific gravity	2.60
2.	Water Absorption	0.5%
3.	Fineness Modulus	2.68

B. ***Mix proportion***

The mix proportioning for M20 grade concrete used in the present work. It is designed as per IS 10262-1982 standards. The mix proportioning adopted was cement: sand: coarse aggregate: water/cement ratio respectively.

Table 4 Mix Proportion

WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
191.6 Lit	426 Kg/m^3	565 Kg/m^3	1164 Kg/m^3
0.5	1	1.32	2.73

C. ***Experimental investigation***

The experiment was conducted to find the distinction in increased compressive strength for dissimilar curing methods. The tests were conducted at 7^{th}, 14^{th} and 28^{th} days. For that we followed all the procedures as per IS code specifications. The cubes of 150 x 150 x 150 mm size were tested.

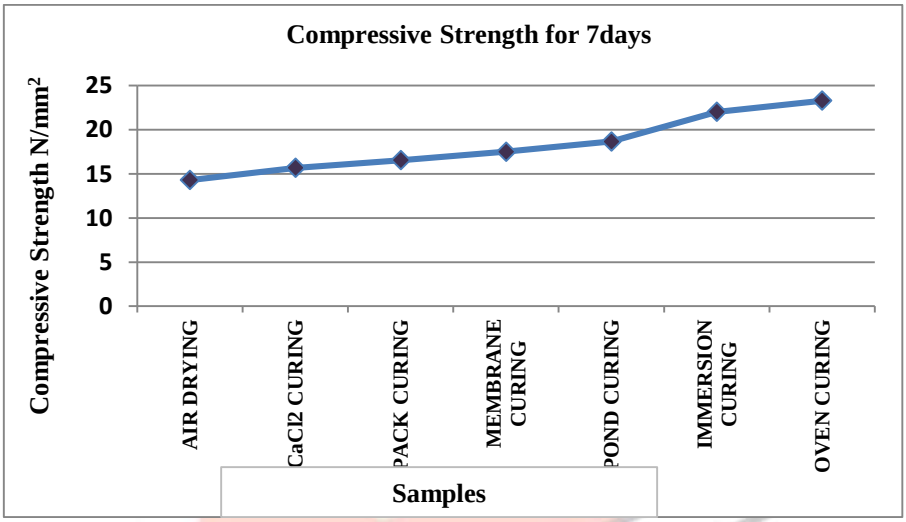

Figure 1. Compressive strength for 7 days

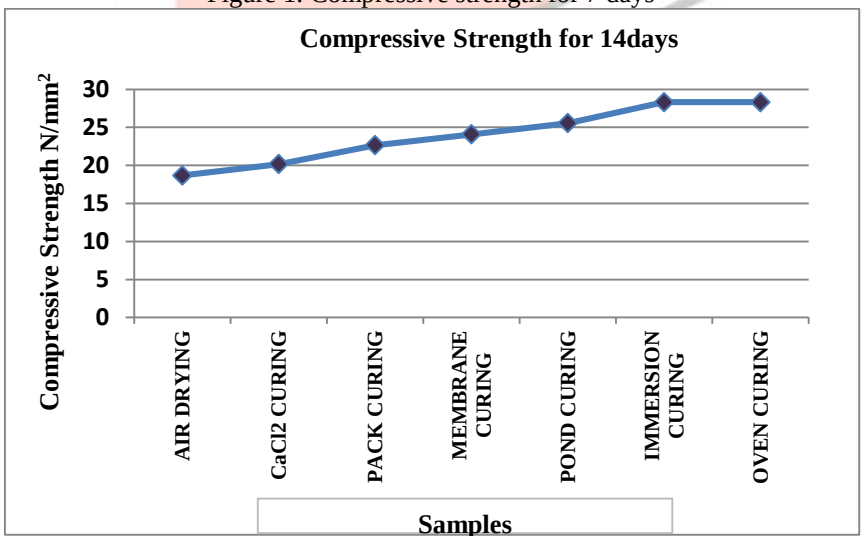

Figure 2. Compressive strength for 14 days

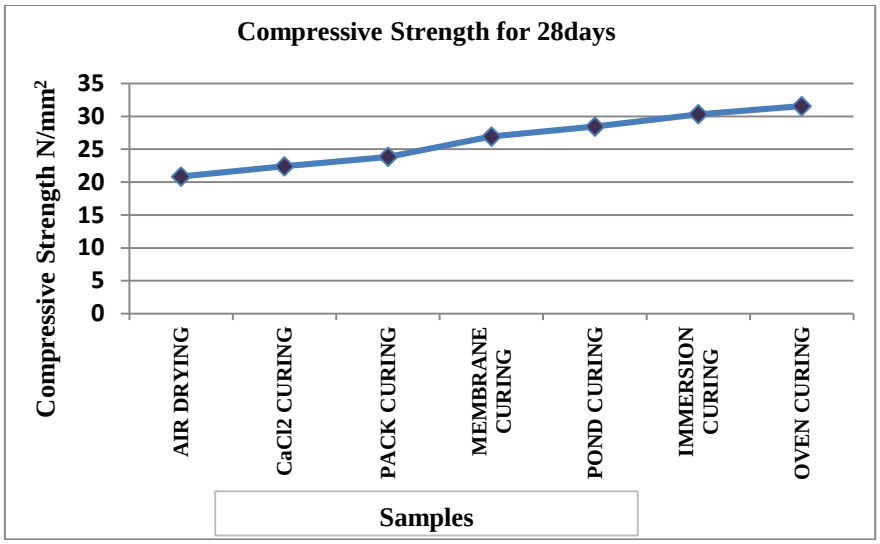

Figure 3. Compressive strength for 28 days

IV. CONCLUSION

Use of white based curing compounds $CaCl_2$ resulted in strength up to 73% to 75% of conventional curing. Ponding were found valuable than membrane curing and attains strength improved up to 26.67% than membrane and shows 93% of conventional curing. A double layer membrane curing shows considerably improved strength than pack curing i.e., 88.9% of conventional immersion curing concrete. Properties when compared with the equivalent single layer application, double layer application of jute bag curing shows improved strength properties of concrete. Pack curing shows increased compressive strength than Air drying and compound curing. It attains 16% increased strength than Air drying and 22% than compound curing. Air drying shows least strength on curing and Oven drying followed by sprinkling shows improved strength than all other methods of curing. Through this study it is concluded that concrete has great influence on its strength properties on different curing.

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