ISSN: 2456 – 043X

IJESAR

International Journal of Engineering Science and Generic Research (IJESAR)

IJESAR : A Innovative Publication Center

Available Online at: www.ijesar.in

Volume – 3, Issue – 2, March – April - 2017, Page No. : 01 - 06

To conduct of various Curing Methods of impression on the Compressive Strength of cement Concrete

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Abstract

Various methods of curing for usually adopted to evaluate the compressive strength of concrete Normal concrete was prepared with a water-cement ratio of 0.40. Cube specimens were cast for testing the compressive strength at 7 ,14 and 21, 28 days of curing respectively using five curing methods namely covering concrete surfaces with hessian or gunny bags, sprinkling of water, Ponding method, Membrane curing, Steam curing and Covering concrete surfaces with hessian or gunny bags, curing to cure the cube specimens until the day of testing. Test results indicates that water curing as well as sprinkling (spraying) curing provided much better results than membrane method of curing stream curing . The rate of drying was significant when the specimens were subjected to membrane method of curing. This thus hampered the hydration process and thus affected the compressive strength property of the hardened concrete. The highest compressive strength 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

Keywords: Curing method, compressive strength, concrete, membrane.

Introduction

There are various methods of curing. The adoption of a particular method will depend upon the nature of work and the climatic conditions. The following methods of curing of concrete are generally adopted. Curing of Concrete

- Wet-covering
- Covering concrete surfaces with hessian or gunny bags
- Sprinkling of water
- Ponding method
- Membrane curing
- Steam curing.
- Plastic sheet

1. Wet-covering

Hessian sac was used like a mulch to maintain water on the surface of the concrete cubes; also, it is important to ensure that the whole areas were covered. Wet covering material was placed as soon as the concrete cubes were hardened sufficiently to prevent surface damage. Through the curing period the sac is kept saturated with water

2. Covering Concrete Surfaces with Hessian Or Gunny Bags

This is a widely used method of curing, particularly for structural concrete. Thus exposed surface of concrete is prevented from drying out by covering it with hessian, canvas or empty cement bags. The covering over vertical and sloping surfaces should be secured properly. These are periodically wetted. The interval of wetting will depend upon the rate of evaporation of water. It should be ensured that the surface of concrete is not allowed to dry even for a short time during the curing period. Special arrangements for keeping the surface wet must be made at nights and on holidays.

3. Sprinkling of Water

Sprinkling of water continuously on the concrete surface provides an efficient curing. It is mostly used for curing floor slabs. The concrete should be allowed to set sufficiently before sprinkling is started. The spray can be obtained from a perforated plastic box. On small jobs sprinkling of water may be done by hand. Vertical and sloping surfaces can be kept continuously wet by sprinkling water on top surfaces and allowing it to run down between the forms and the concrete. For this method of curing the water requirement is higher.

4. Ponding Method

This is the best method of curing. It is suitable for curing horizontal surfaces such as floors, roof slabs, 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 hessian or canvas. After 24 hours, these covers are removed and small ponds of clay or sand are built across and along the pavements. The area is thus 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, the water requirement is very heavy. Ponds easily break and water flows out. After curing it is difficult to clean the clay.

5. Membrane Curing

The method of curing described above come under the category of moist curing. Another method of curing is to cover the wetted concrete surface by a layer of water proof material, which is kept in contact with the concrete surface of seven days. This method of curing is termed as membrane curing. A membrane will prevent the evaporation of water from the concrete. The membrane can be either in solid or liquid form. They are also known as sealing compounds. Bituminized water proof papers, wax emulsions, bitumen emulsions and plastic films are the common types of membrane used.

Whenever bitumen is applied over the surface for curing, it should be done only after 24 hours curing with gunny bags. The surface is allowed to dry out so that loose water is not visible and then the liquid asphalt sprayed throughout. The moisture in the concrete is thus preserved. It is quite enough for curing.

This method of curing does not need constant supervision. It is adopted with advantage at places where water is not available in sufficient quantity for wet curing. This method of curing is not efficient as compared with wet curing because rate of hydration is less. Moreover the strength of concrete cured by any membrane is less than the concrete which is moist cured. When membrane is damaged the curing is badly affected.

6**. Steam Curing**

Steam curing and hot water curing is sometimes adopted. With these methods of curing, the strength development of concrete is very rapid. These methods can best be used in pre cast concrete work. In steam curing the temperature of steam should be restricted to a maximum of 75^0C as in the absence of proper humidity (about 90%) the concrete may dry too soon. In case of hot water curing, temperature may be raised to any limit, ay 100^0C. At this temperature, the development of strength is about 70% of 28 days strength after 4 to 5 hours in both.

Literature review

Thus, 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 favorable 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, favorable to the setting and the hardening of concrete is termed curing (Gambier, 1986).

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,

A proper curing maintains a suitably warm and moist environment for the developments of hydration products, and thus reduces the porosity in the hydrated cements paste and increases the density of microstructure in concrete. The hydration products extend from the surfaces of cement grains, and the volume of pores decreases due to proper cases, the temperature should be fully controlled to avoid non-uniformity. The concrete should be prevented from rapid drying and cooling which would form cracks.

7. Plastic sheet

Plastic sheet materials, such as polyethylene film, were used to cure the concrete cubes. Polyethylene is a lightweight, effective moisture retarder and was used easily applied to simple cubes shapes. 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. (Neville, et al, 1987).

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 (Neil Jackson et al, 1996

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 (Lambert Corporation, 1999).

Curing under appropriate temperature and moisture (Safiudeen et al, 2007).

A proper curing greatly contributes to reduce the porosity and drying shrinkage of concrete, and thus to achieve higher strength and greater resistance to physical or chemical attacks in aggressive environments. Therefore, 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. The study presents the effect of

Materials and Methods

Locally available crushed granite stones and fine aggregate (quartzite sand) were used as coarse and fine aggregate respectively. The fractions of different sizes of crushed granite stone and fine aggregates, as shown in Table 1 were in the ranges specified in Bs 812.

SIEVE SIZE	% FINER BY MASS	
	Crushed Granite Stone (Fineness Modulus: 4:81)	Sand (Fineness Modulus:4.23)
28.00mm	100	
20.00mm	85.91	
14.00mm	19.86	
10.00mm	10.82	
6.30mm	1.28	
.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.

Different curing methods on the compressive strength of concrete using Portland cement and finally identify the most effective curing process for normal concrete. (1960) methods for sampling and testing of aggregates. Ordinary Portland cement was used as the main binder. Portable water from borehole 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.

Materials	Properties
Crushed Granite Stone	Max. size:20mm,unitweight: 434.50kg/m^3 Specific gravity: 2.68, Absorption:0.77%, Moisture content: or 14%, void ratio: 0.46, Porosity: 9.27%
Fine Aggregate	Max. size:5mm, unit weight: 518.70kg/m^3, Specific gravity: 2.77, Absorption:2.29%, Moisture content:4.71%, void ratio: 0.45, Porosity: 0.07%
Ordinary Portland Cement	Specific Gravity: 3.15, unit weight: 1440kg/m^3
Borehole Water	Density: 1000kg/m^3, PH = 6.9

Mixture Proportions of Concrete

The normal concrete was prepared based on water cement ratio of 0.50 and a cement content of 340kg/m^{3}to obtain a compressive strength greater than 20N/mm^2 at 28 days (Immersion method of curing). Quartzite sand was used with a quantity of 33.33% of total aggregates by weight. The concrete mixture was proportioned to have 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 is table

Mixture 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

Preparation of Test Specimens

A total of 48 cubes having dimensions 150mm x 150mm x 150mm each were cast. The specimens were molded in oiled timbers 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 wooden moulds at the age of 24+ – 2 hours.

Curing -The test specimens were cured under three types of curing until the day of testing. These were water curing (WAC), sprinkling of water (SWC) and wrapping with plastic sheeting (PSC).In water curing, the specimens were weighed and immersed in water. Portable borehole water was used in water curing. In sprinkling method, the specimens were also weighed and kept moist by sprinkling water on the specimens 2 times daily (morning and evening) until the date of testing. In plastic sheeting, the specimens were weighed and wrapped in flexible plastic sheets until the testing date. At least 2 layers of wrapping were used to prevent moisture movement from concrete surface. The curing temperature was maintained at 27 + 2^{o}C in all the curing methods.

Compressive Strength

The results of compressive strength have been presented in tables 4-9 and in the graphical representation of average compressive strength versus curing age for different methods of curing used in the experiment (see fig 3). In all curing methods, the compressive strength of the concrete increases with age. The highest compressive strength at all ages was produced by immersion (water) curing. 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. Sprinkling method produced compressive strength close to immersion (Water) curing. Sprinkling method produced a compressive strength of 12.25w/mm^2 and 18.38N/mm^2 at 7 and 28 days respectively. The development of higher compressive strength in immersion (Water) curing and sprinkling method of curing is credited to sufficient moisture and suitable vapor pressure, which were maintained to continue the hydration of cement.

Plastic sheeting (membrane) 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 water curing. The early drying of concrete stopped the cement hydration before the pores were blocked by adequate calcium silicate hydrate.

Conclusions

Water curing was the most effective method of curing. It produced the highest level of 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.

Sprinkling method of curing produces higher compressive strength than plastic sheeting. This is attributed reduced the moisture movement from concrete specimens leading to enhanced degree of cement hydration.

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.

The extent of moisture movement was greatly dependent of the method of curing. Greater moisture movement occurs under plastic sheeting (membrane) method, and it significantly affected the strength property of the concrete. 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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