STRENGTH GAIN IN CONCRETE BY MEMBRANE CURING METHOD

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ABSTRACT

Most of the concrete structures in our country are cured with membrane curing method. In this process, the structural components are covered with burlap and then, this burlap or membrane is wetted at 2 hours, 3 hours or sometime 4 hours intervals. But it is easily understood that concrete does not gain full strength through this process. Therefore, a comparative study was made to investigate the effect of membrane curing. In this research, total 24 concrete cylinders of 6 x 12 inch were made and six of them were cured continuously in bath tub for 28 days. Rest of cylinders were covered with jute membrane similar to the local construction practice and divided into three sub-groups with each group contains six cylinders. These groups of cylinder were cured at 2 hours, 3 hours and 4 hours interval. An effort was made to find out reduction factor that should be multiplied with the strength of continuously cured cylinder to obtain the strength of cylinder which is cured at regular interval by membrane curing method. The reduction factors were found to be 0.889 for 2 hours and 0.712 for 3 hours and 0.651 for 4 hours curing interval for membrane curing method. Based on test results, a new empirical correlation was suggested which can be used to predict reduction factor for other time intervals.

Keywords: *Burlap or membrane, curing, cylinder, concrete strength.*

1. INTRODUCTION

The properties of hardened concrete, especially the durability, are greatly influenced by curing since it has a remarkable effect on the hydration of the cement. Curing is essential if concrete is to perform the intended function over the design life of the structure. The present trend for concrete strength test is to make 6x12 inch cylinder and measure their compressive strength. But the problem is- these cylinders are continuously cured in water tub while the structure made with same concrete is cured in membrane curing process. Most of the cases it is considered that the structural components gain equal strength as tested cylinder specimen. But it is found that due to the differences in the method of curing, a large discrepancy arises between claimed strength and gained strength. In our country, it is observed that most of the structural site use membrane curing process and in this process the structural components are covered with membrane and then the membranes are cured at intervals of (2-4) hours. In this research it was tried to find out reduction factor that should be multiplied with the claimed cylinder strength for the structures that were cured under membrane curing method.

In this research, 24 cylinders concrete specimens with mixing ratio of 1:1.5:3 were prepared with water-cement ratio of 0.5. Among them 6 cylinders were cured continuously in water tub. The rest of the cylinders were covered with burlap and 6 of them were cured at 2 hour intervals and 6 cylinders were cured at 3 hours intervals and other were cured at 4 hours intervals like local construction site of our country.

It was found for 2 hour interval of membrane curing the cylinder specimen gain almost 88.9% and for 3 hour curing interval it gains 71.2% strength and for 4 hour curing interval it gains 65.1% strength compared to continuously cured (immersed condition) cylinders.

2. BACKGROUND

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-

- Covering concrete surfaces with burlap or jute membrane
- Sprinkling of water
- Ponding method
- Membrane curing
- Steam curing

However, the most effective methods of curing concrete are wet coverings or water spraying that keeps the concrete continually damp (Safuddin et.al., 2007), Liquid membrane-forming compounds consisting of waxes, resins, chlorinated rubber, and other materials can be used to retard or reduce evaporation of moisture from concrete. They are the most practical and most widely used method for curing not only for freshly placed concrete but also for extending curing of concrete after removal of forms or after initial moist curing. Curing compounds should be able to maintain the relative humidity of the concrete surface above 80% for seven days to sustain cement hydration (Ephraim, 1994).

Curing compounds should be applied by hand-operated or power-driven spray equipment immediately after final finishing of the concrete. The concrete surface should be damp when the coating is applied. On dry, windy days, or during periods when adverse weather conditions could result in plastic shrinkage cracking, application of a curing compound immediately after final finishing and before all free water on the surface has evaporated will help prevent the formation of cracks. In this method moisture retaining fabrics such as burlap cotton mats and rugs are used as wet covering to keep the concrete in a wet condition during the curing period. If the drying is permitted, the cover will itself absorb the water from the concrete. Alternative cycles of wetting and drying during the early period of curing will cause cracking of the surface. The major disadvantage of this method is discoloring of concrete. Researchers are working in order to identify the effectiveness of the water curing methods over other curing methods. (Rao et.al., 2011). Carried out an experimental study on the effect of elevated temperature on differently cured concrete of M40 grade and subjected to temperature of 150^{o}C, 300^{o}C and 450^{o}C for 1 hour duration in muffle furnace. His study revealed that the 28-day compressive strength of the concrete specimen cured by water curing have been more than those cured by membrane curing in both heated and high temperature exposure condition. Weight loss in both conventional water cured concrete and membrane cured concrete are comparable.

3. METHODOLOGY

For In the laboratory we were facilitated with 12 steel cylinder mould of same sizes (6 inch X 12 inch).And 24 concrete cylinder were made. Fresh concrete was prepared as per ratio (C: FA: CA= 1:1.5:3) mixing by using mixture machine. Cement used in this test process was Portland composite cement with specific gravity 3.15. Fineness modulus of the fine aggregate (Sylhet sand) was found 2.74 and it was found as well graded (Figure 1). Stone chips used in this test were ¾ inch downgraded. Water cement ratio was kept 0.5. The fresh concrete was placed in the mold in three layers and compacted by using 16mm (5/8") diameter and 600mm (24") in length tampering rod with hemispherical tip. In all cases the number of tamping was randomly 25 times per layer. Proper compaction was ensured over the cross-section of the mold through uniform distribution of the temping strokes. Then the specimen was stored undisturbed for 24 hours in such a way that it prevents moisture loss and maintained the specimen within room temperature. In this study weight batching has been used for measuring the materials.

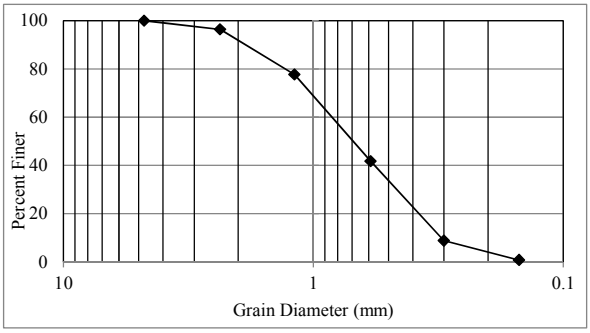

Figure 1: Grain size distribution of fine aggregate.

One day after casting of concrete the shuttering has been removed and the 24 cylinders were divided into four groups each contains six cylinders. Then one group of cylinder was kept in immersed condition in a water tub. The rest three sub-groups were covered with burlap (jute membrane). The one group of burlap covered cylinder was cured at 2 hour intervals, another group at 3 hour intervals and other at 4 hour intervals. This process was continued up to evening (7.00 PM) each day like local construction site of our country. After 28 days all the

cylinders were tested under UTM for compressive strength. At last it was tried to find a relationship from which we can get a reduction factor that should be multiplied with the strength of concrete (immersed condition) depending on intervals of membrane curing in the construction site.

3. RESULT & DISCUSSION

The compressive strength obtained from concrete cylinder specimen cured at different time intervals are given in the Table 1. From the experiment, it was observed that the strength of concrete decreases with the increases of curing interval as expected. During the calculation of average strength for 3 hour curing interval period, the applied load of 450 KN was discarded as incorporation of this value causes high standard deviation. This action was also performed for 2 hours curing interval and for continuous curing or immersed curing condition. For clarity, discarded values are shaded in the Table 1. After obtaining the compressive strength of concrete cylinder specimen for each curing condition, the reduction factor was simply calculated by dividing the compressive strength of concrete cylinder for different curing interval with the compressive strength of continuously cured cylinder. It is also seen that after the curing interval of 2 hours the strength of concrete decreases at a rapid rate and at the curing interval of 4 hours the strength becomes almost 65% of continuous cured cylinders.

Table 1: Strength of concrete cylinder for different curing interval.

SL. NO	Curing Interval in (Hour)	Applied Load (KN)	Applied Load (Average) (KN)	Load in (lb.)	Area (in^2)	Compressive Strength (psi)	Factor w.r.t. 24 hr. Curing Strength
01	4	200	230.83	518611	28.2743	1834	0.651
02		265					
03		285					
04		180					
05		215					
06		240					
07	3	265	252	56652	28.2743	2004	0.712
08		210					
09		245					
10		450					
11		205					
12		335					
13	2	335	315	70815	28.2743	2505	0.889
14		345					
15		440					
16		265					
17		275					
18		355					
19	0 (Immersed)	440	353.75	79583	28.27430	2815	1.00
20		305					
21		355					
22		315					
23		160					
24		240					

When the reduction factors are plotted against curing time interval, it was found that the reduction factor decreases linearly with the increase of curing time interval (Figure 2). The following linear empirical correlation (Eq. 1) was proposed due to its simplicity. In addition, the R-squared value of 0.9452 indicates good correlation.

$$R_F = - 0.0913*t + 1.0185 \quad (1)$$

Where,
R_F = Reduction Factor
t = Curing Interval in hours

Therefore, this equation or graph can be used to find out the reduction factor for other curing interval like 1 hour, 1.5 hours, 3.5 hours etc. The variance represents that graphical values may have 5% deviation from actual value.

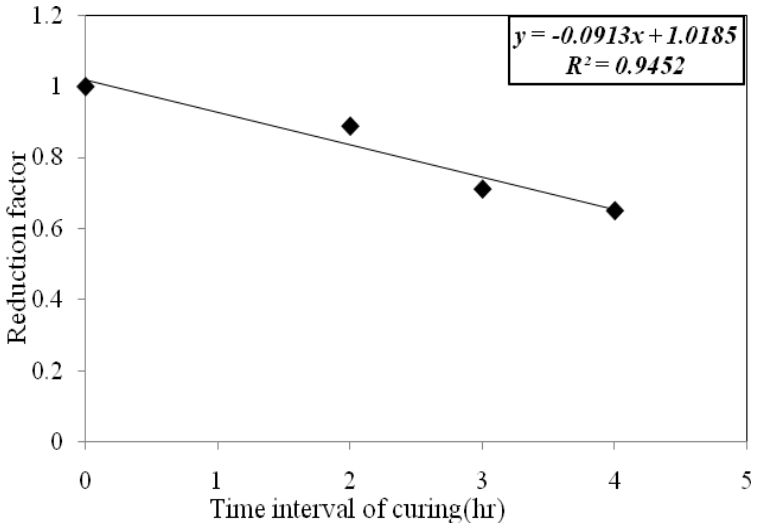

Figure 2: Strength reduction factor versus curing time interval.

4. CONCLUSIONS

From this experimental investigation the following conclusions can be drawn-

- A concrete cylinder cured with membrane curing method does not gain equal strength as continuously cured cylinder.
- The compressive strength of continuously cured cylinder specimen should be multiplied with a reduction factor obtained from Figure 2 or Eq. 1 to predict in-place compressive strength depending on the curing interval.
- The authors recommend keeping the curing interval within 2 hours, so that the expected in-place compressive strength does not reduced considerably than the compressive strength obtained from standard cylinder's compressive strength test.

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