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Curing Acceleration of Concrete Bricks by Using Chemical Admixture

M. N. Shete[1], P. S. Bhandari[2], S. S. Rikame[3] and P. M. Pathak[4]

[1](Lecturer, Chemical Engineering, K.K.Wagh Polytechnic, Nashik, Maharashtra, India)

[2](Head of Chemical Engineering Department, K.K.Wagh Polytechnic, Nashik, Maharashtra, India)

[3](Lecturer, Chemical Engineering, K.K.Wagh Polytechnic, Nashik, Maharashtra, India)

[4](Lecturer, Chemical Engineering, K.K.Wagh Polytechnic, Nashik, M.E-I[st] year, Jawaharlal Nehru Engineering College, Aurangabad, Maharashtra, India)

ABSTRAC

The study was carried out to assess the effect of chemical admixture on the curing of concrete bricks. The effect was assessed in terms of compressive strength gained by the bricks during predetermined period in days. After manufacture, the batches of bricks cured by conventional method. Four sample batches were prepared viz. 0.0, 1.0, 1.5, 2.0 percentage of chemical admixture of the cement used. The compressive strength of the bricks was made on compression testing machine. The plot of the average compressive strength of each batch versus curing time in days obtained on the basis of findings during the tests. It was found that the use of the chemical admixtures improves the rate of curing and helps the concrete to gain earlier strength.

Keywords **-** Chemical Admixture, Compressive Strength, Concrete bricks, Curing, Hydration.

I. Introduction

The curing of concrete is a reaction between cement and water in the concrete, known as hydration of cement, which gives strength to the concrete. As development in construction field continues throughout the world, the desire to construct cheaper structures on sites, which are more difficult to build on, in shorter periods of time, with improved performance will always be desirable in order to maximize both product economy and quality. As such, the construction Industry is constantly searching for ways to improve their product.

One means to this end, rather than relying on improving construction implementation mechanisms such as scheduling, installation techniques, and quality control, is focusing on the industry's improved knowledge and development of materials and their behavior.

In order to maximize the rate of curing process of concrete for precast applications, chemical admixture can play an important role in curing of concrete.

II. Curing of concrete

Curing process can be divided into three distinct stages.

During stage one, the chemical reaction between the Portland cement and the water begins; however, the development of measurable compressive strength gain is minimal. Depending on the particular mix design characteristics, this stage usually lasts for 3-4 hours.

Stage two, beginning at the onset of initial set, is characterized by a rapid rate of hydration, resulting in exothermic heat development as well as rapid compressive strength gain.

Finally, after a majority of the cementitious materials have reacted with water, stage three begins. During this time, less heat is generated by the hydration process, and a slower rate of strength development occurs, typically between 50 to 100 psi per hour. The application of elevated curing temperature has little effect on the rate of strength gain at this point [1].

Two basic approaches can be taken to affect the hydration process in order to achieve high early compressive strength in concrete. First, the environmental curing conditions can be altered in order to accelerate the process. The primary factor affecting the rate of hydration is the concrete curing temperature. Second, the cement composition can be specified in order to maximize the initial rate of compressive strength gain. This can be adjusted through the type of cement used, as well as through the use of both mineral and chemical admixtures. A combination of these various methods is usually employed in order to create the most economical accelerated curing process possible.

III. Chemical Admixture

Chemical admixtures are the ingredients in concrete other than cement, water, and aggregate that is added to the mix immediately before or during mixing. Producers use admixtures primarily to reduce the cost of concrete construction, to modify the properties of hardened concrete, to ensure the quality of concrete during mixing, transporting, placing, and curing, and to overcome certain emergencies during concrete operations.

The effectiveness of an admixture depends on several factors including: type and amount of cement, water content, mixing time, slump, and temperatures of the concrete and air. Sometimes, effects similar to those achieved through the addition of admixtures can be achieved by altering the concrete mixture, reducing the water-cement ratio, adding additional cement, using a different type of cement, or changing the aggregate and aggregate size.

Some of the types of admixtures are as:

1. Water – reducing admixture.
2. Retarding admixtures.
3. Accelerating admixtures.
4. Super plasticizers admixtures.

IV. Selection of Chemical Admixture

In this study, the chemical admixture used is Calcium Chloride (CaCl2). Historically, the use of calcium, particularly in the form of calcium chloride was thought to be an effective acceleration technique in concrete nonetheless, studies have shown that calcium chloride has a significant impact on gaining early strength of concreted .The use of 1% of calcium chloride relative to the weight of cement in a mix has resulted in an increase of strength after 24 hours of 300% [2]. In applications in which metal is not embedded in concrete, the use of calcium chloride as an accelerator is still permitted. The use of Calcium Chloride as an accelerator should not be greater than 2% by weight of cement, and precautions should be taken while using it in concrete subjected to steam curing, if used in concrete containing dissimilar metals, in concrete slabs supported on permanent Galvanized steel forms, and in colored concrete. [3].

4.1 Properties of calcium chloride ($CaCl_2$) -

a. Appearance/Physical State - Powder, dust
b. Color - White
c. Odor - Odorless or no characteristic odor
d. Solubility description - Soluble in water

4.2 Advantages of calcium chloride ($CaCl_2$) -

Anti – icing, ice control, pre-mix, dust control, good dehydrator.

4.3 Disadvantages calcium chloride ($CaCl_2$) -

a. Toxic fumes are emitted from calcium chloride when it is heated to decomposition,
b. Irritating to the respiratory tract if inhaled, c. Harmful if swallowed,
d. May cause gastric distress, nausea and vomiting if ingested,
e. Irritating to the skin, f. Irritating to the eyes

4.4 Objectives for using Calcium Chloride ($CaCl_2$) -

As calcium chloride is a good dehydrator and it is available easily in market with very less cost it is preferred for increasing the strength and accelerating the curing process and drying rate of cement brick. Their hazardous effects are less and mainly cause when heated hence it is safe to use in bricks.

V. Compressive Strength

By definition, the compressive strength of the material is that value of un axial stress reached when the material fails completely. The compressive strength is usually obtained experimentally by means of a compressive test. The apparatus used for this experiment is the same as that used in a tensile test. However, rather than applying a un axial tensile load, a un axial compressive load is applied.

Compressive strength is the capacity of a material or structure to withstand axially directed pushing forces. It provides data of force versus deformation for the conditions of the test method. When the limit of compressive strength is reached, brittle materials are crushed. Concrete are made to have high compressive strength.

Figure 1: Compression Testing Machine

VI. Experiment

In experiment, the ratio of cement,

aggregate, fly ash, water are kept unchanged. The chemical admixture Calcium Chloride ($CaCl_2$) is mixed in 1, 1.5 and 2 percent of cement used in three different batches, while one batch is prepared without adding chemical admixture. After preparation, bricks are cured by conventional method. Periodically, the compressive strength of each batch is measured by Compression Testing Machine (CTM).

VII. Result and Discussion

The compressive strength test yields following observations –

TABLE 1 : Compressive Strength

Sample	**Load at failure point (P) [N]**	**Area (A) [mm^2]**	**Compression strength (P/A) [N/mm^2]**
9th day from manufacture			
0.0 % $CaCl_2$	$11*10^3$	220000	$0.5 N/mm^2$
1.0 % $CaCl_2$	$7.1*10^3$	220000	$0.32 N/mm^2$
1.5 % $CaCl_2$	$18.4*10^3$	220000	$0.84 N/mm^2$
2.0 % $CaCl_2$	$7.7*10^3$	220000	$0.35 N/mm^2$
12th day from manufacture			
0.0 % $CaCl_2$	$7.4*10^3$	220000	$0.34 N/mm^2$
1.0 % $CaCl_2$	$17*10^3$	220000	$0.77 N/mm^2$
1.5 % $CaCl_2$	$17.9*10^3$	220000	$0.81 N/mm^2$
2.0 % $CaCl_2$	$18.9*10^3$	220000	$0.85 N/mm^2$
15th day from manufacture			
0.0 % $CaCl_2$	$19*10^3$	220000	$0.86 N/mm^2$
1.0 % $CaCl_2$	$11.5*10^3$	220000	$0.53 N/mm^2$
1.5 % $CaCl_2$	$21.3*10^3$	220000	$0.97 N/mm^2$
2.0 % $CaCl_2$	$17*10^3$	220000	$0.77 N/mm^2$
18th day from manufacture			
0.0 % $CaCl_2$	$22.6*10^3$	220000	$1.02 N/mm^2$
1.0 % $CaCl_2$	$32.8*10^3$	220000	$1.49 N/mm^2$
1.5 % $CaCl_2$	$40.6*10^3$	220000	$1.84 N/mm^2$
2.0 % $CaCl_2$	$37.5*10^3$	220000	$1.70 N/mm^2$
21st day from manufacture			
0.0 % $CaCl_2$	$26.5*10^3$	220000	$1.20 N/mm^2$
1.0 % $CaCl_2$	$23.7*10^3$	220000	$1.04 N/mm^2$
1.5 % $CaCl_2$	$38.8*10^3$	220000	$1.76 N/mm^2$
2.0 % $CaCl_2$	$28.4*10^3$	220000	$1.290 N/mm^2$
24th day from manufacture			
0.0 % $CaCl_2$	$40.4*10^3$	220000	$1.86 N/mm^2$
1.0 % $CaCl_2$	$47.4*10^3$	220000	$2.136 N/mm^2$
1.5 % $CaCl_2$	$51.4*10^3$	220000	$2.336 N/mm^2$
2.0 % $CaCl_2$	$40.4*10^3$	220000	$1.836 N/mm^2$

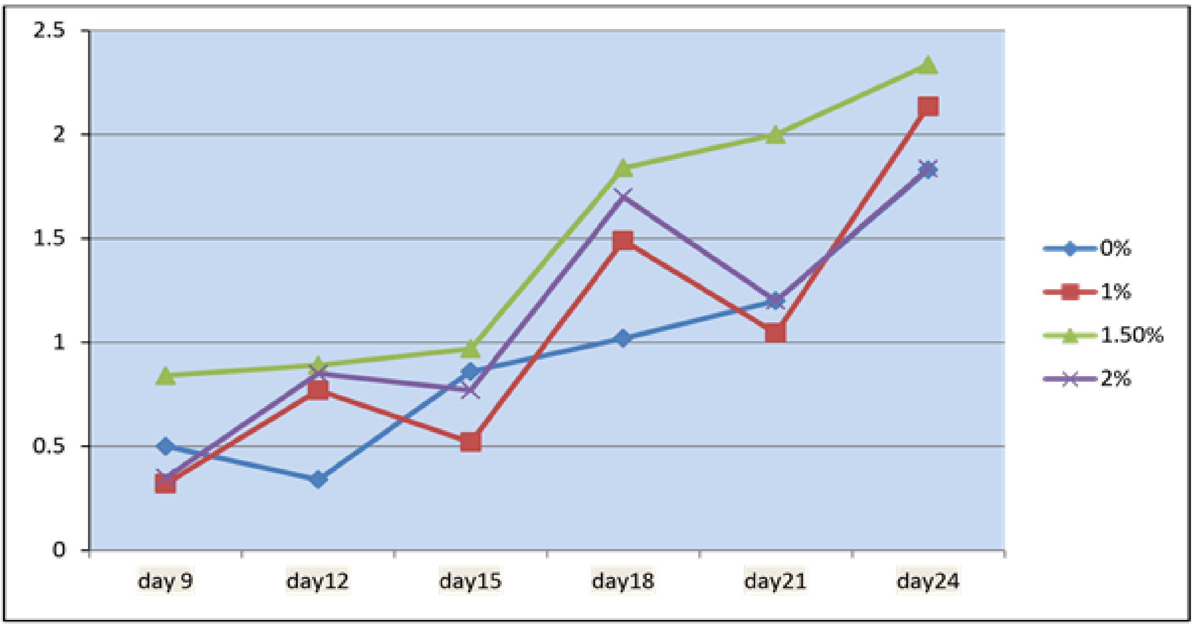

Figure1 Strength vs. Curing in no of days

VIII. Conclusion

Through the observations and plot we can conclude that the sample having 1.5 % $CaCl_2$ as chemical admixture yield good earlier strength for the concrete bricks. Curing process of cement bricks can be achieved in minimum possible days. But the proportion of the $CaCl_2$ should not be exceeded than 1.5% of the cement weight. The bricks manufactured by adding $CaCl_2$ should not be used in contact with steel.
To overcome this disadvantage we are searching for another chemical admixture.

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