Detailed Review on Self Curing Concrete

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Abstract— As curing is most important process in concreting and it requires large amount of water, an alternate approach is taken to reduce the water requirement and to increase its strength properties than conventional concrete. So we go for PEG-400 as an admixture to attain internal curing of concrete. In this method hydration is done by lockingthe water content added for mixing from evaporation and by forming a thin film over it. PEG-400 is added in the ratios 0.5%, 1%, 1.5% and 2% in the weight of cement. Since PEG-400 is soluble in water it can be added along with water in mixing process. Hence self-curing can be an alternate method for conventional curing methods.

Key words: Self Curing Concrete

I. INTRODUCTION

Curing of concrete is defined as providing adequate moisture, temperature and time to allow the concrete to achieve the desired properties for its intended use. Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation. Evaporation in the initial stage leads to plastic shrinkage cracking and at the final stage of setting it leads to drying, shrinkage and cracking. Curing temperature is one of the major factors that affect the strength development rate. In addition to the normal concrete mix, some additional compounds in proper dosage and materials such as fly ash are used to increase the durability and strength of concrete mix.

A. Self Curing

Curing of concrete is maintaining satisfactory moisture content in concrete during its early stages in order to develop the desired properties. However, good curing is not always practical in many cases. Several investigators explored the possibility of accomplishing self curing concrete. Therefore, the need to develop self-curing agents attracted several researchers. The concept of self-curing agents is to reduce the water evaporation from concrete, and hence increase the water retention capacity of the concrete compared to conventional concrete. It was found that water soluble polymers can be used as self-curing agents in concrete. Concrete incorporating self-curing agents will represent a new trend in the concrete construction in the new millennium. Curing of concrete plays a major role in developing the concrete microstructure and pore structure, and hence improves its durability and performance. The concept of self-curing agents is to reduce the water evaporation from concrete, and hence increase the water retention capacity of the concrete compared to conventional concrete. The use of self-curing admixtures is very important from the point of view that water resources are getting valuable every day (i.e., each 1cu.m of concrete requires about 3cu.m of water for construction most of which is for curing). Excessive evaporation of water (internal or external) from fresh concrete should be avoided; otherwise, the degree of cement hydration would get lowered and thereby concrete may develop unsatisfactory properties. Curing operations should ensure that adequate amount of water is available for cement hydration to occur. This investigation discusses different aspects of achieving optimum cure of concrete without the need for applying external curing methods. The effect of curing, particularly new techniques such as "self-curing", on the properties of high performance concrete is of primary importance to the modern concrete industry.

B. Significance of Self-curing:

When the mineral admixtures react completely in a blended cement system, their demand for curing water (External or Internal) can be much greater than that in a conventional Portland pozzolanic cement concrete. When this water is not readily available, significant autogenous deformation and (early age) cracking may result. Due to the chemical shrinkage occurring during cement hydration, empty pores are created within the cement paste leaving to a reduction in its internal relative humidity and also to shrinkage which cause cracking, internal warping and external deflection.

II. LITERATURE SUMMARY & OUT COMINGS

A detailed Literature survey is carried out on Self cured concrete especially on Indian context , the short comings from literature is taken for further work with detailed analysis. based on the results of survey following conclusions are made :

- Performance of the self-curing agent will be affected by the mix proportions mainly the cement content and the w/c ratio.
- Strength of self curing concrete is on par with conventional concrete.
- Self curing concrete is the answer to many problems faced to lack of proper curing.
- Some times works are carried out in place where there is acute shortage of water and the application of water curing is not possible for reasons of economy.
- Prevention of moisture loss from the surface of flat concrete works such as highways and airports have been challenging task for construction managers.
- Internal curing (IC) is a method to provide the water to hydrate all the cement, accomplishing what the mixing water alone cannot do.
- Eliminates largely autogenous shrinkage.
    - The collection of material for the self curing concrete such as PEG-400 Cement, aggregate and water for M20 and M40 concrete mixes are collecting and casting.
    - The conventional concrete is curing in water.M20 and M40 Grade mixes are designating in accordance with IS: 10262-2009.

- We are manufacturing concrete mortars cubes of size 150X150X150 mm which is same a standard cubes .
- Cylindrical specimens of size 300 mm × 150 mm are preparing using the steel molds.
- The suitable proportion is using for Self curing concrete(cement:fine aggregate:coarse aggregates)
- Investigation strength of self curing concrete by adding polyethylene glycol 400 @ 0.5%, 1%, 1.5% and 2% by weight of cement to the concrete.
- Cement concrete is preparing by using suitable water cement ratio according to the IS 383-1970
- We have to filling the concrete in layers and by giving hand compaction the concrete will be settled properly.
- After complete filling the mould with concrete the mould should finally placing on a vibrator for final compaction.
- The vibration is done 3-5 seconds to obtain the final compaction and smooth finish.
- The top layer is levelled and finishing is done for aesthetic use.
- Conventional concrete is casting with M20 and M40 mix and made to water curing.
- Another set of cubes are casting using PEG-400 with M20 and M40 concrete and allowing for atmosphere curing.
- Similarly cubes are for 3, 7, 21 and 28 days for conventional and PEG 400 to study the strength properties (compressive strength and split tensile strength).
- After the completion of 28 days curing, the initial weights of the specimens are noted.

III. MATERIALS REQUIRED

A. Cement

Cement is a binder, a substance that sets and hardens and can bind other materials together. Though all cement conforming to various IS code are suitable, selection of cement should be based on their compressive strength, fineness and compatibility with other ingredients. The strength of cement decides the target strength of concrete. Fineness or particle size of Portland Pozzolana Cement affects rate of hydration, which is responsible for the rate of strength gain. The Ordinary Portland cement of 43-grade PPC is using for this study conforming to IS: 12269-1987 [11]. The specific gravity of cement is 3.15. The standard initial and final setting times are 30 minutes and 600 minutes respectively. Standard consistency of cement was 29%.

B. Fine Aggregate

The river sand is using as fine aggregate conforming to the requirements of IS: 383-1970 [9], having specific gravity of 2.54 .

C. Coarse Aggregate

Coarse aggregate obtained from local quarry units has been using for this study, conforming to IS: 383-1970 [9] is used. Maximum size of aggregate using is 20mm with specific gravity of 2.6

D. Water

The water using for experiments is potable water conforming as per IS: 456-2000 [15]. Water is the one of the major constituents of preparing concrete as well as curing. The water using for concrete mixing should be free from alkalis, oils, acid, organic materials etc. Generally potable water is considered for concrete mixing. Water is an important ingredient of concrete as it actively participates in chemical reaction with cement. This is the least expensive but most important ingredient of concrete. Clean potable water conforming to IS: 456-2000 is using; the water using in the preparation of mortar should not need to be distilled water, but must be free of all acids and other dissolved salts. A lower water-to-cement ratio yields a stronger, more durable concrete,where as more water gives a free-flowing concrete with a higher slump.

E. Polyethylene glycol (PEG)

The polymers added in the mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules of water which in turn reduces the vapour pressure, thus reducing the rate of evaporation from the surface. Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH2CH2)nOH, where n is the average number of repeating oxyethylene groups typically from 4 to about 180. The abbreviation (PEG) is termed in combination with a numeric suffix which indicates the average molecular weights. One common feature of PEG appears to be the water-soluble nature. Polyethylene glycol is non-toxic, odorless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals.

IV. EXPERIMENTAL TESTS

Slump cone test- Properties of fresh concrete will be determining using the slump cone test. The slump cone test is the most commonly used method of measuring consistency of concrete, which can be employed either in the laboratory or at the site of work as per IS 7320-1974 [13]. Slump cone test is used as a control test and to indicate the uniformity of concrete from batch to batch. The slump cone test consists of a cone of height 30 cm, bottom diameter as 20 cm and top diameter as10 cm. The mold is placed on the clean and smooth surface. The mold is then filled in four layers and each layer is tamped 25 times using the tamping rod. After filling the top layer, the concrete is leveled with a tamping rod and trowel. The mold is then removed slowly by raising it carefully in the vertical direction. The difference in level between the height of the mold and that of the highest point of the subsided concrete is measure. The difference in height measured is the slump of the concrete.

A. Compressive Strength Test

Compressive strength of HPFRC mixes was testing using compression testing machine of 3000 kN capacity as per IS 516-1959 [14] specifications. Fresh concrete was filling in the steel molds of required size and then vibrating for 3 minutes using vibrating table for getting better compaction and finishability in concrete. Concrete cubes of size 150 mm ×150 mm × 150 mm are preparing and allowed to dry for 24 hours and demolding from the steel molds and testing for compression at 7 and 28 days. The compressive strength of the test specimens are determing using the formula

$$fc = P/A$$

where fc is the compressive strength of the specimen in N/mm2, P is the maximum load applied in kN and A is the cross sectional area of the specimen in mm2

Split Tensile Strength Test- Cylindrical specimens of size 300 mm × 150 mm are preparing using the steel molds. The specimens are immersing in curing tank after demolding. The specimens are taking out from the curing tank at 7 and 28 days and testing for split tensile strength as displayed in the Figure. The test is carried out by placing horizontally the cylindrical specimen between the loading surfaces of a compression testing machine as per IS 5816-1999 [15] standards. Split tensile strength is calculating using formula

$$T= 2P/ \pi*DL$$

Where: P is the fracture compression force acting along the cylinder;
D is the cylinder diameter;
$\pi = 3.14$;
L is the cylinder length.

V. Literature Reviews

A. M.V.Jagannadha Kumar

Today concrete is most widely used construction material due to its good compressive strength and durability. Depending upon the nature of work the cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce plain concrete. Plain concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days for good hydration and to attain desired strength. Any laxity in curing will badly affect the strength and durability of concrete. Self-curing concrete is one of the special concretes in mitigating insufficient curing due to human negligence paucity of water in arid areas, inaccessibility of structures in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete. The present study involves the use of shrinkage reducing admixture polyethylene glycol (PEG 400) in concrete which helps in self curing and helps in better hydration and hence strength. In the present study, the affect of admixture (PEG 400) on compressive strength, split tensile strength and modulus of rupture by varying the percentage of PEG by weight of cement from 0% to 2% were studied both for M20 and M40 mixes. It was found that PEG 400 could help in self curing by giving strength on par with conventional curing. It was also found that 1% of PEG 400 by weight of cement was optimum for M20, while 0.5 % was optimum for M40 grade concretes for achieving maximum strength without compromising workability.

1) Conclusions

1) The optimum dosage of PEG400 for maximum strengths (compressive, tensile and modulus of rupture) was found to be 1% for M20 and 0.5% for M40 grades of concrete.
2) 2. As percentage of PEG400 increased slump increased for both M20 and M40 grades of concrete.
3) 3. Strength of self curing concrete is on par with conventional concrete.
4) 4. Self curing concrete is the answer to many problems faced due to lack of proper curing.

B. A.A.M. Mahmoud

The study investigates using laboratory synthesized water-soluble polymers: polyethylene glycol (PEG) and polyacrylamide (PAM) as self-curing agents and its effect on the degree of hydration, water absorption, permeable pores

and micro structural characteristics of Portland cement mixtures without and with 8% silica fume replacement. Portland cement mixtures including PEG or PEG+PAM as self-curing agents showed a better quality compared to that of the non-cured mixtures. Mixtures incorporating 8% silica fume including a mixture of PEG and PAM as self-curing agent had a better quality compared to that of the mixture including only PEG especially at later ages.

Polyethylene-glycol (PEG) was used alone with a dosage of 0.02% by weight of cement. Polyacrylamide (PAM) was used in conjunction with PEG as a second alternative for self-curing agent. The dosage of PEG and PAM was 0.02% by weight of the cement, PEG dosage was 0.013% and that of PAM was 0.007%.

1) Conclusions

- Effectiveness of the self-curing agents is affected by the cementitious type used (i.e. OPC or OPC+silica fume).
- The use of high molecular weight water-soluble polymers (PAM) together with low molecular weight polymers (PEG) had better performance in retaining water for longer period and releasing it slowly with time than using PEG only.
- Better water retention for self-curing mixtures including silica fume showed the tendency of improving hydration at 28 days of age.
- Water absorption and permeable pores for self-curing mixtures were lower than those of the conventional non-cured mixtures.
- Self-curing mixtures exhibited denser microstructure compared to conventional non-cured mixtures. Silica fume self-curing mixtures suffered less self-desiccation compared to conventional non-cured mixtures.

C. A.S. El- Dieb

The objective of the research was to find out the water retention capacity and degree of hydration and moisture transport by using self-curing agent and compare to conventional curing of concrete.The self-curing agent used in this study was water soluble polymeric glycol (polyethylene glycol). The dosage of self curing agent was 0.02% by weight of cement. The dosage was kept constant for all the self curing concrete mixes.

The investigation aimed at studying on concrete with different quantities of cement (350-450kg/m3) at different water- cement ratios (0.3-0.4) both for self, conventional and air- curing concrete and compare the results for different test.

1) Conclusions

The following could be concluded from the results obtained in this study.

- Water retention for the concrete mixes incorporating self-curing agent is higher compared to conventional concrete mixes, as found by the weight loss with time.
- Self-curing concrete suffered less self-desiccation under sealed conditions compared to conventional concrete.
- Self-curing concrete resulted in better hydration with time under drying condition compared to conventional concrete.
- Water transport through self-curing concrete is lower than air-cured conventional concrete.
- Water sorptivity and water permeability values for self curing concrete decreased with age indicating lower permeable pores percentage as a result of the continuation of the cement hydration.

