Effect of Potassium Sulphate in The Presence of Water on the Strength of Concrete

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Abstract- *Cementatious materials have been used by mankind for construction from time immemorial. The every rising functional requirement of the structures and the capacity to resist the aggressive elements has necessitated developing the new cementatious materials. Concrete is an artificial material in which the aggregates both fine and coarse are bonded together by the cement when mixed with water. The most important part of the concrete is cement, whose production produces a lot of CO2.Cement mortar cubes were casted using the Tap water in five different sulphate concentrations of 1, 2, 4, 6and8g/l. The sulphates used in the present investigation are potassium sulphate. Controlled sample specimen were casted using tap water with no concentration for comparison. Specimens are tested for compressive strength by using compression testing machine. Testing is done at age of 7, 28 and 48 days. And from this investigation we can conclude that with this concentrations the effect on compressive strength is slightly less when compared with the controlled sample specimen.*

Keywords- Curing, Durability, Strength, Salt, Concrete, Compressive Strength

I. INTRODUCTION

Concrete has become an indispensable construction material and it is now used in greater quantities than any other material. Ordinary Portland cement has a high calcium base affecting the microclimate of concrete and mortar. The interface bond between the cement paste and aggregates can be improved with better pore structure and minimized micro cracks using mineral admixtures like fly ash, granulated blast furnace slag, rice husk, silica fume etc. Out of the above, the use of fly ash has gained prominence due to growing awareness about the benefits and easy availability of the good quality fly ash. Ordinary Portland cement is made by grinding Clinker and Gypsum, One ton of clinker requires approximately 1.5 tons of limestone whose reserves are limited. The remedy for the above problem is blended cement. Blended Cement is the cement with a fixed percentage of pozzolans (A mineral admixture that acts as a supplement to "standard" Portland cement hydration products to create additional binder in a concrete mix.) and the Portland cement clinker of the cement mix. Blended cement is usually understood as cement that is blended by a cement manufacturer rather than a ready-mix supplier. Since water helps to form the strength giving cement gel, the quality of water is to be critically monitored and controlled. In practice, very often, great control on properties of cement and aggregate is exercised, but the control on the quality of water is often neglected. Water used for mixing purpose, exceeding the tolerable limits of impurities, may affect not only the strength and durability but also setting time, soundness, efflorescence (deposits of white salts on the surface of structure) and corrosion of reinforcing or pre-stressing steel. Most soils contain some sulphate in the form of calcium, sodium, potassium and magnesium. They occur in soil or ground water. Water behaves as the Main Culprit in the detrition of the structure. It acts as a carrier for deleterious material, leaves vulnerable voids, shrinkage problems, causes cracks, causes segregation, bleeding.

II. SCOPE AND OBJECTIVES

The specific objectives of the present investigation are:

1. To study the effect of individual like $K_2SO_4$with different concentrations in mixing water on short term and long term compressive strength development of Fly ash based blended cement mortar.
2. To study the effect of the above mentioned chemical substances with different concentrations in mixing water on short term and long term compressive strength development of Fly ash based blended cement mortar.
3. To study the efficiency of blended cement against sulphate attack.

The scope of the present investigation is to investigate the effect of the sulphate present in water with different concentrations on the strength properties of blended cement. Based on the availability of equipment in the laboratory experimental work was conducted on the cement mortar cubes so that it leads to evaluate compression strengths.

III. NEED FOR INVESTIGATION OF THE USAGE OF SULPHATEIN WATER

Many researchers warns that, in near future there will be shortage of drinking water itself, hence sea water will also not be available for concreting purpose. We use bore water for mixing as well as curing of concrete instead of fresh water. But concreting required many billions of water for mixing and curing in the whole world. To fulfill this requirement of water, the study is done on the use of sulphate water instead of fresh or bore water and the effect of Sulphate water as mixing and curing on concrete. An investigation recently carried out by Portland Cement Association (PCA) on long time study of cement performance in concrete (LTS) program provides key insights into the performance of concrete in sea water[7]. Therefore the selection of materials, mix design, and proper detailing of reinforcement are also essential parameters in producing a durable concrete structure for sulphate water [8].
Sea water is water of sea or oceans, which is salty in taste. Sea water can be said to have a solution containing a great number of elements in different proportions. The primary chemical constituents of sea water are the ions of chloride, sodium, magnesium, calcium and potassium. In sea water containing up to 35,000 ppm of dissolved salts, sodium chloride (NaCl) is by far the predominant salt (about 88% by weight of salts) [9]. The pH value of sea water varies between 7.4 and 8.4. Sea water is an adequate electrolytic and plays a major function in any electrolytic action between dissimilar metals and between salt concentration and steel [10].

Further investigation is recommended on this subject of using sea water for concrete mixes, as the planet earth is experiencing noticeable shortage of pure clean water sources for future construction work, and the use of sea water to develop durable concrete of lasting performance will be greatly beneficial.

IV. MATERIALS

The detail of various required materials for the testing are following:-

Cement-: PPC (ACC cement) was used.

Coarse Aggregate: Crushed granite stone aggregate of maximum size 20mm confirming to IS 383-1970 was used. The specific gravity were found to be 2.72 for 20mm size of particle and 2.70 for 10mm size of particle and fineness modulus is found to be 7.25 for 20mm size of particle and 6.68 for 10mm size of particle.

Fine Aggregate: The fine aggregate used in this investigation those sand which passing through 4.75 mm sieve with specific gravity of 2.65. The grading zone of fine aggregate was zone IInd as per Indian standard specification.

Sulphates: Sulphates in the powdered form used for the present investigation are potassium sulphate

Fresh Water: Ordinary clean portable water free from suspended particles and chemical substances was used for both mixing and curing of concrete cubes cast with fresh water.

The water used was gotten from the tap at the Civil Engineering Department Laboratory, Integral University, Lucknow, UP

V. METHODOLOGY

A. Experimental Procedure:

To investigate the effect of Sulphate water on compressive strength of concrete, half of the concrete cubes were cast and cured with potable water and half of the concrete cubes were cast and cured with Sulphate water. The amount of salt (NaCl) used in water was kept as 8g/liter).
The size of cube measuring **150×150×150** mm^3 in dimension was used. The batching of the concrete was carried out by weight. Mixture was proportioned for target strength of 38.25N/mm^2 and a water cement ratio of 0.42. The concrete was properly mixed using the Sulphate water and potable water respectively, the concrete cubes mould were filled in three layers in which each of the layer were compacted 25 times respectively. The concrete cubes were cast and cured for 7, 14, 21and 28 days respectively and was tested for compressive strength.

B. Specimen Preparation and Casting of Concrete Cubes:

The tests was carried out on concrete mixed cured in sea water and sea water in order to determine the effect of the curing conditions for determining concrete strengths, namely, compressive strength, tensile strength, flexural strength and bond strength. Batching was done by weighing the materials for the concrete specimen using a Manual Weighing Balance. Concrete mix ratio of 1:1.46:2.64 by weight of concrete 0.42 water-cement ratio were used. Mixing was done by machine and the materials were thoroughly mixed in the dry state twice, after which water was added gradually while thoroughly mixing the concrete. Mixing of the concrete specimen continued by turning the mixture of cement, water and aggregates until the concrete was uniform in color and consistency. The mould was smear with oil from inside so as to enhance easy removal of the set concrete. The fresh concrete mix for each batch was fully compacted by tamping rods, to remove trapped air, which can reduce the strength of the concrete. Workability of concrete which were made with

sea water and salt water separately, checked in time of casting of concrete cubes. The slump was maintained from 75 to 100mm i.e. for mass concrete.

72 concrete cubes were cast and cured in two batches. 12 cubes were made using fresh water, 60cubes were made using Sulphatewater for 7, 28 and 48. The cubes are de-molded after 24 hour of casting, and cured in water having similar quality as used in the preparation of mix.

VI. TESTING RESULTS

After casting and de-moulding, the salt water concrete cubes has a darker surface than the reference concrete cubes, when cured in salt water a deposit of salt formed on a specimens with whitish appearance at bottom edges. The compressive strength test was performed on the concrete cubes, tested at the curing age of 7, 28, and 48 days using the compression testing machine.

Test results of the cubes prepared from sea water and water containing salts. Results indicate that, there is increase in the compressive strength of concrete of all concrete cubes.

Table 1: Results of 7days cube compressive strength

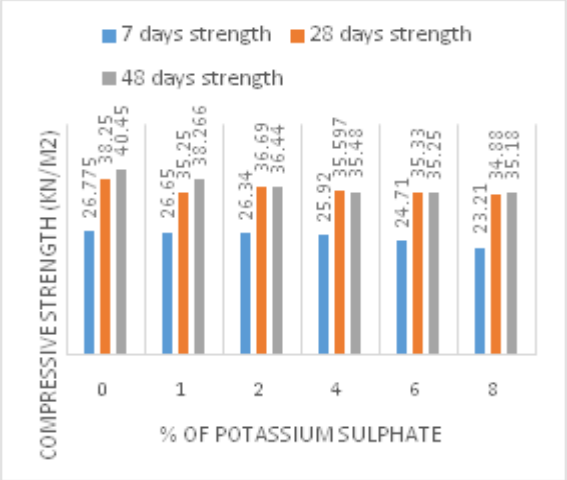
Grade of concrete	% of K_2SO_4 used	Load *(kN)*	Avg. Comp. strength (N/mm^2)
M30	0 %	612	26.775
	1%	611	26.651
	2%	601	26.340
	4%	598	25.925
	6%	568	24.711
	8%	535	23.214

Figure 2: 28 day's compressive strength

Grade of concrete	% of K_2SO_4 used	Load *(kN)*	Avg. Comp. strength (N/mm^2)
M30	0 %	845	38.25
	1%	800	35.259
	2%	832	36.696
	4%	818	35.970
	6%	800	35.333
	8%	790	34.888

Table 3: Results of 48days cube compressive strength

Grade of concrete	% of K_2SO_4 used	Load *(kN)*	Avg. Comp. strength (N/mm^2)
M30	0 %	858	40.45
	1%	870	38.266
	2%	840	36.444
	4%	810	35.48
	6%	805	35.25
	8%	800	35.18



VII. CONCLUSIONS

1. Experiments were conducted on M-30 grade of concrete. From the results it can be said that, there was an slightly decrease in the of compressive strength concrete cubes at early ages which were cast and cured with potassium sulphate water at different concentration(1g/l, 2g/l, 4g/l, 6g/l and 8g/l) as compared with the concrete cubes cast and cured with tap water. The strength decrease at 7 days, 28 days and 48 days .we used 1, 2, 4,6and 8g/l potassium sulphate in water then compressive strength decreases as compare to tap water.
2. There is remarkable reduction in compressive strength due to mixing of potassium sulphate in water and also mixing and curing of concrete with K2SO4 water compared to characteristic target strength. The strength decreases by about 1-8% at 28 days.
3. The average characteristic compressive strength obtained for concrete cubes using tap water and sulphate water was 40.45 N/mm^2 35.18 N/mm^2 respectively for M-30 grade of concrete.
4. From the above finding we can conclude that there is remarkable variation in the compressive strength if potassium sulphate in water is used for casting and curing the concrete. This concrete cannot be safely used for mass concreting

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