

Effect Of Water Quality On The Blended Cement Concrete

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Abstract—Concrete is a composite construction material composed primarily of aggregate, cement and water. There are many formulations that have varied properties. The aggregate is generally coarse gravel or crushed rocks such as limestone, or granite, along with a fine aggregate such as sand. The cement, commonly Portland cement, and other cementitious materials such as fly ash and slag cement, serve as a binder for the aggregate. Various chemical admixtures are also added to achieve varied properties. Water is then mixed with this dry composite which enables it to be shaped (typically poured) and then solidified and hardened into rock-hard strength through a chemical process known as hydration. This study is main aim is to study the effect of water quality on the blended cement concrete.

I. INTRODUCTION

Water used for mixing concrete, exceeding the tolerable limits of impurities, may affect not only the concrete strength and durability but also setting time, soundness, efflorescence (deposits of white salts on the surface of concrete) and corrosion of reinforcing or pre-stressing steel. In general, mixing water is rarely a factor in concrete strength, because in many specifications for making concrete mixtures, the quality of water is specified by a clause stating that the water should be fit for drinking. Municipal drinking water seldom contains dissolved solids in excess of 1,000 ppm (parts per million).

As a rule, water unsuitable for drinking may not necessarily be unfit for mixing concrete. From the standpoint of concrete strength, acidic, alkaline, salty, brackish, colored or foul-smelling water should not be rejected outright. This is important because recycled waters from mining and many other industrial operations can be safely used for making concrete.

A more rational approach had to be thought of, since the standards of drinking water can differ from one locality to another. Moreover, in India, it is not unusual for projects to be undertaken in areas where adequate potable water is just not available to fulfill the additional needs of construction. In case of water shortage at project site, it is usual to keep constraints on the use of potable water for purposes other than human consumption and hence recourse has often to be made to get whatever water available from natural sources without bothering much about the quality of water for mixing concrete. Under these circumstances, only a more precise specification

could sift water, which then is suitable for mixing from those, which are not.

A practical recourse for evaluating the effect of using water of questionable quality is to make comparative tests for times of set and strength of mortar or concrete between the water under consideration and the water of proven quality.

IS 456 -2000 specified that in cases of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by the compressive strength and setting time test. According to these standards, the best way to determine the suitability of a water of unknown performance for making concrete is to compare the setting time of cement and the strength of mortar cubes made with the unknown water and reference water that is clean. The cubes made with the questionable water should have compressive strengths equal to or at least 90 percent of the strength of reference specimens made with a clean water. The quality of mixing water should not affect the setting time of cement to an unacceptable degree and the setting time. The difference between the two should not be more than 30 minutes from the setting time of the control test block prepared with same cement and deionised water.

II. MATERIALS AND EXPERIMENTATION

Ordinary Portland cement of 43 grade of Ultra-tech Cement confirming to IS: 8112-1989 standards was used.

The locally available sand confirming to Zone-II grade of Table 4 of IS 383-1970 has been used as Fine Aggregate.

The locally available crushed granite has been used as coarse aggregate in this investigation.

Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial use of silica fume in concrete is of its chemical and physical properties, it is a very reactive pozzolan. Elkam brand silica fume is used for the investigation and the properties supplied by the supplier are, colour appears to be Gray, Bulk density is 500 Kg/m³, specific surface are 15-30 m²/gm and average particle size is 0.2 micron.

To impart the required workability superplasticizer has been used in this investigation. Superplasticizers are linear polymers containing sulfuric acid groups attached to the polymer backbone at regular intervals.

Crimped Steel fibres have been used in the present investigation in production of Fibre Reinforced Concrete (being referred as Steel Fibre Reinforced Blended Cement Concrete (SFRBCC) in the present study). The said fibres were purchased from Stewols India (P) Ltd., Nagpur, India. Properties of the used steel crimped fibres.

III. RESULTS AND DISCUSSION

The effect of HCl on initial and final setting times is shown in Table 7.1 and Fig. 7.1. From the table and figure, it is observed that both initial and final setting times got retarded with increase in hydrochloric acid concentration in deionised water. The retardation for initial and final setting times is significant (i.e., more than 30 minutes), when the hydrochloric acid content exceeds 500 mg/l. When the acid content is 900 mg/l (Maximum concentration), the initial setting time is about 180 minutes, which is 47 minutes more than that of the control mix. Similarly the difference of 70 minutes is observed in case of final setting time.

For comparison purposes, the effect of HCl on the setting times of OPC is also presented in Fig. 7.1. The results of OPC were taken from the experimentation of Reddy (2004). It can be observed from the figure that the setting times of BC and OPC differed marginally and the effect of HCl is very much similar on both OPC and BC. The setting times of blended cement (BC) are slightly higher when compared to OPC at all HCl concentrations. This is expected due to the presence of fly ash in the BC.

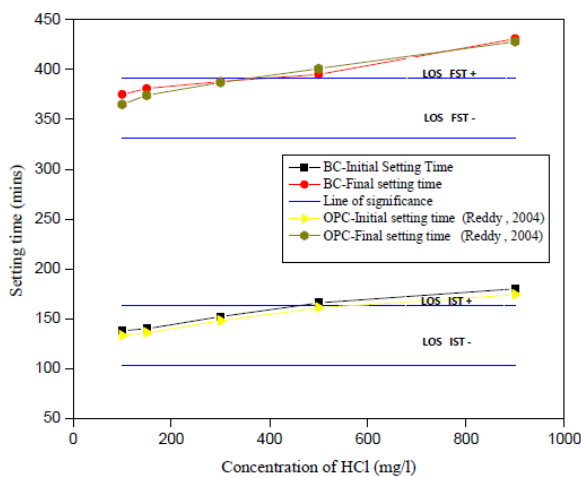


Fig.5.1. Setting times of Blended Cement vs HCl concentrations

The effect of HCl concentration on the compressive strength of BCC is presented in Fig. 7.4 and 7.5. Continuous decrease in compressive strength BCC specimens prepared with HCl acid solution is observed as the acid concentration increases till the maximum concentration (900 mg/l) tested. Although there is decrease in the compressive strength of concrete cubes of all samples, significant decrease is observed only from concentration of 500 mg/l. The rate of decrease in

compressive strength also gradually increases with the increase in the concentration of the HCl.

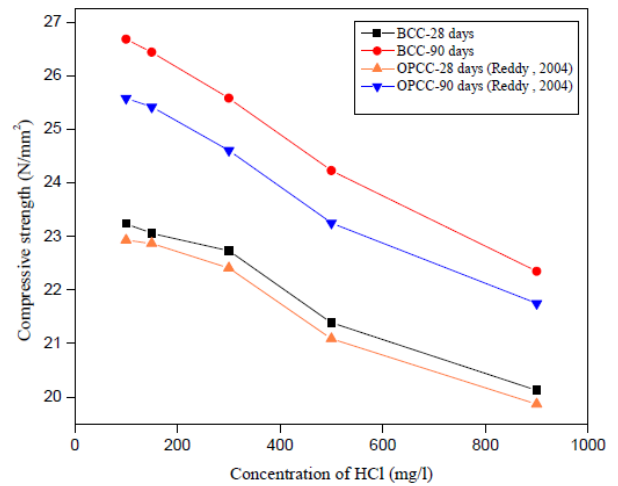


Fig.5.4. Compressive strength of BCC vs HCl concentrations

Powder X-ray diffraction patterns presented in Fig.7.11 and 7.12 are for the BCC and SFBCC cubes prepared with HCl (500 mg/l) in deionised water. Upper portion of the said graph indicates the XRD pattern of the control sample prepared with deionised water. Perusal of the said graphs establishes that the compounds such as $3CaO \cdot Al_2O_3 \cdot CaCl_2 \cdot 10H_2O$ (Friedel's salt), C_2S , C_3S , Calcium Hydroxide (CH), $CaCl_2$ and C-H-S are found at 11.90, 160, 170, 210, 44.70 and 550 respectively. Comparing with control sample, the sample of HCl additionally consists of Friedel's salt and Calcium Chloride.

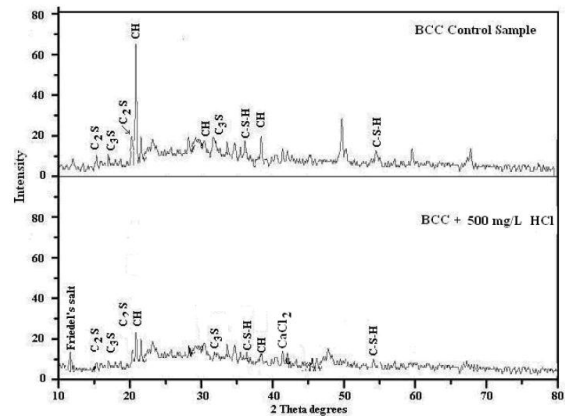


Fig.5.11. XRD pattern of BCC sample prepared with HCl (500 mg/l) in deionised water

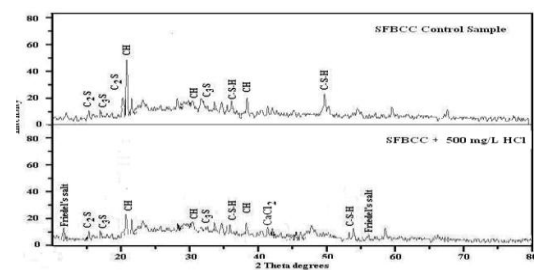


Fig.5.12. XRD pattern of SFBCC sample prepared with HCl (500 mg/l) in deionised water

IV. CONCLUSIONS

Based on the results obtained in the present investigation the following conclusions can be drawn.

- Presence of NaCl in water accelerates the initial and final setting times, of both BC and SFBC, significantly when the concentration is equal to 12 g/l. Further, concentration of 12 g/l results in a significant increase in compressive strength of BCC, SFBCC and SFRBCC. Chloride permeability decreases with increase in NaCl concentration.

- Presence of KCl in water retards both the initial setting and final setting time, of both BC and SFBC, significantly at a concentration of 10 g/l. Further, a concentration of 10 g/l results in a significant increase in compressive strength of all the concretes studied in the present investigation. Chloride permeability decreases with increase in KCl concentration.

- Presence of Na₂SO₄ in concentrations equal to 15 g/l retards significantly the initial and final setting times of both BC and SFBC. Further, at the same concentration a significant decrease in compressive strength was observed. Chloride permeability increases with increase in Na₂SO₄ concentration in mixing water.

- Presence of CaCO₃ in water retards the initial setting time but not significantly, however, it retards final setting time significantly at a concentration of 0.2 g/l in case of both BC and SFBC. Further, there is no significant effect on strength development even at a maximum concentration of 0.3 g/l, though said chemical is increasing the compressive strength of both BCC as well as SFBCC. Chloride permeability decreases with increase in CaCO₃ concentration.

- Presence of CaCl₂ in concentrations equal to 1.0 g/l in water accelerates both initial and final setting time of both the cements i.e BC and SFBC significantly. Its presence in water does not significantly increase the strength with an increase in concentration, the maximum tested concentration being 2.0 g/l. Chloride permeability decreases with increase in CaCl₂ concentration.

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