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INFLUENCE OF CURING ON THE PROPERTIES OF HIGH VOLUME FLY ASH CONCRETE

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Abstract

Fly ash concrete is the most widely used material in building construction. This is because adding fly ash in concrete reduces the cement consumption and contributes less emission. Normal constituents in concrete are cement and aggregates. Adding fly ash in concrete will enhance the

performance of normal concrete. The high volume fly ash concrete is prepared at a ration of 1: 1.5: 3 cement: fine aggregate: coarse aggregate. The concrete is then kept in three different curing regimes. The concrete was then tested for its compressive strength, water absorption and initial surface absorption (ISAT). It is concluded that concrete cured under the normal water curing condition gives the best performance results.

Keywords

Concrete, Strength, Water Absorption, ISAT

1. Introduction

As long as recycling of waste in concrete is concerned, a large amount of research has been carried out in the past and a similar amount is in progress around the globe. Replacing and/or adding concrete's ingredients with solid waste fully or partially, have been a matter of interest for researchers and academicians in the past decades. The most attractive mechanical property of concrete, with no doubt, is its compressive strength. Therefore, establishing relationship between concrete's main components and its compressive strength is necessary. In fact, relationship between concrete compositions and its compressive strength has long been a matter of interest for researchers.

Influence of curing conditions on the performance of concrete has been attempted elsewhere. Sallahan et al [2018] assessed durability and performance of concrete using recycled aggregates. Three curing consitions were used viz., normal curing, normal curing followed by dry curing and sea water curing. Sea water curing was affecting the performance of concrete negatively. Recycled PVC aggregate was used in concrete and tested under continuous water curing, continuous dry curing and laboratory curing with and without initial curing period in water [Nikoo et al., 2016]. Continuous water curing was found to be effective. However, there is no much literature available on testing the effect of curing conditions on the high volume fly ash concrete and hence this study was taken up. A study of the leaching of metals from concrete and its effect in fish pond have been made and found to be safe [Echor, and Felix Okaliwe 2017]. Parikit et al [2015] evaluated the performance of normal concrete with fly ash and bottom ash replacement of up to 30 percent and established that replacement of these components in concrete has improved the workability of concrete. The strength of the concrete cubes also increased up to a certain percentage replacement

and then decreased gradually. The research model may be replicated in construction industries to save cost, reduce concrete weight and make concrete green by saving natural resources.

The main aim of this study is to investigate the performance of high volume fly ash concrete (HVFA) under different curing conditions. Three curing conditions were used viz., water curing (W), Plastic wrapped curing (PW) and dry curing (A). Hardened concrete was tested for compressive strength at 7, 14 and 28 days. The concrete was also tested for water absorption and ISAT . The fly ash is mixed with the ordinary Portland cement at 0% ,20 % ,40 % ,60 % and 80 % .The concrete is then tested for the hardened properties.

1.1 Objectives

- To develop the mix ratio of HVFA concrete.
- To determine the strength of HVFA concrete under three curing conditions viz., normal water curing (W), Plastic wrapped curing (PW) and Air dried curing (A).
- To determine water absorption test and ISAT properties of HVFA concrete.

2. Methodology

Ordinary Portland cement confirming to MS 522: Part 1: 2007 was used to prepare the specimens. The coarse aggregate used for this project was crushed granite with nominal size of 20mm. The sand that was used for this study was river sand with nominal size of 4.75 mm. The fly ash was obtained from Kapar Energy Ventures Sdn Bhd, Kapar, Malaysia. The mix proportions studied in the investigation are presented in Table 1.

Table 1: *Mix Proportions*

Mix ID	Mix Ratio (C:FASH:FA:CA)	W/C	Cement (kg/m^3)	Fly Ash (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)
FA 0	1: 0:1.5 :3	0.55	851.30	0.0	1277.00	2554.00
FA 40	1: 0.2 :1.5:3	0.55	681.1	170.3	1277.15	2554.15
FA 50	1:0.4:1.5:3	0.55	510.8	340.5	1277.21	2554.21
FA 60	1:0.6:1.5:3	0.55	340.5	510.8	1277.00	2554.00
FA 70	1:0.8:1.5:3	0.55	170.3	681.1	1277.00	2554.00

The aggregates were poured into the machine and mixed in dry state for one minute. The cement and fly ash were then added and again dry mixed for 2 minutes. Finally, water was added and the contents mixed for 2 minutes. This mix was then poured into 100 mm cube moulds, vibrated using a table vibrator and then kept covered with wet gunny bags overnight to avoid escape of moisture. The cubes were then transferred to the curing condition and kept it until the day of test.

Tests for compressive strength, water absorption and sorption were done on the hardened concrete. The compressive strength was conducted according to BS 1881- 126- 1990 with a loading rate adjusted such that it takes at least 5 minutes for the cubes to fail. The water absorption test was conducted according to BS 1881 -209: 1990 at 1 min, 5 min, 10 min, 30 min, 60 min. The ISAT test was done as per BS 1881- 5 -1970.

3. Results and Discussion

In the research, the high volume fly ash concrete mixture was made of cement, fly ash, fine aggregate, and the coarse aggregate. While, in the plastic wrapped curing (PW), the specimen were covered with one layer of polystyrene sheet for 7, 14 and 28 days. Three cubes were tested for each test and average value reported

The results of compressive strength for various curing regimes are given in Table 2. It can be observed that at all ages is lowest at fly ash of 60 percent. PW and A curing gives almost equal

strength values as reported in Table 2. This is because of faster rate of hydration of chemicals in concrete [Sivakumar at al., 2009]. Also Water curing is found to give maximum strength. This is understandable as there is enough water to aid hydration. It is concluded that water curing is the correct curing to be followed in concrete in order to avoid false set due to dry curing states.

Table 2: *Compressive Strength*

Mix ID :	**Strength (MPa) at day 7**			**Strength (MPa) at day 14**			**Strength (MPa) at day 28**		
	W	PW	A	W	PW	A	W	PW	A
FA 0	20.6	15.5	14.0	20.0	31.0	21.8	21.9	19.9	17.3
FA 40	18.4	17.7	17.7	10.7	21.9	26.4	20.1	24.3	25.3
FA 50	13.6	18.2	13.6	15.8	20.7	14.6	22.4	21.7	20.8
FA 60	10.1	8.5	9.5	12.8	15.2	12.0	20.3	11.9	13.2
FA 70	18.8	16.3	17.7	17.1	20.3	20.3	25.3	23.2	21.1

W= Water curing. PW= plastic sheet curing. A = air dry curing

The relationship between water absorption and fly ash under curing (PW) is presented in Figure 1; Very similar trend was observed under curing (W) and under curing (A) it was at 7 percent for all mixtures. It can be observed that increase in fly ash reduces the water absorption. This is due to the fact that fly ash acts as filler and fills the voids which will reduce water penetration [Sivakumar et al., 2012; Neville, 1996].

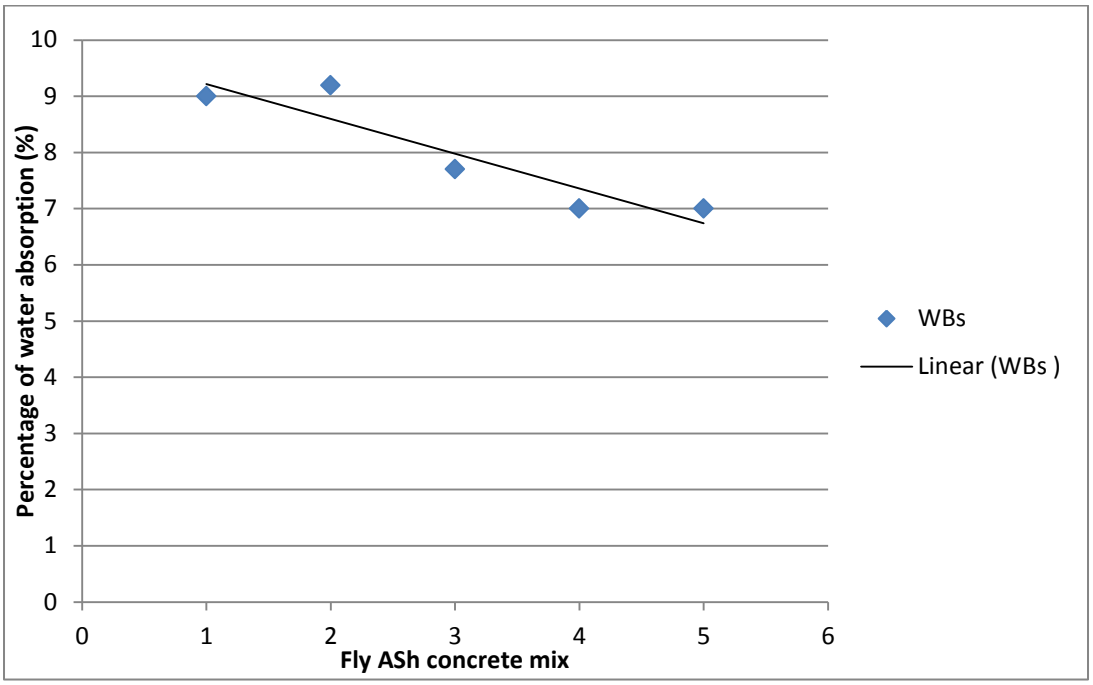

Figure 1: *Water absorption at 28 days under curing (W)*

Results of ISAT test done at 28 days under the three curing regime are presented in Table 3. ISAT reduces with age under all the curing regime. It can be observed that both PW and A curing conditions gave similar values barring experimental errors. Water curing exhibited lowest values of ISAT at 40 % fly ash. It is also observed that increase in fly ash does not have noticeable effect on ISAT values. However, detailed investigation is necessary in order to understand the effect of HVFA in ISAT.

Table 3: *ISAT values*

Mix ID :	***ISAT at Day 7 (ml/m^2/min) at 10 min***			***ISAT at Day 14 (ml/m^2/min) at 30 min***			**ISAT at Day 28 (ml/m^2/min) at 60 min**		
	W	*PW*	*A*	*W*	*PW*	*A*	W	PW	A
FA 0	0.65	*0.68*	*0.59*	*0.33*	*0.37*	*0.33*	0.16	0.18	0.15
FA 40	0.55	*0.55*	*0.59*	*0.18*	*0.30*	*0.33*	0.05	0.12	0.15
FA 50	0.89	*0.92*	*0.89*	*0.35*	*0.43*	*0.35*	0.10	0.14	0.10
FA 60	0.96	*0.98*	*0.95*	*0.43*	*0.44*	*0.42*	0.16	0.15	0.15
FA 70	0.56	*0.57*	*0.56*	*0.35*	*0.38*	*0.35*	0.17	0.16	0.17

4. Conclusion

Increase of fly ash decreases the strength up to 60 % of fly ash and increase in strength was observed at 70% addition of fly ash. HVFA reduces water absorption whereas does not influence ISAT. It is observed from our investigation that fly ash content of around 50 percent is possible in concrete without compromising on the performance. More detailed investigation needs to be done in order to have a realistic understanding of HVFA in concrete. This is because of our limitations in terms of limited mixture proportions and tests adopted in the investigation. The chemical composition of hydrated products needs to be investigated in order to properly conclude the effect of products of hydration on the mixture.

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