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STUDIES ON CHLORIDE PENETRATION OF POLYPROPYLENE FIBRE FLY ASH CONCRETE

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ABSTRACT

The abundant production of fly ash from coal based thermal power plants as waste products becoming problem for their disposal and it is also hazardous to the environment. The inclusion of fly ash in concrete reduces the environmental pollution and improves the workability and durability properties of concrete. The present work has been carried out to find rapid chloride penetration test of fly ash and fibre reinforced concrete with different water binder ratios. The polypropylene fibre fraction 0%, 0.15%, 0.25%, 0.30% were used to find out the optimum volume fraction of glass fibres. For each mix standard sizes of cylinder were cast and tested for RCPT at 28 and 90 days. The percentage of fibre increases, the values of charge passed increases upto volume content 0.30%.

Key words: Fly ash, Fibre, Optimum, RCPT.

INTRODUCTION

Chloride ions may penetrate into the concrete by absorption and capillary forces, diffusion through saturated or nearly saturated concrete and through cracks. Cracking provides an easy pathway for chloride ions to penetrate the concrete cover and reach the reinforcing steel. Structural cracks are aligned perpendicularly to the main reinforcement and therefore, the access of chlorides to the steel bars is limited. These cracks are postponed parallel and directly above bars, and their development depends on the concrete cover, bar diameter, and slump of the concrete. Poon et al.[1] showed that at w/b ratio of 0.24, 45% fly ash replacement resulted in, 62% and 84% reduction in coulombs passed at 28 and 90 days.

Uysa and Akyuncu[2] reported that 30% fly ash concrete mixture had the lowest chloride permeability, rated very low at 90 days among the mixtures had similar compressive

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strength values when compared with control concrete mixtures. Nath and Sarker[3] showed that total charge passed in the rapid chloride permeability test (RCPT) indicates the chloride ion penetration through the concrete. The fly ash concretes have shown better resistance at both the ages and penetrability of reduced with the increase of fly ash in the mixtures. Fledman et al.[4] observed that indaiced changes in the pore structure and the chloride resistivity of the concrete specimens.

Vengata[5] reported that addition of fly ash in high volumes considerably decreases the permeability of concrete even though the strength of fly ash concrete at 28 days is not encouraging. Sujjavanich et al.[6] showed that high volume fly ash concrete has lower chloride permeability and has a tendency to minimize or cause no corrosion risk.

EXPERIMENTAL

Materials used for casting

The materials in the experimental work namely cement, fine aggregate and coarse aggregate (20 mm down and 12.5 mm retained) and Class C fly ash have been used for casting the required specimens according to the IS code for different mix proportions. The details of the materials are discussed below.

Cement

Ordinary Portland cement (53 grade) confirming to IS: 12269-1987[7] (reaffirmed in 2004) was used for all the concrete mixtures.

Aggregate

Crushed granite of 20 mm down and retained on 12.5 mm size was used as coarse aggregate and river sand used as fine aggregate.

Fly ash

Class C fly ash is mineral admixture having pozzolanic property. This fly ash is used as additive according to ASTM C 618[8]. The cement was replaced by 30%, 40% and 50% of fly ash.

Water

Potable water, which is available at the laboratory premises was used for mixing of concrete ingredients and curing of concrete specimens.

Polypropylene fibre

Commercially available polypropylene fibrillated fibers of 12 mm in length were used in this study. The volume fractions of 0.15, 0.2, 0.25 and 0.3% volume fraction were used. The properties of polypropylene fibre are given in the Table 1.

Table 1: Properties of polypropylene fibe

Property	Value
Specific gravity	0.90
Tensile strength, Mpa	800
Elastic modulus, Gpa	3.5
Water absorption	Nil
Yield stress N/mm^2	30

Mix proportions

Absolute volume method was used to find out the mix proportions. The replacement level of cement by fly ash was varied from 30%, 40% and 50% by mass of binder content. The different water binder ratios of 0.35, 0.40, 0.45 and 0.50 were adopted in this study.

The concrete mix AP1w, AP1x, AP1y, AP1z, in this P refers 30% fly ash concrete 1 refers with w/b ratio 0.35 w, x, y and z refers 015, 0.20,0.25 and 0.3%, V_f polypropylene fibres.

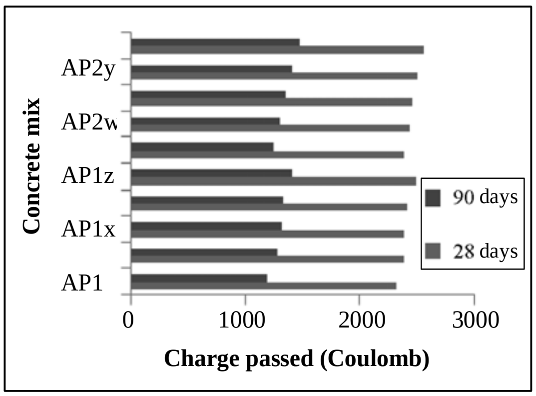
Test on hardened concrete

The Rapid chloride penetration test (RCPT) as per ASTM C1202-95[9] on concrete specimens has been evaluated by testing three cylindrical specimens of size 50 mm length and 100 mm diameter at the age of 28 and 90 days. After casting the specimens, were kept in the moulds for 24 hrs at a temperature about 27 ± $2C^0$ and at least 90% of relative humidity. After 24 hrs of setting, the specimens were removed from the mould and immersed in clean fresh water until taken out for testing at particular age. At the time of testing the specimen was removed from curing tank, blot off excess water. The specimen was insert and clamped the two halves of the test cell together to seal with sealant around the boundaries of the specimen and cell. Each half of the test cell must remain filled with the appropriate solution for the entire period of the test.

RESULTS AND DISCUSSION

Effect of water binder ratio

Fig. 1, display the average Coulomb (cumulative charge) values determined by the RCPT, for the concrete samples. It has been seen from the Fig. 1, the chloride penetration of without polypropylene fibre fly ash concrete shows lesser than fibre fly ash concrete mixes at the age of 28 days of curing. The percentage of increase in charge passed for concrete mixes AP1w, AP1x, AP1y, AP1z are 10%, 10.5%, 12% and 13%, respectively with reference to without fibre concrete for 0.35 water binder ratio. For water binder ratio 0.35, at the age of 90 days, the reduction in the charge passed. For each specific combination of cement and fly ash with fibres, the two test dates of 28 and 90 days are all shown with in the same Figure.



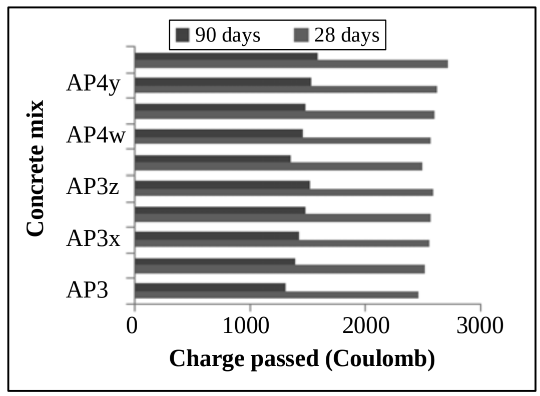


Fig. 1 & 2: RCPT values for 30% fly ash replacement mixes with w/b ratio 0.35 to 0.50

From Fig. 2, it can be observed that, the mix with water binder ratio 0.5 shows the ability of passing the chloride ions comparatively less than concrete with water binder ratio of 0.45 at 28 days. The increase in chloride passing ability of AP3w, AP3x, AP3y, AP3z concrete mixes are 2.0%, 4.0%, 4.2% and 4.1% when compared with AP3 concretes mix at 28 days. But at the age of 90 days, their chloride passing ability is reduced to 46%, 44%, 44% and 40% when compared with AP3 concrete mix series.

From Fig. 3, it shows that concrete mixes AQ2w, AQ2x, AQ2y, AQ2z shows their chloride ion passing ability increases marginally when compared with AQ1 concrete mix series.

The concrete mixes AR2w, AR2x, AR2y and AR2z shows their chloride ion passing ability marginally increases when compare with AR2 concrete mix as shown in Fig. 5. It can be observed from Fig. 6 that, the increase in chloride passing ability for AR3w, AR3x, AR3y, AR3z concrete mixes are 3.4%, 4.2%, 4.8% and 41% when compared with AR3 concrete mix at 28 days. But at the age of 90 days, the chloride passing ability is reduced to 46%, 44%, 42% and 44% for AR3w, AR3x, AR3y, and AR3z concrete mixes when compared with 28 days.

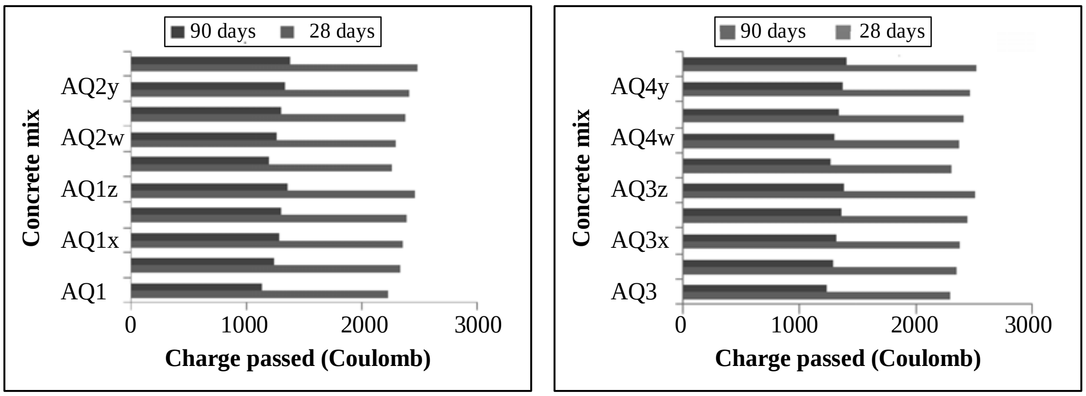


Fig. 3 & 4: RCPT values for 40% fly ash replacement mixes with w/b ratio 0.35 to 0.50

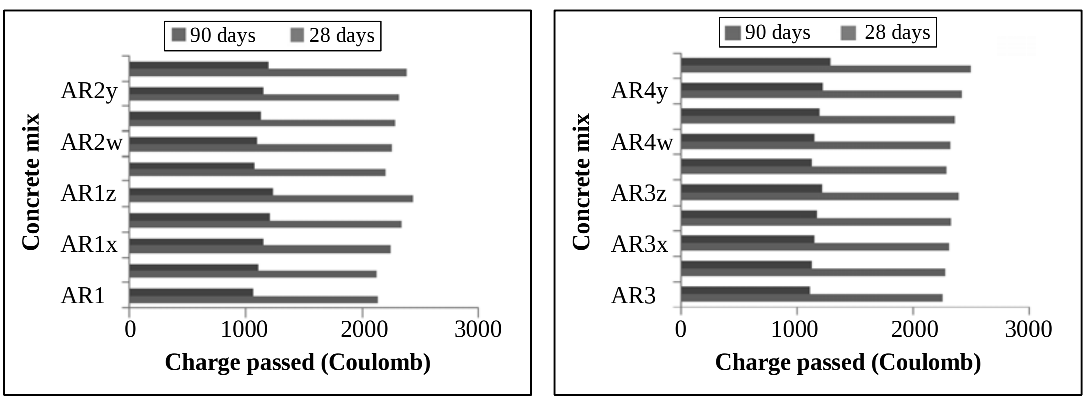


Fig. 5 & 6: RCPT values for 50% fly ash replacement mixes with w/b ratio 0.35 to 0.50

Effect of polypropylene fibre

RCPT of concrete mixtures was determined at the ages of 28 and 90 days is seen from Fig. 1 to Fig. 6. The polypropylene fibres were added to the fly ash concrete mixes with different water binder ratios. The percentage of volume fractions 0.15%, 0.2%, 0.25%

and 0.3% were added to the fly ash concretes. As the fibre content increases, chloride penetration values of the fibre concrete mixes were marginally improved when compared with fly ash concrete mixes. The percentage of fibre increases, the values of charge passed increases upto volume content 0.30%. This is due to high fibre content in the concrete mix.

Effect of fly ash replacement

The percentage of fly ash 30%, 40% and 50% with water binder ratio of 0.35, 0.40, 0.45 and 0.50 were added to the concrete mix. It can observed from the Fig. 1-6, at the age of 28 days, the concrete containing increasing amounts of fly ash generally displayed a corresponding increase in the coulomb values relative to the amount of fly ash replacement. The majority of the pozolonic reaction of the fly ash occurs after this date of curing. The increase in the coulomb readings with increasing amounts of fly ash are largely due to removal of Portland cement. As the curing increases from 28 to 90 days, the coulomb values decrease relative to 28 days depending on the binder proportion.

CONCLUSION

The increase in the fibre content, chloride penetration values of the fibre concrete mixes were marginally improved when compared without fibre concrete mixes. At the age of 90 days, the mixes of water binder ratio 0.35, shows reduction in the charge passed when compared with 28 days.

Coulomb readings increase with increasing amounts of fly ash is largely due to removal of Portland cement. As the curing increases from 28 to 90 days, the coulomb values decrease relative to 28 days depending on the binder proportion.

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