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Water Absorption In Fly Ash Concrete

T.Ch.Madhavi[1], Teja Vardhan Reddy[2] Bhaskar Singh[3], Bheru Lal[4],
[1]Professor and Head, Department of Civil Engineering, SRM University, Ramapuram, Chennai-89, tcmadhvi@yahoo.com
[2]M.Tech (Structural Engg.), SRM University, Ramapuram, Chennai-89
[3]B.Tech (Civil Engineering), SRM University, Ramapuram, Chennai-89
[4]B.Tech (Civil Engineering), SRM University, Ramapuram, Chennai-89

Abstract

Concrete is a porous material and durability of concrete depends largely on the movement of water through the concrete. Hence, this paper presents the effect of fly ash on the water absorption of concrete. Concretes with various proportions of fly ash content and also polypropylene fiber content are investigated. OPC concrete is used as the control concrete. The results of experimental investigations carried out to evaluate the water absorption properties of concrete mixtures in which cement was partially replaced with Class F fly ash are presented. Cement was replaced with four percentages i.e,30%, 40%, 50%, 60% of Class F fly ash. Polypropylene fibers are added in 0.2%, 0.4%, 0.6% and 0.8% fractions. The water absorption was determined at 28 days.

Key Words: Density, Voids, Hardened Concrete, water absorption, Durability.

Introduction

Addition of Fly ash to concrete adds value and also reduces the emission of carbon di oxide, which is produced during the manufacture of cement. Eco system is severely affected by the environmental pollution which is the day's biggest menace. Manufacture process of cement contributes to global warming by emission of carbondioxide at the rate of 0.9 tonne CO_2 for every one tonne of cement produced. To reduce the consumption of cement, the effective method is to replace cement by other materials and fly ash is one such promising material. Fly ash not only improves strength but also improves the long term durability of concrete in addition to ecological benefits.

During mixing presence of excess water in concrete evaporates as concrete hardens and it leaves voids inside the concrete creating capillaries resulting in porosity and permeability.

Performance of concrete is determined by two factors, viz., strength and durability. The quality of concrete can be improved by reducing the water content, increasing the binder and aggregate content, improving compaction and proper curing. Water absorption of concrete is influenced by the size, volume, number and connectivity of pores. Less continuous pores help in improving the strength of concrete. Sorptivity, water absorption and water permeability are different methods to study the water penetration in concrete. The objective of this study is to investigate the effect of fly ash and fibers on water absorption in concrete.

Malhotra and Mehta (2002) reported that the water cement ratio of 0.40 has a permeability of 10-12 m/s. At high levels problems may be encountered with extended set times and slow strength development, leading to low early-age strengths. Properly cured the fly ash concrete provides excellent water tightness and improves durability (Mehta P.K, 2004). Formerly, there was no control on the disposal of fly ash and it was normally released into the atmosphere. But later, it was made mandatory to capture to fly ash before release. Fly is stored and used in landfills. It is estimated that about 43% of the fly ash is recycled and because of its pozzolonic properties is often used in the manufacture or as a partial replacement of cement in the making of concrete.

Flyash has pozzolonic character and is a finely divided powder of amorphous alumino-silicate which reacts. This fly ash reacts with calcium hydroxide released during the hydration process and produces calcium-silicate (C-S-H) and calcium aluminium hydrates. Increase in the quantities of C-S-H and Calcium Aluminium Hydrates improves the long term strength and reduces permeability, thus contributing to increase in strength and durability properties. Water absorption represents the open porosity of cement paste.

Hence, in this paper, the cement is replaced by various percentages of fly ash and its effect on the water absorption is studied. Also the water absorption of fly ash concrete with increase in age is also considered to study the long term effects.

Materials Used

Fly Ash

According to ASTM C618, two classes of fly ash are defined. by Class F fly ash and Class C fly ash. The primary difference between the two is the amount of calcium, silica, alumina, and iron content present in the ash. The chemical content of the coal burnt ie., anthracite, bituminous or lignite defines the chemical properties of the fly ash.

In this work, class F Fly ash obtained from Ennore Power Plant which confines as per IS 3812 – 2000 is used. Properties of fly ash are mentioned in table 1 below.

Table 1: Properties of fly ash

Property	Values
Specific gravity	2.2
Fineness	320 kg/m^2

Cement

The cement used in the study is ordinary Portland cement of 53 grade supplied by Ultra Tech cements. It is tested for physical properties as per IS 12269: 2013 standard. The preliminary test results of the cement are tabulated in table 1 below.

Table 2: Properties of cement

Property	Values
Specific gravity	3.15
Fineness	95%
Normal consistency	35%
Initial setting time	30 mins

Coarse Aggregate

Locally available crushed blue granite stones of nominal size 20 mm in surface dry condition and conforming to IS 383 – 1970 are used.

Fine Aggregate

Fine aggregate is used as a filler material to fill the voids and occupies 60-80% of volume and 70-80% of weight of concrete. Locally available river sand passing through 4.75 mm sieve and conforming to Grading zone III of IS 383 –1970 was used in the study. It has the specific gravity of 2.55.

Super Plasticizer

Sulphonated naphthalene formaldehyde based super plasticizer type G -CONPLAST SP 430 was used as chemical admixture to enhance the workability of the concrete.

Water

Ordinary Potable water is used for casting and curing.

Mix proportion

Mix design was carried out as per IS:10262:2000 and after trial mixes, a mix ratio of 1:1.1:2.0 is used. The water binder ratio is 0.36.

Experimental Work

The water absorption is measured by calculating the difference in specimen weight under oven-dried and fully saturated conditions. The tests are carried out as per ASTM C642. The water absorption of fly ash and fibers is studied by varying the

contents. Test specimens are cores of size 100 mm diameter and 50 mm thickness extracted from cubes of size 150 mm. The water absorption is tested after 28 days.

Figure 1: Cylindrical Core Extracted From Cube

Figure 2: Test specimens

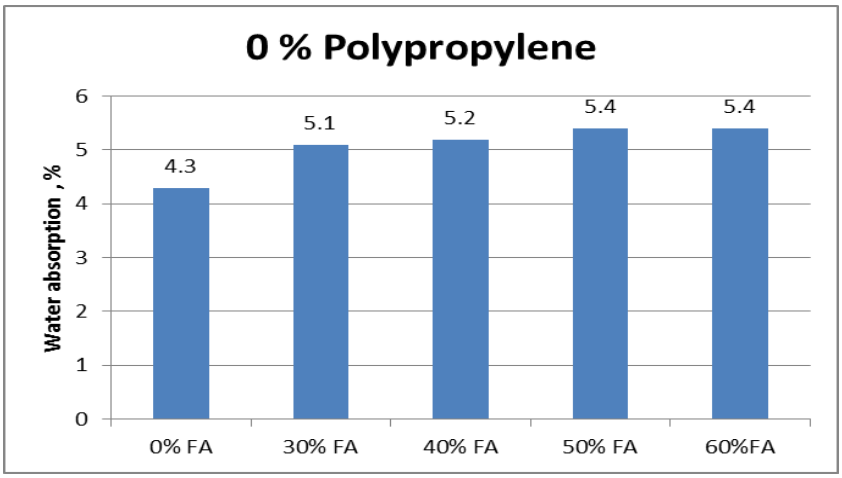
Results and Discussions

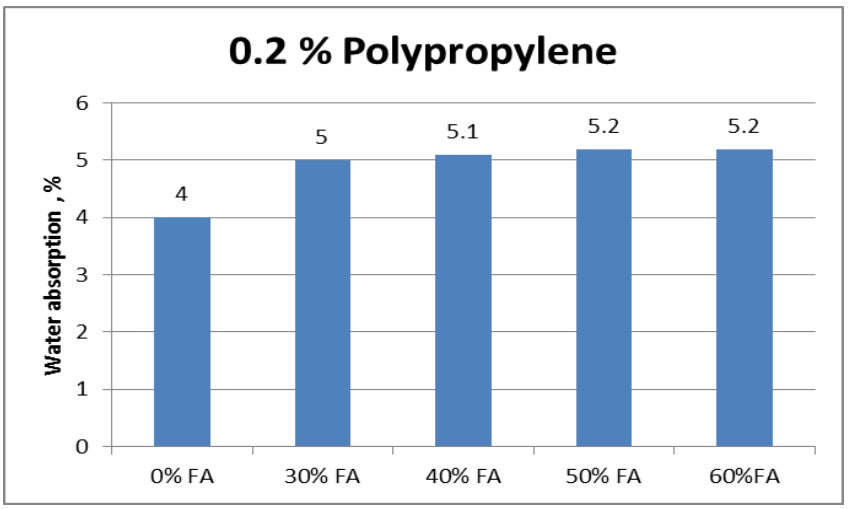
28 days results

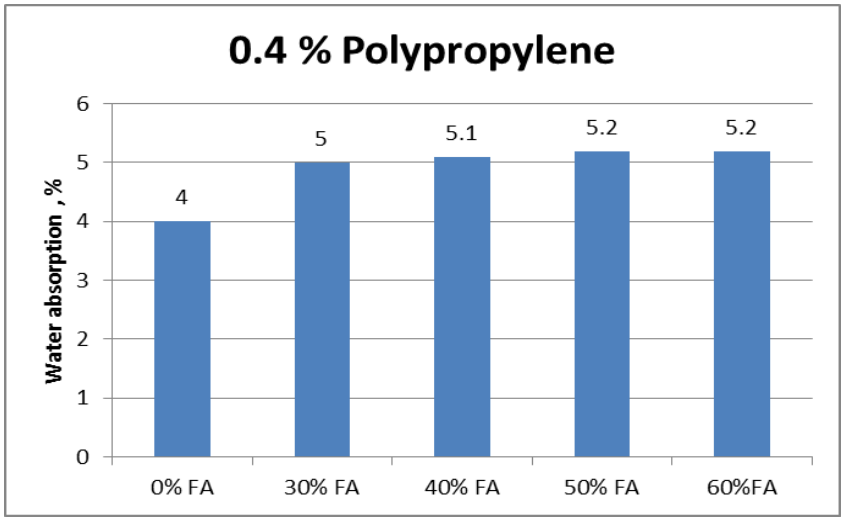
The test results obtained after 28 days of casting are presented in table 3 below. As the fly ash content increased, water absorption increased in concrete after 28 days of curing. The low water absorption values indicate reduced open porosity which inhibits the free flow of water into the concrete.

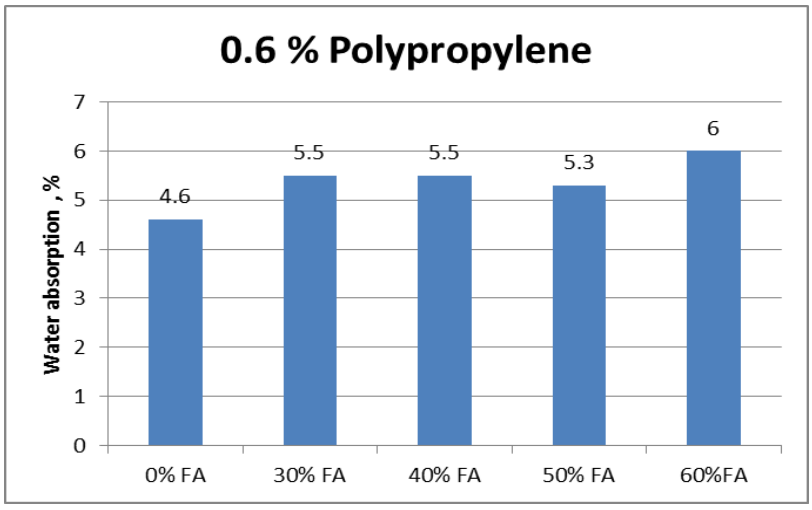
Table 3: 28 days Water Absorption (%)

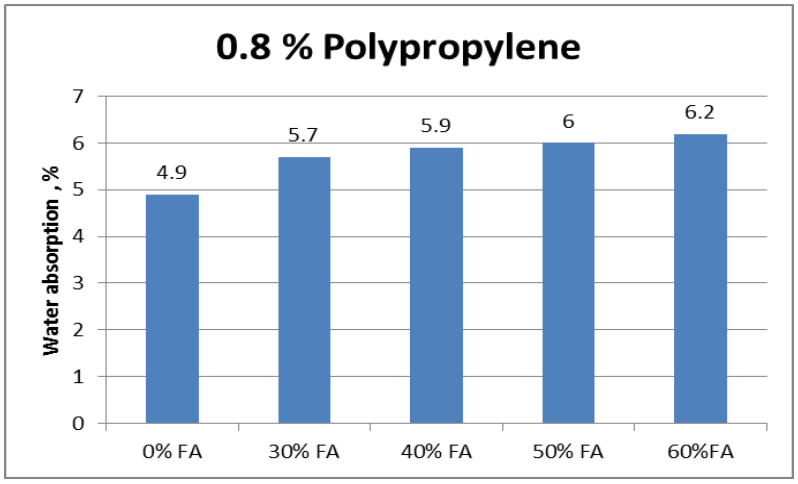
SPECIMEN	0% FA	30% FA	40% FA	50% FA	60%FA
0 % PP	4.3	5.1	5.2	5.4	5.4
0.2% PP	4	5	5.1	**5.2**	5.2
0.4% PP	4	4.7	4.1	5.1	5.3
0.6% PP	4.6	5.5	5.5	5.3	6
0.8% PP	4.9	5.7	5.9	6	6.2

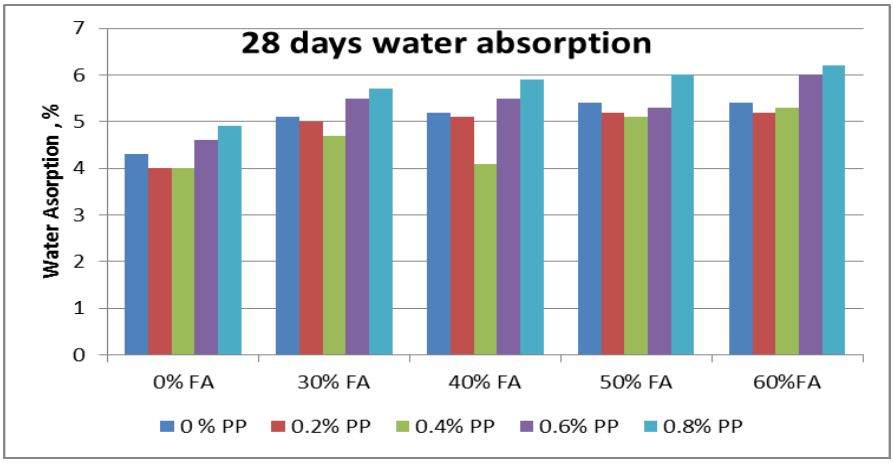




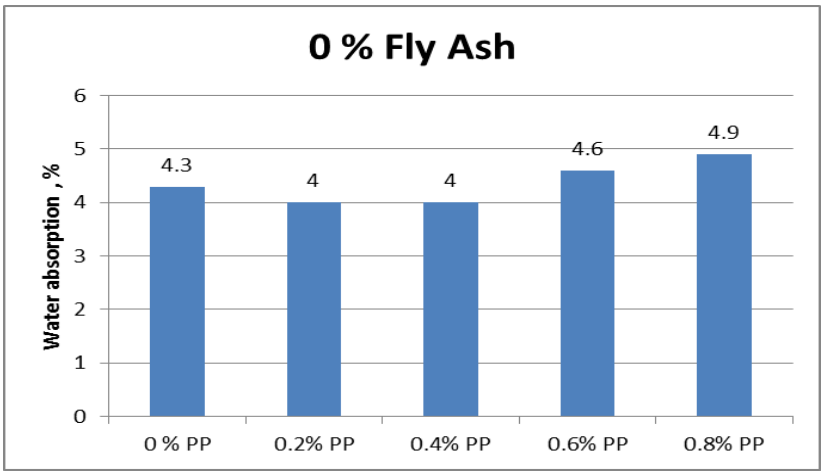

0.4 % Polypropylene
Water absorption , %
0
1
2
3
4
5
6
4
5
5.1
5.2
5.2
0% FA
30% FA
40% FA
50% FA
60%FA

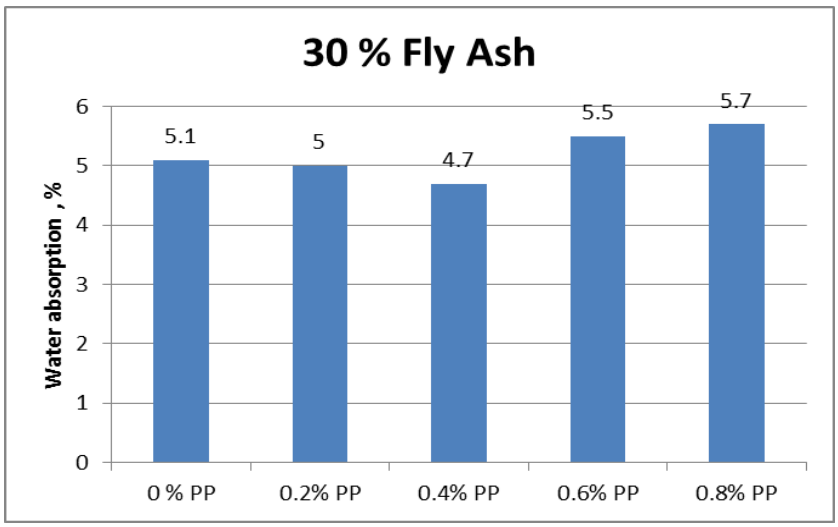

0.6 % Polypropylene
Water absorption , %
0
1
2
3
4
5
6
7
4.6
5.5
5.5
5.3
6
0% FA
30% FA
40% FA
50% FA
60%FA

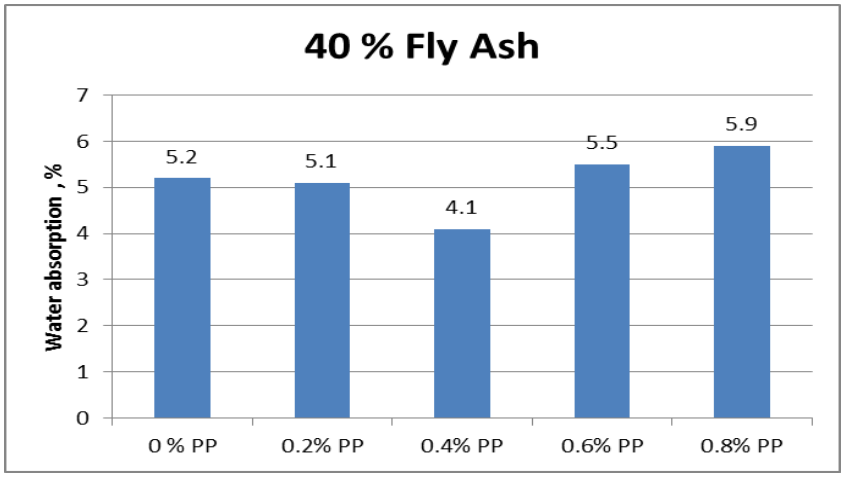

0.8 % Polypropylene
Water absorption , %
0
1
2
3
4
5
6
7
4.9
5.7
5.9
6
6.2
0% FA
30% FA
40% FA
50% FA
60%FA

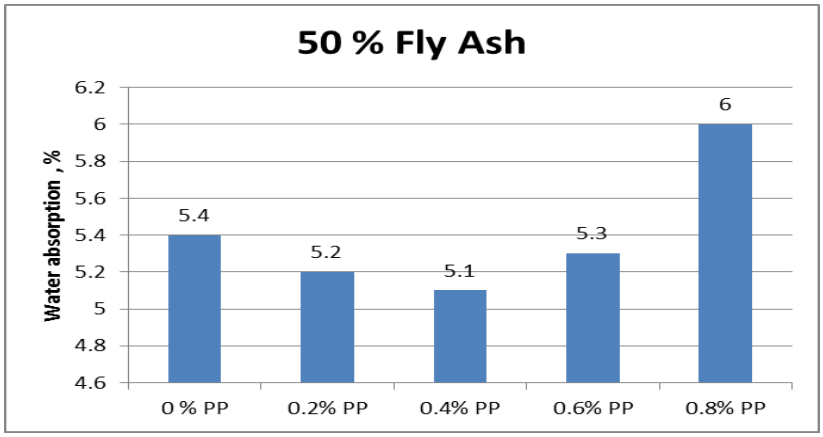


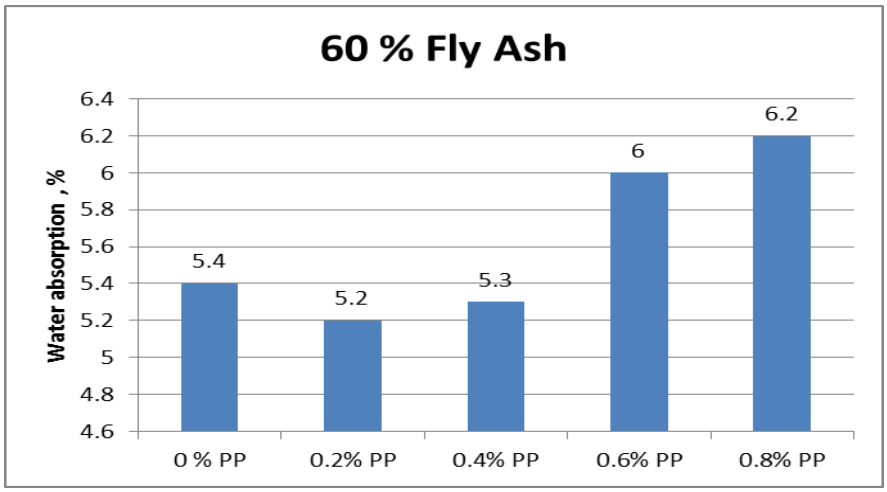
b) Effect of fibers

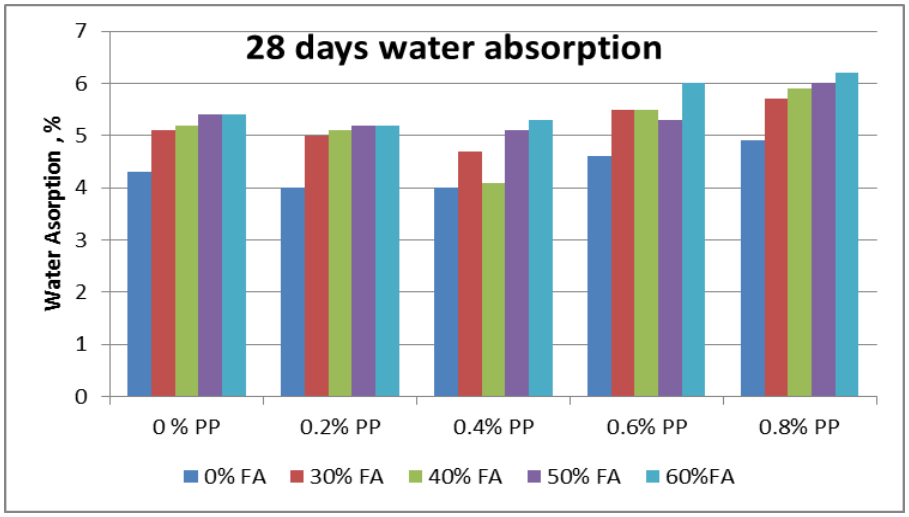





40 % Fly Ash
Water absorption , %
7
6
5
4
3
2
1
0
5.2
5.1
4.1
5.5
5.9
0 % PP
0.2% PP
0.4% PP
0.6% PP
0.8% PP


50 % Fly Ash
Water absorption , %
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
5.4
5.2
5.1
5.3
6
0 % PP
0.2% PP
0.4% PP
0.6% PP
0.8% PP


60 % Fly Ash
Water absorption , %
6.4
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
5.4
5.2
5.3
6
6.2
0 % PP
0.2% PP
0.4% PP
0.6% PP
0.8% PP



The results obtained after 28 days of curing and testing for water absorption as per ASTM C642 are presented in graphs above. The graphs indicated that as the fly ash content increased the water absorption increased, however, the increase in water absorption is not very high but ranging from 16% to 30%.

When polypropylene fibers were added, water absorption was not consistent when compared to the control concrete. The water absorption was initially observed to be decreasing for 0.2% and 0.4% of fiber content. Beyond 0.4%, the water absorption increased. This may be possibly due to the increase in the voids in concrete with addition of higher volumes of fiber.

However, these results are obtained for 28 days test and since the class F fly ash is good in long term effects, with age, as the reactions take place and interspaces gets filled up reducing the voids, the percentage of water absorbed may be less compared to 28 days.

Hence, it is suggested that water the usage of fly ash concrete with fibers should be judiciously selected and used by the engineers depending on the application and durability requirement of structure.

Conclusions

- Absorption in the fiber reinforced concrete is varying with change of fly ash and polypropylene content.
- Increment of polypropylene fiber content in the fly ash concrete will have good durability and less permeability up to 0.4%.
- It is observed that as the fly ash content increased, the water absorption decreased up to 0.4 % and then there is an increase in absorption.
- With increase in fly ash content the water absorption increased. The increase varied from 16% to 30% at 28 days.
- In case of low volume fly ash (say 0%, 30%), the effect of fibers is less whereas in high volume fly ash (say 40%, 50% and 60%), the effect of fibers increases.
- Durability is dependent on the permeability of concrete and lower the permeability results good durability, so from this experimental investigation

the authors observe that the water absorption is not well defined and hence, this concrete should be judiciously used by the engineers depending on the application and durability requirement of the structure.

- Fly ash is an innovative supplementary cementitious Material but decisions are to be taken by engineers and carfully used.

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References

[1] Bai j., Wild S, Sabir BB (2002) “Sorptivity and strength of air-cured and water cured PC-PFA-MK mortar and the influence of binder composition and carbonation depth”. Cement and mortar research 32:1813-1821.

[2] Bentz, D., Ehlen, M., Ferraris, C., and Garboczi, E. "Sorptivity-Based Service Life Predictions for Mortar Pavements." 181–193.

[3] Caliskan, S. (2006). "Influence of curing conditions on the sorptivity and weight change characteristics of self-compacting mortar." *The Arabian Journal for Science and Engineering*, 31(1), 169-178.

[4] Claisse, P. A. (1997). "Absorption and Sorptivity of Cover Mortar."*Journal of Materials in Civil Engineering*, 9(3), 105-110.

[5] Dias, W. P. S. (2000). "Reduction of mortar sorptivity with age through carbonation."*Cement and Mortar Research*, 30(8), 1255-1261.

[6] Deepa A Sinha, Dr.A.K.Verma, Dr.K.B.Prakash (2012) “Sorptivity and waste absorption of steel fibers reinforced ternary blended mortar”. International journal: global research analysis (GRA),volume:1,issue:5,oct2012,issn no:2277-8160.

[7] Gonen, T. and Yazicioglu, S. (2007). “The influence of compactionpores on sorptivity and carbonation of mortar.” *Construction andBuilding Materials*, Vol. 21, No. 5, pp. 1040-1045.

[8] [Güneyisi, E. and Gesog˘lu, M., (2008). “A study on durability properties ofhigh-performance mortars incorporating high replacement levelsof slag.” *Materials and Structures*, Vol. 41, No. 3, pp. 479-493.

[9] Hall, C. (1977). " I.Unsaturated flow theory and its applications."*Building and Environment*, 12(2), 117-125.

[10] Hall, Christopher; Hoff, William D (2012). *Water transport in brick, stone and mortar, 2nd edn*. London and New York: Taylor and Francis. http://www.routledge.com/books/details/9780415564670.