International Journal of ChemTech Research
CODEN (USA): IJCRGG ISSN: 0974-4290
Vol.8, No.12 pp 451-460, 2015

Chloride Penetration in Polypropylene Fiber Reinforced Concrete

T.Ch.Madhavi[1]*, S.Martin Luther[2], P.M.Rameshwaran[1], D.Senthilvelan[1]

[1]Department of Civil Engineering, SRM University, Ramapuram, India
[2]Jehova Nissi Arch Firm, Anna Nagar, Chennai, India

Abstract: Chloride penetration in polypropylene fiber reinforced fly ash concrete is studied experimentally by Rapid Chloride Penetration Test. SixVolume fractions of fly ash i.e, 0%, 30%, 40%, 50% and 60% is considered and fibers in three volume fractions of 0%, 0.2% and 0.4% are considered. Fly ash is used as replacement material for cement. The test results indicated that the addition of fly ash and polypropylene fibers decreased the chloride permeability. Addition of fly ash improved the dispersion of fibers in the concrete, resulting in a significant reduction in the chloride penetration in the polypropylene fiber reinforced concrete.
Key words: Concrete, Chloride penetration, Polypropylene, Fibers, Fly ash.

Introduction[1-9]

Corrosion of steel in concrete due to chloride ingress, that leads to the deterioration of concrete structures is one of the most commonly faced problems. Chloride attack on concrete structures such as buildings, bridges, dams, offshore structures has adverse effects such as loss of strength, corrosion of reinforcement etc. The chloride attack is more prominently observed in hydraulic structures and structures in coastal areas because of the marine environment. Chloride ingress through the cracks deteriorates its strength with age. Corrosion due to chloride attack greatly affects the durability and strength of the structure. The chloride penetration is dependent on the pore structure of concrete.

It is important that a structure should not only exhibit strength but also be durable resisting the weathering action, chemical attacks, freezing and thawing etc. Though concrete has lot of advantages with regard to strength, its brittle behaviour is a handicap particularly when used to resist seismic forces. Addition of fibers to concrete addresses this problem. Though different types of fibers are in use, more recently developed polypropylene fibers help in overcoming these deficiencies.

Addition of fibers increases the strength and reduces the crack width. Researchers world over are developing high performance concrete using different types of fiber. Because of the increasing application of Fiber reinforced concrete, there is a need for studying the durability characteristics of such a concrete. In this work polypropylene fibers are used to improve the mechanical strength. Hence, this paper presents the effects of polypropylene fibers on Chloride Penetration in concrete. 0.2% and 0.4% polypropylene fibers are added to the concrete and compared with concrete without any fiber content. The effect of presence of fly ash is also studied by varying its volume fraction as 0%, 30%, 40%.

Experimental Investigations[1-9]

Materials used

Ordinary Portland Cement of 53 grade satisfying the requirements of IS:12269-1987, local river sand and coarse aggregate of size 20 mm are used for making the concrete mix. Class F fly ash is obtained from Ennore power plant. Portable water and super plasticizer CONPLAST SP430 were added to the dry ingredients to achieve the wet mx of required workability. The mix design was carried out as per IS:10262:2000 and the mix adopted is 1:1.1:2.0 with a water binder ratio of 0.36

Casting and Curing

For carrying out the tests, cylindrical specimens are prepared by cutting a core of 100 mm diameter from inside a cube which is cured for 28 days as shown in Fig 1. The thickness of the cylindrical specimen is 50 mm. The surface of the cylindrical specimen is coated with glue and is allowed to dry. After drying, the specimen is put in vacuum chamber and then it is placed in the testing device (Fig. 2 and 3)

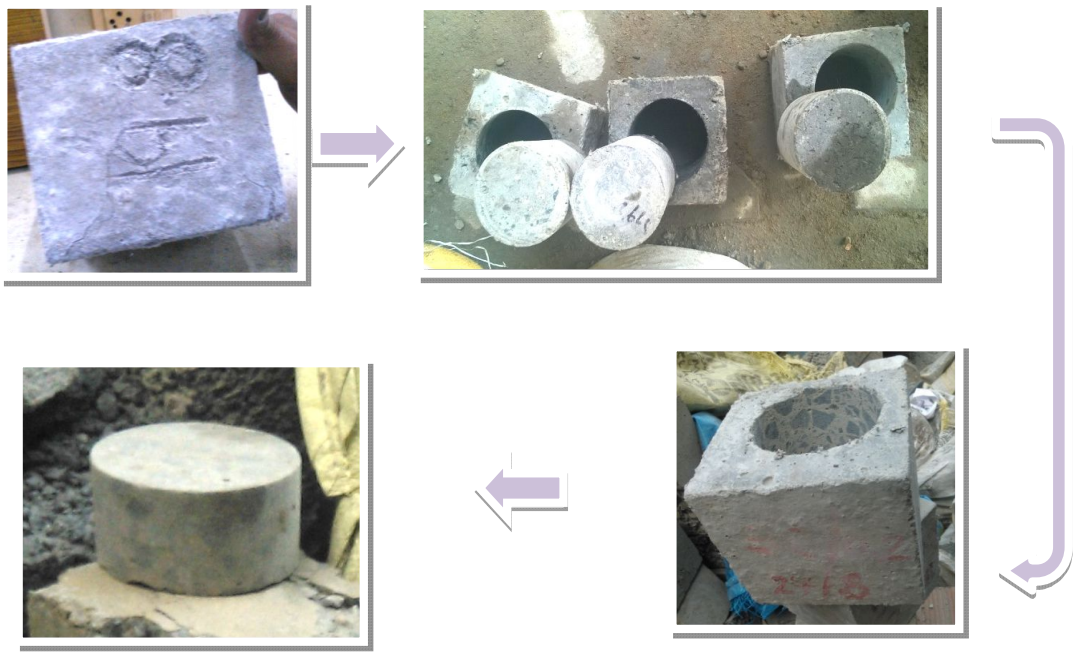

Figure 1 Preparation of Specimens

Testing

The test is carried out in accordance with ASTM C1202 standards. The specimen of 100mm diameter and 50mm thick is immersed in one container with 3.0% NaCl solution and in the other container with 0.3 M NaOH solution. The specimen is subjected to a DC voltage of 60V for 6 hrs. The total charge passed from the fiber reinforced concrete is determined The variation of charge passed for various mix proportions is measured and it gives the resistance of the specimen to chloride ion penetration.

Figure 2 Vacuum Saturation Apparatus Test Setup (ASTM C1202)

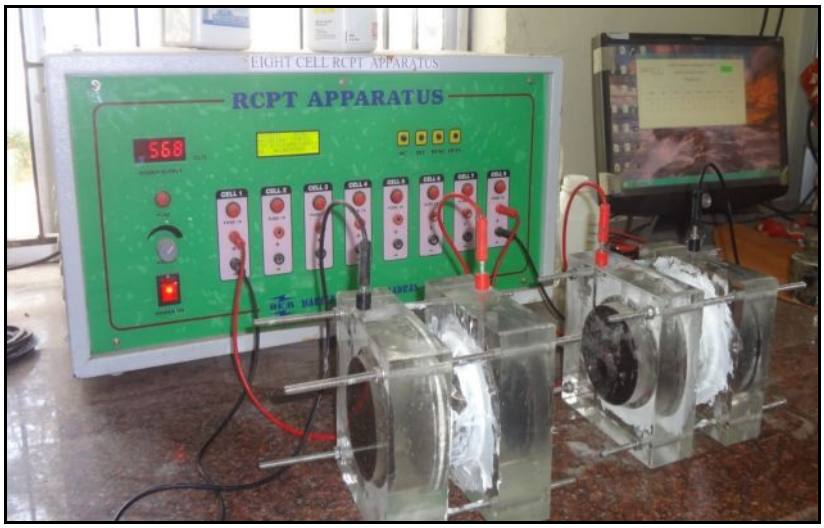

Figure 3 Data logger with RCPT test setup

Table 1Chloride Ion Penetrability Based on Charge

Charge Passed (coulombs)	Chloride Ion Penetrability
> 4,000	High
2,000 - 4,000	Moderate
1,000 - 2,000	Low
100 - 1,000	Very Low
< 100	Negligible

Results and Discussions

The results obtained from the experimental investigations are analysed and the results obtained after 28 days of curing are presented in table 2 below.

Effect of Polypropylene fiber on Chloride permeability

The addition of polypropylene fibers involume fractions of 0%, 0.2% and 0.4 % decreased the chloride penetration into the concrete upto 24.6% when 0.4 % polypropylene fibers were used.

Table 2 Effect of Fibers on Chloride penetrationin concrete with 0% fly ash

Specimen	Chloride penetration in coulombs	%decrease in chloride penetration	Chloride Permeability as per ASTM C1202
PFRC 0/0	2422	-	Moderate
PFRC 0/0.2	2064	14.78%	Moderate
PFRC 0/0.4	2095	13.50%	Moderate

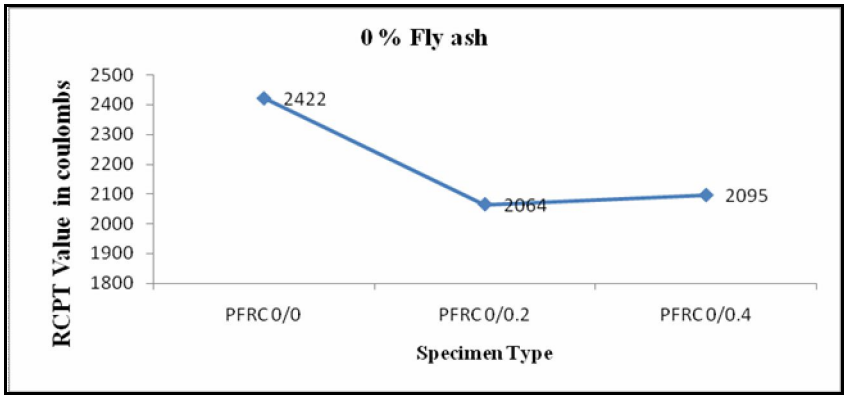

Figure4 .Graphical representation of effect of fibers on Chloride penetration in concrete with 0% fly ash

Table 3. Effect of Fibers on Chloride penetration in concrete with 30% fly ash

Specimen	Chloride penetration in coulombs	% decrease in chloride penetration	Chloride Permeability as per ASTM C1202
PFRC 30/0	2381	-	Moderate
PFRC 30/0.2	2119	11.00%	Moderate
PFRC 30/0.4	2085	12.43%	Moderate

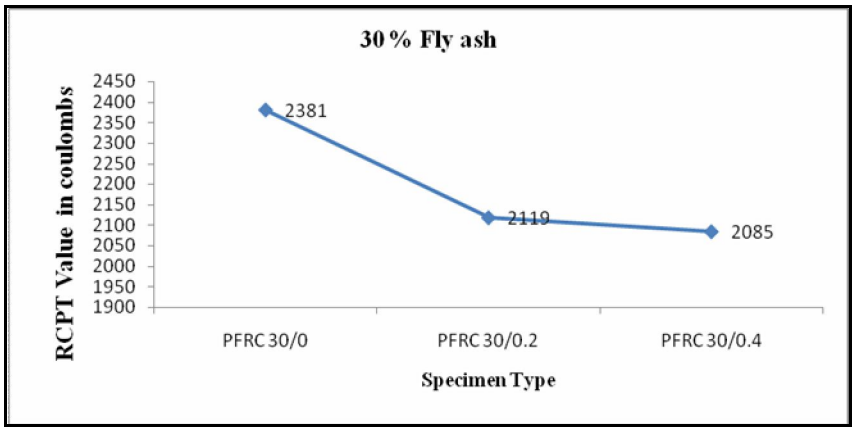

Figure 5 Graphical representation of the effect of fibers on Chloride penetration in concrete with 30% fly ash

Table 4Effect of Fibers on Chloride penetration in concrete with 40% fly ash

Specimen	Chloride penetration in coulombs	% decrease in chloride penetration	Chloride Permeability as per ASTM C1202
PFRC 40/0	2242	-	Moderate
PFRC 40/0.2	2080	7.23%	Moderate
PFRC 40/0.4	1967	12.27%	Low

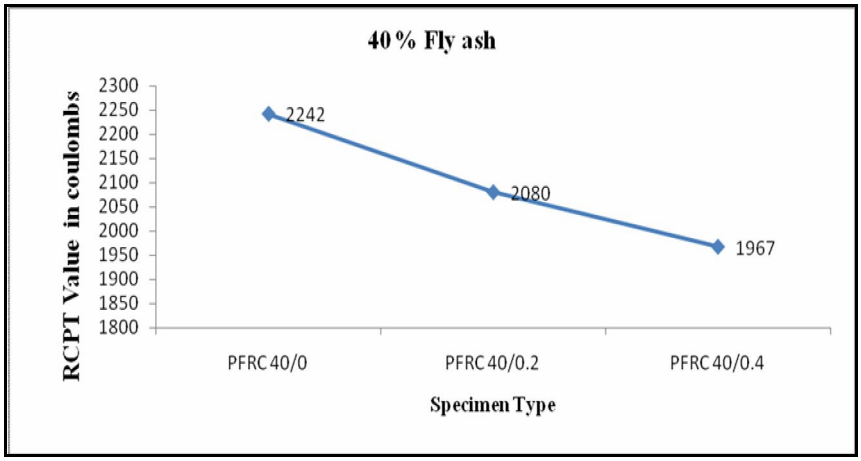

Figure 6 Graphical representation of effect of fibers on Chloride penetration in concrete with 40% fly ash

Table 5 Effect of Fibers on Chloride penetration in concrete with 50% fly ash

Specimen	Chloride penetration in coulombs	% decrease in chloride penetration	Chloride Permeability as per ASTM C1202
PFRC 50/0	1660	-	Low
PFRC 50/0.2	1670	0.60%	Low
PFRC 50/0.4	1583	4.64%	Low

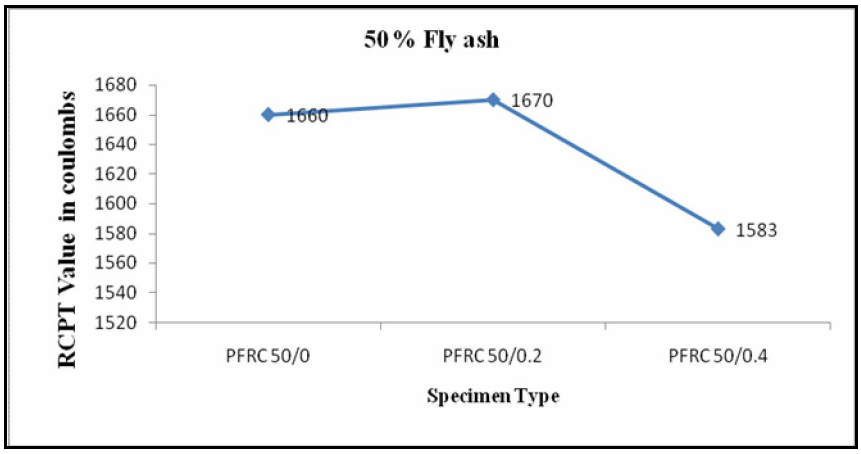

Figure 7 Graphical representation of effect of fibers on Chloride penetration in concrete with 50% fly ash

Table 6 Effect of Fibers on Chloride penetration in concrete with 60% fly ash

Specimen	Chloride penetration in coulombs	% decrease in chloride penetration	Chloride Permeability as per ASTM C1202
PFRC 60/0	1614	-	Low
PFRC 60/0.2	1622	2.29%	Low
PFRC 60/0.4	1251	24.64%	Low

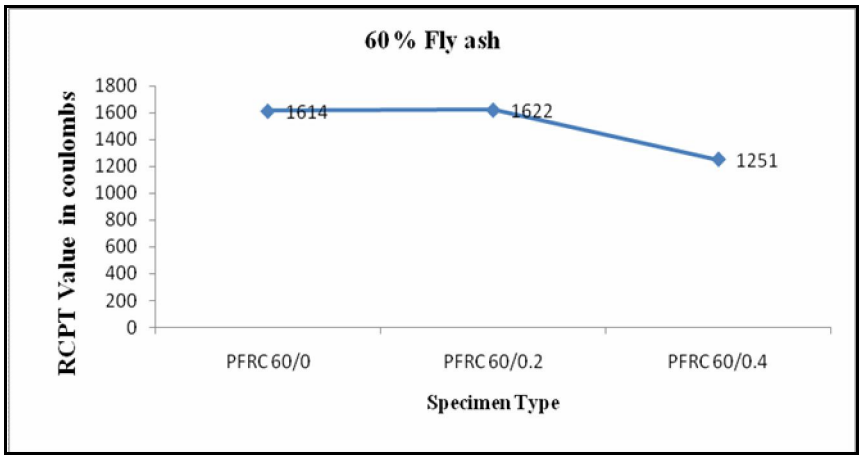

Figure8 Graphical representation of effect of fibers on Chloride penetration in concrete with 60% fly ash

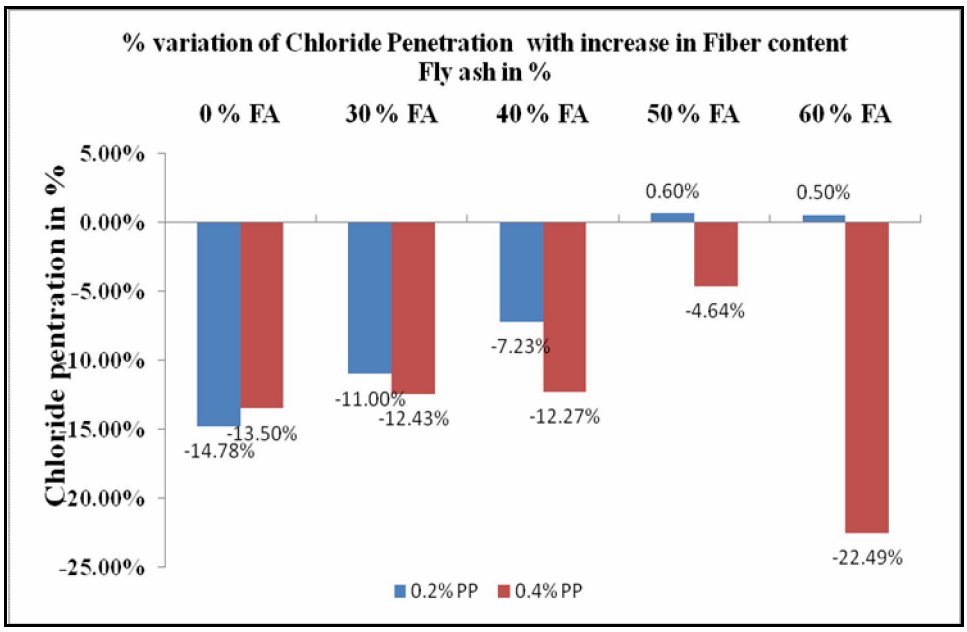

Figure9 Comparison of chloride penetration in different concrete mixes

Effect of Fly ash on Chloride permeability

With the addition of fly ash the chloride penetration decreased and is observed to have decreased to the extent of 40% when 60% fly ash was used.

Table 7Effect of fly ash on chloride penetration in concrete with 0% fibers

Specimen	Chloride penetration in coulombs	% Different from 0% FA	Chloride Permeability as per ASTM C1202
PFRC 0/0	2422	-	Moderate
PFRC 30/0	2381	-1.69%	Moderate
PFRC 40/0	2242	-7.43%	Moderate
PFRC 50/0	1660	-31.46%	Low
PFRC 60/0	1614	-33.36%	Low

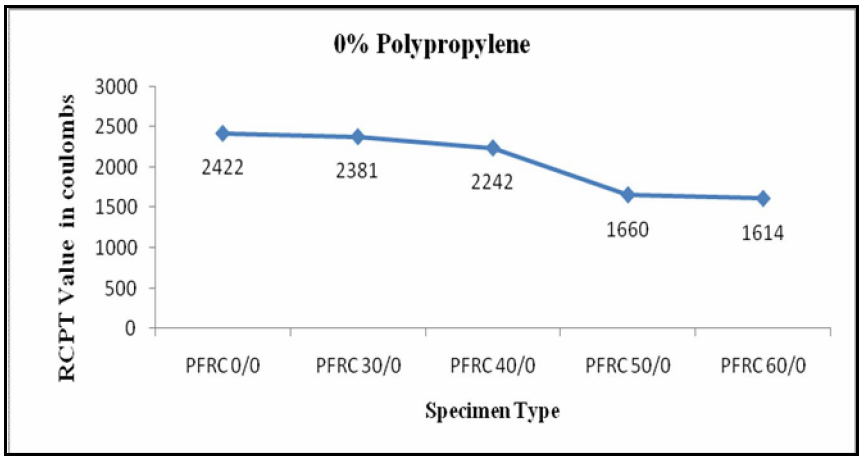

Figure 10 Graphical representation of fly ash on Chloride penetration in concretewith 0% fibers

Table 8Effect of fly ash on chloride penetration in concrete with 0.2% fibers

Specimen	Chloride penetration in coulombs	% Different from 0% FA	Chloride Permeability as per ASTM C1202
PFRC 0/0.2	2064	-	Moderate
PFRC 30/0.2	2119	2.66%	Moderate
PFRC 40/0.2	2080	0.78%	Moderate
PFRC 50/0.2	1670	-19.09%	Low
PFRC 60/0.2	1622	-21.41%	Low

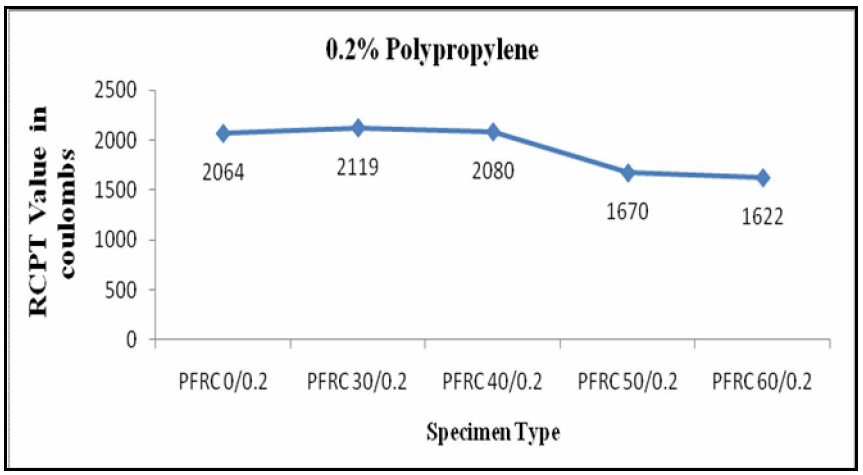

Figure11 Graphical representation of fly ash on Chloride penetration in concrete with 0.2% fibers

Table 9Effect of fly ash on chloride penetration in concrete with 0.4% fibers

Specimen	Chloride penetration in coulombs	% variation from 0% FA	Chloride Permeability as per ASTM C1202
PFRC 0/0.4	2095	-	Moderate
PFRC 30/0.4	2085	-0.48%	Moderate
PFRC 40/0.4	1967	-6.11%	Low
PFRC 50/0.4	1583	-24.44%	Low
PFRC 60/0.4	1251	-40.29%	Low

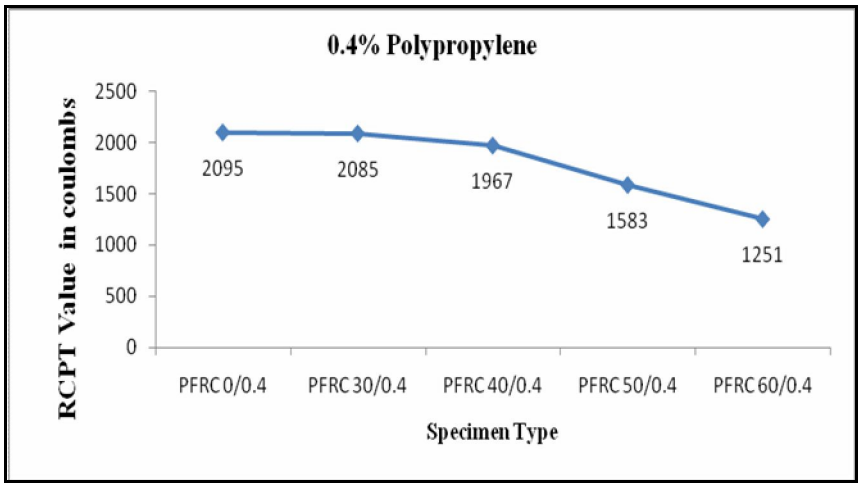

Figure12 Graphical representation of fly ash on Chloride penetration in concrete with 0.4% fibers

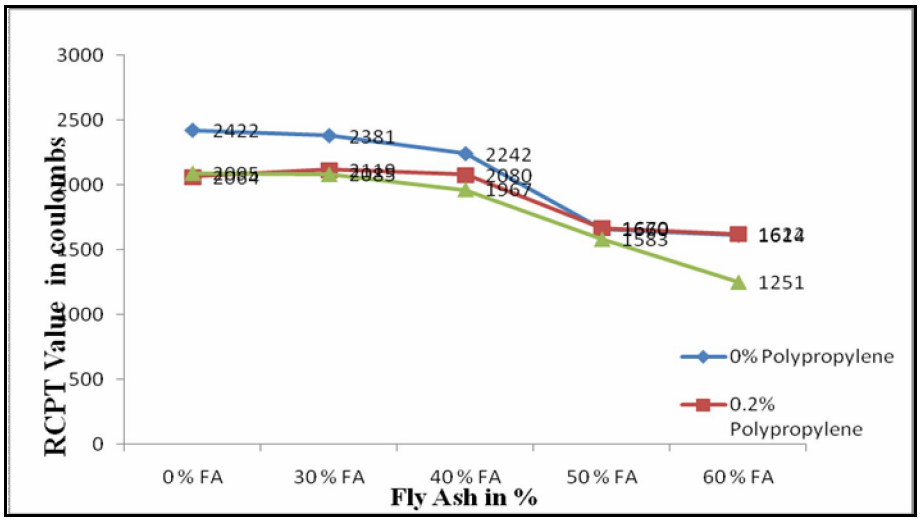

Figure13 Comparison of chloride penetration in different polypropylene fiber reinforced concrete mixes

Table 10 % decrease/Increase in chloride penetration

Specimen	0% PP	0.2% PP	0.4% PP
0 % FA	-	-	-
30 % FA	-1.69%	2.66%	-0.48%
40 % FA	-7.43%	0.78%	-6.11%
50 % FA	-31.46%	-19.09%	-24.44%
60 % FA	-33.36%	-21.41%	-40.29%

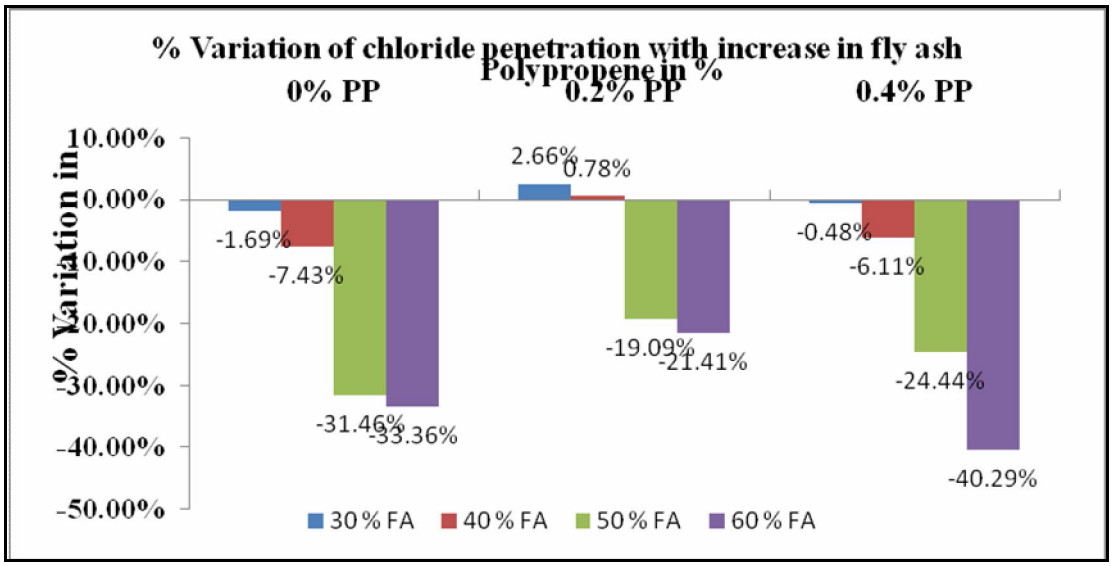

Figure 14 Comparison of chloride penetration in different concrete mixes with different fiber content

Conclusions

1. Polypropylene Fiber Reinforced Fly ash Concrete is a more sustainable concrete compared to conventional concrete.
2. Replacement of fly ashwith cement in concrete reduces the environmental pollution.
3. Experimental results show that the chloride attack is reduced with increase in fly ash content.
4. Also addition of polypropylene fibers upto 0.4% reduced thechloride attack.
5. The addition of 0.4% polypropylene fibers has reduced the chloride attack by 24.6%.
6. Addition of 60% fly ash has shown that the chloride attack is reduced by 40%.

Acknowledgements

The authors would like to thank the management of SRM University for supporting this project and extending financial grant for carrying out these experimental investigations.

References

1. ACI Committee 232, Use of Fly Ash in Concrete, ACI 232.2R- 03, American Concrete Institute, Farmington Hills, Michigan, 1996.
2. H Toutanji, S McNeil, Z Bayasi, “Chloride permeability and impact resistance of polypropylene fiberreinforced silica fume concrete”, Cement and Concrete Research, Volume 28, Issue 7, July 1998, Pages 961–968.
3. ChunxiangQian and Piet Stroeven, ‘Fracture Properties of Concrete Reinforced with steel – polypropylene hybrid fibers, Cement and Concrete Composites,2000, 22, 343-351.
4. Gencel, Ozel, Brostow and Martinez (2011) ‘Mechanical Properties of Self-Compacting Concrete Reinforced with Polypropylene Fibres’, Materials Research Innovations, 2011,Vol 15.
5. Jo Jacob Raju, jino John, “Strength study of High Volume Fly Ash Concrete with Fibers”, Intl. Journal of Advanced Structures and Geotechnical Engineering”, Vol.3, No.1, Jan. 2014.
6. K. Ramamurthy, E.K. KunhanandanNambiar, G. Indu Siva Ranjani, “A classification of studies on properties of foam concrete”, Journal of Cement & Concrete Composites, Vol.31, 2009.
7. K.Murahari, Rama mohanRao p (2013) ‘Effects of Polypropylene fibres on the strength properties Of fly ash based concrete’, International Journal of Engineering Science Invention, Volume 2 Issue 5 ǁ May. 2013, PP.13-19.

8. M. Tamil Selvi, T.S. Thandavamoorthy, 'Studies on the Properties of Steel and Polypropylene Fibre Reinforced Concrete without any Admixture International Journal of Engineering and Innovative Technology , Volume 3, Issue 1, July 2013, pp 411 -416.
9. Mahendra Prasad, Chandak Rajeev and Grover Rakesh, 'A Comparative Study of Polypropylene Fibre Reinforced Silica Fume Concrete with Plain Cement Concrete', International Journal of Engineering Research and Science & Technology, Vol2, No.4, Nov. 2013, pp 127- 136.

*****

ACKNOWLEDGEMENT.

*****