Effect of Integral and External Waterproofing on Durability of Concrete

X. Arulinfanta, J. Bhuvaneswari
UG Student of Civil Engineering,
Ramco Institute of Technology, Rajapalayam

Mr. R. Muruganantham M.E.,
Assistant Professor,
Dept of Civil Engineering, Rajapalayam

Mr. GAB. Suresh M.Tech (IITM),
Senior Manager,
Ramco Research and Development Centre, Chennai

***Abstract*: Concrete is the world's most used construction material and is known to be a very durable material. Water is the most destructive weathering element for concrete structures. Water continues to damage or completely destroy more buildings and structures than war or natural disasters. Usually the amount of water used in concrete is much more than is required to hydrate the cement. This excess water takes up space in the concrete forming a network of capillary voids. This provides channel for water to penetrate the concrete when subjected to hydrostatic pressure. When the foundation is being built at or near the water table or in areas where there is heavier soil that's prone to carry more moisture. The main idea of this project is the usage of water proofing admixtures to review the effect of them on concrete properties and provide some guidelines for adopting appropriate concrete admixture for water proofing construction. In this project, Integral water proofing compounds and external water proofing admixtures are used to review their effect on concrete with OPC and PPC. Further Compressive strength test, Rapid Chloride Penetration Test (RCPT) and Water Permeability tests are carried out. The result shows that, the workability and Durability are high for PPC compared to OPC. And Water Permeability is low for PPC compared to OPC.**

Keyword: Integral and External Waterproofing, Water Permeability, Chloride Penetration.

INTRODUCTION

Concrete is a porous material which has the ability to absorb water and water-borne contaminants. Leaving the concrete exposed to external elements causes deterioration, and reduces the durability and life of the structure. The repair of concrete structures damaged by water or water borne chemicals is estimated to cost billions of dollars every year. To protect concrete structures and ensure its long serviceable life, waterproofing is vital. The waterproofing can be defined as the formation of an internal or external membrane which is capable of preventing water from entering or escaping through a permeable layer .There are two main ways to classify waterproofing systems based on their application: surface applied systems and integral systems. In this paper, integral water proofing and external water proofing admixtures are used in both OPC and PPC. And rheological properties of concrete, Compressive strength, Rapid Chloride Penetration Test and Water permeability tests have been carried out and compared the results of OPC and PPC as well as integral and external water proofing admixtures. The result is a structure with reduced cracking, self-sealing and waterproofing abilities that provide a powerful defence against water damage and corrosion of reinforcing steel.

MATERIAL USED

The materials used for this experimental work are cement, CRF, aggregate, water and Waterproofing Admixtures.
Cement: OPC of 43 grade and PPC were used with specific gravity 3.15 in this experiment conforming to I.S. – 12269-1987.
CRF: CRF of zone II with specific gravity 2.45, water absorption 2% and fineness modulus 2.81, conforming to I.S. – 383-1970.
Coarse aggregate: 20 mm of crushed aggregate with specific gravity 2.781, moisture content 0.25% Water absorption 0.47%.
Water: Portable water was used for the experimentation.

EXPERIMENTAL PROCEDURES

Mix Design: The proportions for normal mix of M20 Normal Mix are 1:1:2 with water cement ratio
0.4. In the present study method for mix design is the Indian Standard Method. The mix design involves the calculation of the amount of cement, fine aggregate and coarse aggregate in addition to other related parameters dependent on the properties of constituent material. The modifications are made and quantities of constituent materials used to cast Reinforced concrete.
Workability Test: Workability is carried out by conducting the slump and flow table test. As per I.S. 1199-1959 on ordinary concrete and waterproof concrete.

Compressive strength test: The compressive strength of concrete is one of most important properties of concrete in most structural applications. For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M20 grade of concrete. After curing, these cubes were tested on Compression Testing machine as per I.S. 516-1959. The failure load was noted. In each category three cubes were tested for each trial batch and their average value is reported. The compressive strength was calculated as follows, Compressive strength (MPa) = Failure load / cross sectional area.

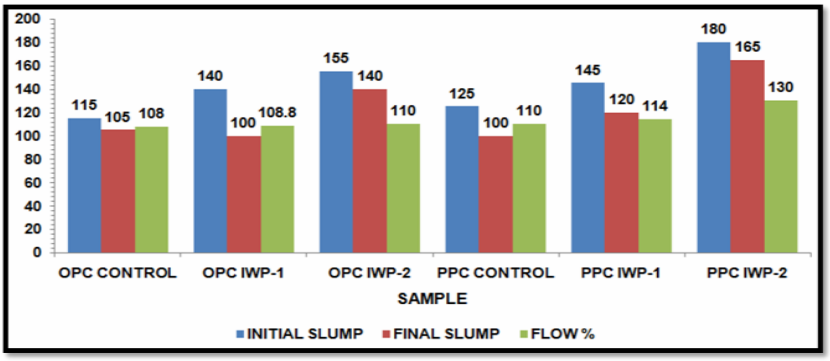
Setting time test of concrete: This test helps in determining the setting time of concrete with slump greater than zero, by testing mortar sieved from the concrete mixture as per IS 8142 – 1976. Initial Setting time is the time when the concrete starts losing its plasticity. Whereas the Final Setting time is the time when the concrete completely losses its plasticity and starts gaining strength. They gave an indication of when the concrete can be properly placed, consolidated and finished.

Rapid Chloride Penetration Test: Durability of concrete is determined by the permeability of concrete. Corrosion of reinforcing steel due to chloride ingress is one of the most common environmental attacks that lead to the deterioration of the concrete structures. The Rapid Chloride Penetration Test (RCPT) determines chloride permeability by measuring the number of coulombs able to pass through a sample as per ASTM C 1202 codal Provision. The construction industry accepts this test procedure as a measurement for determining chloride permeability.

Water Permeability test: Water Permeability test determines the resistance of concrete against water under hydrostatic pressure. This permeability test should be considered as the dominant test to evaluate the case whereby concrete is subjected to hydrostatic pressure. Attack by sulphate, acids and chlorides induce electrochemical corrosion of steel reinforcement. Since this attack takes place within the concrete mass, the attacking agent must be able to penetrate through the concrete, which should be permeable. Permeability who defined it references the ease with which water can travel through concrete. There is no prescribed test by ASTM and BS for permeability but there is one in DIN 1048.

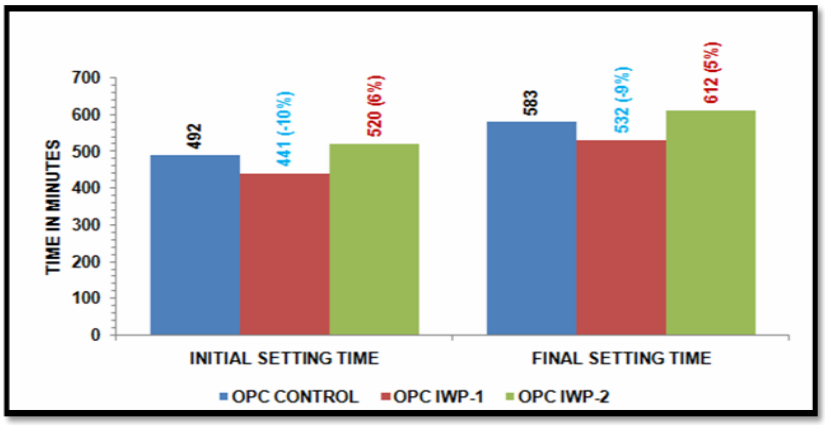
EXPERIMENTAL RESULTS

Slump and Flow table test: The rheological properties of concrete, which is slump and flow table test is shown in Graph No.1.

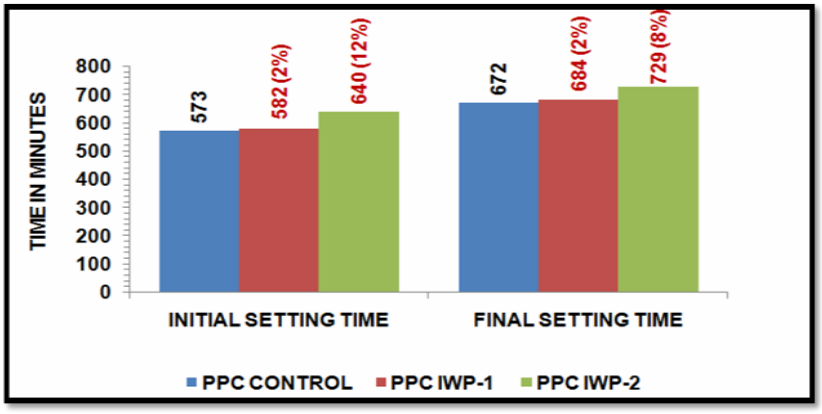


Graph no: 1 Rheological Properties of concrete

Setting time test: Setting time test of concrete for different trials of PPC and OPC with and without integral waterproofing compounds were given as separately in the below graphs

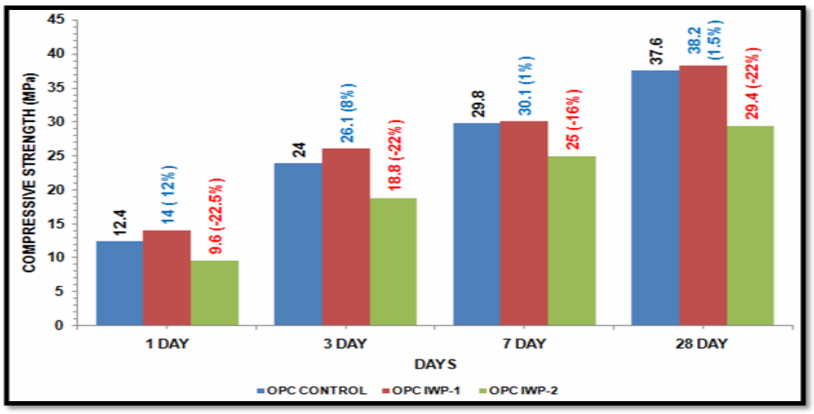


Graph no: 2 Comparisons of Setting Time Values of OPC Concrete

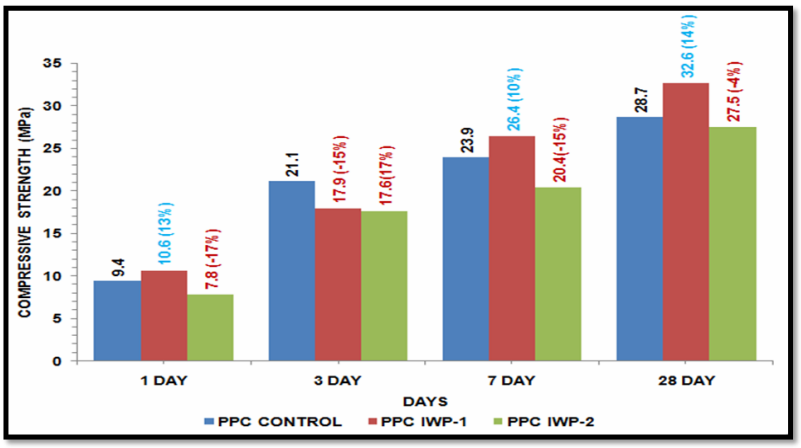


Hardened concrete:
Graph no: 3 Comparisons of Setting Time Values of PPC Concrete

The hardened concrete specimen properties are checked by compressive strength, split tensile strength and flexural strength.
Compressive strength: The compressive strength of cube specimens are checked for 1, 3, 7 & 28 days in compressive testing machine.

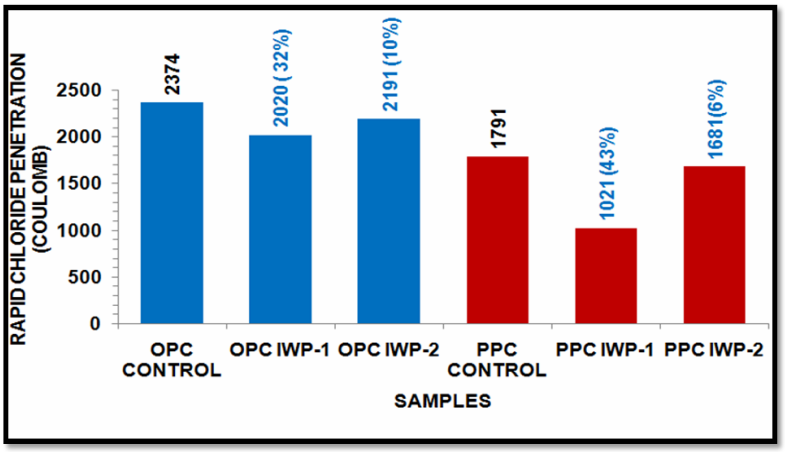


Graph no:4 Compressive Strength of OPC Concrete



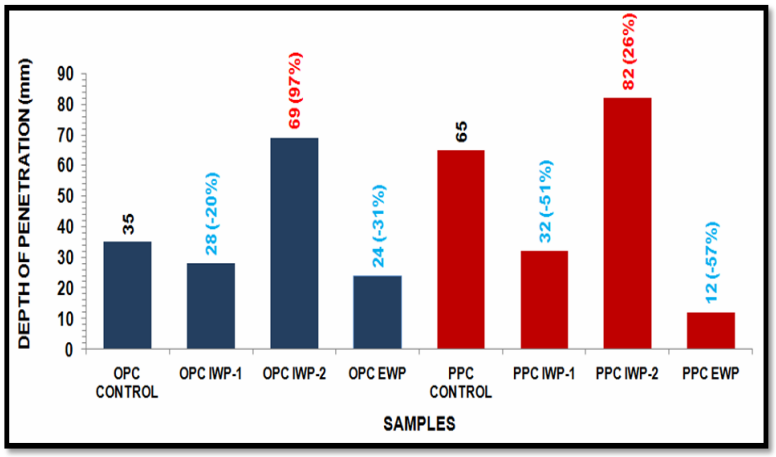
Graph no: 5 Compressive Strength of PPC Concrete

Rapid Chloride Penetration Test: For both PPC and OPC Concrete, with and without Integral Waterproofing compounds the chloride ion penetrations were determined.



Graph no: 6 Rapid Chloride Penetration of Concrete

Water Permeability Test: For both PPC and OPC Concrete, with and without Integral & External Waterproofing compounds the depths of water penetration into the concrete were determined.



Graph no: 7 Comparison of Depth of Penetration of Concrete

CONCLUSION

All OPC and PPC Concretes with IWP-1 & IWP2 compounds had more or less equal slump, retention and flow properties and also most of the PPC concretes with IWP Compounds had **better rheological properties** when compared to concrete without IWP compounds. The compressive strength of OPC with IPW-1 and almost of all PPC with IWP-1 concretes had **higher than 90 percent compressive strength** of concrete without IWP-1 Compound. Whereas, the compressive strengths of OPC and PPC Concretes with IWP-2 compound had **lower than 90 percent compressive strength** of concrete without IWP-2 Compound. All PPC Concretes with IWP Compound samples had more or less equal Initial and Final setting times and also IST and FST are **within the IS Limits** when compared to concrete without IWP compound. Both PPC and OPC concretes with IWP-1 & IWP-2 had **high durability** when compared to control concrete. The OPC and PPC concrete sample with IWP-2 had **more than 50 percent water permeability** when compared to control concrete water permeability. Whereas, the OPC and PPC concrete sample with IWP-1 and EWP had **less than 50 percent water permeability** (with in a limit) when compared to control concrete water permeability.

REFERENCE:

[1] Nasirzakari Muhammad, Ali keyvanfar, MuhdZaimiAbd. Majid, ArezouShafaghat, Jahangir Mirza- **"Waterproof performance of concrete:**
[2] **A critical review on implemented approaches".**15th October 2015. Craig, S. (2010). **"Understanding Integral Waterproofing"**, waterproofmagazine - Magazine-Integral- Waterproofing-April2010.pdf.
[3] v. Foster, B. E. (1950). **"Use of Admixtures as Integral Waterproofing and Damp proofing Materials"**, ACI Journal, 22(1), 46-52.
[4] Prajapati and Arora (2011), **"A study on oxygen permeability of concrete containing different water proofing admixtures and cementations materials"**, International journal of advanced engineering research and studies, Vol. 1.
[5] Kartini, Mahmud and Hamidah (2010), **"Absorption and permeability performance of rice husk ash blended grade 30 concrete"**, Journal of engineering science and technology, Vol. 5.
[6] Faizabdullah and Mirza (2009), **"Effect of sand replacement and silica fume addition on chloride ion permeability of lightweight concrete"**, Journals of king Abdul-Aziz university, Vol. 20 , pp: 61-73.
[7] Gyanen.Takhelmayum, Ravi Prasad, Savitha A.L (2008), **"Experimental Study on the Properties of cement concrete using Rice Husk Ash"**, International Journal of Engineering Science and Innovative Technology,Vol3,Issue 6.
[8] Xinxin Li, Qing Xu, Shenghon Chen-**"An experimental and numerical study on water permeability of concrete",** 24th December 2015.
[9] Kaushal.K. (2000). **"Waterproofing of Buildings"**, NBM & CR, pp. 50-55. ix. Kubal, M. T. (2000). **"Construction waterproofing handbook"**,McGraw- Hill Professional Publishing. IS 2645:2003-Code for practice for Integral waterproofing compounds for cement mortar and concrete (second revision).
[10] IS 456:2000-Indian standard plain and reinforced concrete - Code ofpractice
[11] IS1199:1959- Methods of sampling and analysis of concrete
[12] IS 516:1959- Methods of tests for strength of concrete
[13] IS 10262:2009- Concrete Mix Proportions – Guide lines
[14] IS 456:2000 -Plain and Reinforced Concrete – Code of Practice
[15] IS 11269:1987- Specifications for 53 Grade Ordinary Portland Cement
[16] IS 2386:1963 (Part IV) -Methods of Testing aggregate for concrete
[17] IS 383:1970 -Specifications for Coarse and Fine aggregate from natural sources for concrete
[18] DIN:1048 (Part V)- Testing of Harden Concrete
[19] IS: 4031 – 1988 (Part IV) -Methods of Physical Tests for Hydraulic Cements
[20] ASTM C 1202- Rapid Chloride Permeability test