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AN EXPERIMENTAL STUDY ON COMPRESSIVE STRENGTHS OF DIFFERENT TYPES OF CONCRETES BY NDT

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Abstract: - The objective of this study is to estimate the compressive strength of concretes made by using chemical admixture polycarboxile ether (PCE SP) on OPC, PPC and PSC of three different water cement ratio's i.e., 0.55, 0.45, 0.35. The two most popular NDT methods-Ultrasonic pulse velocity (UPV) & Rebound hammer (RH) in assessing compressive strength of concrete. 150 X 150 X 150mm cubes, 150 X 300mm cylinders and 100 X 100 X 500mm prisms were prepared, cured and subjected to UPV & RH at the end of 28, 56, 90 days. The destructive (compressive strength) test are also done for same specimens after completion of non-destructive tests to compare the results. The conclusion drawn from the analysis, is that combination of rebound hammer and UPV methods is effective in assessing compressive strength of concrete. Hence it is recommended that for more accurate results, rebound hammer should be combined with UPV is preferred.

Keywords: - Chemical admixtures (pce sp), NDT, UPV; RH and Prisms.

Introduction

Non- destructive testing is gaining ground as a technique which will assist in quality control of concrete. NDT maybe applied to both under construction and existing structures, and these are relatively simple to perform. According to ACI 211 of 2010 guidelines for the mix design. A slump of 50 mm to 90 mm is chosen for the concrete mix and water content of 170 kg/m^3 is considered. As per IS 456 of 2005 the maximum free water–cement ratio is 0.55 to have different grades of concrete w/c ratios of 0.45& 0.35 are also considered. The dosage of the (pce sp) decided by trial and error for obtaining a slump in the range of 50-90 mm. accordingly, the sp dosage in liquid form are 0.35%, 0.25% and 0.2% by mass of cement for w/c 0.55, 0.45, and 0.35 respectively.

Standard specimens used are cubes as 150 X 150 X150 mm, cylinders of 15 dia and 300 mm height & prisms of 100 X 100 X 500 mm were cast and tested for compressive strength.

After completion of 28, 56 and 90 days curing period specimens of cubes, cylinders and prisms are subjected to NDT tests i.e. R.H & UPV is assessing compressive strength of concretes

Rebound Hammer:-(BS EN 12504-2)

At the end of each curing days, 9 cubes of different cements, 9 cylinders and 9 prisms were removed from curing tank and allowed to drain and they were subjected to Rebound Hammer.The reading is very sensitive to local variation of the concrete,mainly to the aggregate particles to the surface.There no.of readings are taken and average recorded. BS EN 12504-2 states that not less than nine readings are taken over an area not exceeding 300mm^2,with the impact points not less than 25mm from each or from an edge. The test was carried out at the Strength of materials Lab Civil Engineering at AU Vizag.

Ultrasonic pulse velocity: -

Concrete samples of same different cements were also tested by using Ultrasonic Pulse Velocity. Ultrasonic Pulse Velocity tester used in the testing is pundit 6 model PC 1000 generating a low frequency ultrasound pulse of 54 khz at Strength of materials lab of Civil Engineering at AU, Vizag.

OBJECTIVES OF THE STUDY:

- To study the strength properties of concrete along with chemical admixture of different water-cement ratio.
- Calulate the percentage of chemical admixture for different water-cement ratios i.e, 0.55 , 0.44 and 0.35.
- To compare the strength properties of NDT and DT.

LITERATURE REVIEW

James halel et.al paper reviews that the most frequent non-destructive testing (NDT) procedures of concrete structures used by the structural engineering industry are reviewed in James Halel's study. The principles of nondestructive testing (NDT) methodologies are investigated in terms of their potential, limitations, inspection procedures, and interpretations. The elements that influence the success of NDT approaches are reviewed, as well as strategies for mitigating their impact. Standard guidelines for the application and interpretation of the discussed NDT methods are referred to. Concrete nondestructive testing (NDT) is gaining popularity as a method of assessing the strength, homogeneity, durability, and other qualities of existing concrete buildings. Lack of understanding of construction materials and NDT technologies contributed to NDT perceptions of inadequacy. The purpose of this work is to address these concerns by identifying and explaining the most often used successful NDT methods for concrete buildings.

Tarsem lal et.al research looked into the accuracy of non-destructive tests for hardened concrete strength. Two groups of test specimens in the shape of 150mmX150mmX150mm cubes were employed in this study. The initial set of specimens were used to create calibration curves for the rebound hammer and ultrasonic pulse velocity equipment that were utilised in the test. The results obtained from the calibration curves of the rebound hammer and ultrasonic pulse velocity tester were compared to those acquired from the compressive testing equipment with the second group of test specimens. At the age of 28 days, all of the test samples were examined. . A statistical study was performed to determine if there was a link between the CTM test and non-destructive tests. According to the testing, the difference in results between a fully calibrated hammer and a CTM is between 2 and 7%, while the difference between a properly calibrated USPV and a CTM is between 7 and 17%. By sampling samples from the same batch and curing them in the same conditions, this conclusion was reached. The results strongly suggest that non-destructive testing be used after correctly calibrating the device.

N. R. Chandank et.al The authors attempted to describe methodology, benefits and drawbacks, as well as current work in the field of non-destructive techniques (NDT), such as ultrasonic pulse velocity (UPV) and rebound hammer (RH). These methods allow for the low-cost evaluation of wider areas of concrete members while also providing more information than eye inspection. The effect of the w/c ratio, casting process, casting direction, and cement dose on NDT readings has been documented. The purpose of this study is to present UPV, RH, and the elements that influence the results. The precautions that must be taken when doing NDT tests are also discussed.

Methods and materials

Cement: - Locally available OPC 53 grade, Fly ash based PPC and PSC cements were used in casting as per ACI 211 (2010).

Coarse aggregate and Fine aggregate: -

Coarse aggregate of crushed granite with maximum size of 20 and 12 mm were used.

River sand as per IS 383 of 2007 was used as fine aggregate.

Water: - water used for both mixing of fresh concrete and curing of hardened concrete has free from impurities such as oils, alkaline and organic materials.

Chemical admixture: -

Commercially available (pce). Sp is chosen for the study.

Testing Equipment: -

The equipment used were those available in the CT laboratory of AU Vizag.

Rebound Hammer (RH) and Ultrasonic Pulse Velocity (UPV).

Physical Properties: -

Physical Properties	OPC	PPC	PSC
Specific Gravity	3.15	2.98	3.0
Initial Setting Time	1.35 Min	150 Min	124 Min
Final Setting Time	230 Min	350 Min	224 Min

Chemical Admixtures: -

Pce sp is chosen for the study as per the manufacture's specimen, the sp has specific gravity of 1.09 and solid content of about 30 percentage by weight and complies with IS 9103 (2004).

Concrete Mix: -

ACI 211 (2010) guidelines for mix design and IS 456 (2005) guidelines for durability requirements A slump of 50-90 mm is chosen for concrete mix of water content 170 kg/m^3. As per IS 456 (2005). The mix of water-cement ratio is 0.55. In order to have different grades of concrete water-cement ration is 0.45 and 0.35 also taken.

Quantities per Kg/m^3 of concrete: -

w/c	Cement	Sand	Coarse aggregate	water
0.55	310	865	1056	170
0.45	378	805	1056	170
0.35	485	714	1056	170

RESULTS AND DISCUSSIONS

Results for different curing ages and different cements for 0.55 W/C ratio:

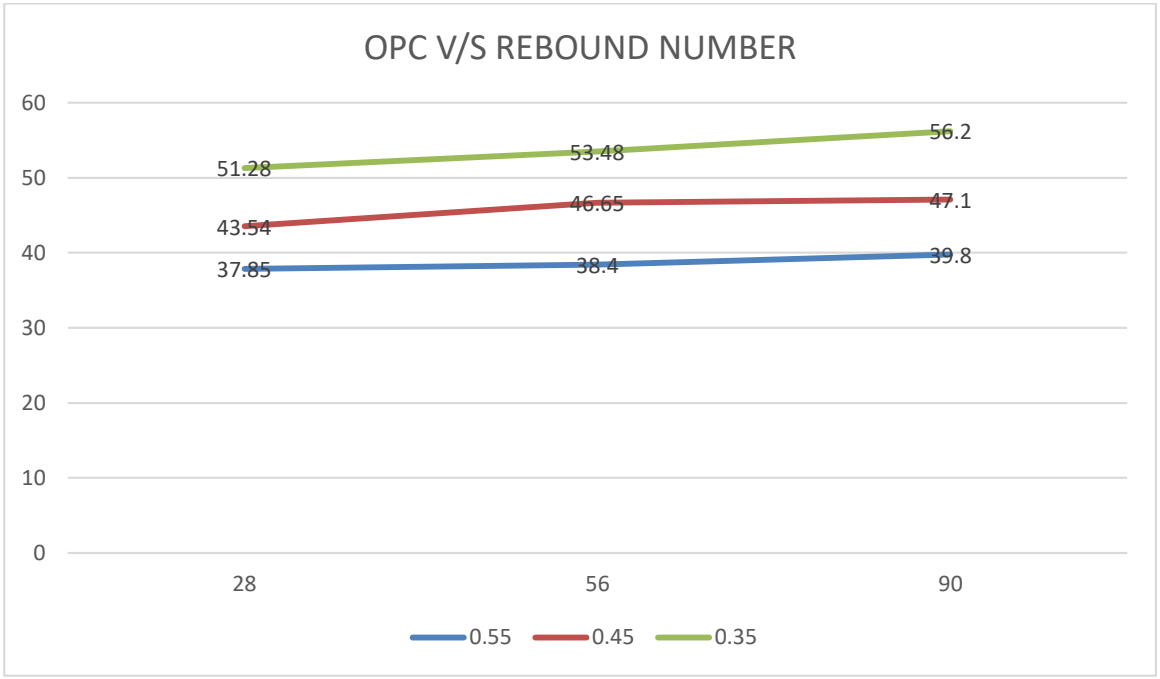
Curing days(age)	Rebound number (R)			Ultrasonic pulse Velocity (KM/S)			Compressive strength (MPA)		
	OPC	PPC	PSC	OPC	PPC	PSC	OPC	PPC	PSC
28	37.85	35.7	33.5	4.57	4.51	4.40	32.26	31.23	31.1
56	38.4	37.46	36.2	4.78	4.69	4.49	36.15	33.89	32.5
90	39.8	39.6	38.3	4.89	4.74	4.6	38.2	36.40	35

Results for different curing ages and different cements for 0.45 W/C ratio:

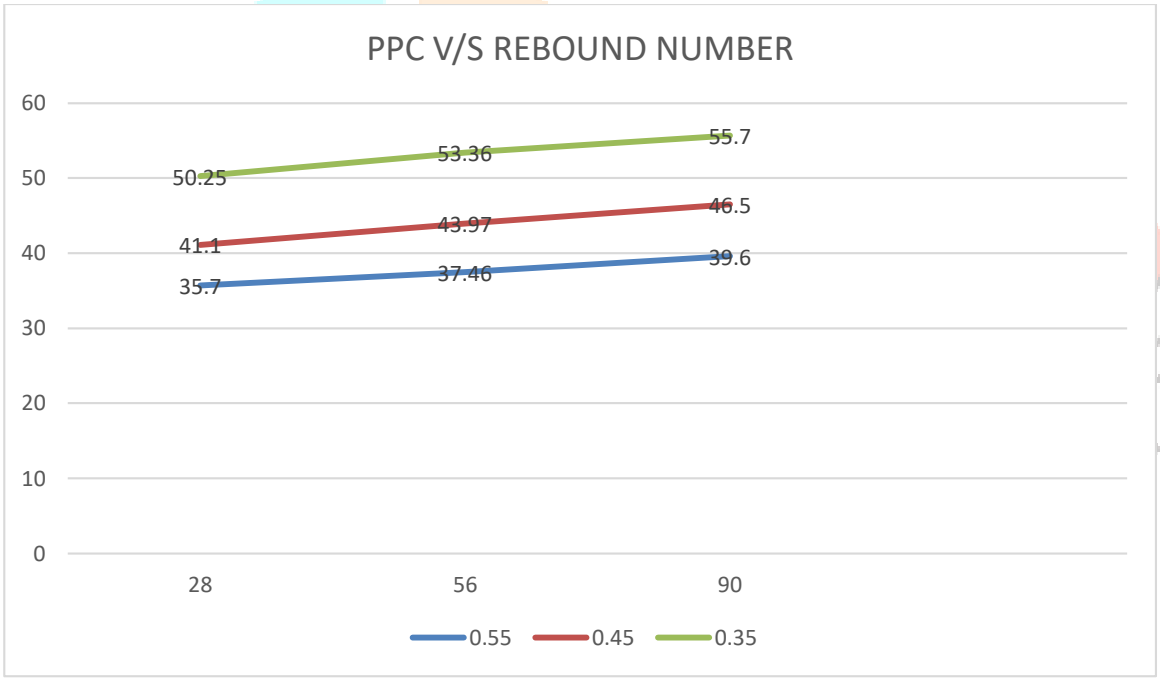
Curing days(age)	Rebound number (R)			Ultrasonic pulse velocity (KM/S)			Compressive strength (MPA)		
	OPC	PPC	PSC	OPC	PPC	PSC	OPC	PPC	PSC
28	43.54	41.10	41	4.89	4.82	4.8	43.67	43.23	42.5
56	46.65	43.97	42.5	4.91	4.9	4.88	46.97	45.74	44.56
90	47.1	46.50	45	5.1	4.99	4.89	49.1	48.5	47.5

Results for different curing ages and different cements for 0.35 W/C ratio:

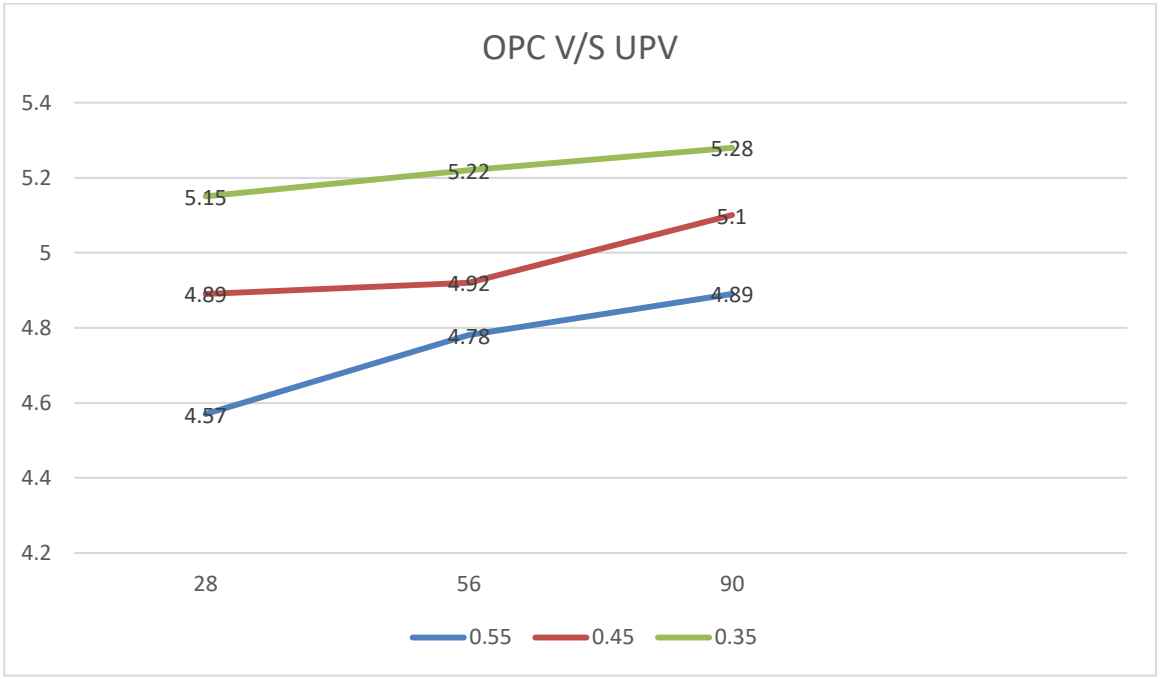
Curing days (age)	Rebound number (R)			Ultrasonic pulse velocity (KM/S)			Compressive strength (MPA)		
	OPC	PPC	PSC	OPC	PPC	PSC	OPC	PPC	PSC
28	52.28	51.5	51.1	5.15	5.01	5.0	54.22	53.8	52.5
56	53.48	53.36	53	5.22	5.10	5.05	59.45	59.33	58.5
90	56.20	55.7	54.5	5.28	5.17	5.11	59.7	59.50	59.0



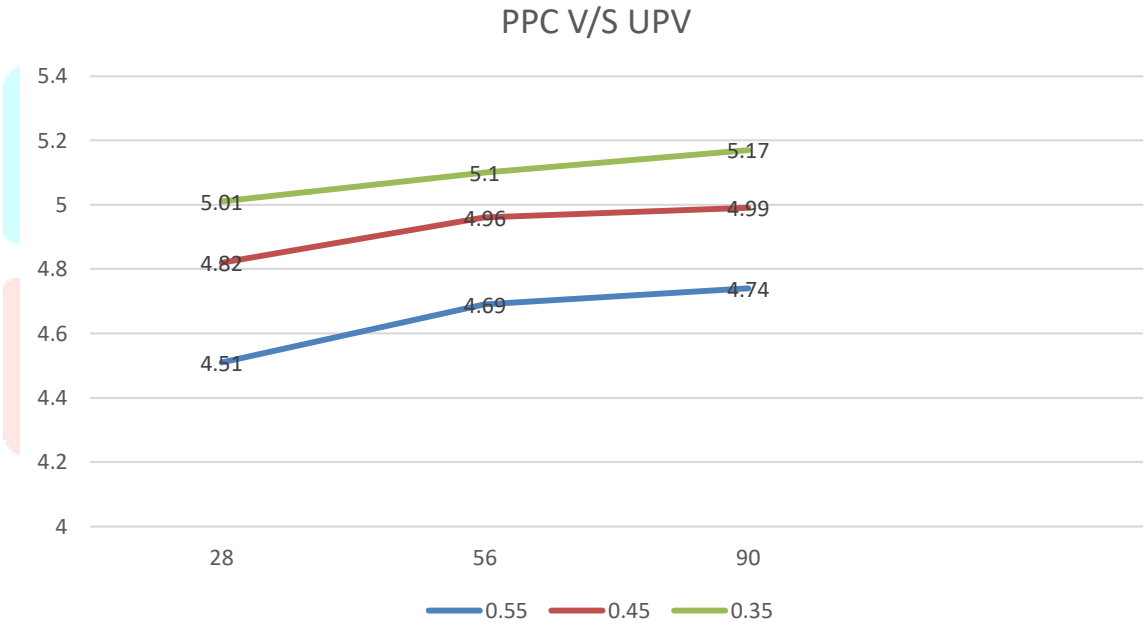
Relation between rebound number (R) and age (days) for OPC of 0.55,0.45 and 0.35 w/c:



Relation between rebound number (R) and age (days) for PPC of 0.55,0.45and0.35w/c:



Relation between ultrasonic pulse velocity (UPV) and age (days) for OPC of 0.55,0.45 and 0.35 w/c:



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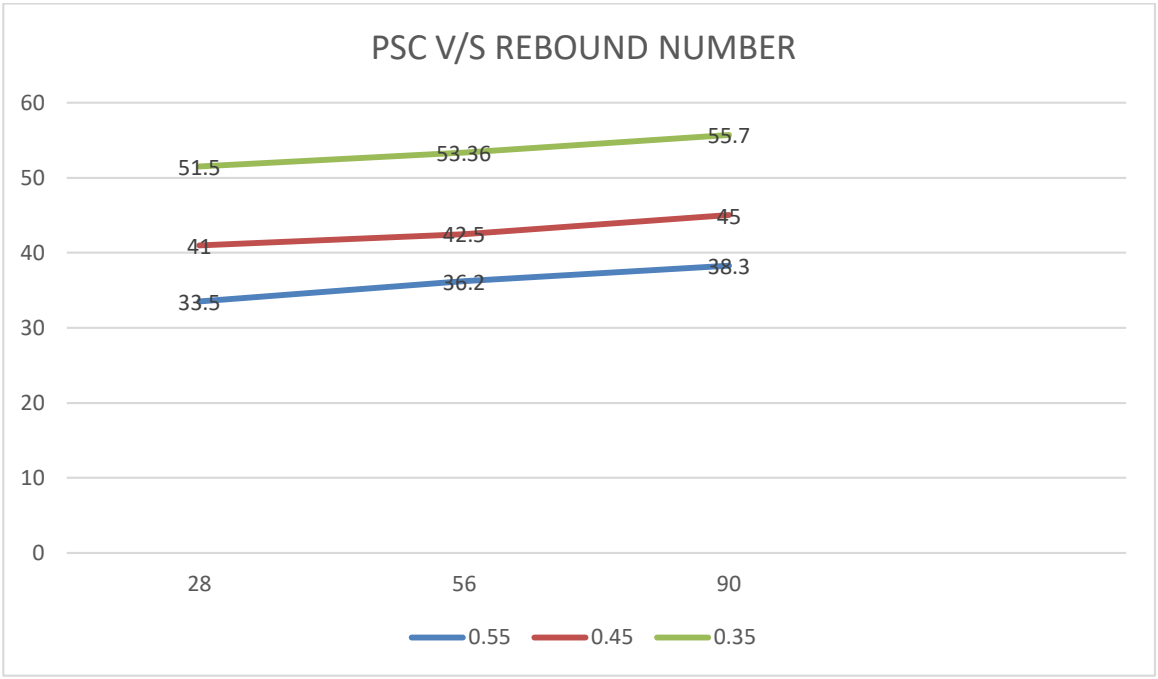
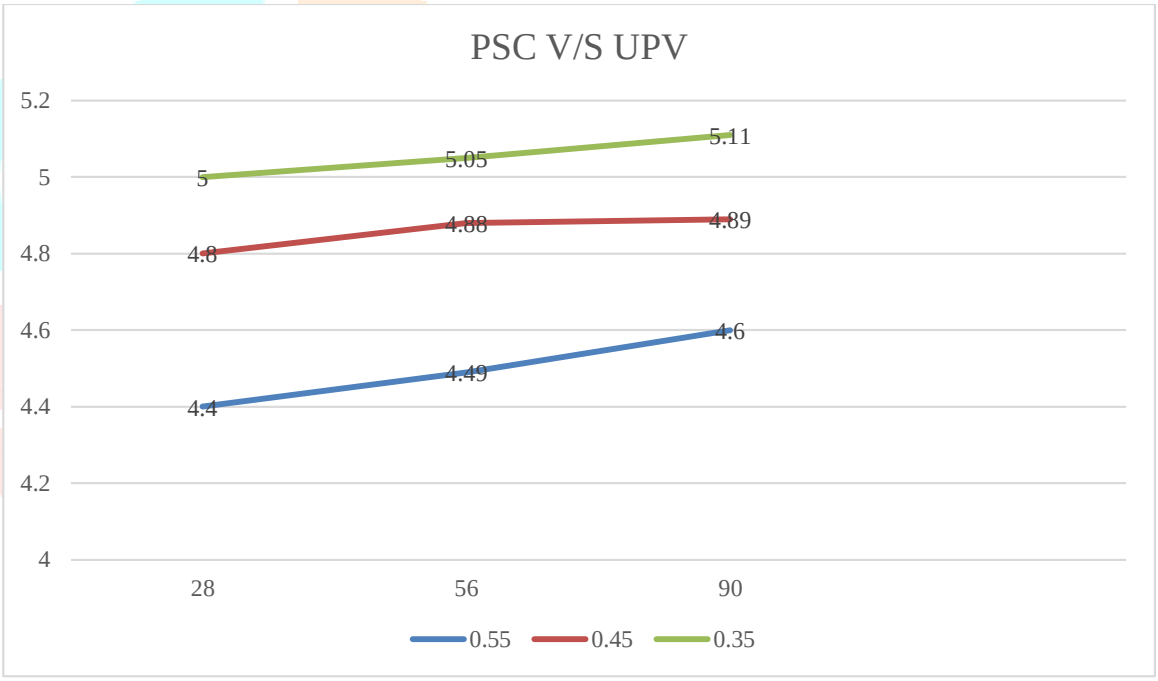


Relation between rebound number (R) and age (days) 0f PSC of 0.55,0.45 and 0.35 w/c:



Relation between ultrasonic pulse velocity (UPV) and age (days) of PSC of 0.55,0.45 and 0.35 w/c:

Conclusions:

1) As a result of the experimental study chemical admixture for different w/c ratios is determined which is used to maintain workability at any temperature.
2) The obtained results shows that slight difference between OPC ,PPC and PSC. But the maximum strength obtained for OPC for all w/c ratios.
3) The final mix designs for w/c ratios of 0.55, 0.45 and 0.35 are M30, M40 and M50 by taking average compressive strength from the graphs.

4) Non distructive tests are very convienient and can be executed anywhere but these tests have their own limitations and these limitations may result in unavoidable errors which can't be eliminated totally.Applying proper correction factor is a must to get the reliable results.

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