Use of Accelerated Curing Methods & Non Destructive Testing For Correlation of 28-day Compressive Strength of Concrete

By

Akshay K.Pittalia

(16MCLC27)

DEPARTMENT OF CIVIL ENGINEERING

INSTITUTE OF TECHNOLOGY

NIRMA UNIVERSITY

AHMEDABAD-382 481

MAY 2018

Use of Accelerated Curing Methods & Non Destructive Testing For Correlation of 28-day Compressive Strength of Concrete

Major Project

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF TECHNOLOGY

IN

CIVIL ENGINEERING

(Computer Aided Structural Analysis and Design)

By

Akshay K.Pittalia

(16MCLC27)

DEPARTMENT OF CIVIL ENGINEERING

INSTITUTE OF TECHNOLOGY

NIRMA UNIVERSITY

AHMEDABAD-382 481

MAY 2018

Declaration

This is to certify that

- The thesis comprises my original work towards the partial fulfillment of requirements for the Degree of Master of Technology in Civil Engineering (Computer Aided Structural Analysis And Design) at Nirma University and has not been submitted elsewhere for a degree.
- Due acknowledgement has been made in the text to all other materials used.

Akshay Pittalia

Certificate

This is to certify that the Major Project entitled "Use of Accelerated Curing Methods & Non Destructive Testing For Correlation of 28-day Compressive Strength of Concrete" submitted by **Mr. Akshay Pittalia (16MCLC27)** towards the partial fulfillment of the requirements for the degree of Masters of Technology in Civil Engineering (Computer Aided Structural Analysis and Design) of Nirma University, Ahmadabad is the record of work carried out by him is under my supervision and guidance. In my opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this project, to the best of my knowledge, have not been submitted to any other university or institution for award of any degree or diploma.

Dr. Urmil Dave
Guide and Professor,
Dep. of Civil Engg.,
Institute of Technology,
Nirma University,
Ahmedabad

Dr. P.V. Patel
Professor and Head,
Dep. of Civil Engg.,
Institute of Technology,
Nirma University,
Ahmedabad

Dr. Alka Mahajan
Director,
Institute of Technology
Nirma University,
Ahmedabad

_____ _____

Examiner Date of Examination

Abstract

The compressive strength of cement concrete obtained after 28 days of moist curing is used in the quality control of concrete constructions. However, for a better quality control, for reworking before the concrete gets hardened and for reducing the waiting time, evaluating the 28-day compressive strength at early age of concrete with a reasonable accuracy is extremely necessary. The 28-day compressive strength of the concrete can be estimated by finding the strength at an early age by using the methodology of accelerated curing. The correlation suggested by IS: 9013-1978 between the accelerated curing for one day and 28-day compressive strength, 28-day compressive strength of concrete is generally predicted.

It has been proved that substantial portion of compressive strength of concrete is attained due to curing. The accelerated curing techniques can be used for early prediction of the compressive strength of concrete. There is a limited amount of work done on the effect of curing period, curing techniques of concrete. Also, it is tried to evaluate the effect of accelerated curing on strength of concrete by varying cementitious material, age and type of curing method on different grades of concrete in the present investigation.

Total 40 concrete mixes are cast.Among these mixes, 7 concrete mixes are directly obtained from RMC plant. On the other have 33 concrete mixes are cast in laboratory with mix design collected from different sites in Gujarat region. 21 concrete mixes consisted combination of OPC and fly ash in addition to other ingredients. Other 19 concrete mixes are cast using OPC along with other ingredients. As per provisions of IS: 9013-1978 for warm water method, after 1.5 hours to 3.5 hours of casting, the concrete cube moulds are placed in accelerated curing tank for 20 hours at 55 $\pm$ 2°C. The concrete cubes are placed in the cooling tank for a period of not less than 1 hour. Similarly for boiling water method after 23 hours of casting, the concrete cube moulds are placed in accelerated curing tank for 3.5 hours at 100°C, and after that the concrete cubes are placed in cooling tank for 2 hours.

By using the methodology of accelerated curing, the compressive strength of all 40 concrete mixes is evaluated at 1 day. 28 day compressive strength is predicted in case of all 40 concrete mixes. The NDT by means of rebound hammer is employed for all the 40

concrete mixes. Concrete cube specimens are tested by keeping position of rebound hammer vertical. Also, NDT by means of UPV is employed for all the 40 concrete mixes. For concrete cube specimens, direct method is adopted to find the UPV results. Rebound Hammer, UPV and compressive strength results are measured for concrete cube. The results are measured at 7 and 28 days as well as 1day by means of accelerated curing test.

From all the results, the correlation between rebound number result taken after 1 day of accelerated curing of concrete and 28 days compressive strength of concrete. Also, correlation is established between rebound hammer result and compressive strength of all the concrete mixes at 28- days. The correlation between compressive strength of concrete after accelerated curing by both methods and 28 day compressive strength of concrete by normal curing with OPC & OPC + fly ash of concrete mixes have been established.

The established correlation between 1 day rebound number and 28 day compressive strength of concrete is helpful in predicting 28 day compressive strength of concrete. Similarly, correlation between rebound number and compressive strength of concrete at 28 days is helpful in cross checking 28 day compressive strength of concrete. Correlation between compressive strength of concrete evaluated at one day and 28 day compressive strength of concrete is helpful in predict 28 day compressive strength of concrete through accelerated curing in case of both the method.

For OPC based concrete the percentage difference in warm water method with respect to 28 day normal curing of concrete is 15% to 20% higher than 28 day normal curing of concrete. In boiling water method percentage difference is 25% to 30%. Similarly, for fly ash based concrete the percentage difference in warm water method with respect to 28 day normal curing of concrete is 2% to 5% higher than 28 day normal curing of concrete. In boiling water method percentage difference is 5% to 10%. From all the results it is conclude that the predicted 28 day compressive strength of concrete by warm water method the results is showing lower then boiling water method. So, warm water method is good to predict 28 day compressive strength for OPC based and fly ash based concrete.

Acknowledgement

I cannot present this work without first expressing my appreciation and gratitude to my guide **Dr. Urmil V.Dave,** Professor, Department of Civil Engineering (CASAD), Institute of Technology, Nirma University, Ahmedabad for his valuable guidance and advice. His willingness to motivate me, his excellent knowledge and experience helped me to carry out the major project work. contributed tremendously to my major project.
I also would like to thank him for numerous simulating discussions, valuable guidance and constant encouragement at every stage of progress of the major project.

I further extend my thanks to **Dr. P. V. Patel**, Head, Department of Civil Engineering, Institute of Technology, Nirma University, Ahmedabad and **Dr. Alka Mahajan**, Director, Institute of Technology, Nirma University, Ahmedabad for providing all kind of required resources during my study.

My sincere thanks to **Dr. S. P. Purohit**, Professor, Department of Civil Engineering, Institute of Technology, Nirma University, Ahmedabad for their continual kind words of encouragement throughout the Dissertation work.

My sincere thanks to **Mr. Prahlad N. Raval, laboratory supervisior** and **Mr. Sunil B. Regar, Laboratory Assistant**, Concrete technology laboratory, Nirma University for their effort and assistance during testing.

I am really thankful to Almighty, to my family members and my friends by whose blessings, endless love and support, help me to complete my study and encouraged me in all possible way.

Akshay K.Pittalia
16MCLC27

Abbreviations and Acronynms

WW ..... Warm Water
BW ..... Boiling water
UPV ..... Ultra Pulse Velocity
RH ..... Rebound Hammer
RN ..... Rebound Number
NDT ..... Non Destructive Testing
RMC ..... Ready Mix Concrete
OPC ..... Ordinary Portland Cement
PPC ..... Portland Pozzolana Cement
PSC ..... Portland Slag cement
CPWD ..... Central Public Works Department
FA ..... Fly Ash
SCC ..... Self Compacted Concrete
HSC ..... High Strength Concrete
GGBFS ..... Ground Granulated Blast Furnace Slag

Contents

List of Tables

List of Figures

Chapter 1

Introduction

1.1 General

Concrete is a construction material which has been widely used in construction industry. Curing is the process in which the concrete is protected from loss of moisture and kept within a reasonable temperature range. This process results in concrete with increased strength and decreased permeability. Curing is also a key player in mitigating cracks. Traditionally, quality of concrete in construction works is calculated in terms of its 28 days compressive strength. If after 28 days, the quality of concrete is found to be dubious, it would have considerably hardened by that time and also might have been buried by subsequent construction. The need for having a reliable and fast method for evaluating controlled concrete in the field using accelerated curing technique was recognized by Cement and Concrete Sectional Committee and further the Committee decided to evolve a standard method of determining the strength of concrete cured by accelerated curing methods. Accelerated curing is any method by which high early age strength is achieved in concrete.

The compressive strength of cement concrete obtained after 28 days of moist curing is considered for quality of concrete in construction works. To get this strength for good quality control one has to wait for 28days. In order to get high early strength and also to reduce time for economical quality control, accelerated curing is used. In this method of curing the temperature of water is increased, which results in increase in concrete temperature and rate of development of strength accelerates which will be more comparing to normal moist curing.

Recent trend in engineering technology is to develop economic concrete and complete the project within time limit. To develop the economic concrete, mix design is to be developed and to complete project within time limit, the compressive strength of concrete cubes for selected mix design should be determined earlier in the laboratory. The compressive strength of hardened concrete is most common property required for the structural use. The rate of strength gain mainly depends upon the rate of hydration and the rate of hydration depends on the surrounding temperature. The strength gain could be accelerated at early age and related to 28 days and 56 days compressive strength through calibration curves.

1.2 Curing of Concrete

Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. In order to obtain good quality concrete, an appropriate mix must be followed by curing in a suitable environment during the early stages of hardening. Properly cured concrete has an adequate amount of moisture for continued hydration and development of strength, volume stability, resistance to freezing and thawing, and abrasion and scaling resistance.

Curing must be undertaken for a reasonable period of time if concrete is to achieve its potential strength and durability. Curing is essential if concrete is to perform its intended function over the design life of the structure whereas; excessive curing time may lead to the escalation of construction cost of the project and unnecessary delays.

Curing in the early ages of concrete is more important. Curing for 14 days is very important. Better to continue it for 7 to 14 days more. If curing is not done properly, the strength of concrete reduces. Cracks develop due shrinkage. The durability of concrete structure reduces.

Curing encompasses the control of temperature as it affects the hydration rate in cement. If, within the curing period, natural temperatures of concrete are in the acceptable range of values, only the moisture content needs to be controlled. If the natural temperature is outside the acceptable range of values, some means will be required for controlling the

temperature of concrete. The curing of concrete is performed both at normal and elevated temperatures also. Curing can be done in a number of ways while the most appropriate means of curing may be dictated by the site conditions or the construction method.

The following curing methods are employed:
(a) Spraying of water: Walls, columns, plastered surfaces are cured by sprinkling water.
(b) Wet covering the surface: Columns and other vertical surfaces may be cured by covering the surfaces with wet gunny bags or straw.
(c) Ponding: The horizontal surfaces like slab and floors are cured by stagnating the water to a height of 25 to 50 mm by providing temporary small hunds with mortar.
(d) Steam curing: In the manufacture of pre-fabricated concrete units steam is passed over the units kept in closed chambers. It accelerates curing process, resulting into the reduction of curing period.
(e) Application of curing compounds: Compounds like calcium chloride may be applied on the curing surface. The compound shows affinity to the moisture and retains it on the surface. It keeps the concrete surface wet for a long time.

There are different ways of accelerated curing, like warm water curing, boiled water curing, autoclave curing, microwave curing, electric curing etc. Generally, the accelerated curing is used for precast products and for high early strengths. To complete the project within the time and to develop economic concrete, the high early compressive strength of concrete can be determined in a laboratory by accelerated curing. It also predicts the 28 days compressive strength within 28 hours.

Effect of curing duration on compressive strength development is presented in Figure 1.1

Purpose of Curing:-
- It protects the finished surface from direct sun and wind.
- It help in chemical reaction of concrete.
- It reduce the shrinkage, increases durability, impermeability.
- protection against rapid cooling in first few days.
- Avoid high internal thermal/temperature gradient

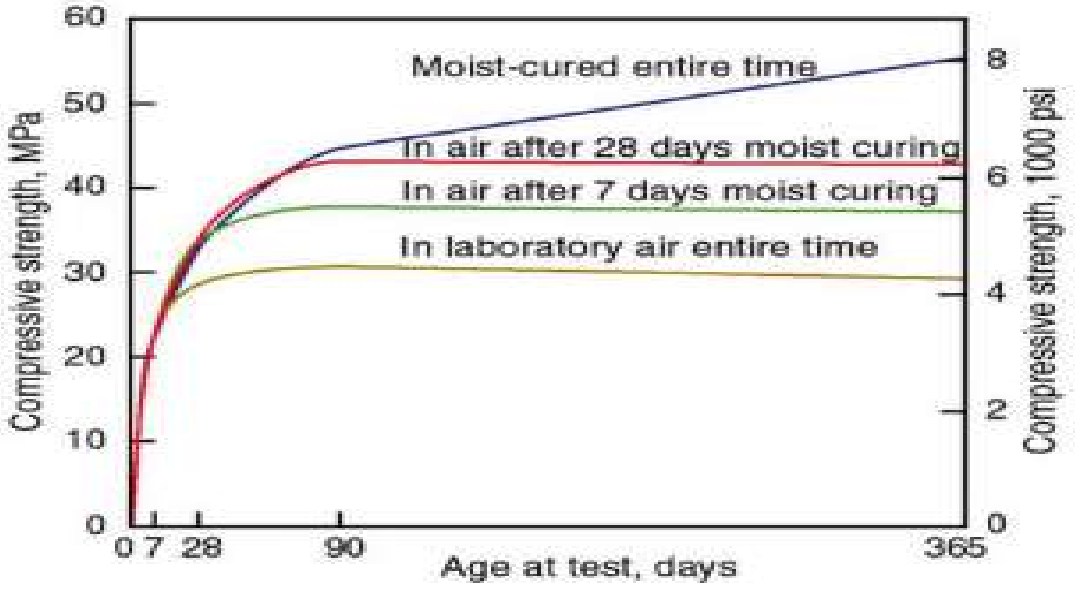

Figure 1.1: Moist Curing Time And Compressive Strength Gain

1.3 Need of Study

Accelerated Curing Method Is Used To Get Early High Compressive Strength In Concrete. Accelerated Curing Method Is Also Used To Find Out 28 Days Compressive Strength Of Concrete In 28 Hours. (As Per IS 9013-1978- Method of making, curing and determining compressive strength of accelerated cured concrete test specimens)

Accelerated Curing Is Useful In The Prefabrication Industry Wherein High Early Age Strength Enables The Removal Of The Formwork Within 24 Hours Thereby Reducing The Cycle Time Resulting In Cost Saving Benefits. The Most Commonly Adopted Curing Techniques are steam curing at atmospheric pressure, warm water curing, boiling water curing & autoclaving.

Quality of concrete is calculated in terms of its 28days compressive strength. This period is too long for control of concrete. Curing of concrete and its gain of strength can be expedited by raising the temperature of curing, thereby speeding up of the hydration reaction.

Accelerated curing strength is a tool for quality control of concrete even though the final acceptance of quality is based on 28-day strength. So, correlating accelerated strength and normal 28-day strength is important.

During review of literatures it is observed that there is limited work in the effect of curing

period and curing techniques and the strength and performance aspect of concrete.

1.4 Objectives of Study

To study various parameters following objectives are decided for major project:

- To cast the OPC and OPC+ Fly Ash concrete mix.
- To find the compressive strength of accelerated curing at 1 day by warm water and boiling water method & also apply non destructive test i.e. rebound hammer & UPV on all concrete mix.
- To find the compressive strength of cubes at 7 days & 28 days for all concrete mix.
- To find the compressive strength of 1 day cube specimens & prediction of 28 days concrete cube strength.
- To develop the correlation between 1 day compressive strength & 28 day compressive strength.
- To develop the correlation between 1 day non-destructive testing (NDT) results & 28 day compressive strength.

1.5 Scope of Work

Scope of work includes theoretical work and experimental work related to finalization of mix designs, casting and testing of concrete specimens.
The size of the cube specimens is ($150mm \times 150mm \times 150mm$) with different concrete grades which are used in the field.
For each mix proportion total 12 specimen cast is to be planned.
3 cube specimens are to be cured in the water at temperature up to 100°C for a period of 3.5 hours in boiling water method (As per IS: 9013-1978).
In the warm water method 3 cube specimens are to be cured in the water temperature up to 55°C for a period of 20 hours (As per IS: 9013-1978 curing time not less than 19hours 50minites.)

3 cube specimens are to be subjected for normal curing for 7 days and 28 days each. Compressive strength of cube specimens subjected to accelerated curing & normal curing method and by accelerated strength also predicted 28 days compressive strength of cubes. Develop a correlation between compressive strength, rebound number after accelerated curing specimens by both methods.

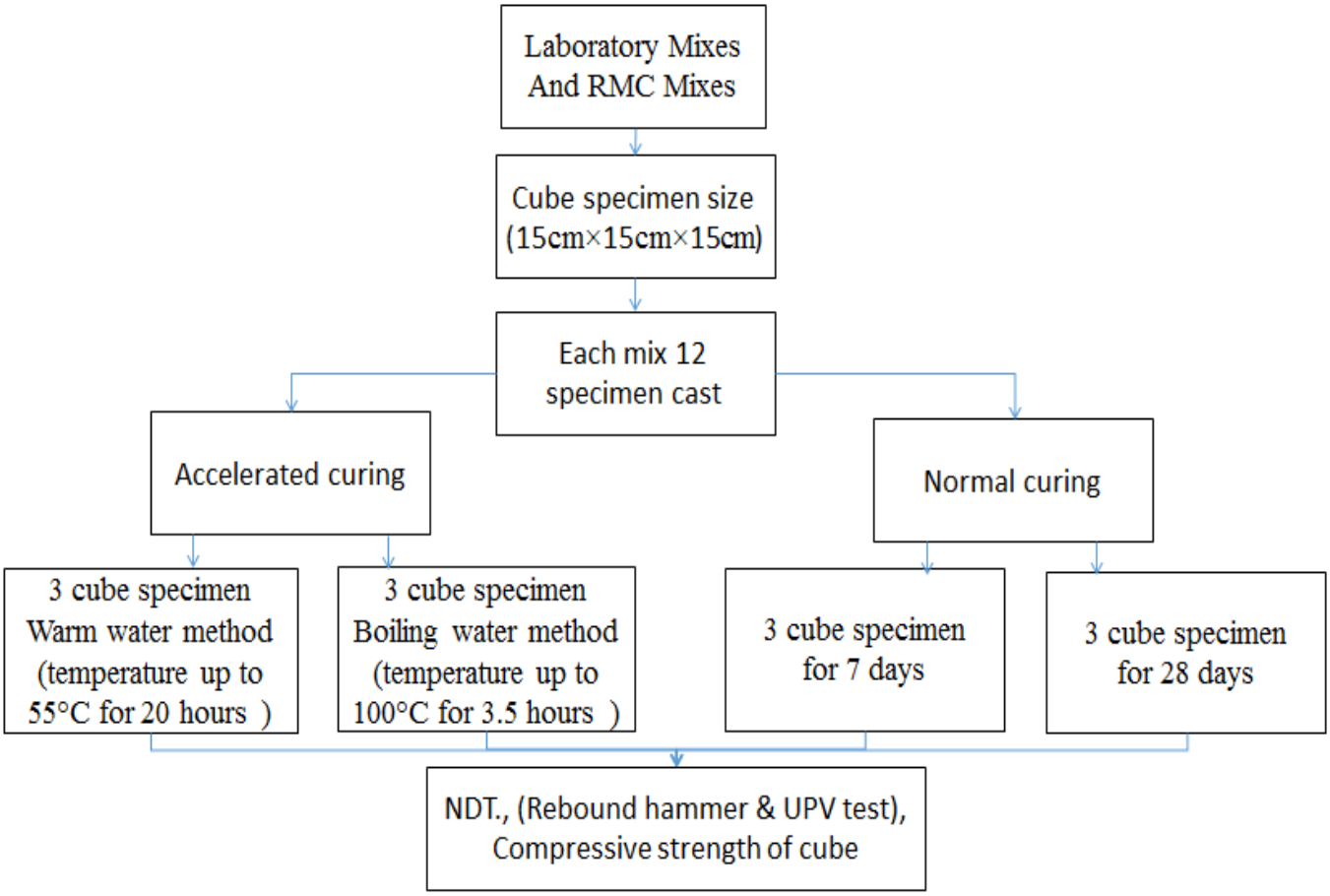

Figure 1.2: Flow Chart

1.6 Organization of Major Project

The report of major project is mainly classified into six chapters which are as given below:

- **Chapter 1** includes the introduction to the topic and the overall background of the report pertaining to need of study, Objectives and Scope of work for the major project.

- **Chapter 2** includes the literature of work that had been done by researchers in past related to the scope of major project.

- **Chapter 3** describes the details of concrete ingredients, Mix design, Casting and Curing of Concrete Specimens, Also various testing procedures of Concrete Specimens.

- **Chapter 4** includes all results of rebound hammer at 1 day and 28 day. Also comparison of UPV at 1 day by both methods and 7 & 28 days. Find regression equation for OPC and F.A. based concrete.

- **Chapter 5** discussion of results related to comparison of compressive strength for all mixes, comparison of rebound hammer, Also comparison of predicted compressive strength then developed correlation for OPC and F.A. based concrete.

- **Chapter 6** includes the future scope of work to be carried out further.

  References

Chapter 2

Literature Review

2.1 General

Literature writing is one of the most indispensable aspects of thesis making. Accelerated curing of concrete is very essential because the compressive strength of concrete obtained after 28 days of moist curing for good quality of concrete so wait for 28 days is required. So by using of different types accelerated curing method & get high early strength and also reduce time for economical quality control is discussed and corresponding investigation conducted by researchers are summarized in this chapter.

2.2 Methodology of Accelerated Curing of Concrete :From IS Code

Indian standard (IS: 9013-1978:- method of making, curing and determining compressive strength of accelerated cured concrete test specimens) evolved a standard method of determining compressive strength of test specimens by accelerated curing. The method laid down in this standard can be used for quality control purposes, or for the prediction of normal strength of concrete at later ages, by the use of an appropriate correlation-curve obtained by testing normally cured and accelerated cured concrete specimens of the mix proportion and materials to be used at the site.

IS: 9013 (1978) covers two methods, in warm water method the concrete specimens are cured at elevated temperature of 55 ±2°C for 19 hours 50minutes and in boiling water method the concrete specimens are cured at elevated temperature of 100°C for 3.5h ± 5minutes. Expected 28 days compressive strength is calculated by empirical formula given in the code. It is found that the above two methods are useful for prediction of expected 28 days compressive strength when concrete is made using OPC.

2.3 Accelerated Curing of Concrete From literature

Krishnan Dhanya et al. [1] has observed that the maximum compressive strength is achived in OPC-53 grade & the w/c ratio 0.4 is good for accelerated curing also 28 day normal curing strength is good. In this paper they have used different type of cement like OPC-53 grade, OPC-43 grade, PPC & PSC. They have studied the relation between accelerated curing strength and normal curing strength. They were made 96 sets of specimen with different grade of cement. Each 24 sets of specimen with w/c ratio 0.45, 0.5, 0.55, 0.4 respectively.

Table 2.1: Details of Mix Design (Quantity of Materials Per Cubic Meter of Concrete)

Sr. No	Cement Type	W/C Ratio	Water (Liter)	Fine Aggregate (Kg.)	Coarse Aggregate (Kg.)	Cement (Kg.)	Mix Proportion	No. Of Specimen
1	OPC 53	0.55	202	702.36	1324.40	364	1:1.93:3.64	6
2	OPC 53	0.5	202	690.51	1301.90	400	1:1.73:3.25	6
3	OPC 53	0.45	202	676.04	1274.60	444	1.1.52:2.87	6
4	OPC 53	0.4	202	660.24	1245.23	462	1:1.42:2.69	6
5	OPC 43	0.55	200	675.45	1140	363.33	1:1.62:2.85	6
6	OPC 43	0.5	200	647.04	1139.15	400	1:1.39:2.55	6
7	OPC 43	0.45	200	616.80	1133.25	444.44	1:1.52:2.62	6
8	OPC 43	0.4	200	645.97	1118.17	425.53	1:1.79:2.9	6
9	PPC	0.55	202	695.96	1124.64	388.46	1:1.52:2.66	6
10	PPC	0.5	202	670.23	1120.48	420.83	1:1.48:2.48	6
11	PPC	0.45	202	649.97	1114.84	448.89	1:1.14:2.20	6
12	PPC	0.4	202	574.27	1101.62	500	1:1.84:3.10	6
13	PSC	0.55	200	667.73	1126.96	363.64	1:1.60:2.81	6
14	PSC	0.5	200	638.76	1124.57	400	1:1.14:2.20	6
15	PSC	0.45	200	607.85	1116.8	444.44	1:1.37:2.51	6
16	PSC	0.4	200	574.27	1101.62	500	1:1.14:2.320	6

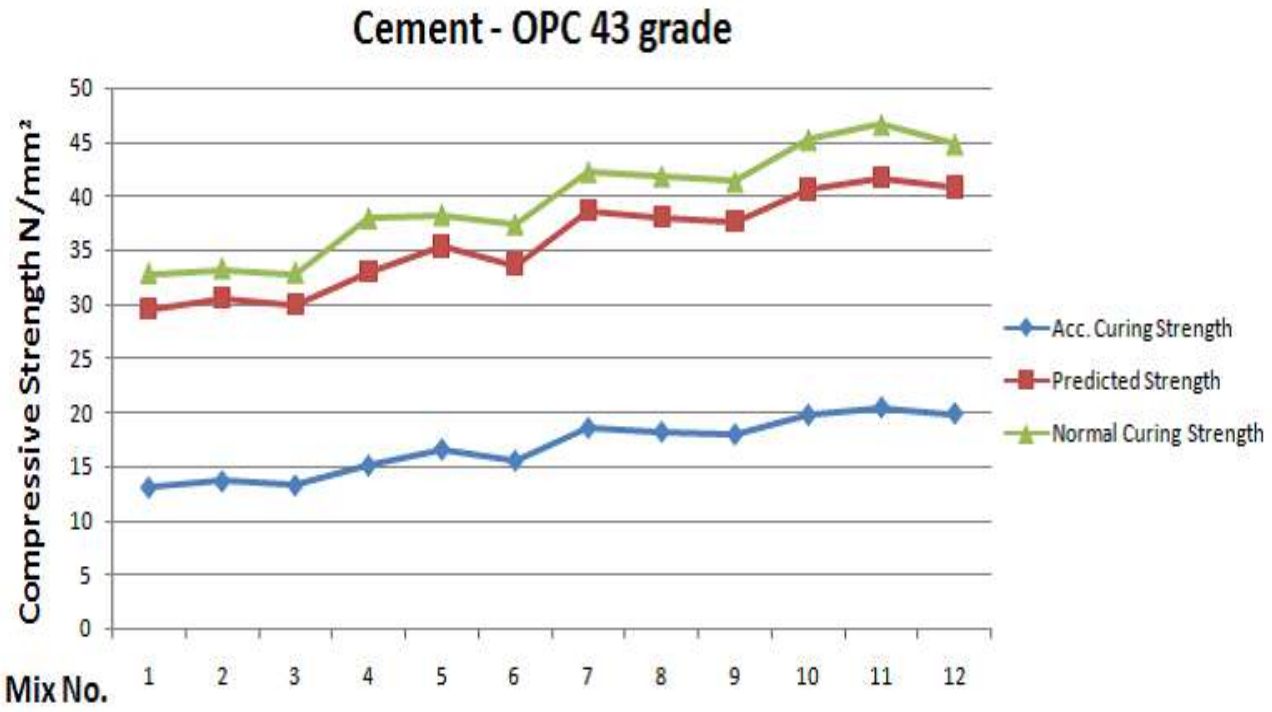

Figure 2.1: Experimental and Predicted Values of Compressive Strength For OPC 43

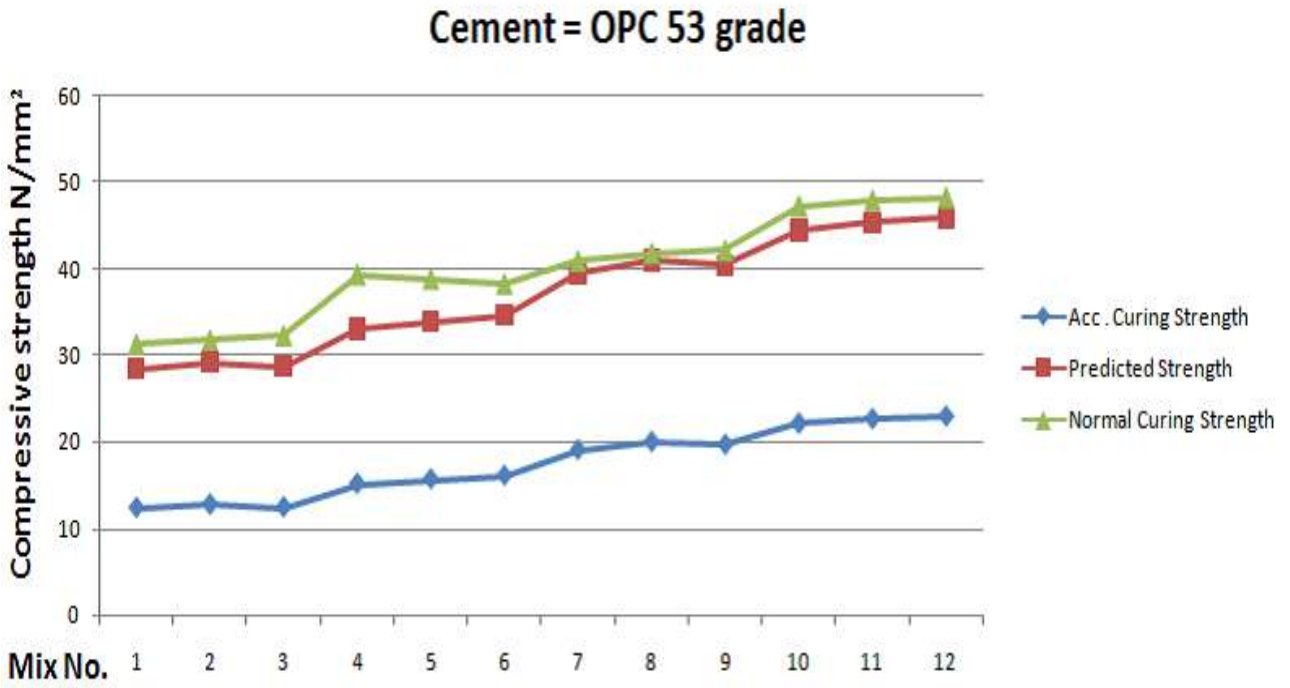

Figure 2.2: Experimented and Predicted Values For OPC 53

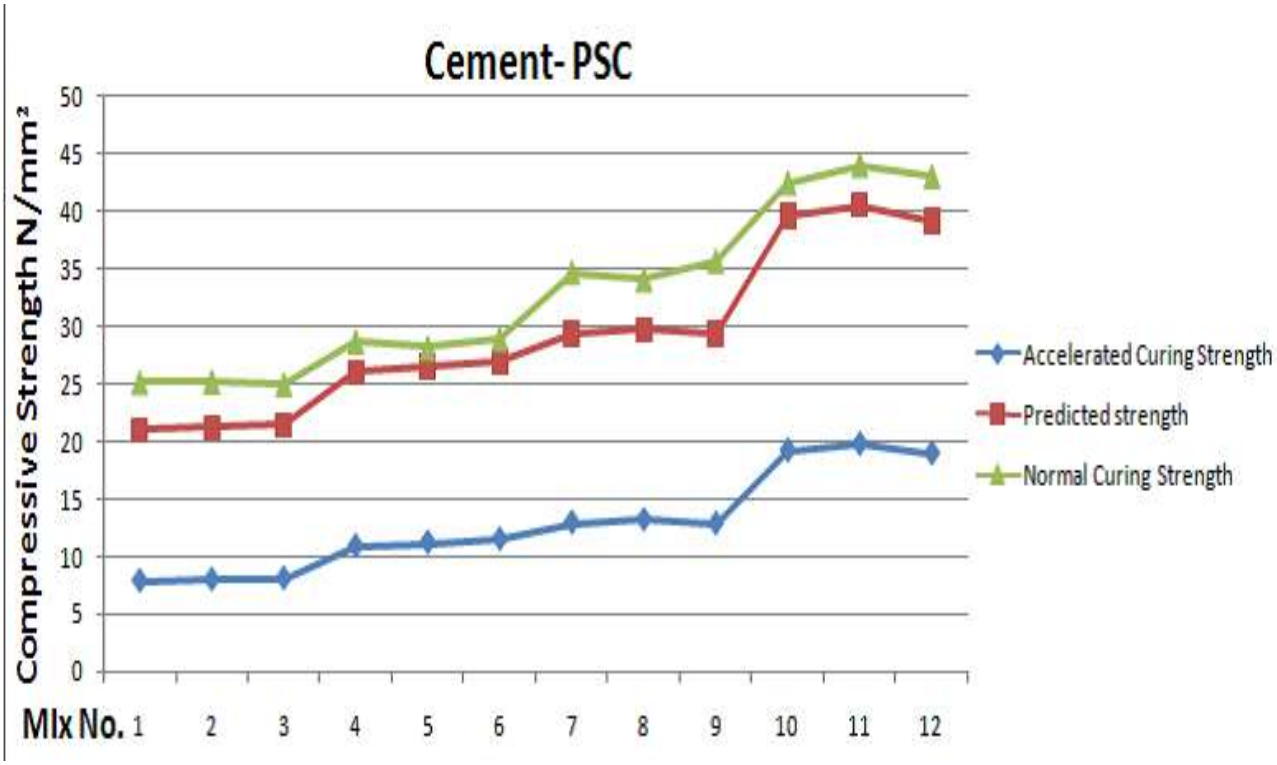

Figure 2.3: Experimented and Predicted Values For PSC

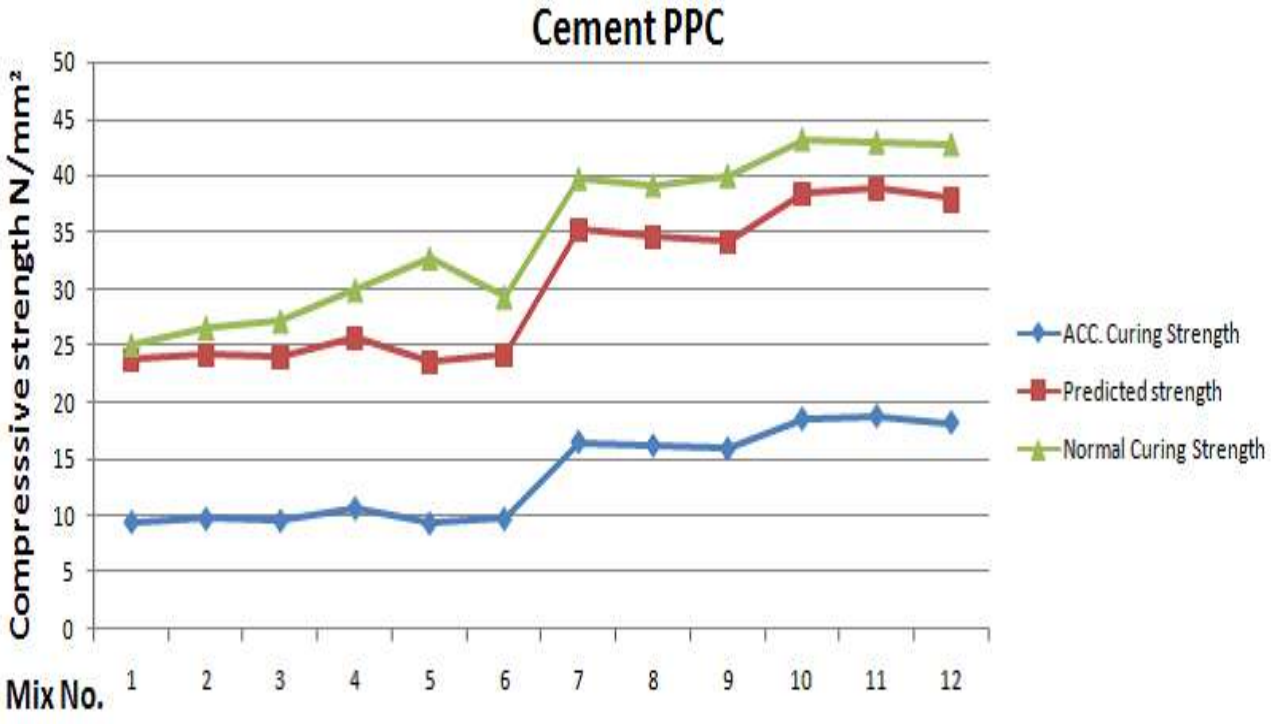

Figure 2.4: Experimented and Predicted Values For PPC

Tokyay M. et al.[2] have introduced relationships between standard compressive strength at 7, 28 & 90 days and early strength attained by 1.) autogeneous, 2.) Warm water, and 3.) Boiling water curing were obtained and a regression expression to predict the strength of concrete containing high-lime & low-lime fly ashes as partial cement replacement and proposed. Fly ash were used to replace 10, 20, & 40% (by weight of plain concrete). They were 52 different concrete mix (including the four control mixes) were prepared. 36 specimens were prepared from each mix. The specimens were cured under four different conditions. And they conclude that it is more dependable for autogeneous & Warm water curing than for boiling water curing.

Table 2.2: Mix Proportion of Control Concrete

Mix	Cement (kg/m3)	Net mixing Water (kg/m3)	0-4 mm,Sand (SSD) (kg/m3)	4-8mm crushed stone (SSD) (kg/m3)	8-16mm crushed stone (SSD) (kg/m3)	HRWRA (kg/m3)
C1	387	184	551	282	964	-
C2	426	115	535	270	926	3.0
C3	453	120	511	264	898	3.17
C4	512	130	500	256	877	3.58

Table 2.3: Compressive Strength Test Result After Standard Moist Curing For 7, 28 and 90 Days and After Autogeneous, Warm Water and Boiling Water Curing

Mix no.	Standard moist curing (Mpa)			Accelerated curing (Mpa)		
	f7	f28	f90	fauto	fww	fbw
10HL11	24.6	38.5	46.1	12.1	12.2	11.5
10HL12	55.3	62.4	80.4	20.2	19.3	15.5
10HL13	59.7	68.5	84	21.6	22.9	16.4
10HL14	60.5	72.7	86.3	23.3	23.8	17.2
10LL11	22.8	37.4	46.8	12.4	12.7	9.6
10LL12	48.5	59.8	82.2	19.4	20.2	14.3
10LL13	58	66.3	86.1	21.7	22.7	15.7
10LL14	63.6	70.5	86.2	22.8	22.9	16.7
20HL11	17.8	37.2	48	10.4	10.1	7.9
20HL12	38.6	59.5	80.7	17.1	17.4	12.6
20HL13	41.5	65.4	85.4	18.3	18.9	13.9
20HL14	42.2	68.4	87.1	18.4	18.3	14.2

Shah Poorav .[3] has observed that increase in curing temperature has more favourable effect on strength gain of concrete with cement & cement replacing material. They were made total 216 cube size ($15cm \times 15cm \times 15cm$). For accelerated curing they used warm water method adopted. Then concrete cube specimen was tested for compressive strength & result are co related with 28 & 56 days compressive strength of standard water curing.

They were used 7 composition of different type of cement were used & for each type of cement, 4 different w/c were used see in table 2.5.

Table 2.4: Different w/c Ratio & Constitute Materials Proportions of The Various Concrete Mixes

w/c ratio	Proportion	Mix Proportion (Kg)			
		Cement	Sand	C.A	Water
0.4	1:1.72:2.28	450	774	1026	180
0.45	1:2.03:2.53	400	812	1026	180
0.5	1:2.35:2.85	360	846	1026.6	180
0.55	1:2.67:3.13	327.17	873.55	1026.6	180

Table 2.5: Composition of Different Types of Cement

Type	Composition
A	OPC
B	88% OPC + 10% Metakaolin + 2% Iron Oxide
C	78% OPC + 10% Metakaolin + 2% Iron Oxide + 10% Fly Ash
D	68% OPC + 10% Metakaolin + 2% Iron Oxide + 20% Fly Ash
E	58% OPC + 10% Metakaolin + 2% Iron Oxide +30% Fly Ash
F	48% OPC + 10% Metakaolin + 2% Iron Oxide +40% Fly Ash
G	38% OPC + 10% Metakaolin + 2% Iron Oxide +50% Fly Ash

Table 2.6: Optimum Strength For Composition of Type B & C

Type of Cement	**W/C Ratio**	**Compressive,Strength (N/mm2)**		**Accelerated Strength (N/mm2)**
		28(days)	**56(days)**	
BM1	0.4	40.55	40.89	43.55
BM2	0.45	47.7	37.78	45.55
BM3	0.5	41.71	33.48	45.41
BM4	0.55	32.3	24.44	35.26
CM1	0.4	40.43	36.3	47.297
CM2	0.45	33.35	31.26	41.91
CM3	0.5	26.14	26.82	32.77
CM4	0.55	29	25.08	33.177

Rao M.V. Krishna.[4] They were testing of total 99 test specimens of standard cube size $15cm \times 15cm \times 15cm$ cast & test to cover the 3 parameters like, age of curing (1, 3, 7, 14 & 28 days), Type of cement (OPC 43, PPC 43 & OPC 43+ 10% S.F.), Type of curing (conventional curing, membrane curing). For accelerated curing method they used boiling water curing method. They have used M-40 grade of concrete. Also they have performed NDT like, Rebound hammer & upv test. And they conclude that at all ages, the compressive strength of concrete with PPC is found to be lower than that of the concrete with OPC & the one with 10% OPC replacement by silica fume for all curing method.

Table 2.7: Details of Specimens Cast

Sr. No	Type of Concrete Mix	Type of Curing	No of Cubes
1	OPC	Conventional Curing	15
2	PPC	Conventional Curing	15
3	OPC+10% SF	Conventional Curing	15
4	OPC	Membrane Curing	15
5	PPC	Membrane Curing	15
6	OPC+10% SF	Membrane Curing	15
7	OPC	Accelerated curing	3
8	PPC	Accelerated curing	3
9	OPC+10% SF	Accelerated curing	3
Total Specimens cast			99

Table 2.8: Compressive Strength of Specimens

Sr. No	Type of Concrete Mix	Type of Curing	Compressive Strength (MPa)				
			1 days	3 days	7 days	14 days	28 days
1	OPC	Conventional	21.58	25.51	38.65	49.05	52.03
2	PPC	Conventional	18.77	24.43	34.49	42.23	46.56
3	OPC+10% SF	Conventional	21.49	28.29	39.67	50	53
4	OPC	Membrane	20.5	24.6	35.73	43.4	48.03
5	PPC	Membrane	14.49	17.6	28.77	37.04	43.76
6	OPC+10% SF	Membrane	20.45	26.7	32.07	38.85	46.49
7	OPC	Accelerated	-	-	-	-	40.97
8	PPC	Accelerated	-	-	-	-	29.34
9	OPC+10% SF	Accelerated	-	-	-	-	40.96

Gokul T.[5] has conclude that the average compressive strength of concrete cubes with accelerated warm water curing method equivalent to 28 days was found to be 22.43 N/mm^2 for M-20 grade. And 40.7 N/mm^2 for M-40 grade of concrete. In this paper total no. of 42 cubes & 42 cylinder were cast & tested. They have used three type of curing method 1.)Accelerated curing, 2.)Wet gunny bag, 3.)Immersion curing.

Table 2.9: Mix Proportion For M-20 & M-40 Grade

Mix	Cement	Silica fume	Fine aggregate	Course aggregate	Water	Super Plasticizer
M-20	1	-	1.58	2.51	0.45	-
M-40	1	0.1	1.9	3.16	0.36	0.02

Pawar J. Abhijit.[6] Have used three method of accelerated curing 1.)Warm water, 2.) Boiling water method & 3.) Gradually rising temperature method. They were cast total 48 sample of two different mix proportions. Also they have used M-20 and M-25 concrete grade for concrete mix design. And conclude that warm water method gives quite comparable results and is acceptable for obtaining early strength.

Table 2.10: Mix Proportions

Concrete Grade		Cement	Water	Fine Aggregate	Course Aggregate (12mm)	Course Aggregate (20mm)
M-20	Proportion	1	0.48	2.43	1.5	2.29
	Quantitiesper m3 of concrete (kg)	320	154	778	480	733
M-25	Proportion	1	0.48	2.25	1.41	2.15
	Quantitiesper m3 of concrete (kg)	345	166	776	486	742

Table 2.11: 28 Days Compressive Strength Result of Cubes

Mix proportions	28 days compressive strength by normal curing in N/mm2			28 days strength by boiling water method in N/mm2				28 days strength by warm water method in N/mm2				28 days strength by gradually rising temperature method in N/mm2			
	Specimens	R28	Avg.	Specimens	Ra	R28	Avg.	Specimens	Ra	R28	Avg.	Specimens	Ra	R28	Avg.
M20	N1	28.78		B1	8.51	22.05		W1	14.09	26.74		R1	13.58	30.04	
	N2	28.66	28.84	B2	9.64	23.9	23.11	W2	13.88	26.53	26.89	R2	12.83	29.13	29.67
	N3	29.1		B3	9.33	23.4		W3	14.75	27.4		R3	13.27	29.85	
M25	N1	33.71		B1	10.41	25.17		W1	19.32	31.97		R1	16.2	34.67	
	N2	33.04	33.39	B2	11	26.13	25.68	W2	19.77	32.42	32.2	R2	16.42	35.02	34.87
	N3	33.43		B3	10.76	25.74		W3	19.58	32.23		R3	16.37	34.94	

Sirin K.[7] Have conclude that the applicability of accelerated curing to high strength concrete specimens is investigated. They using PC 42.5 cement and a superplasticizer, 25 different batchs of concrete with cement contents of 450, 500, 550, 600 kg/m3 were made with water to cement ratios ranging from 0.23 to 0.31. The accelerated curing method used was “the warm water curing method” which is described in the Turkish standard TS 3323. From each batch, 6 specimens were cast 15x30 cm cylindrical steel moulds with cap. 3 of these specimens were subjected to accelerated curing while the others were cured in the standard curing room for 28 days.

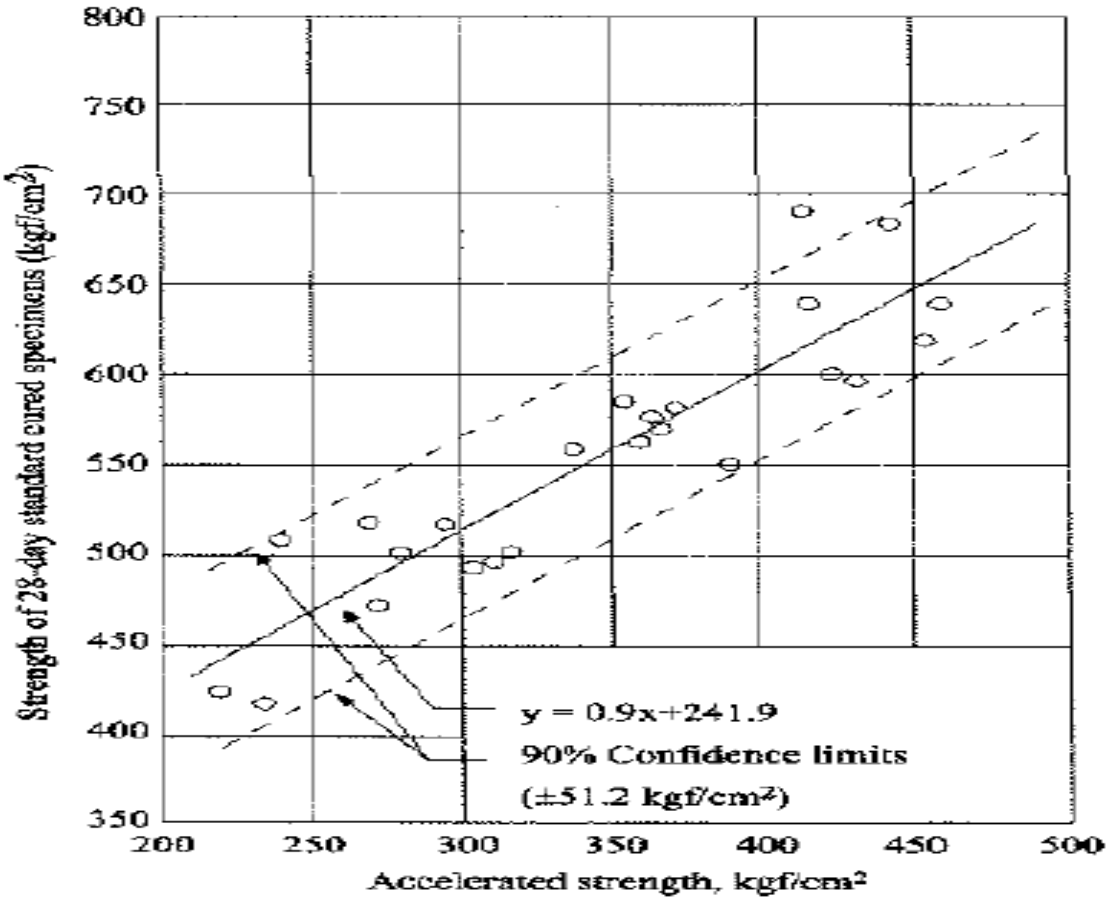

Figure 2.5: 90% Confidence Limis of Linear Regression Equation

2.4 Findings From Review of Literature

It has been observed through various literatures that early prediction of 28 days and 56 days compressive strength results through simple prediction factor is not possible for concrete mix containing cement replacement materials due to their physical and chemical properties on the rate of strength gain. It can also be conclued that increase in curing temperature has more favourable effact on the strength gain of concrete with cement and cement replacing material. Also it conclude actual compressive strength after conventional curing is greater than the strength predicted(accelerated curing) using the correlation equation as per IS 9013.

Chapter 3

Experimental Programme

3.1 General

The chapter describes the material properties which have been used in concrete as a fine aggregate, coarse aggregates and super plasticizer. Further procedure of casting of concrete for site and RMC mixes, normal and accelerated curing method are use for curing of concrete. This is followed by description of specimens used, test parameters, and test procedures. Different types of tests like, rebound hammer, UPV and compressive strength test with their procedures are explained in detail in this chapter.

3.2 Properties of Concrete Ingredients

Details about various ingredients of the concrete such as cement, fine aggregate, coarse aggregate and super plasticizer are as follow:

3.2.1 Cement

In this experimental programme the ordinary portland cement of grade 53 is used.Table 3.1 shows the physical properties of cement.

Table 3.1: Physical Properties of Cement

Sr. No.	Properties	Results Obtained	Specification as per IS:12269-1987[?]
1	Compressive Strength(MPa)		
	3 Days	29.17	Minimum:27
	7 Days	40.02	Minimum:37
	28 Days	55.19	Minimum: 53
2	Fineness(m2/kg)	308.47	Minimum:225
3	Setting Time (minutes)		
	Initial Setting Time	125	Minimum:30
	Final Setting Time	218	Maximum:600
4	Specific Gravity	3.16	NA

3.2.2 Fine Aggregate

Locally available river sand is used as fine aggregate. The aggregates are tested for properties in accordance with the IS standards.Test of fine aggregate has been performed as per IS-383 1970 provision .The result of properties of fine aggregates is mentioned in Table 3.2.

3.2.3 Coarse Aggregate

Locally available 10 mm and 20 mm crushed aggregates have been used as coarse aggregates. The aggregates are tested for properties in accordance with the IS standards.Test of fine aggregate has been performed as per IS-2386-[1963]provision .The result of properties of coarse aggregates is mentioned in Table 3.3 and Table 3.4.

Table 3.2: Properties of Fine Aggregates

Gradation of Fine Aggregates				
Sieve Size	Mass Retained (gms)	% of Mass Retained	Cumulative % of Mass Retained	Cumulative % of Passing
4.75 mm	0	0	0	100
2.36 mm	98.3	9.83	9.83	90.17
1.18 mm	162.9	16.29	26.12	73.88
600 micron	496.1	49.61	75.73	24.27
300 micron	216.8	21.68	97.41	2.59
150 micron	21.4	2.14	99.55	0.45
pan	2	0.2		
Total	997.5	99.75	308.64	
Fineness Modulus			308.64/100	3.094135338
Specific Gravity			2.66	

Table 3.4: Properties of Coarse Aggregates (10 mm)

Gradation of Coarse Aggregates(10 mm)				
Sieve Size	Mass Retained (gms)	% of Mass Retained	Cumulative % of Mass Retained	Cumulative % of Passing
12.5 mm	104.4	10.44	10.44	89.56
10 mm	202	20.2	30.64	69.36
4.75 mm	642.2	64.22	94.86	5.14
2.36 mm	42.6	4.26	99.12	0.88
1.18 mm	8.8	0.88	100	0
600 micron	0	0	100	0
300 micron	0	0	100	0
150 micron	0	0	100	0
Total	1000	100	635.06	
Fineness Modulus =			635.06/100 =	6.3506
Specific Gravity			2.65	

Table 3.3: Properties of Coarse Aggregates (20 mm)

Gradation of Coarse Aggregates (20 mm)				
Sieve Size	Mass Retained gms)	% of Mass Retained	Cumulative % of Mass Retained	Cumulative % of Passing
80 mm	0	0	0	100
40 mm	0	0	0	100
20 mm	383	38.3	38.3	61.7
10 mm	610	61	99.3	0.7
4.75 mm	7	0.7	100	0
2.36 mm	0	0	100	0
1.18 mm	0	0	100	0
600 micron	0	0	100	0
300 micron	0	0	100	0
150 micron	0	0	100	0
Total	1000	100	737.6	
Fineness Modulus =			737.6/100 =	7.376
Specific Gravity			2.79	

3.2.4 Superplasticizer

Determination of optimum dosage of superplasticizer plays a very important role in making durable and long - lasting concrete. This is done with the help of Marsh Cone test. In this experiment, the time taken for cement paste with dierent dosage of superplasticizer is measured. Figure 3.1 shows the result obtained from test in graphical form. The optimum dosage of superplasticizer 0.9% by weight of cement.

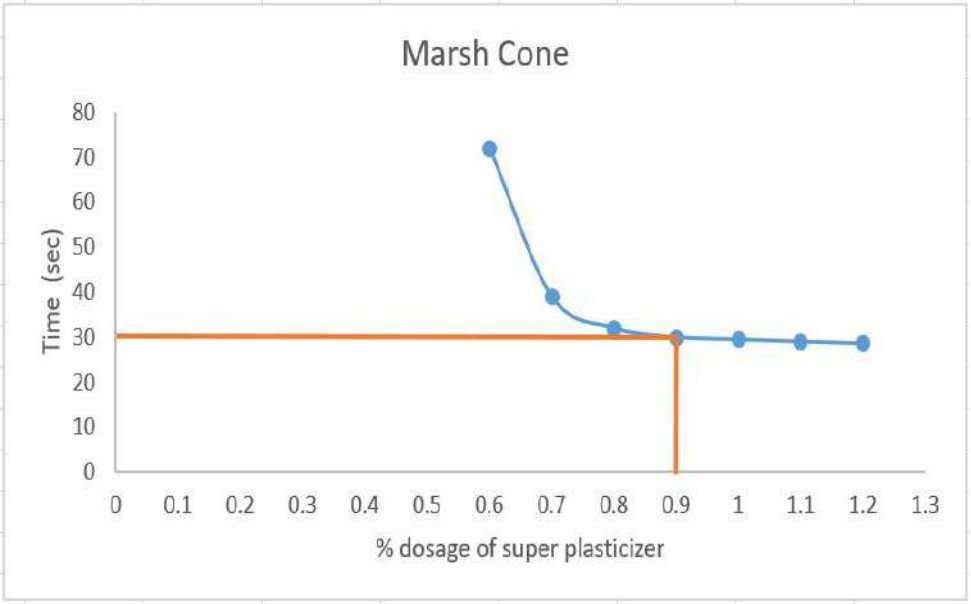

Figure 3.1: Marsh Cone Test

3.3 Casting of Concrete

For casting of concrete there is two type of mix consider:- site mix & RMC mix. the procedure of that mixes are described below

3.3.1 Site Mix

This process plays very important role with respect to all properties of fresh as well as hardened concrete. First of all weighing and batching process of all ingredients of concrete i.e. cement, fine aggregate and coarse aggregate i.e. 10 mm and 20 mm, water and super plasticizer is to be done at laboratory temperature with accuracy before starting the mixing process. Dry mix is to be made in the pan mixer for 20 to 30 seconds to make the consistent mix by mixing only fine and coarse aggregate first. Cement is added in to mix. After mixing of all ingredient is to be done then gradually water is added in to the mix. Moulds of the specimens are made ready for pouring the fresh concrete in it by applying proper lubricant. The mixing is continued for 3 to 4 minutes.
The concrete is poured into the moulds specimens immediately after the mixing of in three layers. Each layer of concrete mix is compacted using 20 mm dia. tamping rod with 25 to 30 manual strokes. The concrete mix is vibrated further until using table vibrator and make sure that over compaction is not to be done.

Figure 3.2: Casting of Cube Specimens

After compaction, concrete surface is levelled using trowel and sides of the mould are stuck by hammer in order to expel air if any present inside and make cube surfaces smooth. After casting, the concrete specimens remain as rest period of 24 hours as per IS: 516-1959 and then remove the mould. Curing of concrete specimens are to be done for 28 days.

3.3.2 RMC Mix

Due to proposed research, which aims to collects the mixtures of ready-mix-concrete made in mixture truck, the collection of samples was made outside the laboratory environment. For each one RMC mix total 12 cubes of specimens is to be cast. the concrete is poured

Figure 3.3: Collected Concrete Mix From RMC Plants

into the moulds specimens immediately after mixing pouring in three layers. Each layer of concrete mix is compacted using 20 mm dia. tamping rod with 25 to 30 manual strokes. after the completion of sample collection, the samples were kept open to air for 60 to 90 minutes (for intial setting time) then the samples were kept in accelerated curing tank.

Figure 3.4: Pouring and Compaction of Concrete

3.4 Accelerated Curing & Normal Curing

Figure 3.5: Accelerated Curing Tank

- Accelerated Curing

For the accelerated curing by warm water method the specimens are removed in 20 hours and achieved results in 1 day. And accelerated curing by boiling water method the specimens are removed in 26.5 hours and results achieved in 28.5 hours.

-Normal Curing

The test specimens shall be stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27 ± 2 C for 24 hours ± 0.5 hour from the time of addition of water to the dry ingredients. After this period, the specimens

shall be marked and removed from the moulds and, unless required for test within 24 hours, immediately submerged in clean, fresh water or saturated lime solution and kept there until taken out just prior to test. The water or solution in which the specimens are submerged shall be renewed every seven days and shall be maintained at a temperature of 27 ± 2 C. The specimens shall not be allowed to become dry at any time until they have been tested.

3.5 Testing of Concrete Specimens

3.5.1 Compressive Strength

The compressive strength of concrete has been evaluated using 3000 kN capacity Compression testing machine. For compressive strength test cube of size $150mm \times 150mm \times 150$mm are tested in compression accordance with test procedure given in IS : 516-1959.

Figure 3.6: Cube Test In Compression Testing Machine

Finding out compressive strength of cube specimen following equation is used:

$$\text{Compressive strength of concrete (N/mm}^2) = \frac{P \times 10^3}{A}$$

Where

P = failure of load of cube (kN)

A = area of concrete cube specimen in mm2 ($150mm \times 150mm$)

3.5.2 Rebound Hammer Test

Types of Non Destructive Tests CPWD has suggested 40 tests for different properties under investigation.

These tests can be broadly classified for different properties:

- Corrosion and embedded steel
- Concrete quality, durability and deterioration
- Concrete strength
- Integrity and performance

IS 13311:(part2)1992 Non-destructive testing of Concrete-methods of test Part 2 Rebound Hammer Specification:

- For testing, smooth, clean and dry surface is to be selected.
- The point of impact should be at least 20 mm away from any edge or shape discontinuity.

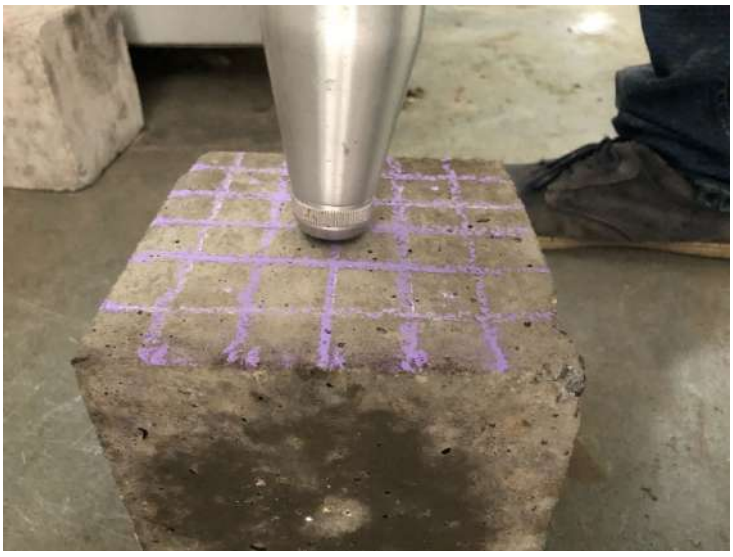

Figure 3.7: Taking Rebound Number

- Rebound hammer is used to find out the surface hardness of concrete surface. Rebound hammer is applied on the concrete surface either vertical or horizontal test procedure given in IS 13311-1991(part 2). Based on the scale given on rebound hammer. On cube specimen each face 5 readings are taken, hence total 30 readings for each cube of rebound hammer.

3.5.3 Ultrasonic Pulse Velocity Test

The quality of concrete is measured by the ultrasonic pulse velocity (UPV) test. In this method, an ultrasonic pulse of longitudinal vibration is produced by an electro acoustical transducer which is held in contact with surface of concrete. Proper airtight medium like grease is applied between the transducers and the concrete surface to avoid the entrapment of air. Direct method is adopted for cube specimens. The test procedure is given in IS 13311-1991(part 1).

Figure 3.8: Taking Velocity of Cubes By UPV

Table 3.5: Relation Between Concrete Quality and Pulse Velocity

PULSE VELOCITY BY CROSS PROBING (km/s)	CONCRETE QUALITY
Above 4.5	Excellent
3.5 to 4.5	Good
3.0 to 3.5	Medium
Below 3.0	Doubtful

Chapter 4

Result of Experimental Programme

4.1 General

This chapter contains test results of different type of accelerated curing like warm water and boiling water and 28 day results of various types of mix design. Non-destructive testing i.e. rebound hammer and UPV of concrete specimens with various type of concrete. Concrete at various age period of 1 day for accelerated curing & 7, 28 days for normal curing followed by compressive strength of concrete.

4.2 Summary of Mix Design

Mix design is given in table 4.1, 4.2 & 4.3. In table 4.1 the data collects from various site and it's given with practical applications and cast in laboratory. In table 4.2 the data collects from RMC plant which include with or without replacement of fly ash. In table 4.3 the all 7 mixes are casted in RMC plant.

Table 4.1: Mix Design Collected From Various Site

					Mix proportion						
Mix No.	**Practical application**	**Data from**	**Concrete grade**	**Structural members**	**Cement (kg/m3)**	**Sand (kg/m3)**	**C.A. (10 mm)**	**C.A. (20 mm)**	**Water (Lit.)**	**Super plas ticizer (%)**	**Fly ash (%)**
1	Bungalow (G+1)	SITE	M-20	Footing, Slab & Beam	315	810	440	655	170	-	-
2	Gov. quarters (G+13)	SITE	M-20	Footing	372	680	415	805	190	-	-
3	Canal Dam	SITE	M-20	Vertical mass concrete	310	840	506	760	145	1.1	-
4	Bungalow (G+2)	SITE	M-25	Column	340	805	478	678	160	-	-
5	Commercial building (G+4)	SITE	M-25	Column	360	816	524	623	157	0.8	-
6	Residential building (G+6)	SITE	M-25	Footing, column, beam & slab	352	820	500	638	162	1	-
7	Institutional building (G+7)	SITE	M-25	Beam & Slab	340	828	502	666	160	1	-
8	Gov. quarters (G+13)	SITE	M-25	Beam & Slab	386	679	415	805	189	-	-
9	Commercial building (G+4)	SITE	M-25	Beam, Slab	288	816	524	623	157	0.8	20
10	Canal Dam	SITE	M-25	Wind raft	322	772	485	727	166	1	-
				wall							
11	Canal Dam	SITE	M-30	Column, beam (RCC work)	410	770	464	697	168	0.95	
12	Gov. quarters (G+13)	SITE	M-30	Column	371	656	396	769	190	-	20
13	Residential building (G+13)	SITE	M-30	Column	400	782	476	676	162	-	
14	River bridge	SITE	M-35	Girder	440	721	350	816	176	0.5	
15	Canal Dam	SITE	M-35	Wearing coat (75-100 mm surface)	446	723	474	711	165	1.2	
16	Institutional building (G+7)	SITE	M-40	Column	442	714	584	584	178	1.2	
17	Railway over bridge (span-24 c/c)	SITE	M-40	Crash barrier	391	765	449	674	179	1	15
18	Railway over bridge (span-24 c/c)	SITE	M-45	PSC super structure (Girder)	413	739	451	676	179	1	15

Table 4.2: Mix Design Collected From RMC Plant

Mix No.	CONCRETE GRADE	TOTAL CEMENTITIOUS CONTENT (kg/m3)	CEMENT (kg/m3)	SAND (kg/m3)	C.A. (10 MM)	C.A. (20 MM)	WATER (LIt.)	SUPER PLASTICIZER (%)	FLY ASH (%)	FLY ASH (KG)
19	M-20	-	353	848	438	658	173	0.69	-	-
20	M-25	-	391	818	437	655	173	0.69	-	-
21	M-30	-	440	785	434	650	173	0.69	-	-
22	M-20	353	282	852	426	639	172	0.7	20	71
23	M-25	391	313	819	425	637	172	0.7	20	78
24	M-30	440	352	783	421	631	173	0.7	20	88
25	M-20	353	265	850	425	637	172	0.7	25	88
26	M-25	391	293	816	423	635	172	0.7	25	98
27	M-30	440	330	779	419	629	173	0.7	25	110
28	M-20	353	247	847	423	635	172	0.7	30	106
29	M-25	391	274	813	421	632	172	0.7	30	118
30	M-30	440	308	754	417	625	172	0.7	30	132
31	M-20	353	230	844	422	633	172	0.65	35	123
32	M-25	391	255	810	420	630	172	0.65	35	137
33	M-30	440	286	772	415	623	172	0.65	35	154

Table 4.3: RMC Mix

RMC Mix No.	CONCRETE GRADE	TOTAL CEMENTITIOUS CONTENT (kg/m3)	CEMENT (kg/m3)	SAND (kg/m3)	C.A. (10 MM)	C.A. (20 MM)	WATER (Lit.)	SUPER PLASTICIZER (%)	FLY ASH (%)
RMC-1	M-25	330	330	878	434	652	192	1.1	-
RMC-2	M-25	350	250	840	470	655	154	1	30
RMC-3	M-20	350	225	844	454	670	150	0.7	35
RMC-4	M-45	500	400	698	465	703	175	0.65	20
RMC-5	M-35	380	380	800	450	675	160	1	-
RMC-6	M-30	420	300	826	438	660	160	0.65	30
RMC-7	M-45	545	435	678	376	651	202	0.75	20

4.3 Rebound Hammer Results

Rebound hammer is used to find out the surface hardness of concrete surface. For all the results of Rebound hammer is applied on the concrete surface by vertically.

On cube specimen each face 5 readings are taken, hence total 30 readings for each cube of rebound hammer. So, for 3 cube total 90 reading is achieved. By the average of 3 cubes 1 average result of rebound hammer can get.

4.3.1 Accelerated Curing By Warm Water Method

Rebound hammer results is find out for accelerated curing by warm water method for all 40 mixes. with the help of result of rebound number is converted to compressive strength and by 1 day rebound hammer strength result is predicted to 28 days compressive strength result.

Table 4.4: Rebound Hammer Test on Warm Water Specimen Mix-1

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	20	20	20	22	23	21
Corner-2	21	20	21	20	21	22
Corner-3	22	20	20	20	20	20
Corner-4	20	22	20	21	22	21
Middle	20	22	20	22	22	20
Avg. of cube 1	= 20.83					
Cube-2						
Corner-1	22	20	22	20	20	23
Corner-2	20	21	22	21	22	20
Corner-3	20	20	20	20	22	20
Corner-4	20	21	20	20	20	21
Middle	25	20	23	20	21	22
Avg. of cube 2	= 20.93					
Cube-3						
Corner-1	20	20	21	20	21	21
Corner-2	20	21	22	21	20	20
Corner-3	20	22	20	20	22	20
Corner-4	22	20	20	22	20	21
Middle	22	20	23	23	21	21
Avg. of cube 3	= 20.86					
Total avg. of cubes	= 20.87					

Table 4.5: Rebound Hammer Test on Warm Water Specimen Mix-2

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	20	23	22	25	21	19
Corner-2	22	20	29	19	22	20
Corner-3	20	22	23	16	23	22
Corner-4	20	23	22	25	21	24
Middle	24	25	24	30	25	24
Avg. of cube 1	= 22.50					
Cube-2						
Corner-1	21	19	21	20	22	20
Corner-2	22	18	22	22	23	19
Corner-3	20	18	24	25	20	22
Corner-4	15	21	20	20	19	20
Middle	22	27	30	24	22	25
Avg. of cube 2	= 21.43					
Cube-3						
Corner-1	20	23	20	25	20	24
Corner-2	22	24	24	24	19	21
Corner-3	21	20	23	21	25	23
Corner-4	20	19	20	22	20	19
Middle	24	22	27	26	24	25
Avg. of cube 3	= 22.23					
Total avg. of cubes	= 22.05					

Table 4.6: Rebound Hammer Test on Warm Water Specimen Mix-3

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	23	21	21	22	23	24
Corner-2	22	22	20	27	22	20
Corner-3	22	23	22	25	24	25
Corner-4	21	20	20	21	20	22
Middle	26	26	26	21	22	22
Avg. of cube 1	= 22.50					
Cube-2						
Corner-1	23	20	23	23	26	21
Corner-2	21	21	21	30	20	22
Corner-3	24	20	20	21	24	25
Corner-4	20	20	21	22	22	24
Middle	20	23	24	25	22	26
Avg. of cube 2	= 22.46					
Cube-3						
Corner-1	22	25	24	22	24	25
Corner-2	21	27	20	24	22	22
Corner-3	25	20	25	20	21	20
Corner-4	20	22	21	25	24	25
Middle	25	23	22	22	26	21
Avg. of cube 3	= 22.83					
Total avg. of cubes	= 22.59					

Table 4.7: Rebound Hammer Test on Warm Water Specimen Mix-4

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	23	21	21	22	23	24
Corner-2	22	22	20	20	22	20
Corner-3	20	23	22	20	24	20
Corner-4	21	19	20	21	20	22
Middle	19	20	22	21	22	22
Avg. of cube 1	= 21.26					
Cube-2						
Corner-1	23	19	23	23	20	21
Corner-2	21	21	21	19	20	22
Corner-3	24	22	20	21	24	21
Corner-4	20	20	21	22	22	24
Middle	20	23	22	23	22	20
Avg. of cube 2	= 21.46					
Cube-3						
Corner-1	22	24	24	22	24	23
Corner-2	21	21	20	23	22	22
Corner-3	23	20	22	20	21	20
Corner-4	20	22	21	19	20	21
Middle	22	23	22	22	21	21
Avg. of cube 3	= 21.6					
Total avg. of cubes	= 21.44					

Table 4.8: Rebound Hammer Test on Warm Water Specimen Mix-5

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	24	25	22	25	25	24
Corner-2	23	24	25	27	25	26
Corner-3	25	23	24	22	23	24
Corner-4	26	25	24	24	26	25
Middle	25	27	26	24	23	22
Avg. of cube 1	= 24.43					
Cube-2						
Corner-1	25	23	25	23	25	26
Corner-2	27	22	26	23	24	25
Corner-3	22	24	24	25	23	26
Corner-4	24	26	25	26	25	24
Middle	26	27	22	25	27	22
Avg. of cube 2	= 24.56					
Cube-3						
Corner-1	25	26	25	23	27	24
Corner-2	26	25	27	22	26	23
Corner-3	24	26	22	24	24	25
Corner-4	25	24	24	26	25	26
Middle	22	22	26	27	23	25
Avg. of cube 3	= 24.63					
Total avg. of cubes	= 24.54					

Table 4.9: Rebound Hammer Test on Warm Water Specimen Mix-6

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	24	25	22	25	25	24
Corner-2	23	24	25	27	25	26
Corner-3	24	23	24	22	23	24
Corner-4	26	25	23	24	26	25
Middle	25	27	26	24	23	21
Avg. of cube 1	= 24.3					
Cube-2						
Corner-1	25	23	25	23	25	26
Corner-2	27	22	26	23	24	25
Corner-3	22	23	24	25	23	26
Corner-4	24	26	25	26	25	24
Middle	26	26	22	25	26	22
Avg. of cube 2	= 24.46					
Cube-3						
Corner-1	25	26	25	23	27	24
Corner-2	25	25	26	22	26	23
Corner-3	24	26	22	24	24	25
Corner-4	25	24	24	26	25	26
Middle	22	22	26	27	23	25
Avg. of cube 3	= 24.51					
Total avg. of cubes	= 24.42					

Table 4.10: Rebound Hammer Test on Warm Water Specimen Mix-7

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	23	21	21	22	23	24
Corner-2	22	22	20	20	22	20
Corner-3	20	23	22	20	24	20
Corner-4	21	19	20	21	20	22
Middle	19	20	22	21	22	22
Avg. of cube 1	= 21.2					
Cube-2						
Corner-1	23	19	23	23	20	21
Corner-2	21	21	21	19	20	22
Corner-3	24	22	20	21	24	21
Corner-4	20	20	21	22	22	24
Middle	20	23	22	23	22	20
Avg. of cube 2	= 21.4					
Cube-3						
Corner-1	22	24	24	22	24	23
Corner-2	21	21	20	23	22	22
Corner-3	23	20	22	20	21	20
Corner-4	20	22	21	19	20	21
Middle	22	23	22	22	21	21
Avg. of cube 3	= 21.6					
Total avg. of cubes	= 21.4					

Table 4.11: Rebound Hammer Test on Warm Water Specimen Mix-8

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	24	25	26	25	25	24
Corner-2	25	24	25	27	25	26
Corner-3	25	25	24	22	23	24
Corner-4	26	25	24	24	26	25
Middle	26	27	26	24	23	22
Avg. of cube 1	= 24.78					
Cube-2						
Corner-1	25	23	25	23	25	26
Corner-2	27	22	26	23	24	25
Corner-3	22	24	24	25	23	26
Corner-4	24	26	25	26	25	24
Middle	26	27	22	25	27	22
Avg. of cube 2	= 24.59					
Cube-3						
Corner-1	25	26	25	23	27	24
Corner-2	26	25	27	22	26	23
Corner-3	24	26	22	24	24	25
Corner-4	25	24	24	26	25	26
Middle	22	22	26	27	23	25
Avg. of cube 3	= 24.93					
Total avg. of cubes	= 24.76					

Table 4.12: Rebound Hammer Test on Warm Water Specimen Mix-9

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	23	21	21	22	23	21
Corner-2	22	22	20	20	22	20
Corner-3	20	23	22	22	24	20
Corner-4	21	22	20	21	20	22
Middle	22	20	22	21	22	22
Avg. of cube 1	= 21.43					
Cube-2						
Corner-1	23	21	23	23	20	21
Corner-2	21	21	21	20	20	22
Corner-3	24	22	20	21	24	21
Corner-4	20	20	21	22	22	24
Middle	20	23	22	23	22	20
Avg. of cube 2	= 21.57					
Cube-3						
Corner-1	22	24	24	22	24	23
Corner-2	21	21	20	23	22	22
Corner-3	23	20	22	20	21	20
Corner-4	20	22	21	22	20	21
Middle	22	23	22	22	21	21
Avg. of cube 3	= 21.7					
Total avg. of cubes	= 21.56					

Table 4.13: Rebound Hammer Test on Warm Water Specimen Mix-10

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	26	24	23	24	23	24
Corner-2	22	23	20	23	22	20
Corner-3	20	23	22	25	24	21
Corner-4	22	22	20	22	20	22
Middle	23	20	22	20	22	22
Avg. of cube 1	= 22.20					
Cube-2						
Corner-1	25	23	24	23	24	24
Corner-2	20	22	22	24	23	23
Corner-3	21	24	20	22	23	25
Corner-4	22	20	25	20	24	22
Middle	22	22	23	22	20	20
Avg. of cube 2	= 22.47					
Cube-3						
Corner-1	24	24	23	24	24	25
Corner-2	23	22	22	23	22	23
Corner-3	25	23	24	23	21	21
Corner-4	22	25	23	24	22	22
Middle	23	23	22	20	25	23
Avg. of cube 3	= 22.82					
Total avg. of cubes	= 22.50					

Table 4.14: Rebound Hammer Test on Warm Water Specimen Mix-11

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	28	29	27	29	28	28
Corner-2	29	28	28	28	29	28
Corner-3	28	28	29	29	28	27
Corner-4	30	28	28	27	30	29
Middle	30	30	27	30	29	30
Avg. of cube 1	= 28.53					
Cube-2						
Corner-1	27	28	27	29	28	29
Corner-2	28	29	28	28	29	28
Corner-3	29	28	27	28	28	29
Corner-4	28	30	29	28	29	27
Middle	27	29	30	30	30	30
Avg. of cube 2	= 28.21					
Cube-3						
Corner-1	29	30	28	30	27	28
Corner-2	28	28	28	29	28	29
Corner-3	29	29	27	28	29	28
Corner-4	28	27	29	30	28	30
Middle	30	30	30	30	27	29
Avg. of cube 3	= 28.67					
Total avg. of cubes	= 28.47					

Table 4.15: Rebound Hammer Test on Warm Water Specimen Mix-12

ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	27	26	28	26	27	28
Corner-2	28	27	27	28	26	28
Corner-3	27	26	28	27	27	27
Corner-4	28	28	28	28	28	26
Middle	28	27	27	28	27	27
Avg. of cube 1	= 27.20					
Cube-2						
Corner-1	26	26	28	29	28	27
Corner-2	27	28	28	28	27	26
Corner-3	28	27	27	27	28	26
Corner-4	28	28	26	28	28	28
Middle	27	28	27	28	27	29
Avg. of cube 2	= 27.86					
Cube-3						
Corner-1	27	28	29	26	26	28
Corner-2	28	27	26	27	28	28
Corner-3	27	28	26	26	29	27
Corner-4	29	28	28	28	28	26
Middle	28	27	29	27	27	28
Avg. of cube 3	= 27.45					
Total avg. of cubes	= 27.50					

Table 4.16: Rebound Hammer Test on Warm Water Specimen Mix-13

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	28	27	30	27	30	28
Corner-2	30	28	29	29	29	30
Corner-3	29	28	30	28	30	29
Corner-4	28	29	28	29	29	27
Middle	29	28	28	28	27	29
Avg. of cube 1	= 28.2					
Cube-2						
Corner-1	30	28	27	30	28	27
Corner-2	29	30	28	29	30	29
Corner-3	30	29	28	30	29	28
Corner-4	28	27	29	29	28	29
Middle	28	29	28	27	29	28
Avg. of cube 2	= 28.9					
Cube-3						
Corner-1	28	30	28	27	27	30
Corner-2	30	29	30	28	29	29
Corner-3	29	30	29	28	28	30
Corner-4	27	28	28	29	29	29
Middle	29	28	29	28	28	27
Avg. of cube 3	= 28.7					
Total avg. of cubes	= 28.6					

Table 4.17: Rebound Hammer Test on Warm Water Specimen Mix-14

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	33	34	31	33	32	33
Corner-2	32	33	32	33	32	32
Corner-3	34	32	32	34	34	31
Corner-4	32	33	34	32	34	34
Middle	33	31	33	31	33	33
Avg. of cube 1	= 31.9					
Cube-2						
Corner-1	32	31	33	33	34	33
Corner-2	32	32	32	32	33	33
Corner-3	34	32	34	31	32	34
Corner-4	34	34	32	34	33	32
Middle	33	33	33	33	31	31
Avg. of cube 2	= 30.7					
Cube-3						
Corner-1	33	32	34	33	33	31
Corner-2	32	32	33	33	32	32
Corner-3	34	34	32	34	31	32
Corner-4	32	34	33	32	34	34
Middle	33	33	31	31	33	33
Avg. of cube 3	= 31.8					
Total avg. of cubes	= 31.5					

Table 4.18: Rebound Hammer Test on Warm Water Specimen Mix-15

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	33	34	32	34	32	33
Corner-2	32	33	32	33	32	32
Corner-3	34	31	34	31	34	34
Corner-4	33	32	32	32	32	33
Middle	33	33	33	33	33	33
Avg. of cube 1	= 33.1					
Cube-2						
Corner-1	32	34	33	33	34	32
Corner-2	32	33	32	32	33	32
Corner-3	34	31	34	34	31	34
Corner-4	32	32	33	33	32	32
Middle	33	33	33	33	33	33
Avg. of cube 2	= 32.5					
Cube-3						
Corner-1	34	33	34	32	33	32
Corner-2	33	32	33	32	32	32
Corner-3	31	34	31	34	34	34
Corner-4	32	33	32	32	33	32
Middle	33	33	33	33	33	33
Avg. of cube 3	= 32.3					
Total avg. of cubes	= 32.6					

Table 4.19: Rebound Hammer Test on Warm Water Specimen Mix-16

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	35	36	37	36	37	35
Corner-2	36	37	35	37	35	36
Corner-3	36	35	36	35	36	36
Corner-4	35	36	36	36	36	35
Middle	34	35	34	35	34	34
Avg. of cube 1	= 36.0					
Cube-2						
Corner-1	35	35	37	36	38	36
Corner-2	36	36	35	37	35	37
Corner-3	36	36	36	35	36	35
Corner-4	35	35	36	36	36	36
Middle	34	34	34	35	34	35
Avg. of cube 2	= 35.2					
Cube-3						
Corner-1	37	36	35	35	37	36
Corner-2	35	37	36	36	35	37
Corner-3	36	35	36	36	36	35
Corner-4	36	36	35	35	36	36
Middle	34	35	34	34	34	35
Avg. of cube 3	= 35.5					
Total avg. of cubes	= 35.53					

Table 4.20: Rebound Hammer Test on Warm Water Specimen Mix-17

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	34	33	33	32	33	34
Corner-2	33	34	34	34	33	32
Corner-3	35	32	33	33	32	35
Corner-4	33	34	34	34	34	33
Middle	32	33	33	33	33	33
Avg. of cube 1	= 34.1					
Cube-2						
Corner-1	33	34	34	33	33	32
Corner-2	33	32	33	34	34	34
Corner-3	32	35	35	32	33	33
Corner-4	34	33	33	34	34	34
Middle	33	33	32	33	33	33
Avg. of cube 2	= 33.5					
Cube-3						
Corner-1	32	33	34	34	33	33
Corner-2	34	33	32	33	34	34
Corner-3	33	32	35	35	32	33
Corner-4	34	34	33	33	34	34
Middle	33	33	33	32	33	33
Avg. of cube 3	= 33.2					
Total avg. of cubes	= 33.66					

Table 4.21: Rebound Hammer Test on Warm Water Specimen Mix-18

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	38	37	35	36	37	38
Corner-2	37	38	37	38	37	36
Corner-3	36	36	36	37	36	37
Corner-4	37	38	37	38	37	37
Middle	38	37	38	37	38	38
Avg. of cube 1	= 37.1					
Cube-2						
Corner-1	36	37	38	38	37	35
Corner-2	38	37	36	37	38	37
Corner-3	37	36	37	36	36	36
Corner-4	38	37	37	37	38	37
Middle	37	38	38	38	37	38
Avg. of cube 2	= 36.8					
Cube-3						
Corner-1	37	35	38	36	37	38
Corner-2	38	37	36	38	37	37
Corner-3	36	36	37	37	36	36
Corner-4	38	37	37	38	37	37
Middle	37	38	38	37	38	38
Avg. of cube 3	= 37.2					
Total avg. of cubes	= 37.0					

Table 4.22: Rebound Hammer Test on Warm Water Specimen Mix-19

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	23	22	24	23	24	23
Corner-2	24	24	23	24	24	24
Corner-3	23	23	22	23	22	23
Corner-4	22	22	22	23	21	22
Middle	22	22	23	22	23	22
Avg. of cube 1	= 22.9					
Cube-2						
Corner-1	24	23	23	22	24	23
Corner-2	24	24	24	24	23	24
Corner-3	22	23	23	23	22	23
Corner-4	21	22	22	22	22	23
Middle	23	22	22	22	23	22
Avg. of cube 2	= 22.4					
Cube-3						
Corner-1	23	22	24	23	24	23
Corner-2	24	24	23	24	24	24
Corner-3	23	23	22	23	22	23
Corner-4	22	22	22	23	21	22
Middle	22	22	23	22	23	22
Avg. of cube 3	= 22.8					
Total avg. of cubes	= 22.73					

Table 4.23: Rebound Hammer Test on Warm Water Specimen Mix-20

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	24	26	25	25	24	24
Corner-2	25	25	26	25	26	25
Corner-3	23	24	24	26	25	24
Corner-4	26	25	24	25	24	26
Middle	24	24	26	24	26	24
Avg. of cube 1	= 24.6					
Cube-2						
Corner-1	24	24	24	26	25	25
Corner-2	26	25	25	25	26	25
Corner-3	25	24	23	24	24	26
Corner-4	24	26	26	25	24	25
Middle	26	24	24	24	26	24
Avg. of cube 2	= 25.1					
Cube-3						
Corner-1	24	26	24	24	25	25
Corner-2	25	25	26	25	26	25
Corner-3	23	24	25	24	24	26
Corner-4	26	25	24	26	24	25
Middle	24	24	26	24	26	24
Avg. of cube 3	= 24.4					
Total avg. of cubes	= 24.73					

Table 4.24: Rebound Hammer Test on Warm Water Specimen Mix-21

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	27	29	30	28	29	28
Corner-2	28	30	28	30	28	28
Corner-3	29	29	29	29	29	29
Corner-4	28	28	27	28	27	28
Middle	30	28	28	28	28	30
Avg. of cube 1	= 27.8					
Cube-2						
Corner-1	28	29	28	27	29	30
Corner-2	30	28	28	28	30	28
Corner-3	29	29	29	29	29	29
Corner-4	28	27	28	28	28	27
Middle	28	28	30	30	28	28
Avg. of cube 2	= 28.9					
Cube-3						
Corner-1	29	28	27	29	30	28
Corner-2	28	28	28	30	28	30
Corner-3	29	29	29	29	29	29
Corner-4	27	28	28	28	27	28
Middle	28	30	30	28	28	28
Avg. of cube 3	= 29.1					
Total avg. of cubes	= 28.53					

Table 4.25: Rebound Hammer Test on Warm Water Specimen Mix-22

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	21	23	22	23	23	22
Corner-2	22	22	23	22	23	22
Corner-3	23	23	21	23	21	23
Corner-4	22	21	22	21	22	22
Middle	21	22	21	22	21	21
Avg. of cube 1	= 22.2					
Cube-2						
Corner-1	23	23	22	22	21	23
Corner-2	22	23	22	23	22	22
Corner-3	23	21	23	21	23	23
Corner-4	21	22	22	22	22	21
Middle	22	21	21	21	21	22
Avg. of cube 2	= 21.9					
Cube-3						
Corner-1	21	23	23	23	22	22
Corner-2	22	22	22	23	22	23
Corner-3	23	23	23	21	23	21
Corner-4	22	21	21	22	22	22
Middle	21	22	22	21	21	21
Avg. of cube 3	= 21.7					
Total avg. of cubes	= 21.93					

Table 4.26: Rebound Hammer Test on Warm Water Specimen Mix-23

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	22	24	23	25	24	25
Corner-2	24	23	24	23	24	24
Corner-3	26	23	26	23	26	26
Corner-4	23	24	24	24	24	23
Middle	24	25	23	25	23	24
Avg. of cube 1	= 24.1					
Cube-2						
Corner-1	23	25	25	22	24	24
Corner-2	24	23	24	24	23	24
Corner-3	26	23	26	26	23	26
Corner-4	24	24	23	23	24	24
Middle	23	25	24	24	25	23
Avg. of cube 2	= 23.9					
Cube-3						
Corner-1	25	22	24	24	23	25
Corner-2	24	24	23	24	24	23
Corner-3	26	26	23	26	26	23
Corner-4	23	23	24	24	24	24
Middle	24	24	25	23	23	25
Avg. of cube 3	= 23.6					
Total avg. of cubes	= 23.86					

Table 4.27: Rebound Hammer Test on Warm Water Specimen Mix-24

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	26	26	27	25	28	27
Corner-2	27	27	28	26	28	27
Corner-3	28	27	28	27	28	28
Corner-4	27	28	27	28	27	27
Middle	28	28	26	28	26	28
Avg. of cube 1	= 28.1					
Cube-2						
Corner-1	25	28	27	26	26	27
Corner-2	26	28	27	27	27	28
Corner-3	27	28	28	28	27	28
Corner-4	28	27	27	27	28	27
Middle	28	26	28	28	28	26
Avg. of cube 2	= 27.5					
Cube-3						
Corner-1	25	28	26	26	27	27
Corner-2	26	28	27	27	28	27
Corner-3	27	28	28	27	28	28
Corner-4	28	27	27	28	27	27
Middle	28	26	28	28	26	28
Avg. of cube 3	= 27.6					
Total avg. of cubes	= 27.8					

Table 4.28: Rebound Hammer Test on Warm Water Specimen Mix-25

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	23	23	22	23	24	23
Corner-2	21	21	23	22	23	21
Corner-3	22	22	21	22	21	22
Corner-4	23	21	23	21	23	23
Middle	22	23	21	23	21	22
Avg. of cube 1	= 22.4					
Cube-2						
Corner-1	23	24	23	23	23	22
Corner-2	22	23	21	21	21	23
Corner-3	22	21	22	22	22	21
Corner-4	21	23	23	23	21	23
Middle	23	21	22	22	23	21
Avg. of cube 2	= 22.0					
Cube-3						
Corner-1	23	23	22	23	24	23
Corner-2	21	21	23	22	23	21
Corner-3	22	22	21	22	21	22
Corner-4	23	21	23	21	23	23
Middle	22	23	21	23	21	22
Avg. of cube 3	= 21.8					
Total avg. of cubes	= 22.0					

Table 4.29: Rebound Hammer Test on Warm Water Specimen Mix-26

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	25	24	24	25	24	24
Corner-2	22	25	23	25	24	22
Corner-3	24	23	25	23	25	24
Corner-4	24	23	23	23	23	25
Middle	23	22	24	22	24	23
Avg. of cube 1	= 23.6					
Cube-2						
Corner-1	24	24	25	24	24	25
Corner-2	24	22	22	25	23	25
Corner-3	25	24	24	23	25	23
Corner-4	23	25	24	23	23	23
Middle	24	23	23	22	24	22
Avg. of cube 2	= 22.8					
Cube-3						
Corner-1	25	24	24	25	24	24
Corner-2	22	25	23	25	24	22
Corner-3	24	23	25	23	25	24
Corner-4	24	23	23	23	23	25
Middle	23	22	24	22	24	23
Avg. of cube 3	= 23.9					
Total avg. of cubes	= 23.5					

Table 4.30: Rebound Hammer Test on Warm Water Specimen Mix-27

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	27	28	26	26	27	27
Corner-2	26	27	28	27	28	27
Corner-3	28	25	26	28	26	28
Corner-4	27	28	27	28	27	27
Middle	26	26	27	26	27	26
Avg. of cube 1	= 27.3					
Cube-2						
Corner-1	27	27	27	28	26	26
Corner-2	28	27	26	27	28	27
Corner-3	26	28	28	25	26	28
Corner-4	27	27	27	28	27	28
Middle	27	26	26	26	27	26
Avg. of cube 2	= 26.7					
Cube-3						
Corner-1	26	26	27	27	27	28
Corner-2	28	27	28	27	26	27
Corner-3	26	28	26	28	28	25
Corner-4	27	28	27	27	27	28
Middle	27	26	27	26	26	26
Avg. of cube 3	= 26.3					
Total avg. of cubes	= 26.8					

Table 4.31: Rebound Hammer Test on Warm Water Specimen Mix-28

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	21	23	20	22	23	21
Corner-2	22	22	22	23	22	22
Corner-3	21	21	21	21	21	21
Corner-4	22	21	22	21	22	22
Middle	22	22	21	22	21	22
Avg. of cube 1	= 20.9					
Cube-2						
Corner-1	23	21	21	23	20	22
Corner-2	22	22	22	22	22	23
Corner-3	21	21	21	21	21	21
Corner-4	22	22	22	21	22	21
Middle	21	22	22	22	21	22
Avg. of cube 2	= 21.5					
Cube-3						
Corner-1	21	23	20	22	23	21
Corner-2	22	22	22	23	22	22
Corner-3	21	21	21	21	21	21
Corner-4	22	21	22	21	22	22
Middle	22	22	21	22	21	22
Avg. of cube 3	= 21.8					
Total avg. of cubes	= 21.46					

Table 4.32: Rebound Hammer Test on Warm Water Specimen Mix-29

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	23	25	24	24	25	22
Corner-2	22	24	23	23	24	22
Corner-3	23	22	23	22	23	23
Corner-4	24	23	22	23	22	24
Middle	24	23	25	23	25	24
Avg. of cube 1	= 22.8					
Cube-2						
Corner-1	25	22	23	25	24	24
Corner-2	24	22	22	24	23	23
Corner-3	23	23	23	22	23	22
Corner-4	22	24	24	23	22	23
Middle	25	24	24	23	25	23
Avg. of cube 2	= 23.2					
Cube-3						
Corner-1	23	25	25	22	24	24
Corner-2	22	24	24	22	23	23
Corner-3	23	22	23	23	23	22
Corner-4	24	23	22	24	22	23
Middle	24	23	25	24	25	23
Avg. of cube 3	= 23.8					
Total avg. of cubes	= 23.3					

Table 4.33: Rebound Hammer Test on Warm Water Specimen Mix-30

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	26	27	25	28	26	25
Corner-2	25	26	26	26	26	25
Corner-3	26	27	27	27	27	26
Corner-4	27	28	27	28	27	27
Middle	26	26	26	26	26	26
Avg. of cube 1	= 25.9					
Cube-2						
Corner-1	26	25	26	27	25	28
Corner-2	26	25	25	26	26	26
Corner-3	27	26	26	27	27	27
Corner-4	27	27	27	28	27	28
Middle	26	26	26	26	26	26
Avg. of cube 2	= 26.1					
Cube-3						
Corner-1	25	28	26	25	26	27
Corner-2	26	26	26	25	25	26
Corner-3	27	27	27	26	26	27
Corner-4	27	28	27	27	27	28
Middle	26	26	26	26	26	26
Avg. of cube 3	= 26.8					
Total avg. of cubes	= 26.3					

Table 4.34: Rebound Hammer Test on Warm Water Specimen Mix-31

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	22	20	21	21	21	22
Corner-2	21	22	20	22	20	22
Corner-3	20	21	22	21	22	21
Corner-4	20	20	20	20	20	20
Middle	21	21	21	21	21	21
Avg. of cube 1	= 20.7					
Cube-2						
Corner-1	21	22	22	20	21	21
Corner-2	20	22	21	22	20	22
Corner-3	22	21	20	21	22	21
Corner-4	20	20	20	20	20	20
Middle	21	21	21	21	21	21
Avg. of cube 2	= 21.3					
Cube-3						
Corner-1	21	21	21	22	22	20
Corner-2	20	22	20	22	21	22
Corner-3	22	21	22	21	20	21
Corner-4	20	20	20	20	20	20
Middle	21	21	21	21	21	21
Avg. of cube 3	= 20.4					
Total avg. of cubes	= 20.8					

Table 4.35: Rebound Hammer Test on Warm Water Specimen Mix-32

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	24	23	25	24	24	23
Corner-2	22	24	22	24	22	22
Corner-3	24	22	23	22	25	24
Corner-4	23	23	22	23	22	23
Middle	22	24	24	24	24	22
Avg. of cube 1	= 23.5					
Cube-2						
Corner-1	24	24	23	24	23	25
Corner-2	24	22	22	22	24	22
Corner-3	22	25	24	24	22	23
Corner-4	23	22	23	23	23	22
Middle	24	24	22	22	24	24
Avg. of cube 2	= 23.0					
Cube-3						
Corner-1	23	25	24	24	24	23
Corner-2	22	22	24	22	22	24
Corner-3	24	23	22	25	24	22
Corner-4	23	22	23	22	23	23
Middle	22	24	24	24	22	24
Avg. of cube 3	= 22.5					
Total avg. of cubes	= 23.0					

Table 4.36: Rebound Hammer Test on Warm Water Specimen Mix-33

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	25	25	24	23	24	25
Corner-2	23	24	23	24	23	24
Corner-3	24	24	25	24	25	24
Corner-4	23	23	24	23	24	23
Middle	24	24	23	24	23	24
Avg. of cube 1	= 23.5					
Cube-2						
Corner-1	24	25	25	25	24	23
Corner-2	23	24	23	24	23	24
Corner-3	25	24	24	24	25	24
Corner-4	24	23	23	23	24	23
Middle	23	24	24	24	23	24
Avg. of cube 2	= 24.2					
Cube-3						
Corner-1	25	25	24	25	22	23
Corner-2	23	24	23	24	23	24
Corner-3	24	24	25	24	25	24
Corner-4	23	23	24	23	24	23
Middle	24	24	23	24	23	24
Avg. of cube 3	= 23.9					
Total avg. of cubes	= 23.86					

Table 4.37: Rebound Hammer Test on Warm Water Specimen RMC Mix-1

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	22	24	20	20	24	24
Corner-2	21	21	23	25	25	22
Corner-3	23	22	19	20	21	21
Corner-4	21	23	24	20	24	22
Middle	25	26	22	21	22	25
Avg. of cube 1	= 22.40					
Cube-2						
Corner-1	20	25	25	24	25	26
Corner-2	21	23	24	22	21	24
Corner-3	22	22	22	23	24	25
Corner-4	20	25	23	23	23	24
Middle	22	20	25	25	23	22
Avg. of cube 2	= 23.10					
Cube-3						
Corner-1	20	22	22	25	24	20
Corner-2	23	20	23	22	22	25
Corner-3	20	22	22	24	24	24
Corner-4	20	20	20	25	21	24
Middle	24	23	23	20	25	22
Avg. of cube 3	= 22.36					
Total avg. of cubes	= 22.62					

Table 4.38: Rebound Hammer Test on Warm Water Specimen RMC Mix-2

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	23	24	21	22	23	21
Corner-2	22	22	24	20	22	23
Corner-3	24	23	22	23	24	20
Corner-4	25	22	20	21	20	24
Middle	22	20	23	24	22	22
Avg. of cube 1	= 22.67					
Cube-2						
Corner-1	23	23	23	21	23	24
Corner-2	21	22	22	24	22	22
Corner-3	24	24	20	22	24	23
Corner-4	20	20	21	20	25	22
Middle	22	22	22	23	22	20
Avg. of cube 2	= 22.23					
Cube-3						
Corner-1	22	24	24	22	24	23
Corner-2	21	21	20	23	22	22
Corner-3	23	20	22	20	21	20
Corner-4	20	22	21	22	20	21
Middle	22	23	22	22	21	21
Avg. of cube 3	= 22.10					
Total avg. of cubes	= 22.33					

Table 4.39: Rebound Hammer Test on Warm Water Specimen RMC Mix-3

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	20	20	22	21	20	21
Corner-2	22	22	21	22	21	22
Corner-3	20	21	21	21	21	20
Corner-4	22	21	20	21	20	21
Middle	23	20	22	20	22	22
Avg. of cube 1	= 21.0					
Cube-2						
Corner-1	20	21	22	21	20	20
Corner-2	21	22	21	22	22	22
Corner-3	21	20	21	21	20	21
Corner-4	20	21	20	21	22	21
Middle	22	22	22	20	23	20
Avg. of cube 2	= 21.4					
Cube-3						
Corner-1	20	20	20	21	22	21
Corner-2	22	22	21	22	21	22
Corner-3	20	21	21	20	21	21
Corner-4	22	21	20	21	20	21
Middle	23	20	22	22	22	20
Avg. of cube 3	= 20.6					
Total avg. of cubes	= 21.0					

Table 4.40: Rebound Hammer Test on Warm Water Specimen RMC Mix-4

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	30	34	32	33	32	31
Corner-2	32	32	32	32	33	32
Corner-3	31	31	33	31	33	31
Corner-4	33	33	31	33	31	33
Middle	33	31	31	31	31	33
Avg. of cube 1	= 31.5					
Cube-2						
Corner-1	32	31	32	33	30	34
Corner-2	33	32	32	32	32	32
Corner-3	33	31	33	31	31	31
Corner-4	31	33	31	33	33	33
Middle	31	33	31	31	33	31
Avg. of cube 2	= 30.9					
Cube-3						
Corner-1	32	31	30	34	32	33
Corner-2	33	32	32	32	32	32
Corner-3	33	31	31	31	33	31
Corner-4	31	33	33	33	31	33
Middle	31	33	33	31	31	31
Avg. of cube 3	= 31.2					
Total avg. of cubes	= 31.2					

Table 4.41: Rebound Hammer Test on Warm Water Specimen RMC Mix-5

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	28	29	30	28	29	27
Corner-2	28	27	28	29	30	29
Corner-3	29	29	29	29	28	28
Corner-4	27	27	27	27	27	27
Middle	30	29	28	29	28	30
Avg. of cube 1	= 28.7					
Cube-2						
Corner-1	29	27	28	29	30	28
Corner-2	30	29	28	27	28	29
Corner-3	28	28	29	29	29	29
Corner-4	27	27	27	27	27	27
Middle	28	30	30	29	28	29
Avg. of cube 2	= 27.0					
Cube-3						
Corner-1	30	28	29	27	28	29
Corner-2	28	29	30	29	28	27
Corner-3	29	29	28	28	29	29
Corner-4	27	27	27	27	27	27
Middle	28	29	28	30	30	29
Avg. of cube 3	= 27.9					
Total avg. of cubes	= 28.2					

Table 4.42: Rebound Hammer Test on Warm Water Specimen RMC Mix-6

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	24	26	26	25	27	25
Corner-2	27	27	25	26	25	27
Corner-3	26	27	25	27	25	26
Corner-4	25	26	24	26	24	25
Middle	26	26	27	26	27	26
Avg. of cube 1	= 25.1					
Cube-2						
Corner-1	27	25	26	25	24	26
Corner-2	25	27	25	26	27	27
Corner-3	25	26	25	27	26	27
Corner-4	24	25	24	26	25	26
Middle	27	26	27	26	26	26
Avg. of cube 2	= 25.4					
Cube-3						
Corner-1	26	25	24	26	27	25
Corner-2	25	26	27	27	25	27
Corner-3	25	27	26	27	25	26
Corner-4	24	26	25	26	24	25
Middle	27	26	26	26	27	26
Avg. of cube 3	= 26.0					
Total avg. of cubes	= 25.5					

Table 4.43: Rebound Hammer Test on Warm Water Specimen RMC Mix-7

AFTER ACCELERATED CURING BY WARM WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	38	36	37	37	36	37
Corner-2	37	38	36	38	36	37
Corner-3	38	37	38	37	37	38
Corner-4	37	38	38	38	38	36
Middle	37	37	37	36	37	37
Avg. of cube 1	= 37.0					
Cube-2						
Corner-1	36	37	38	36	37	37
Corner-2	36	37	37	38	36	38
Corner-3	37	38	38	37	38	37
Corner-4	38	36	37	38	38	38
Middle	37	37	37	37	37	36
Avg. of cube 2	= 37.6					
Cube-3						
Corner-1	37	37	36	37	38	36
Corner-2	36	38	36	37	37	38
Corner-3	38	37	37	38	38	37
Corner-4	38	38	38	36	37	38
Middle	37	36	37	37	37	37
Avg. of cube 3	= 37.9					
Total avg. of cubes	= 37.5					

4.3.2 Accelerated Curing By Boiling Water Method

Rebound hammer results is find out for accelerated curing by boiling water method for all 40 mixes. with the help of result of rebound number is converted to compressive strength and by 1 day rebound hammer strength result is predicted to 28 days compressive strength result.

Table 4.44: Rebound Hammer Test on Boiling Water Specimen Mix-1

ACCELERATED CURING BY BOILING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	21	18	20	22	21	20
Corner-2	19	20	18	20	18	17
Corner-3	18	22	22	17	16	19
Corner-4	22	17	18	18	22	22
Middle	20	22	20	21	20	21
Avg. of cube 1	= 19.7					
Cube-2						
Corner-1	16	21	22	20	21	16
Corner-2	22	16	21	16	24	19
Corner-3	18	21	17	22	19	21
Corner-4	20	16	19	19	16	20
Middle	25	22	23	25	20	22
Avg. of cube 2	= 19.96					
Cube-3						
Corner-1	20	21	20	19	22	20
Corner-2	22	20	22	21	17	21
Corner-3	18	16	18	18	19	18
Corner-4	16	20	19	20	20	17
Middle	22	22	22	22	21	22
Avg. of cube 3	= 19.83					
Total avg. of cubes	= 19.83 = 20					

Table 4.45: Rebound Hammer Test on Boiling Water Specimen Mix-2

ACCELERATED CURING BY BOILING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	21	19	18	19	20	21
Corner-2	19	16	17	18	17	16
Corner-3	16	15	19	18	15	17
Corner-4	20	18	21	20	19	19
Middle	19	19	20	21	18	20
Avg. of cube 1	= 18.50					
Cube-2						
Corner-1	18	15	16	16	17	18
Corner-2	16	20	18	21	16	16
Corner-3	18	16	16	18	19	19
Corner-4	16	16	17	17	20	21
Middle	18	17	21	19	21	20
Avg. of cube 2	= 17.86					
Cube-3						
Corner-1	21	18	17	19	20	16
Corner-2	17	17	20	17	16	18
Corner-3	16	16	16	20	18	20
Corner-4	18	18	18	16	20	16
Middle	18	20	21	15	18	19
Avg. of cube 3	= 17.93					
Total avg. of cubes	= 18.09 = 20					

Table 4.46: Rebound Hammer Test on Boiling Water Specimen Mix-3

AFTER ACCELERATED CURING BY BOILING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	19	19	17	18	20	20
Corner-2	17	20	18	15	16	19
Corner-3	18	18	15	16	15	18
Corner-4	18	18	17	16	18	15
Middle	20	21	20	19	18	20
Avg. of cube 1	= 17.93					
Cube-2						
Corner-1	18	15	18	20	18	18
Corner-2	16	17	17	16	15	15
Corner-3	16	19	16	20	18	20
Corner-4	15	16	16	15	20	17
Middle	20	19	20	18	16	21
Avg. of cube 2	= 17.50					
Cube-3						
Corner-1	20	18	20	20	19	20
Corner-2	16	20	19	18	17	18
Corner-3	18	16	16	15	16	16
Corner-4	15	15	18	18	17	15
Middle	21	20	16	19	20	21
Avg. of cube 3	= 17.90					
Total avg. of cubes	= 17.77 = 20					

Table 4.47: Rebound Hammer Test on Boiling Water Specimen Mix-4

AFTER ACCELERATED CURING BY BOILING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	19	19	22	20	20	20
Corner-2	21	20	19	21	19	19
Corner-3	23	20	24	23	22	21
Corner-4	21	24	21	20	21	22
Middle	20	21	20	19	19	20
Avg. of cube 1	= 20.66					
Cube-2						
Corner-1	19	20	19	20	22	21
Corner-2	21	21	20	22	24	21
Corner-3	20	23	24	24	18	20
Corner-4	24	22	21	18	20	23
Middle	20	20	20	22	22	22
Avg. of cube 2	= 21.10					
Cube-3						
Corner-1	22	19	21	22	20	20
Corner-2	24	20	21	22	21	21
Corner-3	19	23	20	20	23	23
Corner-4	20	21	23	18	22	22
Middle	22	20	22	20	20	20
Avg. of cube 3	= 21.03					
Total avg. of cubes	= 20.93					

Table 4.48: Rebound Hammer Test on Boiling Water Specimen Mix-5

AFTER ACCELERATED CURING BY BOILING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	22	21	22	22	20	20
Corner-2	21	20	21	21	20	23
Corner-3	23	22	24	23	22	21
Corner-4	21	24	21	20	21	22
Middle	20	21	20	21	22	20
Avg. of cube 1	= 21.36					
Cube-2						
Corner-1	22	22	23	20	22	21
Corner-2	21	21	20	22	24	22
Corner-3	20	23	24	24	21	20
Corner-4	24	22	21	21	20	23
Middle	21	20	20	22	22	22
Avg. of cube 2	= 21.58					
Cube-3						
Corner-1	22	22	21	22	20	20
Corner-2	24	20	24	22	21	21
Corner-3	21	23	20	20	23	23
Corner-4	20	21	23	21	22	22
Middle	22	20	22	23	20	20
Avg. of cube 3	= 21.48					
Total avg. of cubes	= 21.47					

Table 4.49: Rebound Hammer Test on Boiling Water Specimen Mix-6

AFTER ACCELERATED CURING BY BOILING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	22	21	22	22	20	20
Corner-2	21	20	21	21	20	23
Corner-3	23	22	22	23	22	21
Corner-4	21	23	21	20	21	22
Middle	20	21	20	21	22	20
Avg. of cube 1	= 21.15					
Cube-2						
Corner-1	22	22	23	20	22	21
Corner-2	21	21	20	22	24	22
Corner-3	20	23	22	23	21	20
Corner-4	23	22	21	21	20	23
Middle	21	20	20	22	22	22
Avg. of cube 2	= 21.38					
Cube-3						
Corner-1	22	22	21	22	20	20
Corner-2	23	20	24	22	21	21
Corner-3	21	23	20	20	23	23
Corner-4	20	21	23	21	22	22
Middle	22	20	22	23	20	20
Avg. of cube 3	= 21.4					
Total avg. of cubes	= 21.31					

Table 4.50: Rebound Hammer Test on Boiling Water Specimen Mix-7

AFTER ACCELERATED CURING BY BOILING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	19	19	22	20	20	20
Corner-2	21	20	19	21	19	19
Corner-3	23	20	24	23	22	21
Corner-4	21	24	21	20	21	22
Middle	20	21	20	19	19	20
Avg. of cube 1	= 20.5					
Cube-2						
Corner-1	19	20	19	20	22	21
Corner-2	21	21	20	22	24	21
Corner-3	20	23	24	24	18	20
Corner-4	24	22	21	18	20	23
Middle	20	20	20	22	22	22
Avg. of cube 2	= 20.95					
Cube-3						
Corner-1	22	19	21	22	20	20
Corner-2	24	20	21	22	21	21
Corner-3	19	23	20	20	23	23
Corner-4	20	21	23	18	22	22
Middle	22	20	22	20	20	20
Avg. of cube 3	= 20.8					
Total avg. of cubes	= 20.75					

Table 4.51: Rebound Hammer Test on Boiling Water Specimen Mix-8

AFTER ACCELERATED CURING BY BOILING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	22	21	22	22	20	20
Corner-2	21	20	21	21	20	23
Corner-3	23	22	24	23	22	21
Corner-4	21	24	21	22	21	22
Middle	21	22	22	21	22	20
Avg. of cube 1	= 21.55					
Cube-2						
Corner-1	22	22	23	20	22	21
Corner-2	21	21	20	22	24	22
Corner-3	20	23	24	24	21	20
Corner-4	24	22	21	21	20	23
Middle	23	20	22	22	23	22
Avg. of cube 2	= 21.95					
Cube-3						
Corner-1	22	22	21	22	20	22
Corner-2	24	20	24	22	21	21
Corner-3	21	23	20	21	23	23
Corner-4	22	21	23	21	22	22
Middle	22	20	22	23	21	20
Avg. of cube 3	= 21.3					
Total avg. of cubes	= 21.6					

Table 4.52: Rebound Hammer Test on Boiling Water Specimen Mix-9

AFTER ACCELERATED CURING BY BOILING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	19	21	21	20	18	20
Corner-2	21	20	18	21	20	19
Corner-3	19	20	19	19	19	21
Corner-4	20	19	21	18	21	17
Middle	18	17	20	21	18	20
Avg. of cube 1	= 19.50					
Cube-2						
Corner-1	18	20	19	21	21	20
Corner-2	20	19	21	18	18	21
Corner-3	19	21	19	20	19	19
Corner-4	20	17	20	19	21	18
Middle	18	18	18	17	20	21
Avg. of cube 2	= 19.35					
Cube-3						
Corner-1	21	20	19	21	18	20
Corner-2	18	21	21	20	20	19
Corner-3	19	19	19	20	19	21
Corner-4	21	18	20	19	20	17
Middle	20	21	18	17	18	18
Avg. of cube 3	= 19.17					
Total avg. of cubes	= 19.34 = 20					

Table 4.53: Rebound Hammer Test on Boiling Water Specimen Mix-10

AFTER ACCELERATED CURING BY BOILING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	19	19	22	20	20	20
Corner-2	21	20	19	21	19	19
Corner-3	23	20	24	23	22	21
Corner-4	21	24	21	20	21	22
Middle	20	21	20	19	19	20
Avg. of cube 1	= 20.89					
Cube-2						
Corner-1	19	20	19	20	22	21
Corner-2	21	21	20	22	24	21
Corner-3	20	23	24	24	18	20
Corner-4	24	22	21	18	20	23
Middle	20	20	20	22	22	22
Avg. of cube 2	= 21.3					
Cube-3						
Corner-1	22	19	21	22	20	20
Corner-2	24	20	21	22	21	21
Corner-3	19	23	20	20	23	23
Corner-4	20	21	23	18	22	22
Middle	22	20	22	20	20	20
Avg. of cube 3	= 21.55					
Total avg. of cubes	= 21.24					

Table 4.54: Rebound Hammer Test on Boiling Water Specimen Mix-11

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	25	27	24	27	25	24
Corner-2	26	24	23	25	26	24
Corner-3	24	26	26	25	25	26
Corner-4	26	24	25	24	26	26
Middle	25	23	24	23	24	24
Avg. of cube 1	= 24.86					
Cube-2						
Corner-1	27	27	24	25	24	25
Corner-2	24	25	24	26	23	24
Corner-3	25	25	26	24	26	25
Corner-4	24	24	25	26	25	26
Middle	23	23	24	25	24	24
Avg. of cube 2	= 24.43					
Cube-3						
Corner-1	25	24	25	27	27	24
Corner-2	26	25	26	24	25	24
Corner-3	24	26	25	26	25	26
Corner-4	26	25	26	24	24	26
Middle	27	24	24	25	23	24
Avg. of cube 3	= 24.97					
Total avg. of cubes	= 24.75					

Table 4.55: Rebound Hammer Test on Boiling Water Specimen Mix-12

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	25	24	25	26	23	26
Corner-2	26	25	25	25	24	24
Corner-3	24	23	26	24	26	25
Corner-4	25	24	24	25	25	26
Middle	26	26	23	24	24	23
Avg. of cube 1	= 24.73					
Cube-2						
Corner-1	24	25	26	24	26	23
Corner-2	25	26	25	25	24	24
Corner-3	23	24	24	26	25	26
Corner-4	24	25	25	24	24	24
Middle	25	24	24	23	23	24
Avg. of cube 2	= 24.57					
Cube-3						
Corner-1	25	24	26	26	23	26
Corner-2	26	25	25	25	24	24
Corner-3	24	26	26	24	26	25
Corner-4	25	24	24	25	25	26
Middle	26	26	25	26	26	23
Avg. of cube 3	= 24.98					
Total avg. of cubes	= 24.73					

Table 4.56: Rebound Hammer Test on Boiling Water Specimen Mix-13

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	24	23	25	26	24	25
Corner-2	25	24	24	25	25	24
Corner-3	25	24	26	23	24	26
Corner-4	26	25	24	26	25	24
Middle	25	25	23	25	23	23
Avg. of cube 1	= 24.8					
Cube-2						
Corner-1	25	26	24	24	23	24
Corner-2	24	25	25	25	24	24
Corner-3	26	23	25	24	24	25
Corner-4	24	26	26	25	25	24
Middle	23	25	25	23	25	23
Avg. of cube 2	= 23.9					
Cube-3						
Corner-1	23	24	25	25	26	24
Corner-2	24	25	24	24	25	25
Corner-3	24	25	26	26	23	24
Corner-4	25	26	24	24	26	25
Middle	25	25	23	23	25	23
Avg. of cube 3	= 24.9					
Total avg. of cubes	= 24.6					

Table 4.57: Rebound Hammer Test on Boiling Water Specimen Mix-14

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	28	28	29	27	29	29
Corner-2	29	29	28	29	29	27
Corner-3	28	30	30	30	30	28
Corner-4	28	28	28	29	27	28
Middle	29	29	28	29	28	29
Avg. of cube 1	= 28.1					
Cube-2						
Corner-1	29	28	28	29	29	27
Corner-2	29	29	29	27	28	29
Corner-3	30	28	30	28	30	30
Corner-4	27	28	28	28	28	29
Middle	28	29	29	29	28	29
Avg. of cube 2	= 27.4					
Cube-3						
Corner-1	29	27	29	28	28	29
Corner-2	28	29	29	29	29	27
Corner-3	30	30	30	28	30	28
Corner-4	28	29	27	28	28	28
Middle	28	29	28	29	29	29
Avg. of cube 3	= 27.2					
Total avg. of cubes	= 27.5					

Table 4.58: Rebound Hammer Test on Boiling Water Specimen Mix-15

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	29	28	29	28	29	29
Corner-2	28	29	29	29	29	28
Corner-3	30	30	28	30	28	30
Corner-4	28	29	27	29	27	28
Middle	28	28	28	28	28	28
Avg. of cube 1	= 28.4					
Cube-2						
Corner-1	29	29	29	28	29	28
Corner-2	29	28	28	29	29	29
Corner-3	28	30	30	30	28	30
Corner-4	27	28	28	29	27	29
Middle	28	28	28	28	28	28
Avg. of cube 2	= 28.8					
Cube-3						
Corner-1	28	29	28	29	29	29
Corner-2	29	28	29	29	28	29
Corner-3	30	30	30	28	30	28
Corner-4	29	28	29	27	28	27
Middle	28	28	28	28	28	28
Avg. of cube 3	= 28.5					
Total avg. of cubes	= 28.5					

Table 4.59: Rebound Hammer Test on Boiling Water Specimen Mix-16

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	31	29	30	30	30	31
Corner-2	29	28	29	29	29	30
Corner-3	30	27	30	30	31	27
Corner-4	29	30	28	28	27	29
Middle	28	31	28	28	28	28
Avg. of cube 1	= 28.8					
Cube-2						
Corner-1	30	31	31	30	29	30
Corner-2	29	30	29	29	28	29
Corner-3	31	27	30	30	27	30
Corner-4	27	29	29	28	30	28
Middle	28	28	28	28	31	28
Avg. of cube 2	= 29.0					
Cube-3						
Corner-1	31	29	30	31	30	30
Corner-2	30	28	29	29	29	29
Corner-3	27	27	31	30	30	30
Corner-4	29	30	27	29	28	28
Middle	28	31	28	28	28	28
Avg. of cube 3	= 29.2					
Total avg. of cubes	= 29.0					

Table 4.60: Rebound Hammer Test on Boiling Water Specimen Mix-17

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	27	28	26	26	27	27
Corner-2	26	27	27	27	26	27
Corner-3	28	28	28	29	28	28
Corner-4	27	27	27	28	27	27
Middle	28	28	28	28	28	26
Avg. of cube 1	= 27.6					
Cube-2						
Corner-1	27	27	26	27	28	26
Corner-2	26	27	27	26	27	27
Corner-3	28	4028	29	28	28	28
Corner-4	27	27	28	27	27	27
Middle	28	26	28	28	28	28
Avg. of cube 2	= 27.9					
Cube-3						
Corner-1	26	27	28	27	27	26
Corner-2	27	26	27	26	27	27
Corner-3	28	28	28	28	28	29
Corner-4	27	27	27	27	27	28
Middle	28	28	28	28	26	28
Avg. of cube 3	= 27.3					
Total avg. of cubes	= 27.63					

Table 4.61: Rebound Hammer Test on Boiling Water Specimen Mix-18

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	30	30	29	31	28	30
Corner-2	31	29	30	29	29	31
Corner-3	32	32	31	32	31	32
Corner-4	31	31	29	31	29	31
Middle	30	32	30	32	30	30
Avg. of cube 1	= 30.5					
Cube-2						
Corner-1	28	30	30	30	29	31
Corner-2	29	31	31	29	30	29
Corner-3	31	32	32	32	31	32
Corner-4	29	31	31	31	29	31
Middle	30	30	30	32	30	32
Avg. of cube 2	= 29.9					
Cube-3						
Corner-1	29	31	28	30	30	30
Corner-2	30	29	29	31	31	29
Corner-3	31	32	31	32	32	32
Corner-4	29	31	29	31	31	31
Middle	30	32	30	30	30	32
Avg. of cube 3	= 30.8					
Total avg. of cubes	= 30.46					

Table 4.62: Rebound Hammer Test on Boiling Water Specimen Mix-19

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	19	19	17	18	20	20
Corner-2	17	20	18	15	16	19
Corner-3	18	18	15	16	15	18
Corner-4	18	18	17	16	18	15
Middle	20	21	20	19	18	20
Avg. of cube 1	= 17.93					
Cube-2						
Corner-1	18	15	18	20	18	18
Corner-2	16	17	17	16	15	15
Corner-3	16	19	16	20	18	20
Corner-4	15	16	16	15	20	17
Middle	20	19	20	18	16	21
Avg. of cube 2	= 17.50					
Cube-3						
Corner-1	20	18	20	20	19	20
Corner-2	16	20	19	18	17	18
Corner-3	18	16	16	15	16	16
Corner-4	15	15	18	18	17	15
Middle	21	20	16	19	20	21
Avg. of cube 3	= 17.90					
Total avg. of cubes	= 17.77 20					

Table 4.63: Rebound Hammer Test on Boiling Water Specimen Mix-20

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	22	21	23	22	23	21
Corner-2	23	23	23	24	24	24
Corner-3	22	21	22	21	22	22
Corner-4	23	22	23	22	23	23
Middle	20	22	21	22	21	20
Avg. of cube 1	= 22.1					
Cube-2						
Corner-1	23	21	22	21	23	22
Corner-2	24	24	23	23	23	24
Corner-3	22	22	22	21	22	21
Corner-4	23	23	23	22	23	22
Middle	21	20	20	22	21	22
Avg. of cube 2	= 22.4					
Cube-3						
Corner-1	22	21	23	22	23	21
Corner-2	23	23	23	24	24	24
Corner-3	22	21	22	21	22	22
Corner-4	23	22	23	22	23	23
Middle	20	22	21	22	21	20
Avg. of cube 3	= 21.7					
Total avg. of cubes	= 22.06					

Table 4.64: Rebound Hammer Test on Boiling Water Specimen Mix-21

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	24	25	26	26	25	26
Corner-2	26	24	25	24	25	26
Corner-3	23	26	23	26	23	23
Corner-4	25	26	25	26	25	25
Middle	26	24	24	24	24	26
Avg. of cube 1	= 25.1					
Cube-2						
Corner-1	26	25	24	25	26	26
Corner-2	24	25	26	24	26	25
Corner-3	26	23	23	26	23	23
Corner-4	26	25	25	26	25	25
Middle	24	24	26	24	26	24
Avg. of cube 2	= 24.9					
Cube-3						
Corner-1	24	25	26	25	26	26
Corner-2	26	24	24	25	25	26
Corner-3	23	26	26	23	23	23
Corner-4	25	26	26	25	25	25
Middle	26	24	24	24	24	26
Avg. of cube 3	= 24.6					
Total avg. of cubes	= 24.8					

Table 4.65: Rebound Hammer Test on Boiling Water Specimen Mix-22

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	19	19	17	18	20	20
Corner-2	17	20	18	15	16	19
Corner-3	18	18	15	16	15	18
Corner-4	18	18	17	16	18	15
Middle	20	21	20	19	18	20
Avg. of cube 1	= 17.7					
Cube-2						
Corner-1	14	15	18	20	18	18
Corner-2	16	17	17	16	15	15
Corner-3	16	19	16	20	18	20
Corner-4	15	16	16	15	20	17
Middle	20	19	20	18	16	21
Avg. of cube 2	= 16.9					
Cube-3						
Corner-1	20	18	20	20	19	20
Corner-2	16	20	19	18	17	18
Corner-3	18	16	16	15	16	16
Corner-4	15	15	18	18	17	15
Middle	21	20	16	19	20	21
Avg. of cube 3	= 17.4					
Total avg. of cubes	= 17.34 20					

Table 4.66: Rebound Hammer Test on Boiling Water Specimen Mix-23

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	21	20	23	22	23	22
Corner-2	23	22	21	22	22	23
Corner-3	22	21	22	21	22	22
Corner-4	23	22	21	22	21	23
Middle	22	23	20	23	20	22
Avg. of cube 1	= 21.7					
Cube-2						
Corner-1	23	22	23	22	21	20
Corner-2	21	22	22	23	23	22
Corner-3	22	21	22	22	22	21
Corner-4	21	22	21	23	23	22
Middle	20	23	20	22	22	23
Avg. of cube 2	= 22.1					
Cube-3						
Corner-1	23	22	21	20	23	22
Corner-2	21	22	23	22	22	23
Corner-3	22	21	22	21	22	22
Corner-4	21	22	23	22	21	23
Middle	20	23	22	23	20	22
Avg. of cube 3	= 21.3					
Total avg. of cubes	= 21.73					

Table 4.67: Rebound Hammer Test on Boiling Water Specimen Mix-24

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	23	24	25	25	26	24
Corner-2	24	25	26	25	25	24
Corner-3	25	23	24	23	24	25
Corner-4	25	25	25	25	25	25
Middle	24	25	24	25	24	24
Avg. of cube 1	= 24.9					
Cube-2						
Corner-1	26	24	23	24	25	25
Corner-2	25	24	24	25	26	26
Corner-3	24	25	25	23	24	24
Corner-4	25	25	25	25	25	25
Middle	24	24	24	25	24	24
Avg. of cube 2	= 24.5					
Cube-3						
Corner-1	25	23	24	25	26	24
Corner-2	26	24	25	26	25	24
Corner-3	24	25	23	24	24	25
Corner-4	25	25	25	25	25	25
Middle	24	24	25	24	24	24
Avg. of cube 3	= 24.0					
Total avg. of cubes	= 24.5					

Table 4.68: Rebound Hammer Test on Boiling Water Specimen Mix-25

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	15	19	17	15	20	15
Corner-2	17	15	18	15	16	19
Corner-3	18	18	15	16	15	18
Corner-4	18	18	17	16	18	15
Middle	20	21	20	15	18	15
Avg. of cube 1	= 15.2					
Cube-2						
Corner-1	18	15	20	17	15	19
Corner-2	15	16	19	18	17	20
Corner-3	16	15	18	15	15	18
Corner-4	16	18	15	17	18	18
Middle	15	18	15	20	20	21
Avg. of cube 2	= 15.9					
Cube-3						
Corner-1	19	15	18	15	15	17
Corner-2	17	20	15	16	19	18
Corner-3	18	18	16	15	18	15
Corner-4	18	18	16	18	15	17
Middle	15	21	19	18	15	15
Avg. of cube 3	= 15.7					
Total avg. of cubes	= 15.57 20					

Table 4.69: Rebound Hammer Test on Boiling Water Specimen Mix-26

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	21	22	20	22	22	23
Corner-2	21	21	21	23	21	21
Corner-3	23	20	23	20	23	23
Corner-4	22	21	22	21	22	22
Middle	22	22	21	22	21	22
Avg. of cube 1	= 21.9					
Cube-2						
Corner-1	22	20	22	23	21	22
Corner-2	21	21	23	21	21	21
Corner-3	23	23	20	23	23	20
Corner-4	22	22	21	22	22	21
Middle	21	21	22	22	22	22
Avg. of cube 2	= 21.5					
Cube-3						
Corner-1	21	22	23	20	22	22
Corner-2	21	21	21	21	23	21
Corner-3	23	20	23	23	20	23
Corner-4	22	21	22	22	21	22
Middle	22	22	22	21	22	21
Avg. of cube 3	= 21.1					
Total avg. of cubes	= 21.5					

Table 4.70: Rebound Hammer Test on Boiling Water Specimen Mix-27

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	24	23	25	22	26	25
Corner-2	25	24	23	24	23	25
Corner-3	24	24	24	24	24	24
Corner-4	23	23	23	23	23	23
Middle	23	24	23	24	23	23
Avg. of cube 1	= 23.3					
Cube-2						
Corner-1	22	26	25	24	23	25
Corner-2	24	23	25	25	24	23
Corner-3	24	24	24	24	24	24
Corner-4	23	23	23	23	23	23
Middle	24	23	23	23	24	23
Avg. of cube 2	= 23.9					
Cube-3						
Corner-1	24	23	25	22	26	25
Corner-2	25	24	23	24	23	25
Corner-3	24	24	24	24	24	24
Corner-4	23	23	23	23	23	23
Middle	23	24	23	24	23	23
Avg. of cube 3	= 23.8					
Total avg. of cubes	= 23.66					

Table 4.71: Rebound Hammer Test on Boiling Water Specimen Mix-28

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	15	14	15	13	15	13
Corner-2	14	15	13	15	14	14
Corner-3	16	13	15	13	15	16
Corner-4	13	15	14	15	14	13
Middle	13	16	13	16	13	13
Avg. of cube 1	= 14.2					
Cube-2						
Corner-1	15	13	15	13	15	14
Corner-2	13	15	14	14	14	15
Corner-3	15	13	15	16	16	13
Corner-4	14	15	14	13	13	15
Middle	13	16	13	13	13	16
Avg. of cube 2	= 13.9					
Cube-3						
Corner-1	15	13	15	13	15	14
Corner-2	14	14	13	15	14	15
Corner-3	15	16	15	13	16	13
Corner-4	14	13	14	15	13	15
Middle	13	13	13	16	13	16
Avg. of cube 3	= 14.8					
Total avg. of cubes	= 14.34 20					

Table 4.72: Rebound Hammer Test on Boiling Water Specimen Mix-29

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	21	21	22	22	21	23
Corner-2	22	23	21	23	21	22
Corner-3	20	21	20	21	20	20
Corner-4	22	20	22	20	22	22
Middle	21	20	21	20	21	21
Avg. of cube 1	= 20.7					
Cube-2						
Corner-1	21	23	21	21	22	22
Corner-2	21	22	22	23	21	23
Corner-3	20	20	20	21	20	21
Corner-4	22	22	22	20	22	20
Middle	21	21	21	20	21	20
Avg. of cube 2	= 21.5					
Cube-3						
Corner-1	21	21	22	22	21	23
Corner-2	22	23	21	23	21	22
Corner-3	20	21	20	21	20	20
Corner-4	22	20	22	20	22	22
Middle	21	20	21	20	21	21
Avg. of cube 3	= 21.4					
Total avg. of cubes	= 21.1					

Table 4.73: Rebound Hammer Test on Boiling Water Specimen Mix-30

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	23	22	24	24	22	24
Corner-2	22	23	23	23	23	22
Corner-3	24	24	22	24	22	24
Corner-4	23	22	24	22	24	23
Middle	24	23	23	23	23	24
Avg. of cube 1	= 22.8					
Cube-2						
Corner-1	22	24	23	22	24	24
Corner-2	23	22	22	23	23	23
Corner-3	22	24	24	24	22	24
Corner-4	24	23	23	22	24	22
Middle	23	24	24	23	23	23
Avg. of cube 2	= 23.3					
Cube-3						
Corner-1	24	24	22	24	23	22
Corner-2	23	23	23	22	22	23
Corner-3	22	24	22	24	24	24
Corner-4	24	22	24	23	23	22
Middle	23	23	23	24	24	23
Avg. of cube 3	= 23.1					
Total avg. of cubes	= 23.0					

Table 4.74: Rebound Hammer Test on Boiling Water Specimen Mix-31

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	15	14	15	13	15	13
Corner-2	14	15	13	15	14	14
Corner-3	16	13	15	13	15	16
Corner-4	13	15	14	15	14	13
Middle	13	16	13	16	13	13
Avg. of cube 1	= 13.8					
Cube-2						
Corner-1	15	13	15	13	15	14
Corner-2	13	15	14	14	14	15
Corner-3	15	13	15	16	16	13
Corner-4	14	15	14	13	13	15
Middle	13	16	13	13	13	16
Avg. of cube 2	= 14.4					
Cube-3						
Corner-1	15	13	15	13	15	14
Corner-2	14	14	13	15	14	15
Corner-3	15	16	15	13	16	13
Corner-4	14	13	14	15	13	15
Middle	13	13	13	16	13	16
Avg. of cube 3	= 14.1					
Total avg. of cubes	= 14.1 20					

Table 4.75: Rebound Hammer Test on Boiling Water Specimen Mix-32

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	21	20	21	21	21	21
Corner-2	20	20	21	20	21	20
Corner-3	21	22	20	21	20	21
Corner-4	21	21	20	21	21	21
Middle	20	20	20	20	20	20
Avg. of cube 1	= 20.1					
Cube-2						
Corner-1	21	21	21	21	21	20
Corner-2	21	20	21	20	20	20
Corner-3	20	21	20	21	21	22
Corner-4	20	21	21	21	21	21
Middle	20	20	20	20	20	20
Avg. of cube 2	= 20.3					
Cube-3						
Corner-1	21	21	21	20	21	21
Corner-2	21	20	20	20	21	20
Corner-3	20	21	21	22	20	21
Corner-4	21	21	21	21	20	21
Middle	20	20	20	20	20	20
Avg. of cube 3	= 21.1					
Total avg. of cubes	= 20.5					

Table 4.76: Rebound Hammer Test on Boiling Water Specimen Mix-33

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	22	23	21	24	22	21
Corner-2	23	22	22	22	21	23
Corner-3	22	21	24	21	24	22
Corner-4	21	23	22	23	22	21
Middle	24	23	21	23	21	24
Avg. of cube 1	= 22.7					
Cube-2						
Corner-1	23	22	21	22	21	24
Corner-2	22	21	23	23	22	22
Corner-3	21	24	22	22	24	21
Corner-4	23	22	21	21	22	23
Middle	23	21	24	24	21	23
Avg. of cube 2	= 22.3					
Cube-3						
Corner-1	21	24	23	22	21	22
Corner-2	22	22	22	21	23	23
Corner-3	24	21	21	24	22	22
Corner-4	22	23	23	22	21	21
Middle	21	23	23	21	24	24
Avg. of cube 3	= 21.9					
Total avg. of cubes	= 22.3					

Table 4.77: Rebound Hammer Test on Boiling Water Specimen RMC Mix-1

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	18	16	15	18	19	19
Corner-2	17	18	20	20	15	17
Corner-3	15	15	18	19	17	18
Corner-4	18	18	15	15	15	19
Middle	20	19	20	20	18	16
Avg. of cube 1	= 17.56					
Cube-2						
Corner-1	19	18	20	18	18	17
Corner-2	17	17	17	15	15	15
Corner-3	18	16	18	16	19	19
Corner-4	19	15	14	18	16	15
Middle	15	18	22	20	15	18
Avg. of cube 2	= 17.23					
Cube-3						
Corner-1	16	16	18	19	19	15
Corner-2	17	18	15	20	17	18
Corner-3	15	15	16	15	16	14
Corner-4	16	16	17	16	16	15
Middle	19	20	18	17	15	20
Avg. of cube 3	= 16.80					
Total avg. of cubes	= 17.19 20					

Table 4.78: Rebound Hammer Test on Boiling Water Specimen RMC Mix-2

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	19	19	22	20	20	20
Corner-2	21	20	19	21	19	19
Corner-3	23	20	24	23	22	21
Corner-4	21	24	21	20	21	22
Middle	20	21	20	19	19	20
Avg. of cube 1	= 20.67					
Cube-2						
Corner-1	22	19	21	22	20	20
Corner-2	24	20	21	22	21	21
Corner-3	19	23	20	20	23	23
Corner-4	20	21	23	18	22	22
Middle	22	20	22	20	20	20
Avg. of cube 2	= 21.4					
Cube-3						
Corner-1	19	20	19	20	22	21
Corner-2	21	21	20	22	24	21
Corner-3	20	23	24	24	18	20
Corner-4	24	22	21	18	20	23
Middle	20	20	20	22	22	22
Avg. of cube 3	= 20.77					
Total avg. of cubes	= 20.94					

Table 4.79: Rebound Hammer Test on Boiling Water Specimen RMC Mix-3

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	18	16	15	18	19	19
Corner-2	17	18	20	20	15	17
Corner-3	15	15	18	19	17	18
Corner-4	18	18	15	15	15	19
Middle	20	19	20	20	18	16
Avg. of cube 1	= 17.5					
Cube-2						
Corner-1	19	18	20	18	18	17
Corner-2	17	17	17	15	15	15
Corner-3	18	16	18	16	19	19
Corner-4	19	15	14	18	16	15
Middle	15	18	22	20	15	18
Avg. of cube 2	= 17.9					
Cube-3						
Corner-1	16	16	18	19	19	15
Corner-2	17	18	15	20	17	18
Corner-3	15	15	16	15	16	14
Corner-4	16	16	17	16	16	15
Middle	19	20	18	17	15	20
Avg. of cube 3	= 18.2					
Total avg. of cubes	= 17.8 = 20					

Table 4.80: Rebound Hammer Test on Boiling Water Specimen RMC Mix-4

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	30	27	28	28	29	29
Corner-2	29	28	27	28	27	29
Corner-3	27	29	26	29	26	27
Corner-4	30	29	29	29	29	30
Middle	28	30	29	30	29	28
Avg. of cube 1	= 30.1					
Cube-2						
Corner-1	28	28	29	29	30	27
Corner-2	27	28	27	29	29	28
Corner-3	26	29	26	27	27	29
Corner-4	29	29	29	30	30	29
Middle	29	30	29	28	28	30
Avg. of cube 2	= 29.1					
Cube-3						
Corner-1	29	29	30	27	28	28
Corner-2	27	29	29	28	27	28
Corner-3	26	27	27	29	26	29
Corner-4	29	30	30	29	29	29
Middle	29	28	28	30	29	30
Avg. of cube 3	= 29.0					
Total avg. of cubes	= 29.4					

Table 4.81: Rebound Hammer Test on Boiling Water Specimen RMC Mix-5

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	26	24	25	25	25	27
Corner-2	24	26	25	26	24	25
Corner-3	25	25	24	25	24	25
Corner-4	25	27	26	27	26	25
Middle	27	26	25	26	25	27
Avg. of cube 1	= 26.1					
Cube-2						
Corner-1	25	27	26	24	25	25
Corner-2	24	25	24	26	25	26
Corner-3	24	25	25	25	24	25
Corner-4	26	25	25	27	26	27
Middle	25	27	27	26	25	26
Avg. of cube 2	= 25.5					
Cube-3						
Corner-1	25	25	25	27	26	24
Corner-2	25	26	24	25	24	26
Corner-3	24	25	24	25	25	25
Corner-4	26	27	26	25	25	27
Middle	25	26	25	27	27	26
Avg. of cube 3	= 25.8					
Total avg. of cubes	= 25.8					

Table 4.82: Rebound Hammer Test on Boiling Water Specimen RMC Mix-6

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	25	22	24	23	24	22
Corner-2	24	23	25	23	23	24
Corner-3	22	22	23	22	23	22
Corner-4	23	24	24	24	24	23
Middle	24	23	24	23	25	24
Avg. of cube 1	= 23.5					
Cube-2						
Corner-1	24	22	25	22	24	23
Corner-2	23	24	24	23	25	23
Corner-3	23	22	22	22	23	22
Corner-4	24	23	23	24	24	24
Middle	25	24	24	23	24	23
Avg. of cube 2	= 23.3					
Cube-3						
Corner-1	24	23	24	22	25	22
Corner-2	25	23	23	24	24	23
Corner-3	23	22	23	22	22	22
Corner-4	24	24	24	23	23	24
Middle	24	23	25	24	24	23
Avg. of cube 3	= 22.8					
Total avg. of cubes	= 23.2					

Table 4.83: Rebound Hammer Test on Boiling Water Specimen RMC Mix-7

AFTER ACCELERATED CURING BY BOILLING WATER METHOD						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	31	32	30	31	32	30
Corner-2	32	31	31	31	31	32
Corner-3	31	30	32	30	32	31
Corner-4	30	32	32	32	32	30
Middle	31	31	30	31	30	31
Avg. of cube 1	= 31.3					
Cube-2						
Corner-1	32	30	31	32	30	31
Corner-2	31	32	32	31	31	31
Corner-3	32	31	31	30	32	30
Corner-4	32	30	30	32	32	32
Middle	30	31	31	31	30	31
Avg. of cube 2	= 30.7					
Cube-3						
Corner-1	30	31	32	30	31	32
Corner-2	31	31	31	32	32	31
Corner-3	32	30	32	31	31	30
Corner-4	32	32	32	30	30	32
Middle	30	31	30	31	31	31
Avg. of cube 3	= 31.0					
Total avg. of cubes	= 31.0					

4.3.3 Test At 28 Days

Rebound hammer results is find out at 28 days for all 40 mixes. with the help of result of rebound number is converted to compressive strength and by 28 day rebound hammer strength result is compared to 28 days compressive strength result.

Table 4.84: Rebound Hammer Test on 28 Days Specimens Mix-1

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	25	23	22	21	28	21
Corner-2	24	22	24	24	25	26
Corner-3	24	22	24	22	24	27
Corner-4	22	24	22	21	22	24
Middle	30	28	28	26	24	25
Avg. of cube1	= 24.13					
Cube-2						
Corner-1	23	23	23	22	22	24
Corner-2	24	26	25	26	26	22
Corner-3	28	24	23	27	25	22
Corner-4	25	22	30	24	28	25
Middle	29	27	28	25	24	26
Avg. of cube 2	= 24.93					
Cube-3						
Corner-1	24	24	24	25	22	25
Corner-2	25	22	25	22	26	28
Corner-3	26	22	22	24	28	24
Corner-4	25	25	25	25	22	22
Middle	22	26	30	28	25	24
Avg. of cube 3	= 24.56					
Total avg. of cubes	= 24.54					

Table 4.85: Rebound Hammer Test on 28 Days Specimens Mix-2

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	27	24	28	22	25	26
Corner-2	23	25	25	26	24	22
Corner-3	25	27	22	24	26	24
Corner-4	25	26	24	27	23	26
Middle	22	23	25	24	22	25
Avg. of cube 1	= 24.57					
Cube-2						
Corner-1	28	22	26	25	27	25
Corner-2	25	26	23	23	25	24
Corner-3	26	27	24	27	26	25
Corner-4	23	23	26	24	24	23
Middle	22	25	25	22	23	24
Avg. of cube 2	= 24.60					
Cube-3						
Corner-1	24	22	25	24	22	25
Corner-2	25	24	24	25	26	24
Corner-3	24	24	25	22	27	25
Corner-4	22	26	23	25	23	22
Middle	23	23	24	24	25	26
Avg. of cube 3	= 24.10					
Total avg. of cubes	= 24.42					

Table 4.86: Rebound Hammer Test on 28 Days Specimens Mix-3

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	28	25	28	26	31	30
Corner-2	27	26	26	27	27	26
Corner-3	29	25	28	30	25	29
Corner-4	25	28	25	26	28	27
Middle	28	31	29	28	25	26
Avg. of cube 1	= 28.72					
Cube-2						
Corner-1	26	31	30	29	28	25
Corner-2	27	26	26	26	27	29
Corner-3	30	28	26	30	29	27
Corner-4	26	27	27	26	27	28
Middle	28	28	25	27	28	25
Avg. of cube 2	= 28.4					
Cube-3						
Corner-1	29	28	25	29	28	25
Corner-2	27	27	29	27	25	27
Corner-3	30	29	27	29	28	30
Corner-4	26	26	28	27	28	27
Middle	27	28	26	28	27	28
Avg. of cube 3	= 28.67					
Total avg. of cubes	= 28.6					

Table 4.87: Rebound Hammer Test on 28 Days Specimens Mix-4

Rebound Hammer Test on 28 Days Specimen						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	30	30	32	28	31	30
Corner-2	27	29	29	29	28	27
Corner-3	31	30	33	30	30	32
Corner-4	27	28	31	31	28	27
Middle	28	31	30	30	29	29
Avg. of cube 1	= 29.5					
Cube-2						
Corner-1	29	31	30	31	28	30
Corner-2	30	28	27	27	32	29
Corner-3	33	30	31	32	31	30
Corner-4	31	28	27	27	29	29
Middle	30	30	28	29	30	31
Avg. of cube 2	= 29.6					
Cube-3						
Corner-1	31	31	30	29	30	28
Corner-2	29	29	29	30	27	32
Corner-3	30	32	28	33	31	31
Corner-4	29	27	32	31	28	29
Middle	31	29	29	30	28	30
Avg. of cube 3	= 29.8					
Total avg. of cubes	= 29.63					

Table 4.88: Rebound Hammer Test on 28 Days Specimens Mix-5

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	32	33	32	28	31	30
Corner-2	29	29	29	29	29	29
Corner-3	31	32	33	30	30	32
Corner-4	29	28	31	31	28	28
Middle	28	31	30	30	29	29
Avg. of cube 1	= 30.7					
Cube-2						
Corner-1	29	33	30	31	28	30
Corner-2	30	28	27	27	32	29
Corner-3	33	30	31	32	31	30
Corner-4	31	28	30	30	29	29
Middle	30	30	28	29	30	31
Avg. of cube 2	= 30.9					
Cube-3						
Corner-1	33	31	31	29	30	28
Corner-2	29	29	29	32	33	32
Corner-3	30	32	28	33	31	31
Corner-4	29	32	32	31	28	29
Middle	31	29	33	30	28	30
Avg. of cube 3	= 31.7					
Total avg. of cubes	= 31.1					

Table 4.89: Rebound Hammer Test on 28 Days Specimen Mix-6

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	32	32	32	28	31	30
Corner-2	29	29	29	29	29	29
Corner-3	31	31	31	30	30	32
Corner-4	29	28	31	31	28	28
Middle	28	31	30	30	29	29
Avg. of cube 1	= 30.2					
Cube-2						
Corner-1	29	31	30	31	28	30
Corner-2	30	28	27	27	32	29
Corner-3	32	30	31	32	31	30
Corner-4	31	28	30	30	29	29
Middle	30	30	28	29	30	31
Avg. of cube 2	= 30.5					
Cube-3						
Corner-1	33	31	31	29	30	28
Corner-2	29	29	29	32	31	32
Corner-3	30	32	28	33	31	31
Corner-4	29	32	32	31	28	29
Middle	31	29	32	30	28	30
Avg. of cube 3	= 30.62					
Total avg. of cubes	= 30.44					

Table 4.90: Rebound Hammer Test on 28 Days Specimen Mix-7

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	30	30	32	28	31	30
Corner-2	27	29	29	29	28	27
Corner-3	31	30	33	30	30	32
Corner-4	27	28	31	31	28	27
Middle	28	31	30	30	29	29
Avg. of cube 1	= 29.45					
Cube-2						
Corner-1	29	31	30	31	28	30
Corner-2	30	28	27	27	32	29
Corner-3	29	30	30	30	31	30
Corner-4	31	28	30	30	29	29
Middle	30	30	28	29	30	31
Avg. of cube 2	= 28.9					
Cube-3						
Corner-1	30	31	31	29	30	28
Corner-2	29	29	29	30	31	30
Corner-3	30	32	28	30	31	31
Corner-4	29	32	30	31	28	29
Middle	31	29	30	30	28	30
Avg. of cube 3	= 29.1					
Total avg. of cubes	= 29.15					

Table 4.91: Rebound Hammer Test on 28 Days Specimen Mix-8

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	32	33	32	28	31	30
Corner-2	29	29	29	29	29	29
Corner-3	31	32	33	30	30	32
Corner-4	29	28	31	31	28	28
Middle	28	31	30	30	29	29
Avg. of cube 1	= 30.85					
Cube-2						
Corner-1	29	33	30	31	28	30
Corner-2	30	28	27	27	32	29
Corner-3	33	30	31	32	31	30
Corner-4	31	28	30	30	29	29
Middle	30	30	28	29	30	31
Avg. of cube 2	= 30.9					
Cube-3						
Corner-1	33	31	31	29	30	28
Corner-2	29	29	29	32	33	32
Corner-3	30	32	28	33	31	31
Corner-4	29	32	32	31	28	29
Middle	31	29	33	30	28	30
Avg. of cube 3	= 31.9					
Total avg. of cubes	= 31.2					

Table 4.92: Rebound Hammer Test on 28 Days Specimen Mix-9

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	26	27	26	28	27	25
Corner-2	25	25	27	25	26	27
Corner-3	27	25	30	28	28	26
Corner-4	25	27	26	26	27	28
Middle	28	24	27	27	30	27
Avg. of cube 1	= 26.95					
Cube-2						
Corner-1	28	28	27	30	27	26
Corner-2	27	27	26	29	25	27
Corner-3	28	30	28	27	26	29
Corner-4	26	28	27	25	27	30
Middle	30	27	30	28	27	27
Avg. of cube 2	= 27.71					
Cube-3						
Corner-1	28	28	29	28	26	27
Corner-2	29	27	25	29	27	29
Corner-3	27	28	26	26	29	28
Corner-4	28	30	27	28	30	27
Middle	30	27	30	29	27	30
Avg. of cube 3	= 28.30					
Total avg. of cubes	= 27.65					

Table 4.93: Rebound Hammer Test on 28 Days Specimen Mix-10

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	30	30	32	28	31	30
Corner-2	27	29	29	29	28	27
Corner-3	31	30	33	30	30	32
Corner-4	27	28	31	31	28	27
Middle	28	31	30	30	29	29
Avg. of cube 1	= 29.79					
Cube-2						
Corner-1	29	31	30	31	28	30
Corner-2	30	28	27	27	32	29
Corner-3	33	30	31	32	31	30
Corner-4	31	28	27	27	29	29
Middle	30	30	28	29	30	31
Avg. of cube 2	= 29.92					
Cube-3						
Corner-1	31	31	30	29	30	28
Corner-2	29	29	29	30	27	32
Corner-3	30	32	28	33	31	31
Corner-4	29	28	32	31	28	29
Middle	31	29	29	30	30	30
Avg. of cube 3	= 29.86					
Total avg. of cubes	= 29.85					

Table 4.94: Rebound Hammer Test on 28 Days Specimen Mix-11

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	37	36	37	36	37	36
Corner-2	35	38	37	37	36	37
Corner-3	38	36	38	38	38	37
Corner-4	36	37	36	36	36	38
Middle	37	38	38	38	37	38
Avg. of cube 1	= 36.97					
Cube-2						
Corner-1	36	36	36	37	37	37
Corner-2	37	37	37	35	37	36
Corner-3	36	38	37	38	38	38
Corner-4	37	36	38	36	36	36
Middle	38	37	36	37	38	37
Avg. of cube 2	= 36.79					
Cube-3						
Corner-1	37	37	37	36	38	36
Corner-2	36	37	36	38	37	37
Corner-3	38	38	38	36	38	37
Corner-4	36	36	36	37	36	38
Middle	37	38	37	38	38	38
Avg. of cube 3	= 37.01					
Total avg. of cubes	= 36.92					

Table 4.95: Rebound Hammer Test on 28 Days Specimen Mix-12

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	34	32	36	35	33	36
Corner-2	35	35	34	35	35	35
Corner-3	37	34	38	36	35	38
Corner-4	34	37	35	34	37	35
Middle	36	35	36	36	35	36
Avg. of cube 1	= 35.19					
Cube-2						
Corner-1	35	33	34	36	34	35
Corner-2	35	35	35	34	35	36
Corner-3	36	35	36	37	37	34
Corner-4	34	37	35	35	34	37
Middle	36	35	36	36	36	35
Avg. of cube 2	= 35.51					
Cube-3						
Corner-1	36	34	34	36	34	34
Corner-2	34	35	35	35	35	35
Corner-3	38	35	37	38	37	34
Corner-4	35	37	34	35	34	37
Middle	36	35	36	36	36	35
Avg. of cube 3	= 35.24					
Total avg. of cubes	= 35.30					

Table 4.96: Rebound Hammer Test on 28 Days Specimen Mix-13

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	37	36	38	35	35	37
Corner-2	36	35	36	37	36	36
Corner-3	38	38	37	38	38	38
Corner-4	35	36	37	36	36	37
Middle	37	37	35	37	37	35
Avg. of cube 1	= 35.9					
Cube-2						
Corner-1	36	35	37	36	38	35
Corner-2	36	36	36	35	36	37
Corner-3	38	38	38	38	37	38
Corner-4	37	36	35	36	37	36
Middle	36	37	37	37	35	37
Avg. of cube 2	= 36.6					
Cube-3						
Corner-1	37	38	38	35	35	36
Corner-2	36	36	36	37	36	35
Corner-3	38	37	37	38	38	38
Corner-4	37	35	37	36	36	36
Middle	35	37	35	37	37	37
Avg. of cube 3	= 36.8					
Total avg. of cubes	= 36.5					

Table 4.97: Rebound Hammer Test on 28 Days Specimen Mix-14

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	41	37	38	39	38	40
Corner-2	38	38	38	38	37	38
Corner-3	38	40	40	40	40	39
Corner-4	40	38	39	40	39	40
Middle	39	39	39	39	40	39
Avg. of cube 1	= 38.5					
Cube-2						
Corner-1	38	41	40	37	39	38
Corner-2	38	38	38	38	38	37
Corner-3	40	38	39	40	40	40
Corner-4	39	40	40	38	40	39
Middle	39	39	39	39	39	40
Avg. of cube 2	= 39.2					
Cube-3						
Corner-1	37	40	39	38	38	41
Corner-2	38	38	38	38	37	38
Corner-3	40	39	40	40	40	38
Corner-4	38	40	40	39	39	40
Middle	39	39	39	39	40	39
Avg. of cube 3	= 38.7					
Total avg. of cubes	= 38.8					

Table 4.98: Rebound Hammer Test on 28 Days Specimen Mix-15

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	40	41	38	41	38	40
Corner-2	39	39	37	39	37	39
Corner-3	39	38	40	38	40	39
Corner-4	38	40	38	40	38	38
Middle	39	38	40	38	40	39
Avg. of cube 1	= 38.6					
Cube-2						
Corner-1	40	40	38	41	38	41
Corner-2	39	39	37	39	37	39
Corner-3	39	39	40	38	40	38
Corner-4	38	38	38	40	38	40
Middle	39	39	40	38	40	38
Avg. of cube 2	= 39.3					
Cube-3						
Corner-1	38	41	40	40	41	38
Corner-2	37	39	39	39	39	37
Corner-3	40	38	39	39	38	40
Corner-4	38	40	38	38	40	38
Middle	40	38	39	39	38	40
Avg. of cube 3	= 39.0					
Total avg. of cubes	= 38.93					

Table 4.99: Rebound Hammer Test on 28 Days Specimen Mix-16

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	38	40	38	41	39	38
Corner-2	39	41	40	41	40	39
Corner-3	40	39	39	39	39	40
Corner-4	39	38	40	38	40	39
Middle	40	40	39	40	39	40
Avg. of cube 1	= 38.9					
Cube-2						
Corner-1	39	38	38	40	38	41
Corner-2	40	39	39	41	40	41
Corner-3	39	40	40	39	39	39
Corner-4	40	39	39	38	40	38
Middle	39	40	40	40	39	40
Avg. of cube 2	= 39.4					
Cube-3						
Corner-1	38	41	39	38	38	40
Corner-2	40	41	40	39	39	41
Corner-3	39	39	39	40	40	39
Corner-4	40	38	40	39	39	38
Middle	39	40	39	40	40	40
Avg. of cube 3	= 39.6					
Total avg. of cubes	= 39.33					

Table 4.100: Rebound Hammer Test on 28 Days Specimen Mix-17

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	40	41	38	41	39	41
Corner-2	39	40	39	39	38	38
Corner-3	40	38	40	38	40	40
Corner-4	38	39	41	40	41	38
Middle	39	42	40	42	40	39
Avg. of cube 1	= 39.9					
Cube-2						
Corner-1	38	41	39	41	40	41
Corner-2	39	39	38	38	39	40
Corner-3	40	38	40	40	40	38
Corner-4	41	40	41	38	38	39
Middle	40	42	40	39	39	42
Avg. of cube 2	= 38.9					
Cube-3						
Corner-1	39	41	40	41	38	41
Corner-2	38	38	39	40	39	39
Corner-3	40	40	40	38	40	38
Corner-4	41	38	38	39	41	40
Middle	40	39	39	42	40	42
Avg. of cube 3	= 39.8					
Total avg. of cubes	= 39.6					

Table 4.101: Rebound Hammer Test on 28 Days Specimen Mix-18

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	41	42	39	42	40	40
Corner-2	40	39	41	40	42	40
Corner-3	42	41	41	41	41	42
Corner-4	43	40	43	40	43	43
Middle	39	43	40	43	40	40
Avg. of cube 1	= 41.5					
Cube-2						
Corner-1	40	40	41	42	39	42
Corner-2	42	40	40	39	41	40
Corner-3	41	42	42	41	41	41
Corner-4	43	43	43	40	43	40
Middle	40	40	39	43	40	43
Avg. of cube 2	= 41.9					
Cube-3						
Corner-1	41	42	39	42	40	40
Corner-2	40	39	41	40	42	40
Corner-3	42	41	41	41	41	42
Corner-4	43	40	43	40	43	43
Middle	39	43	40	43	40	40
Avg. of cube 3	= 41.5					
Total avg. of cubes	= 41.66					

Table 4.102: Rebound Hammer Test on 28 Days Specimen Mix-19

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	30	33	32	33	32	31
Corner-2	29	28	31	29	30	29
Corner-3	30	30	30	30	30	30
Corner-4	32	32	31	32	32	31
Middle	28	33	28	33	28	28
Avg. of cube 1	= 30.1					
Cube-2						
Corner-1	32	33	32	31	30	33
Corner-2	31	29	30	29	29	28
Corner-3	30	30	30	30	30	30
Corner-4	31	32	32	31	32	32
Middle	28	33	28	28	28	33
Avg. of cube 2	= 30.9					
Cube-3						
Corner-1	32	33	30	33	32	31
Corner-2	31	29	29	28	30	29
Corner-3	30	30	30	30	30	30
Corner-4	31	32	32	32	32	31
Middle	28	33	28	33	28	28
Avg. of cube 3	= 30.5					
Total avg. of cubes	= 30.46					

Table 4.103: Rebound Hammer Test on 28 Days Specimen Mix-20

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	34	33	34	32	35	35
Corner-2	33	36	33	36	33	32
Corner-3	33	34	35	35	34	33
Corner-4	36	33	34	33	34	36
Middle	34	34	33	34	33	34
Avg. of cube 1	= 33.8					
Cube-2						
Corner-1	35	35	34	33	34	32
Corner-2	33	32	33	36	33	36
Corner-3	34	33	33	34	35	35
Corner-4	34	36	36	33	34	33
Middle	33	34	34	34	33	34
Avg. of cube 2	= 34.2					
Cube-3						
Corner-1	34	33	34	32	35	35
Corner-2	33	36	33	36	33	32
Corner-3	33	34	35	35	34	33
Corner-4	36	33	34	33	34	36
Middle	34	34	33	34	33	34
Avg. of cube 3	= 33.8					
Total avg. of cubes	= 33.93					

Table 4.104: Rebound Hammer Test on 28 Days Specimen Mix-21

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	38	38	38	36	37	37
Corner-2	37	35	37	35	38	37
Corner-3	36	36	35	36	35	36
Corner-4	36	37	35	37	35	36
Middle	35	37	36	37	36	35
Avg. of cube 1	= 36.8					
Cube-2						
Corner-1	36	37	37	38	38	38
Corner-2	35	38	37	37	35	37
Corner-3	36	35	36	36	36	35
Corner-4	37	35	36	36	37	35
Middle	37	36	35	35	37	36
Avg. of cube 2	= 36.5					
Cube-3						
Corner-1	36	37	38	38	38	37
Corner-2	35	38	37	35	37	37
Corner-3	36	35	36	36	35	36
Corner-4	37	35	36	37	35	36
Middle	37	36	35	37	36	35
Avg. of cube 3	= 35.9					
Total avg. of cubes	= 36.4					

Table 4.105: Rebound Hammer Test on 28 Days Specimen Mix-22

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	28	28	29	29	30	27
Corner-2	29	29	30	29	30	29
Corner-3	28	28	28	28	28	28
Corner-4	28	29	29	29	29	28
Middle	29	30	28	30	28	29
Avg. of cube 1	= 28.5					
Cube-2						
Corner-1	29	30	27	30	29	29
Corner-2	29	30	29	30	30	29
Corner-3	28	28	28	28	28	28
Corner-4	29	29	28	29	29	29
Middle	30	28	29	28	28	30
Avg. of cube 2	= 29.1					
Cube-3						
Corner-1	30	29	30	27	29	29
Corner-2	30	29	30	29	30	29
Corner-3	28	28	28	28	28	28
Corner-4	29	29	29	28	29	29
Middle	28	30	28	29	28	30
Avg. of cube 3	= 28.4					
Total avg. of cubes	= 28.66					

Table 4.106: Rebound Hammer Test on 28 Days Specimen Mix-23

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	33	35	33	32	34	32
Corner-2	34	33	34	33	34	34
Corner-3	32	34	35	34	35	32
Corner-4	33	32	32	32	32	33
Middle	32	34	34	34	34	32
Avg. of cube 1	= 32.9					
Cube-2						
Corner-1	33	32	33	35	34	32
Corner-2	34	33	34	33	34	34
Corner-3	35	34	32	34	35	32
Corner-4	32	32	33	32	32	33
Middle	34	34	32	34	34	32
Avg. of cube 2	= 33.6					
Cube-3						
Corner-1	33	35	34	32	33	32
Corner-2	34	33	34	34	34	33
Corner-3	32	34	35	32	35	34
Corner-4	33	32	32	33	32	32
Middle	32	34	34	32	34	34
Avg. of cube 3	= 33.4					
Total avg. of cubes	= 33.33					

Table 4.107: Rebound Hammer Test on 28 Days Specimen Mix-24

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	34	35	34	36	35	36
Corner-2	34	34	36	34	36	35
Corner-3	35	32	36	32	36	35
Corner-4	36	37	35	37	35	36
Middle	37	35	38	35	38	37
Avg. of cube 1	= 35.8					
Cube-2						
Corner-1	34	36	34	35	35	36
Corner-2	36	34	34	34	36	35
Corner-3	36	32	35	32	36	35
Corner-4	35	37	36	37	35	36
Middle	38	35	37	35	38	37
Avg. of cube 2	= 35.1					
Cube-3						
Corner-1	35	36	34	36	34	35
Corner-2	36	35	36	34	34	34
Corner-3	36	35	36	32	35	32
Corner-4	35	36	35	37	36	37
Middle	38	37	38	35	37	35
Avg. of cube 3	= 35.2					
Total avg. of cubes	= 35.33					

Table 4.108: Rebound Hammer Test on 28 Days Specimen Mix-25

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	29	28	28	29	27	29
Corner-2	27	29	29	29	29	27
Corner-3	29	28	27	28	27	29
Corner-4	28	28	28	28	28	28
Middle	30	29	29	29	29	30
Avg. of cube 1	= 27.8					
Cube-2						
Corner-1	27	29	29	28	28	29
Corner-2	29	27	27	29	29	29
Corner-3	27	29	29	28	27	28
Corner-4	28	28	28	28	28	28
Middle	29	30	30	29	29	29
Avg. of cube 2	= 27.6					
Cube-3						
Corner-1	29	28	27	29	28	29
Corner-2	27	29	29	27	29	29
Corner-3	29	28	27	29	27	28
Corner-4	28	28	28	28	28	28
Middle	30	29	29	30	29	29
Avg. of cube 3	= 28.5					
Total avg. of cubes	= 28.33					

Table 4.109: Rebound Hammer Test on 28 Days Specimen Mix-26

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	31	30	34	30	33	32
Corner-2	30	31	31	30	32	30
Corner-3	32	34	32	34	32	32
Corner-4	33	33	32	33	32	33
Middle	32	33	34	33	34	32
Avg. of cube 1	= 32.2					
Cube-2						
Corner-1	33	32	31	30	34	30
Corner-2	32	30	30	31	31	30
Corner-3	32	32	32	34	32	34
Corner-4	32	33	33	33	32	33
Middle	34	32	32	33	34	33
Avg. of cube 2	= 31.5					
Cube-3						
Corner-1	34	30	33	32	31	30
Corner-2	31	30	32	30	30	31
Corner-3	32	34	32	32	32	34
Corner-4	32	33	32	33	33	33
Middle	34	33	34	32	32	33
Avg. of cube 3	= 31.8					
Total avg. of cubes	= 31.86					

Table 4.110: Rebound Hammer Test on 28 Days Specimen Mix-27

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	34	35	34	36	35	34
Corner-2	36	35	36	35	36	35
Corner-3	33	34	33	34	33	34
Corner-4	34	36	36	36	36	34
Middle	35	34	34	34	34	35
Avg. of cube 1	= 34.9					
Cube-2						
Corner-1	35	34	36	35	34	34
Corner-2	35	36	35	36	35	36
Corner-3	34	33	34	33	34	33
Corner-4	36	36	36	36	34	34
Middle	34	34	34	34	35	35
Avg. of cube 2	= 35.1					
Cube-3						
Corner-1	35	34	34	35	34	36
Corner-2	36	35	36	35	36	35
Corner-3	33	34	33	34	33	34
Corner-4	36	34	34	36	36	36
Middle	34	35	35	34	34	34
Avg. of cube 3	= 35.2					
Total avg. of cubes	= 35.0					

Table 4.111: Rebound Hammer Test on 28 Days Specimen Mix-28

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	29	27	28	26	27	29
Corner-2	28	28	28	28	28	29
Corner-3	27	29	29	29	29	27
Corner-4	28	28	28	28	28	28
Middle	28	27	26	27	27	28
Avg. of cube 1	= 27.8					
Cube-2						
Corner-1	27	29	29	27	28	26
Corner-2	28	29	28	28	28	28
Corner-3	29	27	27	29	29	29
Corner-4	28	28	28	28	28	28
Middle	27	28	28	27	26	27
Avg. of cube 2	= 28.2					
Cube-3						
Corner-1	29	27	27	29	28	26
Corner-2	28	28	28	29	28	28
Corner-3	27	29	29	27	29	29
Corner-4	28	28	28	28	28	28
Middle	28	27	27	28	26	27
Avg. of cube 3	= 28.0					
Total avg. of cubes	= 27.97					

Table 4.112: Rebound Hammer Test on 28 Days Specimen Mix-29

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	30	32	31	30	31	31
Corner-2	32	29	29	29	29	32
Corner-3	33	31	32	31	32	33
Corner-4	30	30	32	30	31	30
Middle	31	31	30	31	30	31
Avg. of cube 1	= 31.2					
Cube-2						
Corner-1	31	31	30	32	31	30
Corner-2	29	32	32	29	29	29
Corner-3	32	33	33	31	32	31
Corner-4	31	30	30	30	32	30
Middle	30	31	31	31	30	31
Avg. of cube 2	= 30.7					
Cube-3						
Corner-1	30	32	31	31	31	30
Corner-2	32	29	29	32	29	29
Corner-3	33	31	32	33	32	31
Corner-4	30	30	31	30	32	30
Middle	31	31	30	31	30	31
Avg. of cube 3	= 30.6					
Total avg. of cubes	= 30.86					

Table 4.113: Rebound Hammer Test on 28 Days Specimen Mix-30

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	33	32	36	31	35	34
Corner-2	36	35	34	35	34	36
Corner-3	34	34	33	34	33	34
Corner-4	35	33	34	33	34	35
Middle	34	32	33	32	33	34
Avg. of cube 1	= 34.3					
Cube-2						
Corner-1	31	35	34	33	32	36
Corner-2	35	34	36	36	35	34
Corner-3	34	33	34	34	34	33
Corner-4	33	34	35	35	33	34
Middle	32	33	34	34	32	33
Avg. of cube 2	= 33.8					
Cube-3						
Corner-1	33	32	36	31	35	34
Corner-2	36	35	34	35	34	36
Corner-3	34	34	33	34	33	34
Corner-4	35	33	34	33	34	35
Middle	34	32	33	32	33	34
Avg. of cube 3	= 34.1					
Total avg. of cubes	= 34.0					

Table 4.114: Rebound Hammer Test on 28 Days Specimen Mix-31

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	27	26	27	27	26	26
Corner-2	26	27	26	27	26	27
Corner-3	28	27	28	28	28	28
Corner-4	27	26	27	26	27	27
Middle	26	27	26	27	26	26
Avg. of cube 1	= 27.1					
Cube-2						
Corner-1	27	26	26	27	26	27
Corner-2	27	26	27	26	27	26
Corner-3	28	28	28	28	27	28
Corner-4	26	27	27	27	26	27
Middle	27	26	26	26	27	26
Avg. of cube 2	= 26.6					
Cube-3						
Corner-1	27	26	27	27	26	26
Corner-2	26	27	26	27	26	27
Corner-3	28	27	28	28	28	28
Corner-4	27	26	27	26	27	27
Middle	26	27	26	27	26	26
Avg. of cube 3	= 27.2					
Total avg. of cubes	= 26.93					

Table 4.115: Rebound Hammer Test on 28 Days Specimen Mix-32

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	28	31	29	30	30	29
Corner-2	31	28	29	28	29	30
Corner-3	31	31	31	31	31	31
Corner-4	30	30	30	30	30	30
Middle	29	29	31	29	31	29
Avg. of cube 1	= 30.2					
Cube-2						
Corner-1	30	30	29	29	28	31
Corner-2	28	29	30	29	31	28
Corner-3	31	31	31	31	31	31
Corner-4	30	30	30	30	30	30
Middle	29	31	29	31	29	29
Avg. of cube 2	= 29.4					
Cube-3						
Corner-1	29	28	31	30	30	29
Corner-2	30	31	28	28	29	29
Corner-3	31	31	31	31	31	31
Corner-4	30	30	30	30	30	30
Middle	29	29	29	29	31	31
Avg. of cube 3	= 30.4					
Total avg. of cubes	= 30.0					

Table 4.116: Rebound Hammer Test on 28 Days Specimen Mix-33

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	34	32	35	33	34	35
Corner-2	33	34	34	34	34	33
Corner-3	32	31	32	31	32	32
Corner-4	34	35	31	35	31	34
Middle	33	33	31	33	32	33
Avg. of cube 1	= 33.1					
Cube-2						
Corner-1	34	35	33	34	32	35
Corner-2	34	33	34	33	34	34
Corner-3	32	32	31	32	31	32
Corner-4	31	34	35	34	35	31
Middle	32	33	33	33	33	31
Avg. of cube 2	= 33.4					
Cube-3						
Corner-1	34	33	32	35	34	35
Corner-2	33	34	34	34	34	33
Corner-3	32	31	31	32	32	32
Corner-4	34	35	35	31	31	34
Middle	33	33	33	31	32	33
Avg. of cube 3	= 32.5					
Total avg. of cubes	= 33.0					

Table 4.117: Rebound Hammer Test on 28 Days Specimen RMC Mix-1

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	30	30	32	28	31	30
Corner-2	25	25	29	29	28	27
Corner-3	30	27	30	30	30	32
Corner-4	27	28	31	31	28	27
Middle	28	25	30	30	26	29
Avg. of cube 1	= 29.38					
Cube-2						
Corner-1	29	31	30	31	28	30
Corner-2	30	28	27	27	32	29
Corner-3	31	30	31	32	31	30
Corner-4	31	28	27	27	29	29
Middle	30	30	28	29	30	31
Avg. of cube 2	= 29.65					
Cube-3						
Corner-1	31	31	30	29	30	28
Corner-2	29	29	29	30	27	32
Corner-3	30	32	28	33	31	31
Corner-4	29	28	32	31	28	29
Middle	31	29	29	30	30	30
Avg. of cube 3	= 29.86					
Total avg. of cubes	= 29.63					

Table 4.118: Rebound Hammer Test on 28 Days Specimen RMC Mix-2

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	26	27	26	28	27	25
Corner-2	25	25	27	25	26	27
Corner-3	27	28	30	28	28	26
Corner-4	29	27	26	26	27	28
Middle	28	26	27	27	30	27
Avg. of cube 1	= 27.10					
Cube-2						
Corner-1	28	28	27	30	27	26
Corner-2	27	27	26	29	25	27
Corner-3	28	30	28	27	26	29
Corner-4	26	28	27	25	27	30
Middle	30	27	30	28	27	27
Avg. of cube 2	= 27.56					
Cube-3						
Corner-1	28	28	29	28	26	27
Corner-2	29	27	25	29	27	29
Corner-3	27	28	26	26	29	28
Corner-4	28	30	27	28	30	27
Middle	30	27	30	29	27	30
Avg. of cube 3	= 28.20					
Total avg. of cubes	= 27.62					

Table 4.119: Rebound Hammer Test on 28 Days Specimen RMC Mix-3

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	27	26	27	27	27	27
Corner-2	25	25	26	25	27	26
Corner-3	26	26	28	26	28	26
Corner-4	25	26	27	26	27	25
Middle	24	27	26	27	26	24
Avg. of cube 1	= 27.3					
Cube-2						
Corner-1	27	27	27	26	27	27
Corner-2	27	26	25	25	26	25
Corner-3	28	26	26	26	28	26
Corner-4	27	25	25	26	27	26
Middle	26	24	24	27	26	27
Avg. of cube 2	= 26.8					
Cube-3						
Corner-1	27	27	27	27	27	26
Corner-2	26	25	27	26	25	25
Corner-3	28	26	28	26	26	26
Corner-4	27	26	27	25	25	26
Middle	26	27	26	24	24	27
Avg. of cube 3	= 27.5					
Total avg. of cubes	= 27.2					

Table 4.120: Rebound Hammer Test on 28 Days Specimen RMC Mix-4

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	37	40	38	39	37	38
Corner-2	39	38	36	38	36	38
Corner-3	37	37	39	40	39	37
Corner-4	38	39	40	39	40	38
Middle	39	37	38	37	38	39
Avg. of cube 1	= 38.7					
Cube-2						
Corner-1	37	38	38	39	37	40
Corner-2	36	38	36	38	39	38
Corner-3	39	37	39	40	37	37
Corner-4	40	38	40	39	38	39
Middle	38	39	38	37	39	37
Avg. of cube 2	= 37.9					
Cube-3						
Corner-1	38	39	37	40	37	38
Corner-2	36	38	39	38	36	38
Corner-3	39	40	37	37	39	37
Corner-4	40	39	38	39	40	38
Middle	38	37	39	37	38	39
Avg. of cube 3	= 38.9					
Total avg. of cubes	= 38.5					

Table 4.121: Rebound Hammer Test on 28 Days Specimen RMC Mix-5

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	35	34	37	36	37	36
Corner-2	37	33	35	33	36	34
Corner-3	34	35	34	35	34	34
Corner-4	33	34	33	34	33	33
Middle	35	36	32	36	32	35
Avg. of cube 1	= 35.2					
Cube-2						
Corner-1	37	36	35	34	37	36
Corner-2	36	34	37	33	35	33
Corner-3	34	34	34	35	34	35
Corner-4	33	33	33	34	33	34
Middle	32	35	35	36	32	36
Avg. of cube 2	= 35.0					
Cube-3						
Corner-1	37	36	37	36	35	34
Corner-2	35	33	36	34	37	33
Corner-3	34	35	34	34	34	35
Corner-4	33	34	33	33	33	34
Middle	32	36	32	35	35	36
Avg. of cube 3	= 34.8					
Total avg. of cubes	= 34.9					

Table 4.122: Rebound Hammer Test on 28 Days Specimen RMC Mix-6

REBOUND HAMMER TEST ON 28 DAYS SPECIMENS						
Cube-1						
	Face-1	Face-2	Face-3	Face-4	Face-5	Face-6
Corner-1	33	33	31	32	30	34
Corner-2	35	34	33	34	33	33
Corner-3	36	32	34	32	34	32
Corner-4	34	33	35	33	35	34
Middle	32	31	33	31	33	32
Avg. of cube 1	= 33.1					
Cube-2						
Corner-1	30	34	33	33	31	32
Corner-2	33	33	35	34	33	34
Corner-3	34	32	36	32	34	32
Corner-4	35	34	34	33	35	33
Middle	33	32	32	31	33	31
Avg. of cube 2	= 32.8					
Cube-3						
Corner-1	31	32	30	34	33	33
Corner-2	33	34	33	33	35	34
Corner-3	34	32	34	32	36	32
Corner-4	35	33	35	34	34	33
Middle	33	31	33	32	32	31
Avg. of cube 3	= 32.5					
Total avg. of cubes	= 32.8					

4.4 UPV Results

UPV test is measured by the ultrasonic pulse velocity test. In this test Direct method is adopted for cube specimens. This test is conducted for normal curing at 7 and 28 day also for accelerated curing at 1 day by warm water method and boiling water method. For all 40 mixes this test is used and after that comparison between accelerated curing at 1 day and normal curing at 7 & 28 days.

Table 4.123: UPV Test For Normal Curing And Accelerated Curing Mix-1

Mix-1	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	3880	3450	3820	4330
Side-2	3760	3260	3750	4640
Cube-2				
Side-1	3910	3230	3960	4370
Side-2	3640	3160	3710	4360
Cube-3				
Side-1	3810	3250	3810	4380
Side-2	3670	3190	3780	4660
Avg. of 3 cubes =	3778	3256	3805	4455
Concrete Quality	Good	Medium	Good	Good

Table 4.124: UPV Test For Normal Curing And Accelerated Curing Mix-2

Mix-2	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4260	3790	4370	4550
Side-2	4350	3620	4270	4490
Cube-2				
Side-1	4390	3650	4360	4510
Side-2	4310	3570	4110	4480
Cube-3				
Side-1	4360	3590	4370	4480
Side-2	4250	3450	4030	4260
Avg. of 3 cubes =	4320	3612	4252	4462
Concrete Quality	Good	Good	Good	Good

Table 4.125: UPV Test For Normal Curing And Accelerated Curing Mix-3

Mix-3	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4140	3740	4220	4830
Side-2	4120	3800	4150	4690
Cube-2				
Side-1	4030	3690	4290	4810
Side-2	3930	3790	4020	4700
Cube-3				
Side-1	4130	3650	4110	4750
Side-2	4050	3560	4050	4670
Avg. of 3 cubes =	4066	3705	4340	4741
Concrete Quality	Good	Good	Good	Excellent

Table 4.126: UPV Test For Normal Curing And Accelerated Curing Mix-4

Mix-4	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4470	4120	4560	4850
Side-2	4370	4010	4630	4820
Cube-2				
Side-1	4400	3930	4690	4920
Side-2	4410	3900	4780	4890
Cube-3				
Side-1	4350	4030	4610	4820
Side-2	4430	4090	4670	4900
Avg. of 3 cubes =	4405	4013	4656	4866
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.127: UPV Test For Normal Curing And Accelerated Curing Mix-5

Mix-5	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4470	4120	4520	4970
Side-2	4550	4150	4660	4870
Cube-2				
Side-1	4400	4030	4610	4920
Side-2	4510	3940	4700	4940
Cube-3				
Side-1	4450	4130	4690	4810
Side-2	4530	4010	4770	4950
Avg. of 3 cubes =	4485	4063	4660	4910
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.128: UPV Test For Normal Curing And Accelerated Curing Mix-6

Mix-6	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4570	4170	4570	4970
Side-2	4530	4150	4760	4890
Cube-2				
Side-1	4430	4030	4650	4980
Side-2	4510	4140	4700	4870
Cube-3				
Side-1	4410	4130	4720	4850
Side-2	4530	4010	4770	4970
Avg. of 3 cubes =	4490	4105	4695	4930
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.129: UPV Test For Normal Curing And Accelerated Curing Mix-7

Mix-7	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4430	4130	4550	4850
Side-2	4320	4010	4620	4820
Cube-2				
Side-1	4400	3950	4690	4910
Side-2	4430	3870	4740	4830
Cube-3				
Side-1	4320	4050	4610	4810
Side-2	4430	4070	4650	4900
Avg. of 3 cubes =	4385	3970	4645	4820
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.130: UPV Test For Normal Curing And Accelerated Curing Mix-8

Mix-8	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4270	4130	4670	4950
Side-2	4390	4070	4620	4860
Cube-2				
Side-1	4400	3990	4730	4910
Side-2	4430	3870	4790	4870
Cube-3				
Side-1	4270	4150	4610	4910
Side-2	4430	4070	4650	4900
Avg. of 3 cubes =	4365	4045	4680	4930
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.131: UPV Test For Normal Curing And Accelerated Curing Mix-9

Mix-9	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4120	3730	4510	4810
Side-2	4250	3640	4460	4760
Cube-2				
Side-1	4110	3710	4480	4660
Side-2	4140	3720	4410	4630
Cube-3				
Side-1	4070	3650	4360	4730
Side-2	4190	3740	4440	4820
Avg. of 3 cubes =	4146	3698	4443	4735
Concrete Quality	Good	Good	Good	Excellent

Table 4.132: UPV Test For Normal Curing And Accelerated Curing Mix-10

Mix-10	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4400	4040	4670	4820
Side-2	4360	4030	4690	4750
Cube-2				
Side-1	4620	4050	4610	4770
Side-2	4410	3990	4750	4670
Cube-3				
Side-1	4550	4030	4610	4620
Side-2	4430	4090	4670	4750
Avg. of 3 cubes =	4461	4038	4666	4730
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.133: UPV Test For Normal Curing And Accelerated Curing Mix-11

Mix-11	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4270	4110	4670	4870
Side-2	4180	4050	4560	4910
Cube-2				
Side-1	4140	4090	4550	4820
Side-2	4210	4150	4510	4950
Cube-3				
Side-1	4250	4000	4520	4810
Side-2	4130	4140	4610	4860
Avg. of 3 cubes =	4195	4090	4570	4870
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.134: UPV Test For Normal Curing And Accelerated Curing Mix-12

Mix-12	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4150	3980	4620	4810
Side-2	4190	4050	4460	4790
Cube-2				
Side-1	4040	4010	4520	4750
Side-2	4120	3950	4670	4820
Cube-3				
Side-1	4170	4070	4570	4700
Side-2	4080	4000	4420	4770
Avg. of 3 cubes =	4125	4010	4545	4775
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.135: UPV Test For Normal Curing And Accelerated Curing Mix-13

Mix-13	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4150	4080	4550	4820
Side-2	4280	4040	4670	4850
Cube-2				
Side-1	4210	4120	4610	4910
Side-2	4150	4090	4690	4880
Cube-3				
Side-1	4220	4110	4570	4790
Side-2	4100	4050	4650	4850
Avg. of 3 cubes =	4185	4080	4625	4850
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.136: UPV Test For Normal Curing And Accelerated Curing Mix-14

Mix-14	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4450	4180	4780	4770
Side-2	4490	4240	4560	4850
Cube-2				
Side-1	4340	4210	4650	4790
Side-2	4430	4250	4510	4810
Cube-3				
Side-1	4470	4240	4530	4870
Side-2	4400	4190	4570	4750
Avg. of 3 cubes =	4430	4220	4600	4810
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.137: UPV Test For Normal Curing And Accelerated Curing Mix-15

Mix-15	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4430	4210	4710	4920
Side-2	4450	4240	4690	4890
Cube-2				
Side-1	4410	4180	4610	4810
Side-2	4470	4290	4590	4960
Cube-3				
Side-1	4360	4310	4730	4910
Side-2	4420	4250	4650	4930
Avg. of 3 cubes =	4425	4250	4665	4905
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.138: UPV Test For Normal Curing And Accelerated Curing Mix-16

Mix-16	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4440	4210	4670	4990
Side-2	4380	4370	4710	5010
Cube-2				
Side-1	4410	4250	4590	4940
Side-2	4450	4310	4620	4900
Cube-3				
Side-1	4340	4360	4730	4920
Side-2	4420	4320	4790	4890
Avg. of 3 cubes =	4410	4305	4685	4945
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.139: UPV Test For Normal Curing And Accelerated Curing Mix-17

Mix-17	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4380	4230	4510	5010
Side-2	4320	4170	4630	4950
Cube-2				
Side-1	4350	4280	4670	4890
Side-2	4420	4210	4550	4920
Cube-3				
Side-1	4310	4170	4450	4830
Side-2	4440	4230	4590	4900
Avg. of 3 cubes =	4370	4215	4570	4920
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.140: UPV Test For Normal Curing And Accelerated Curing Mix-18

Mix-18	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4280	4170	4810	5140
Side-2	4350	4230	4750	5130
Cube-2				
Side-1	4320	4240	4710	5010
Side-2	4370	4300	4790	4990
Cube-3				
Side-1	4270	4110	4690	4930
Side-2	4340	4270	4750	5120
Avg. of 3 cubes =	4325	4220	4750	5055
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.141: UPV Test For Normal Curing And Accelerated Curing Mix-19

Mix-19	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4150	3620	4420	4680
Side-2	4090	3570	4490	4710
Cube-2				
Side-1	4080	3550	4380	4750
Side-2	4010	3670	4450	4790
Cube-3				
Side-1	4130	3660	4510	4610
Side-2	4050	3540	4490	4750
Avg. of 3 cubes =	4085	3605	4460	4715
Concrete Quality	Good	Good	Good	Excellent

Table 4.142: UPV Test For Normal Curing And Accelerated Curing Mix-20

Mix-20	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4380	4050	4550	4810
Side-2	4490	4130	4590	4790
Cube-2				
Side-1	4450	4180	4610	4910
Side-2	4330	4210	4520	4850
Cube-3				
Side-1	4420	4110	4620	4820
Side-2	4310	4190	4570	4740
Avg. of 3 cubes =	4400	4145	4575	4820
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.143: UPV Test For Normal Curing And Accelerated Curing Mix-21

Mix-21	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4410	4280	4720	4980
Side-2	4390	4110	4750	4920
Cube-2				
Side-1	4470	4190	4690	4950
Side-2				
Side-1	4420	4210	4610	4910
Side-2	4340	4240	4550	4990
Avg. of 3 cubes =	4410	4190	4670	4960
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.144: UPV Test For Normal Curing And Accelerated Curing Mix-22

Mix-22	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	3950	3480	4410	4620
Side-2	4080	3530	4450	4740
Cube-2				
Side-1	4030	3570	4490	4580
Side-2	3940	3510	4520	4630
Cube-3				
Side-1	4010	3470	4550	4610
Side-2	3990	3570	4420	4730
Avg. of 3 cubes =	4000	3525	3805	4655
Concrete Quality	Good	Good	Good	Excellent

Table 4.145: UPV Test For Normal Curing And Accelerated Curing Mix-23

Mix-23	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4270	3970	4650	4700
Side-2	4350	4020	4740	4790
Cube-2				
Side-1	4380	4070	4610	4850
Side-2	4410	4130	4720	4730
Cube-3				
Side-1	4290	4010	4650	4780
Side-2	4370	4110	4710	4830
Avg. of 3 cubes =	4345	4055	4680	4780
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.146: UPV Test For Normal Curing And Accelerated Curing Mix-24

Mix-24	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4280	3910	4410	4780
Side-2	4120	4030	4550	4840
Cube-2				
Side-1	4270	4070	4620	4680
Side-2	4150	3980	4510	4770
Cube-3				
Side-1	4140	3910	4450	4720
Side-2	4190	4000	4550	4810
Avg. of 3 cubes =	4195	3985	4515	4770
Concrete Quality	Good	Good	Excellent	Excellent

Table 4.147: UPV Test For Normal Curing And Accelerated Curing Mix-25

Mix-25	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4100	3550	4350	4650
Side-2	4050	3480	4480	4710
Cube-2				
Side-1	3970	3530	4440	4690
Side-2	3920	3540	4490	4530
Cube-3				
Side-1	4030	3410	4310	4610
Side-2	3960	3570	4370	4680
Avg. of 3 cubes =	4005	3515	4410	4645
Concrete Quality	Good	Good	Good	Excellent

Table 4.148: UPV Test For Normal Curing And Accelerated Curing Mix-26

Mix-26	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4250	3930	4410	4750
Side-2	4310	4050	4560	4680
Cube-2				
Side-1	4290	4010	4510	4710
Side-2	4330	4090	4490	4660
Cube-3				
Side-1	4230	4000	4510	4610
Side-2	4300	3950	4470	4720
Avg. of 3 cubes =	4285	4005	4490	4690
Concrete Quality	Good	Good	Good	Excellent

Table 4.149: UPV Test For Normal Curing And Accelerated Curing Mix-27

Mix-27	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4070	3930	4450	4750
Side-2	4150	3890	4560	4630
Cube-2				
Side-1	4020	3910	4410	4720
Side-2	4130	4000	4520	4610
Cube-3				
Side-1	4110	3870	4550	4690
Side-2	4070	3910	4420	4710
Avg. of 3 cubes =	4090	3920	4485	4675
Concrete Quality	Good	Good	Good	Excellent

Table 4.150: UPV Test For Normal Curing And Accelerated Curing Mix-28

Mix-28	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	3860	3340	4250	4580
Side-2	3910	3420	4310	4610
Cube-2				
Side-1	3770	3480	4340	4650
Side-2	3810	3310	4270	4540
Cube-3				
Side-1	3710	3370	4300	4640
Side-2	3830	3450	4290	4600
Avg. of 3 cubes =	3815	3395	4295	4605
Concrete Quality	Good	Medium	Good	Excellent

Table 4.151: UPV Test For Normal Curing And Accelerated Curing Mix-29

Mix-29	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4280	3910	4530	4540
Side-2	4110	4030	4310	4670
Cube-2				
Side-1	4230	3990	4470	4610
Side-2	4220	3970	4450	4590
Cube-3				
Side-1	4160	4050	4410	4500
Side-2	4210	3920	4510	4650
Avg. of 3 cubes =	4200	3980	4445	4595
Concrete Quality	Good	Good	Good	Excellent

Table 4.152: UPV Test For Normal Curing And Accelerated Curing Mix-30

Mix-30	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	3990	3750	4430	4680
Side-2	4170	3820	4570	4630
Cube-2				
Side-1	4130	3840	4550	4710
Side-2	4070	3780	4480	4640
Cube-3				
Side-1	4000	3710	4410	4600
Side-2	4120	3830	4530	4690
Avg. of 3 cubes =	4080	3790	4495	4660
Concrete Quality	Good	Good	Good	Excellent

Table 4.153: UPV Test For Normal Curing And Accelerated Curing Mix-31

Mix-31	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	3630	3450	4170	4490
Side-2	3750	3310	4130	4570
Cube-2				
Side-1	3690	3220	4220	4470
Side-2	3610	3280	4180	4590
Cube-3				
Side-1	3600	3370	4210	4440
Side-2	3720	3290	4100	4520
Avg. of 3 cubes =	3670	3320	4170	4520
Concrete Quality	Good	Medium	Good	Excellent

Table 4.154: UPV Test For Normal Curing And Accelerated Curing Mix-32

Mix-32	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4080	3820	4400	4660
Side-2	4130	3930	4320	4470
Cube-2				
Side-1	4170	3850	4330	4570
Side-2	4060	3710	4450	4410
Cube-3				
Side-1	4090	3770	4410	4590
Side-2	4120	3810	4470	4480
Avg. of 3 cubes =	4110	3815	4400	4530
Concrete Quality	Good	Good	Good	Excellent

Table 4.155: UPV Test For Normal Curing And Accelerated Curing Mix-33

Mix-33	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4010	3630	4350	4530
Side-2	4130	3780	4490	4690
Cube-2				
Side-1	3930	3720	4430	4640
Side-2	4050	3670	4520	4540
Cube-3				
Side-1	4090	3610	4410	4510
Side-2	4100	3680	4390	4590
Avg. of 3 cubes =	4055	3685	4435	4585
Concrete Quality	Good	Good	Good	Excellent

Table 4.156: UPV Test For Normal Curing And Accelerated Curing RMC Mix-1

RMC Mix-1	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4250	3650	4240	4850
Side-2	4360	3610	4310	4750
Cube-2				
Side-1	4420	3790	4250	4730
Side-2	4410	3820	4170	4620
Cube-3				
Side-1	4380	3640	4320	4630
Side-2	4430	3510	4290	4790
Avg. of 3 cubes =	4375	3670	4263	4728
Concrete Quality	Good	Good	Good	Excellent

Table 4.157: UPV Test For Normal Curing And Accelerated Curing RMC Mix-2

RMC Mix-2	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4120	3840	4390	4620
Side-2	4030	3730	4360	4550
Cube-2				
Side-1	4140	3950	4260	4570
Side-2	4110	3990	4350	4670
Cube-3				
Side-1	4240	3830	4410	4620
Side-2	4160	4010	4360	4590
Avg. of 3 cubes =	4133	3891	4355	4603
Concrete Quality	Good	Good	Good	Excellent

Table 4.158: UPV Test For Normal Curing And Accelerated Curing RMC Mix-3

RMC Mix-3	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	3610	3340	4100	4460
Side-2	3730	3310	4160	4550
Cube-2				
Side-1	3580	3220	4220	4410
Side-2	3600	3370	4130	4530
Cube-3				
Side-1	3710	3260	4190	4560
Side-2	3520	3200	4200	4440
Avg. of 3 cubes =	3625	3285	4170	4490
Concrete Quality	Good	Medium	Good	Good

Table 4.159: UPV Test For Normal Curing And Accelerated Curing RMC Mix-4

RMC Mix-4	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4250	3650	4240	4850
Side-2	4360	3610	4310	4750
Cube-2				
Side-1	4420	3790	4250	4730
Side-2	4410	3820	4170	4620
Cube-3				
Side-1	4380	3640	4320	4630
Side-2	4430	3510	4290	4790
Avg. of 3 cubes =	4375	3670	4265	4730
Concrete Quality	Good	Good	Good	Excellent

Table 4.160: UPV Test For Normal Curing And Accelerated Curing RMC Mix-5

RMC Mix-5	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4250	3650	4240	4850
Side-2	4360	3610	4310	4750
Cube-2				
Side-1	4420	3790	4250	4730
Side-2	4410	3820	4170	4620
Cube-3				
Side-1	4380	3640	4320	4630
Side-2	4430	3510	4290	4790
Avg. of 3 cubes =	4375	3670	4265	4730
Concrete Quality	Good	Good	Good	Excellent

Table 4.161: UPV Test For Normal Curing And Accelerated Curing RMC Mix-6

RMC Mix-6	W.W. Method (m/sec)	B.W. Method (m/sec)	7 days (m/sec)	28 days (m/sec)
Cube-1				
Side-1	4150	3970	4550	4870
Side-2	4120	3930	4670	4670
Cube-2				
Side-1	4240	3970	4650	4750
Side-2	4180	4030	4690	4840
Cube-3				
Side-1	4120	3950	4580	4850
Side-2	4250	3800	4630	4910
Avg. of 3 cubes =	4175	3940	4630	4820
Concrete Quality	Good	Good	Excellent	Excellent

4.5 Regression Equation For OPC Based Concrete

Regression analysis were conducted using Ms Excel software to study the correlation between Accelerated curing strength at 1 day and compressive strength at 28 days of standard concrete cube.

4.5.1 Regression Equation For Warm Water Curing Method

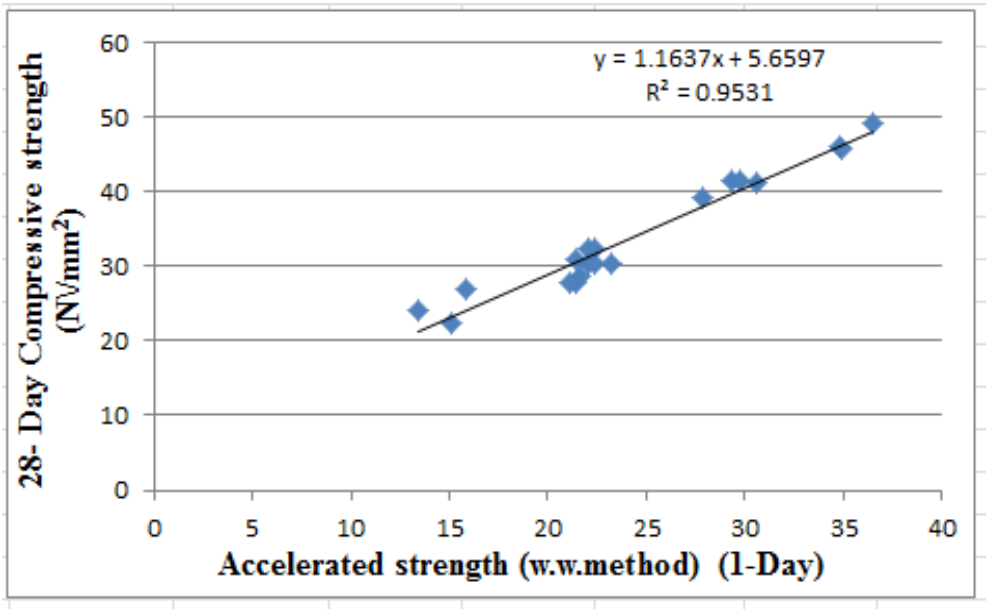

Figure 4.1: Typical Relation Between Accelerated And 28-day Compressive Strength of Concrete (Warm Water Method)

4.5.2 Regression Equation For Boiling Water Curing Method

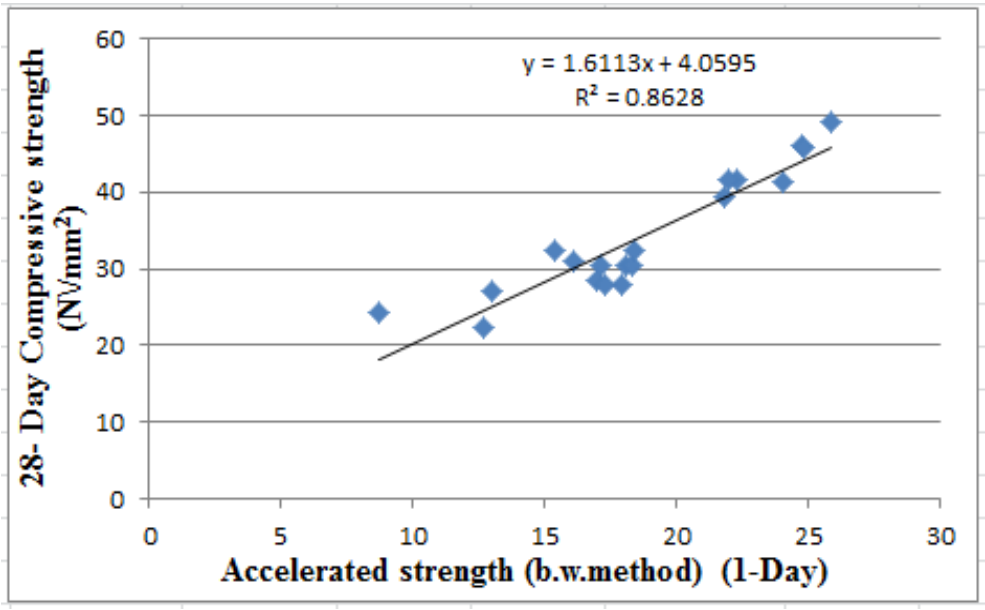

Figure 4.2: Typical Relation Between Accelerated And 28-day Compressive Strength of Concrete (Boilling Water Method)

The scatter plot (Figures 4.1 & 4.2) representing the Accelerated curing strength versus concrete compressive strength could give the following regression equations are concluded for the predicted values of the concrete compressive strength(MPa) at 28 days for OPC based concrete :

$$R_{28} = 1.1637Ra + 5.6597 \tag{4.1}$$

$$R_{28} = 1.6113Ra + 4.0595 \tag{4.2}$$

Where,

R_{28} = Compressive strength of concrete at 28 day (N/mm^2)

R_a = Accelerated curing strength at 1 day

4.6 Regression Equation For Concrete With Cement Replaced By Fly Ash

4.6.1 Regression Equation For Warm Water Curing Method

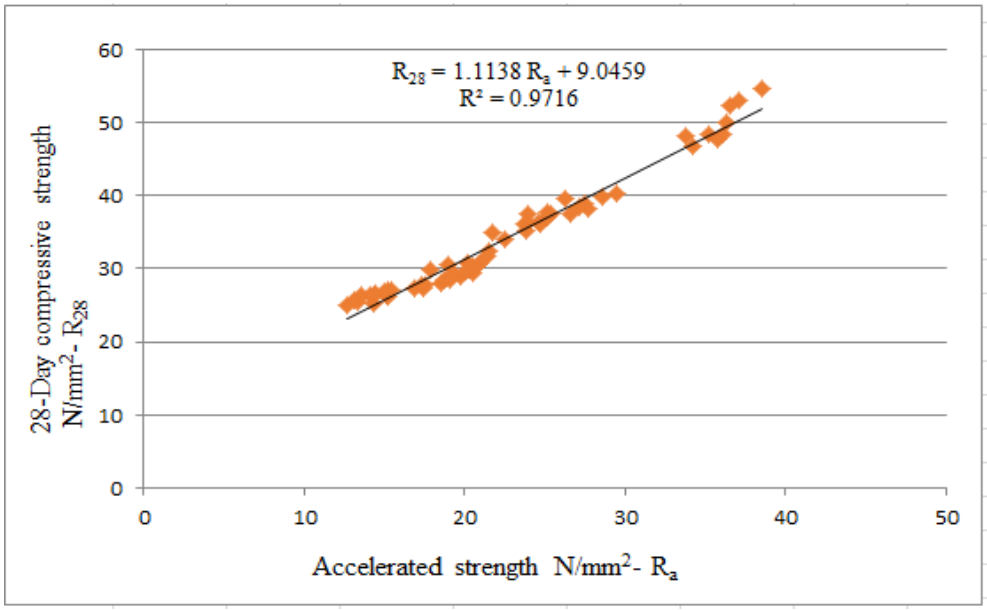

Figure 4.3: Typical Relation Between Accelerated And 28-day Compressive Strength of Concrete (Warm Water Method)

4.6.2 Regression Equation For Boiling Water Curing Method

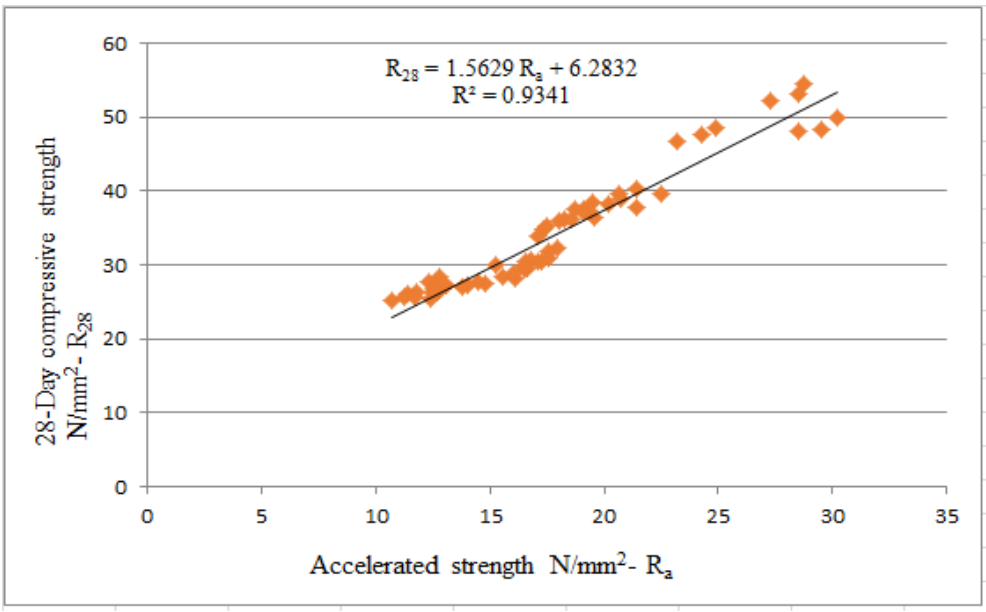

Figure 4.4: Typical Relation Between Accelerated And 28-day Compressive Strength of Concrete (Boilling Water Method)

The scatter plot (Figures 4.3 & 4.4) representing the Accelerated curing strength versus concrete compressive strength could give the following regression equations are concluded for the predicted values of the concrete compressive strength(MPa) at 28 days for Cementitious Material-fly Ash (15% To 35%) based concrete :

$$R_{28} = 1.1138Ra + 9.0459 \tag{4.3}$$

$$R_{28} = 1.5629Ra + 6.2832 \tag{4.4}$$

Where,

R_{28} = Compressive strength of concrete at 28 day (N/mm^2)

R_a = Accelerated curing strength at 1 day

Chapter 5

Discussion of Results

5.1 General

This chapter contains test results of different type of accelerated curing like warm water and boiling water with different conditions. Non-destructive testing i.e. rebound hammer and UPV of concrete specimens with various type of concrete. Concrete at various age period of 1 day for accelerated curing & 7, 28 days for normal curing followed by compressive strength of concrete.

For age 1 day for accelerated curing & 7, 28 days for normal curing first of all rebound hammer results are to be taken by keeping rebound hammer in vertical position. At 1 day after accelerated curing process is done by both methods then 3 nos. of cube specimens were tested for NDT results and compressive strength. Further same process for the 7 days and 28 days cube specimens. In each cube total 30 readings are to be taken, 5 from each face for vertical position of rebound hammer.

Then UPV results are to be taken by direct method. After non-destructive testing compressive strength of concrete specimens are to be found by compression testing machine.

5.2 Comparison of Compressive Strength

By using the methodology of accelerated curing warm water & boiling water method, the compressive strength of concrete cube for all 40 concrete cube mixes is evaluated at 1 day and predicted to 28 day compressive strength for all 40 concrete cube mixes. By predicted results of warm water method and boiling water method is compared to 28 days normal curing compressive strength of concrete cubes.

Table 5.1: Comparison of Compressive Strength Mix-1

Mix-1	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28days Normal Curing strength	
	Ra (24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28days (Mpa)	Avg. (Mpa)
Cube-1	14.48	-	8.95	-	24.5	24.16
Cube-2	13.65	-	8.81	-	24.1	
Cube-3	12.00	-	8.48	-	23.9	
Avg. of 3 cubes =	13.37	26.02	8.74	22.43		

Table 5.2: Comparison of Compressive Strength Mix-2

Mix-2	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28days Normal Curing strength	
	Ra (24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	16.78	-	13.56	-	23.24	22.40
Cube-2	14.52	-	12.52	-	22.55	
Cube-3	14.00	-	11.88	-	21.41	
Avg. of 3 cubes =	15.10	27.75	12.65	28.84		

Table 5.3: Comparison of Compressive Strength Mix-3

Mix-3	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra (24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	22.95	-	17.20	-	29.74	28.59
Cube-2	21.53	-	17.42	-	28.92	
Cube-3	20.58	-	16.18	-	27.12	
Avg. of 3 cubes =	21.68	34.33	16.93	35.85		

Table 5.4: Comparison of Compressive Strength Mix-4

Mix-4	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28days Normal Curing strength	
	Ra (24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28days (Mpa)	Avg. (Mpa)
Cube-1	22.40	-	17.78	-	30.54	27.95
Cube-2	21.33	-	17.34	-	27.31	
Cube-3	20.45	-	18.61	-	26.02	
Avg. of 3 cubes =	21.39	34.04	17.91	37.46		

Table 5.5: Comparison of Compressive Strength Mix-5

Mix-5	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28days Normal Curing strength	
	Ra (24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28days (Mpa)	Avg. (Mpa)
Cube-1	23.48	-	17.29	-	31.67	30.33
Cube-2	21.87	-	18.23	-	30.34	
Cube-3	20.78	-	15.89	-	29.00	
Avg. of 3 cubes =	22.04	34.69	17.13	36.18		

Table 5.6: Comparison of Compressive Strength Mix-6

Mix-6	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra (24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28days (Mpa)	Avg. (Mpa)
Cube-1	22.49	-	17.22	-	31.34	30.88
Cube-2	21.50	-	15.32	-	31.22	
Cube-3	20.38	-	15.66	-	30.10	
Avg. of 3 cubes =	21.45	34.1	16.06	34.43		

Table 5.7: Comparison of Compressive Strength Mix-7

Mix-7	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra (24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28days (Mpa)	Avg. (Mpa)
Cube-1	22.67	-	16.64	-	29.57	27.89
Cube-2	20.24	-	17.07	-	27.10	
Cube-3	20.53	-	18.10	-	27.02	
Avg. of 3 cubes =	21.14	33.79	17.27	36.41		

Table 5.8: Comparison of Compressive Strength Mix-8

Mix-8	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc.Curing by b.w. method R28 = 8.09 + 1.64 Ra		28days Normal Curing strength	
	Ra (24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28days (Mpa)	Avg. (Mpa)
Cube-1	23.22	-	18.25	-	31.40	30.37
Cube-2	22.68	-	18.46	-	30.43	
Cube-3	21.14	-	17.58	-	29.30	
Avg. of 3 cubes =	22.38	35.03	18.09	37.75		

Table 5.9: Comparison of Compressive Strength Mix-9

Mix-9	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	17.82	-	15.25	-	29.91	28.21
Cube-2	17.42	-	14.78	-	27.39	
Cube-3	16.83	-	13.07	-	27.33	
Avg. of 3 cubes =	17.35	28.31	14.36	28.68		

Table 5.10: Comparison of Compressive Strength Mix-10

Mix-10	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc.Curing by b.w. method R28 = 8.09 + 1.64 Ra		28days Normal Curing strength	
	Ra (24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28days (Mpa)	Avg. (Mpa)
Cube-1	24.35	-	19.94	-	31.78	30.31
Cube-2	23.33	-	17.82	-	30.20	
Cube-3	21.96	-	17.25	-	28.97	
Avg. of 3 cubes =	23.21	35.86	18.33	38.15		

Table 5.11: Comparison of Compressive Strength Mix-11

Mix-11	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	30.10	-	23.10	-	42.15	41.50
Cube-2	28.85	-	21.37	-	40.80	
Cube-3	29.18	-	22.29	-	41.55	
Avg. of 3 cubes =	29.37	42.02	22.25	44.58		

Table 5.12: Comparison of Compressive Strength Mix-12

Mix-12	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	26.30	-	22.50	-	37.80	37.91
Cube-2	25.10	-	19.60	-	36.40	
Cube-3	24.55	-	21.40	-	39.54	
Avg. of 3 cubes =	25.31	37.14	21.16	39.29		

Table 5.13: Comparison of Compressive Strength Mix-13

Mix-13	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	28.40	-	22.34	-	40.10	39.38
Cube-2	27.95	-	21.59	-	38.45	
Cube-3	27.10	-	21.45	-	39.59	
Avg. of 3 cubes =	27.81	40.46	21.79	43.83		

Table 5.14: Comparison of Compressive Strength Mix-14

Mix-14	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	34.42	-	25.15	-	46.82	46.09
Cube-2	35.85	-	24.78	-	45.37	
Cube-3	34.10	-	24.31	-	46.10	
Avg. of 3 cubes =	34.79	47.44	24.74	48.66		

Table 5.15: Comparison of Compressive Strength Mix-15

Mix-15	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	35.55	-	25.34	-	46.10	45.81
Cube-2	34.45	-	24.59	-	45.75	
Cube-3	34.87	-	24.49	-	45.55	
Avg. of 3 cubes =	34.95	47.60	24.80	48.76		

Table 5.16: Comparison of Compressive Strength Mix-16

Mix-16	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	36.55	-	26.89	-	49.65	49.15
Cube-2	37.10	-	25.75	-	49.0	
Cube-3	35.95	-	24.92	-	48.8	
Avg. of 3 cubes =	36.53	49.18	25.85	50.48		

Table 5.17: Comparison of Compressive Strength Mix-17

Mix-17	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	36.10	-	24.85	-	48.51	47.63
Cube-2	35.79	-	24.29	-	47.73	
Cube-3	34.23	-	23.18	-	46.67	
Avg. of 3 cubes =	35.37	48.31	24.10	43.88		

Table 5.18: Comparison of Compressive Strength Mix-18

Mix-18	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	38.49	-	28.73	-	54.58	53.31
Cube-2	37.10	-	28.54	-	53.11	
Cube-3	36.49	-	27.28	-	52.23	
Avg. of 3 cubes =	37.37	50.53	28.18	50.24		

Table 5.19: Comparison of Compressive Strength Mix-19

Mix-19	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	16.15	-	13.78	-	27.42	27.11
Cube-2	15.45	-	12.35	-	27.15	
Cube-3	15.95	-	12.89	-	26.78	
Avg. of 3 cubes =	15.85	28.50	13.0	29.41		

Table 5.20: Comparison of Compressive Strength Mix-20

Mix-20	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	23.15	-	18.95	-	33.30	32.51
Cube-2	22.75	-	18.75	-	32.45	
Cube-3	21.28	-	17.48	-	31.80	
Avg. of 3 cubes =	22.39	35.04	18.39	38.25		

Table 5.21: Comparison of Compressive Strength Mix-21

Mix-21	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	30.42	-	23.42	-	42.48	41.58
Cube-2	29.73	-	21.37	-	41.50	
Cube-3	29.05	-	21.10	-	40.78	
Avg. of 3 cubes =	29.73	42.38	21.96	44.10		

Table 5.22: Comparison of Compressive Strength Mix-22

Mix-22	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	15.47	-	13.98	-	27.16	26.65
Cube-2	15.13	-	12.75	-	26.48	
Cube-3	14.31	-	12.48	-	26.32	
Avg. of 3 cubes =	14.97	25.66	13.07	26.67		

Table 5.23: Comparison of Compressive Strength Mix-23

Mix-23	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	21.53	-	17.93	-	32.35	31.65
Cube-2	21.37	-	17.53	-	31.82	
Cube-3	20.13	-	16.77	-	30.78	
Avg. of 3 cubes =	21.01	32.37	17.41	33.44		

Table 5.24: Comparison of Compressive Strength Mix-24

Mix-24	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	29.50	-	21.45	-	40.38	39.42
Cube-2	28.53	-	20.68	-	39.73	
Cube-3	27.73	-	20.15	-	38.15	
Avg. of 3 cubes =	28.58	40.77	20.76	38.66		

Table 5.25: Comparison of Compressive Strength Mix-25

Mix-25	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	15.22	-	13.78	-	27.0	26.37
Cube-2	15.0	-	12.57	-	26.82	
Cube-3	14.37	-	12.42	-	25.32	
Avg. of 3 cubes =	14.86	25.54	12.92	26.44		

Table 5.26: Comparison of Compressive Strength Mix-26

Mix-26	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	21.0	-	17.57	-	30.90	30.28
Cube-2	20.5	-	17.11	-	30.45	
Cube-3	20.7	-	16.45	-	29.50	
Avg. of 3 cubes =	20.73	32.06	17.04	32.86		

Table 5.27: Comparison of Compressive Strength Mix-27

Mix-27	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	27.44	-	20.72	-	38.85	38.3
Cube-2	27.15	-	19.49	-	38.48	
Cube-3	26.63	-	19.13	-	37.57	
Avg. of 3 cubes =	27.07	39.10	19.78	37.14		

Table 5.28: Comparison of Compressive Strength Mix-28

Mix-28	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	14.45	-	12.75	-	26.71	26.21
Cube-2	14.05	-	11.75	-	26.38	
Cube-3	13.37	-	11.68	-	25.55	
Avg. of 3 cubes =	13.96	24.55	12.06	25.09		

Table 5.29: Comparison of Compressive Strength Mix-29

Mix-29	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	20.55	-	17.77	-	30.45	29.75
Cube-2	20.27	-	16.47	-	29.89	
Cube-3	19.78	-	16.04	-	28.92	
Avg. of 3 cubes =	20.2	31.47	16.57	32.13		

Table 5.30: Comparison of Compressive Strength Mix-30

Mix-30	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	25.41	-	19.37	-	37.41	36.91
Cube-2	25.11	-	19.07	-	37.12	
Cube-3	24.67	-	18.22	-	36.22	
Avg. of 3 cubes =	25.06	36.87	18.88	35.73		

Table 5.31: Comparison of Compressive Strength Mix-31

Mix-31	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	13.55	-	12.70	-	26.45	25.78
Cube-2	13.10	-	11.20	-	25.77	
Cube-3	12.70	-	10.70	-	25.13	
Avg. of 3 cubes =	13.11	23.60	11.53	24.27		

Table 5.32: Comparison of Compressive Strength Mix-32

Mix-32	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	20.08	-	16.63	-	29.65	29.16
Cube-2	19.28	-	16.55	-	29.40	
Cube-3	19.05	-	15.57	-	28.40	
Avg. of 3 cubes =	19.47	30.66	16.25	31.63		

Table 5.33: Comparison of Compressive Strength Mix-33

Mix-33	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	23.93	-	18.60	-	36.25	35.15
Cube-2	23.81	-	17.52	-	35.21	
Cube-3	22.50	-	17.10	-	34.0	
Avg. of 3 cubes =	23.41	35.03	17.74	33.95		

Table 5.34: Comparison of Compressive Strength RMC Mix-1

RMC Mix-1	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	23.44	-	16.51	-	33.73	32.32
Cube-2	22.69	-	15.16	-	32.80	
Cube-3	19.91	-	14.41	-	30.45	
Avg. of 3 cubes =	22.01	34.66	15.36	33.28		

Table 5.35: Comparison of Compressive Strength RMC Mix-2

RMC Mix-2	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	18.97	-	16.54	-	30.46	28.76
Cube-2	18.55	-	16.09	-	28.11	
Cube-3	17.49	-	14.46	-	27.73	
Avg. of 3 cubes =	18.33	29.39	15.69	30.76		

Table 5.36: Comparison of Compressive Strength RMC Mix-3

RMC Mix-3	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	13.33	-	12.20	-	26.19	25.52
Cube-2	13.10	-	11.35	-	25.37	
Cube-3	12.45	-	10.30	-	25.0	
Avg. of 3 cubes =	12.96	23.44	11.28	23.89		

Table 5.37: Comparison of Compressive Strength RMC Mix-4

RMC Mix-4	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	36.30	-	30.18	-	49.94	48.80
Cube-2	35.23	-	29.48	-	48.36	
Cube-3	33.76	-	28.50	-	48.10	
Avg. of 3 cubes =	35.09	48.0	29.38	52.11		

Table 5.38: Comparison of Compressive Strength RMC Mix-5

RMC Mix-5	Acc. Curing by w.w. method R28 = 12.65 + Ra		Acc. Curing by b.w. method R28 = 8.09 + 1.64 Ra		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	31.53	-	25.31	-	42.40	41.23
Cube-2	30.89	-	23.76	-	42.24	
Cube-3	29.32	-	22.09	-	39.06	
Avg. of 3 cubes =	30.58	43.23	24.0	47.45		

Table 5.39: Comparison of Compressive Strength RMC Mix-6

RMC Mix-6	Acc. Curing by w.w. method R28 = 1.11Ra + 9.05		Acc. Curing by b.w. method R28 = 1.56Ra + 6.28		28 days Normal Curing strength	
	Ra 24 hours) (Mpa)	R28 (predicted strength) (Mpa)	Ra (28.5 hours) (Mpa)	R28 (predicted strength) (Mpa)	28 days (Mpa)	Avg. (Mpa)
Cube-1	23.89	-	18.72	-	37.45	36.12
Cube-2	23.76	-	18.03	-	36.05	
Cube-3	21.76	-	17.31	-	36.86	
Avg. of 3 cubes =	22.90	34.47	18.02	34.39		

5.3 Comparison of Rebound Hammer Result

In the table 5.40 and 5.41 for opc based and fly ash based concrete mix is given. In that comparison of warm water method, boiling water method and 28 day results are there. In which for warm water method results the rebound number on w.w. cube is convert into compressive strength by the graph of (rebound hammer vs compressive strength) and then by the regression equations the predicted compressive strength can achieved. similarly for boiling water method. And by both the accelerated curing method is compare to 28 days compressive strength results.

Table 5.40: Comparison of Rebound Hammer Result For OPC Concrete

	Warm water method results			**Boiling water method results**			**28 days results**	
Mix No	**R.H. Results on warm water Cube**	**R.N. Convert into compressive strength (Mpa)**	**R28 (Predicted Strength) (R28 = 12.65 + Ra) (Mpa)**	**R.H. Results on boiling water Cube**	**R.N. Convert into compressive strength (Mpa)**	**R28 (Predicted Strength) (R28 = 8.09 + 1.64 Ra) (Mpa)**	**R.H. Results on 28 Days Cube**	**28 Days R.N. Convert into Compressive Strength (Mpa)**
1	20.87	16.0	**28.65**	20	14.0	**31.05**	24.54	**20.0**
2	22.05	17.0	**29.05**	20	14.0	**31.05**	24.42	**20.0**
3	22.59	17.0	**29.65**	20	14.0	**31.05**	28.60	**26.0**
4	21.44	16.0	**28.65**	20.93	15.0	**32.69**	29.63	**28.0**
5	24.54	20.0	**32.65**	21.47	16.0	**34.33**	31.10	**30.0**
6	24.42	20.0	**32.65**	21.31	16.0	**34.33**	30.44	**29.0**
7	21.40	16.0	**28.65**	20.75	15.0	**32.69**	29.53	**27.0**
8	24.76	21.0	**33.65**	21.60	16.5	**35.15**	31.2	**30.0**
10	22.50	17.0	**29.65**	21.24	16.0	**34.33**	29.85	**28.0**
11	28.47	26.0	**38.65**	24.75	20.50	**41.71**	36.92	**40.0**
13	28.60	26.0	**38.65**	24.6	20.5	**41.71**	36.5	**39.0**

Table 5.40 continued from previous page

	Warm water method results			**Boiling water method results**			**28 days results**	
14	31.50	31.0	**43.65**	27.5	25.0	**49.09**	38.8	**43.0**
15	32.6	33.0	**45.65**	28.5	26.0	**50.73**	38.93	**43.5**
16	35.53	37.0	**49.65**	29.0	27.0	**52.37**	39.33	**44.0**
19	22.73	18.0	**30.65**	20.0	14.0	**31.05**	30.46	**29.0**
20	24.73	21.0	**33.65**	22.06	17.0	**35.97**	33.93	**35.0**
21	28.53	26.0	**38.65**	24.8	20.5	**41.71**	36.4	**39.0**
RMC-1	22.62	17.5	**30.15**	20.0	14.0	**31.05**	29.63	**28.0**
RMC-5	22.33	17.0	**27.92**	20.94	15.5	**30.46**	27.62	**25.0**

Table 5.41: Comparison of Rebound Hammer Result For Fly Ash Concrete

	Warm water method results			**Boiling water method results**			**28 days results**	
Mix No	**R.H. Results on warm water Cube**	**R.N. Convert into compressive strength (Mpa)**	**R28 (Predicted Strength) (R28 = 1.11 Ra+ 9.05) (Mpa)**	**R.H. Results on boiling water Cube**	**R.N. Convert into compressive strength (Mpa)**	**R28 (Predicted Strength) (R28 = 1.56 Ra + 6.28) (Mpa)**	**R.H. Results on 28 Days Cube**	**28 Days R.N. Convert into Compressive Strength (Mpa)**
9	21.56	16.0	**26.81**	20.0	14.0	**28.12**	27.65	**25.0**
12	27.5	25.0	**36.8**	24.73	20.5	**38.26**	35.30	**37.0**
17	33.66	34.0	**46.79**	27.63	25.0	**45.28**	39.6	**45.0**
18	37.0	40.0	**53.45**	30.46	29.0	**51.52**	41.66	**49.0**
22	21.93	17.0	**27.92**	20.0	14.0	**28.12**	28.66	**27.0**
23	23.86	19.5	**30.7**	21.73	17.0	**32.8**	33.33	**34.0**
24	27.8	25.0	**36.8**	24.5	20.0	**37.48**	35.33	**37.0**
25	22.0	17.0	**27.92**	20.0	14.0	**28.12**	28.33	**26.0**
26	23.5	19.0	**30.14**	21.5	16.0	**31.24**	31.86	**32.0**
27	26.8	24.0	**35.69**	23.66	19.0	**35.92**	35.0	**36.0**
28	21.46	16.0	**26.81**	20.0	14.0	**28.12**	27.97	**25.50**

Table 5.41 continued from previous page

	Warm water method results			**Boiling water method results**			**28 days results**	
29	23.3	18.5	**29.59**	21.1	15.5	**30.46**	30.86	**30.0**
30	26.3	22.5	**34.03**	23.0	18.0	**34.36**	34.0	**35.0**
31	20.8	15.5	**26.25**	20.0	14.0	**28.12**	26.93	**24.0**
32	23.0	18.0	**29.03**	20.5	15.0	**29.68**	30.0	**28.5**
33	23.86	19.0	**30.14**	22.3	17.0	**32.8**	33.0	**33.0**
RMC-2	22.33	17.0	**27.92**	20.94	15.5	**30.46**	27.62	**25.0**
RMC-3	21.0	15.5	**26.25**	20.0	14.0	**28.12**	27.2	**24.0**
RMC-4	31.2	30.0	**42.35**	29.4	28.0	**49.46**	38.5	**43.0**
RMC-6	25.5	22.0	**33.47**	23.2	18.0	**34.36**	32.8	**33.0**

5.4 Comparison of predicted compressive strength

Table 5.42: Comparison of Predicted Compressive Strength For All Mixes

Mix No	28 Days		W.W.		B.W.	
	Normal curing strength (Mpa)	Compressive strength (R.H) (Mpa)	R28 Predicted strength (Mpa)	Predicted Compressive strength (R.H) (Mpa)	R28 Predicted strength (Mpa)	Predicted Compressive strength (R.H) (Mpa)
1	24.16	20.0	26.02	28.65	22.43	31.05
2	22.40	20.0	27.75	29.65	28.84	31.05
3	28.59	26.0	34.33	29.65	35.85	31.05
4	27.95	28.0	34.04	28.65	37.46	32.69
5	30.33	30.0	34.69	32.65	36.18	34.33
6	30.88	29.0	34.1	32.65	34.43	34.33
7	27,89	27.0	33.79	28.65	36.41	32.69
8	30.37	30.0	35.03	33.65	37.75	35.15
9	28.21	25.0	28.31	26.81	28.68	28.12
10	30.31	28.0	35.86	29.65	38.15	34.33
11	41.5	40.0	42.02	38.65	44.58	41.71
12	37.91	37.0	37.14	36.8	39.29	38.26
13	39.38	39.0	40.46	38.65	43.83	41.71
14	46.09	43.0	47.44	43.65	48.66	49.09
15	45.81	43.5	47.6	45.65	48.76	50.73
16	49.15	44.0	49.18	49.65	50.48	52.37
17	47.63	45.0	48.31	46.79	43.88	45.28
18	53.31	49.0	50.53	53.45	50.24	51.52
19	27.11	29.0	28.5	30.65	29.41	31.05
20	32.51	35.0	35.04	33.65	38.25	35.97
21	41.58	39.0	42.38	38.65	44.10	41.71
22	26.65	27.0	25.66	27.92	26.67	28.12

Table 5.42 continued from previous page

Mix No	28 Days		W.W.		B.W.	
	Normal curing strength (Mpa)	**Compressive strength (R.H) (Mpa)**	**R28 Predicted strength (Mpa)**	**Predicted Compressive strength (R.H) (Mpa)**	**R28 Predicted strength (Mpa)**	**Predicted Compressive strength (R.H) (Mpa)**
23	31.65	34.0	32.37	30.7	33.44	32.8
24	39.42	37.0	40.77	36.8	38.66	37.48
25	26.37	26.0	25.54	27.92	26.44	28.12
26	30.28	32.0	32.06	30.14	32.86	31.24
27	38.3	36.0	39.10	35.69	37.14	35.92
28	26.21	25.5	24.55	26.81	25.09	28.12
29	29.75	30.0	31.47	29.59	32.13	30.46
30	36.91	35.0	36.87	34.03	35.73	34.36
31	25.78	24.0	23.60	26.25	24.27	28.12
32	29.16	28.5	30.66	29.03	31.63	29.68
33	35.15	33.0	35.03	30.14	33.95	32.8
RMC-1	32.32	28.0	34.66	30.15	33.28	31.05
RMC-2	28.76	25.0	29.39	27.92	30.76	30.46
RMC-3	25.52	24.0	23.44	26.25	24.89	28.12
RMC-4	48.80	43.0	48.0	42.45	52.11	49.96
RMC-5	41.23	36.0	43.23	37.65	47.45	44.17
RMC-6	36.12	33.0	34.47	33.47	34.39	34.36

5.5 Correlation of Compressive Strength and NDT Results for OPC Based Concrete

all age 1, 7, 28 days first of all rebound hammer results are to be taken by keeping rebound hammer in vertical position. At 1 days 6 nos. of cube specimens were tested for NDT results by both method and compressive strength. For 7 and 28days 6 nos.of specimens were tested. In each cube total 30 readings are to be taken, 5 from each face for vertical position of rebound hammer. Then UPV results are to be taken by direct method. After non-destructive testing compressive strength of concrete specimens are to be found by compression testing machine.

5.5.1 Relationship Between 28 Day Rebound Number And 28 Day Compressive Strength For OPC Concrete Mixes)

Regression analysis were conducted using Ms Excel software to study the correlation between NDT results and compressive strength of standard concrete cube. Graphical representation of correlation between Compressive strength and NDT results for age of 28 days for OPC based concrete are as shown in Figure 5.1. scatter plot (Figures 5.1)

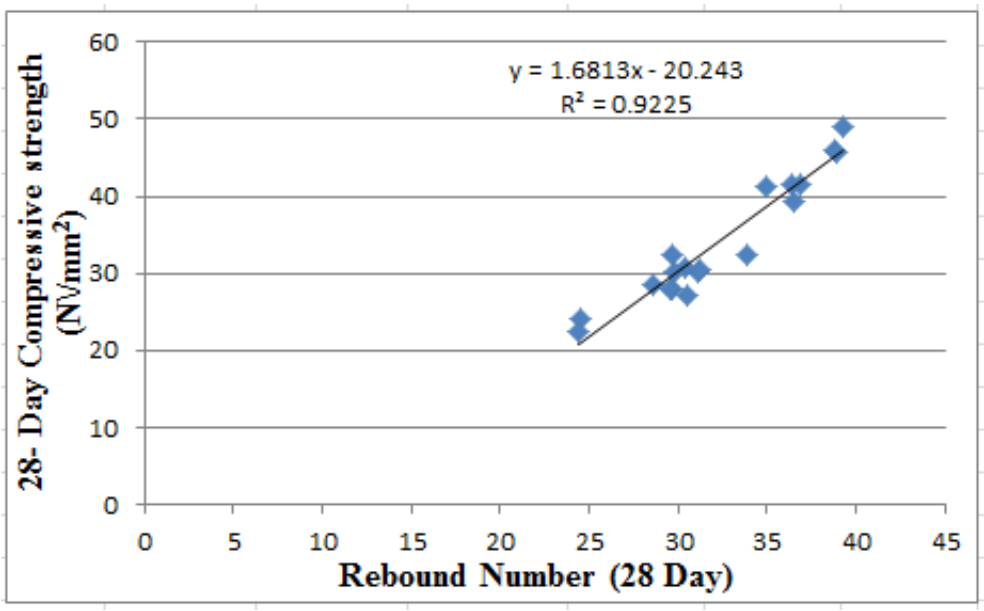

Figure 5.1: Correlation Between Compressive Strength And Rebound Number(Vertical Position) For 28 Days

representing the 28 day rebound number versus concrete compressive strength at 28 day could give the following linear equations are concluded for the predicted values of the concrete compressive strength(MPa) at 28 days for OPC based concrete :

$$S_c = 1.6813R_N - 20.243 \tag{5.1}$$

Where,

S_c = Compressive strength of concrete at 28 day (N/mm^2)

R_N = Rebound number at 28 day

R square value for Eq.5.1 are 0.922. 0.922 value explained that 92.2 % of the variability for the data around the regression line and 7.75 % of the residual data could not explained by Eq.5.1.

5.5.2 Relationship Between 1 Day Rebound Number And 28 Day Compressive Strength For OPC Based Concrete

5.5.2.1 W.W. Method (OPC)

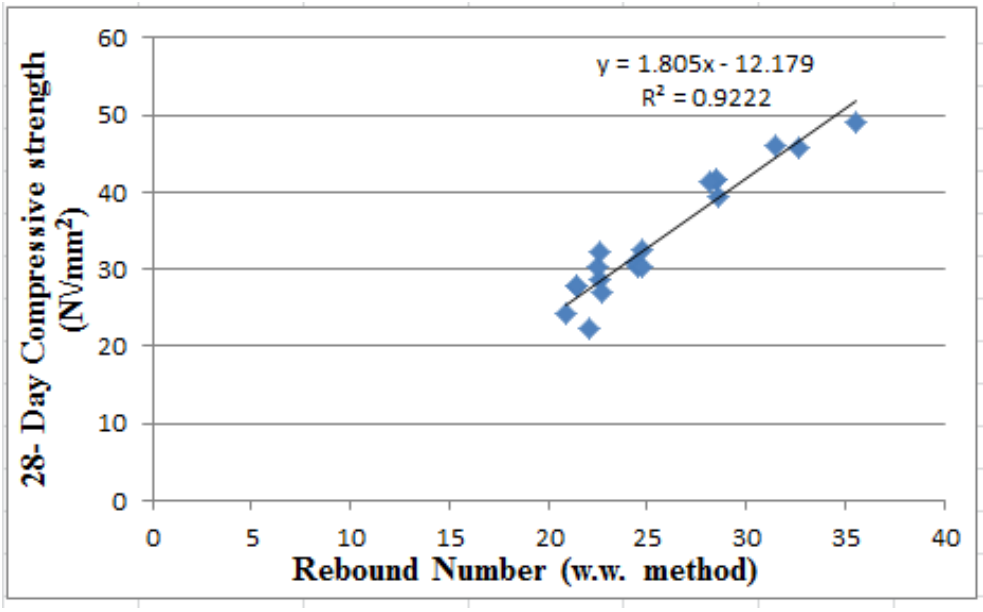

Figure 5.2: Correlation Between Compressive Strength And Rebound Number(Vertical Position) For 28 Days OPC Mixes

5.5.2.2 B.W Method (OPC)

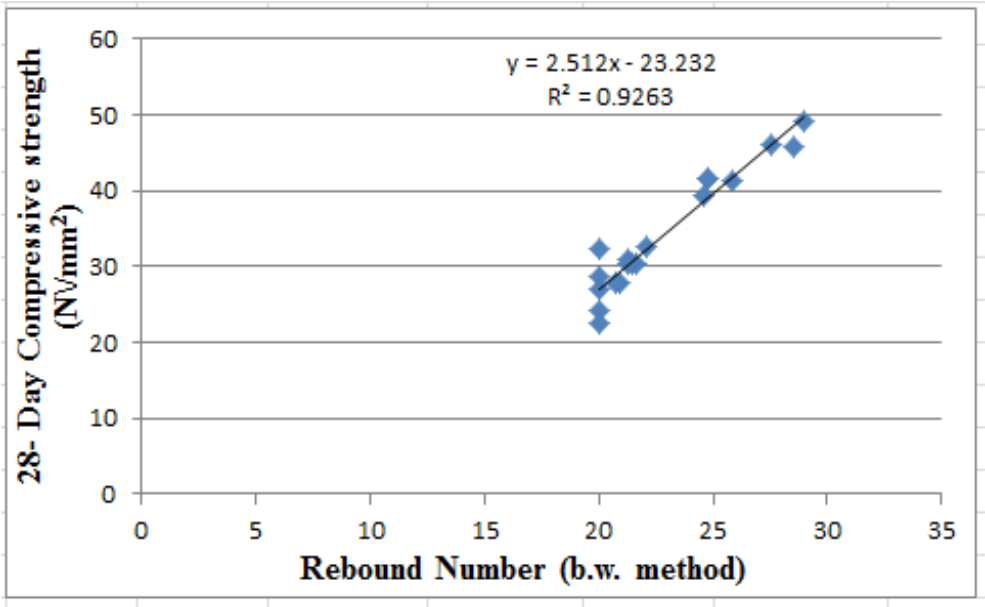

Figure 5.3: Correlation Between Compressive Strength And Rebound Number(Vertical Position) For 28 Days OPC Mixes

scatter plot (Figures 5.2 & 5.3) representing the 1 day rebound number versus concrete compressive strength could give the following linear equations are concluded for the predicted values of the concrete compressive strength(MPa) at 28 days for OPC based concrete :

$$S_c = 1.805R_N - 12.179 \tag{5.2}$$

$$S_c = 2.512R_N - 23.232 \tag{5.3}$$

Where,

S_c = Compressive strength of concrete at 28 day (N/mm^2)

R_N = Rebound number at 1 day (ww & bw method)

R square value for Eq.5.2 and Eq.5.3 are 0.9222 and 0.9263 respectively. 0.9222 value explained that 92.22 % of the variability for the data around the regression line and 7.78 % of the residual data could not explained by Eq.5.2. In the case of Eq.5.3 92.63 % of the variability for the data around the line and 7.37 % remain unexplained.

5.6 Correlation of Compressive Strength and NDT Results for Fly Ash Based Concrete

5.6.1 Relationship Between 28 Day Rebound Number And 28 Day Compressive Strength For Fly Ash Concrete Mixes)

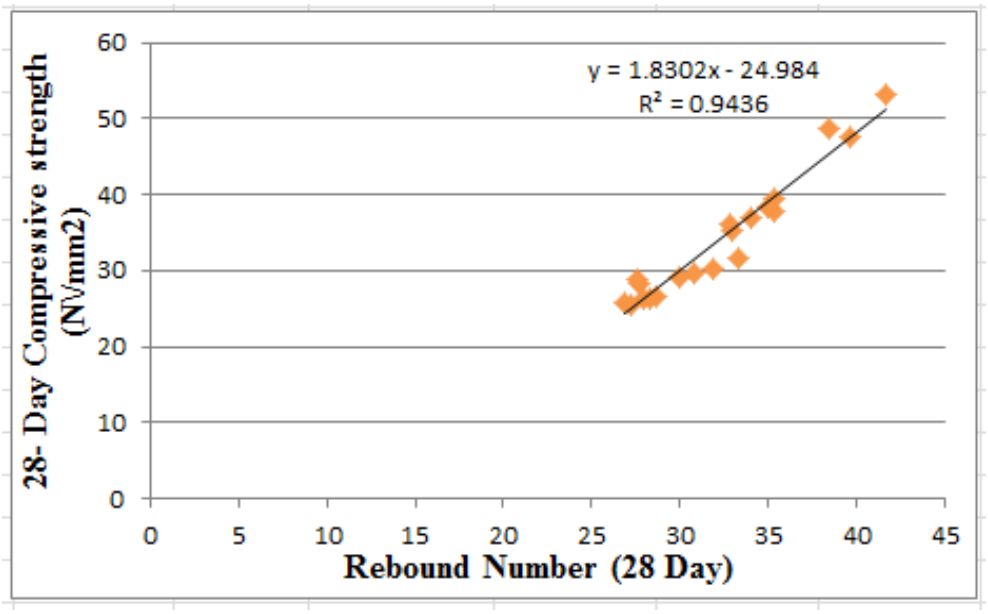

Figure 5.4: Correlation Between Compressive Strength And Rebound Number(Vertical Position) For 28 Days

scatter plot (Figures 5.4) representing the 28 day rebound number versus concrete compressive strength at 28 day could give the following linear equations are concluded for the predicted values of the concrete compressive strength(MPa) at 28 days for Fly Ash based concrete :

$$S_c = 1.8302 R_N - 24.984 \tag{5.4}$$

Where,

S_c = Compressive strength of concrete at 28 day (N/mm^2)

R_N = Rebound number at 28 day

R square value for Eq.5.4 are 0.9436. 0.9436 value explained that 94.36 % of the variability

for the data around the regression line and 5.64 % of the residual data could not explained by Eq.5.4.

5.6.2 Relationship Between 1 Day Rebound Number And 28 Day Compressive Strength For Fly Ash Based Concrete

5.6.2.1 W.W. Method (Fly Ash)

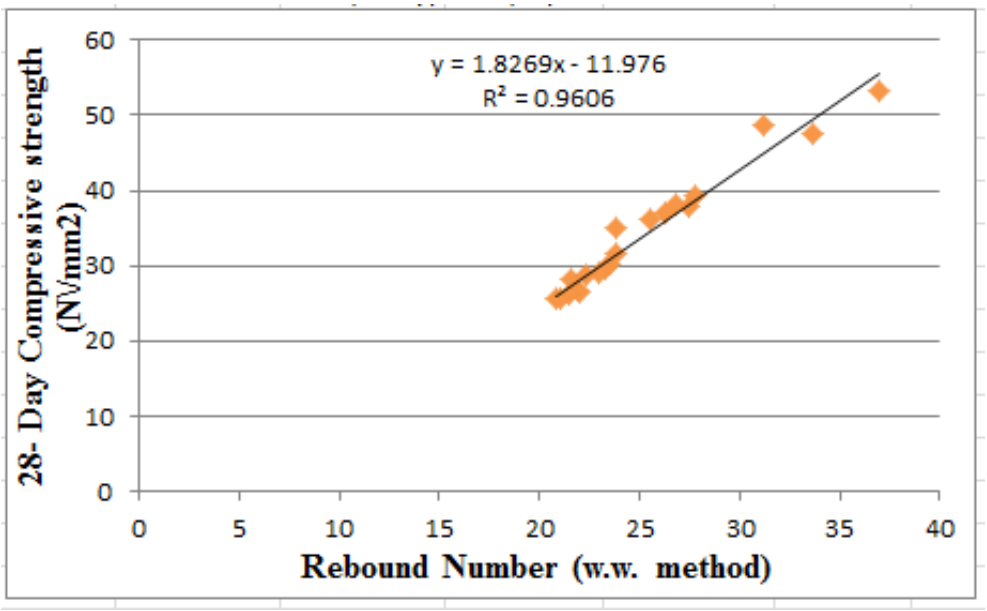

Figure 5.5: Correlation Between Compressive Strength And Rebound Number(Vertical Position) For 28 Days Fly Ash Mixes

5.6.2.2 B.W Method (Fly Ash)

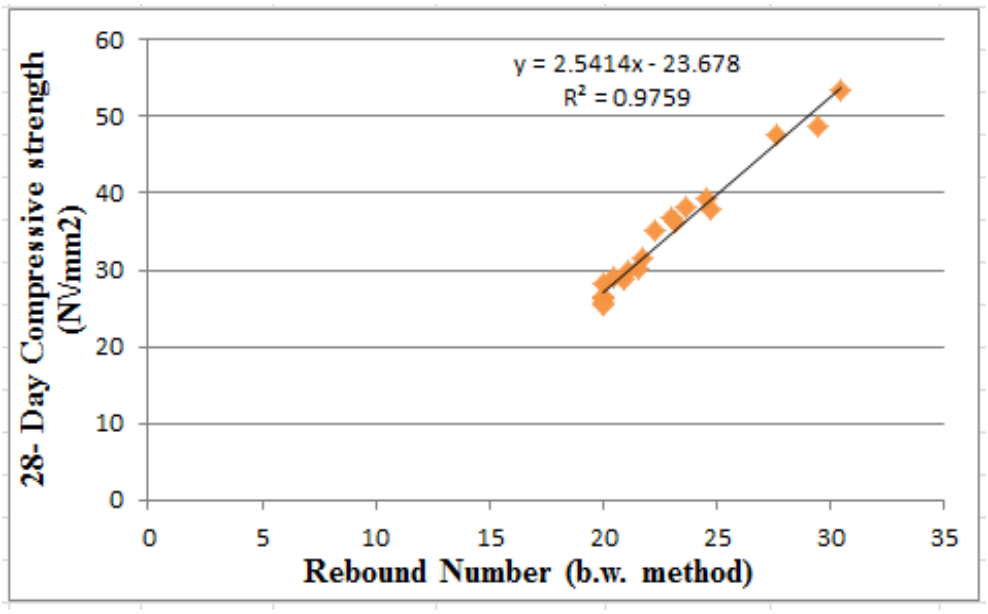

Figure 5.6: Correlation Between Compressive Strength And Rebound Number(Vertical Position) For 28 Days Fly Ash Mixes

scatter plot (Figures 5.5 & 5.6) representing the 1 day rebound number versus concrete compressive strength could give the following linear equations are concluded for the predicted values of the concrete compressive strength(MPa) at 28 days for Fly Ash based concrete :

$$S_c = 1.8269R_N - 11.976 \tag{5.5}$$

$$S_c = 2.5414R_N - 23.678 \tag{5.6}$$

Where,

S_c = Compressive strength of concrete at 28 day (N/mm^2)

R_N = Rebound number at 1 day (ww & bw method)

R square value for Eq.5.5 and Eq.5.6 are 0.9606 and 0.9759 respectively. 0.9606 value explained that 96.06 % of the variability for the data around the regression line and 3.94 % of the residual data could not explained by Eq.5.5. In the case of Eq.5.6 97.59 % of the variability for the data around the line and 2.41 % remain unexplained.

- Comparison of Compressive Strength By Graphically

compressive strength for w.w., b.w. and 28 day shown in figure 5.6. In this figure the overall prediction of boiling water method is higher then the warm water method..

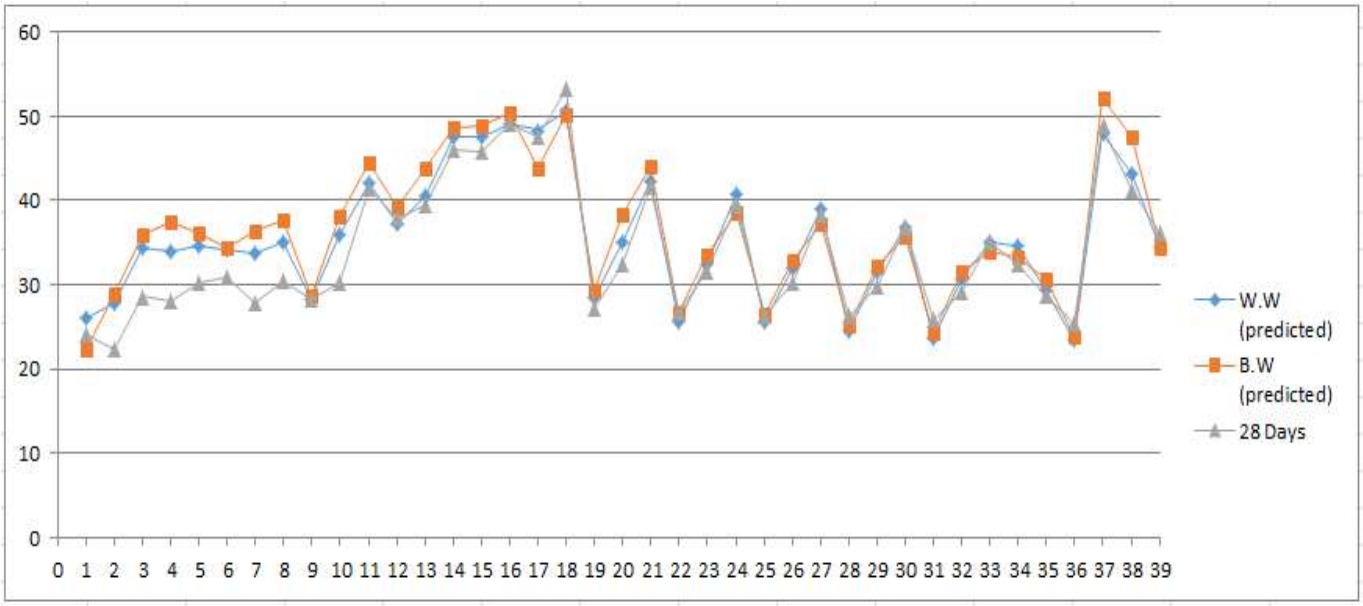

Figure 5.7: Figure-20 Compressive Strength of Predicted Value (W.W. & B.W.) And 28 Day For Different Mixes

Table 5.43: Relationship Between Accelerated (1 Day) And 28 Day Compressive Strength

Relationship between Accelerated (1 day) and 28 day compressive strength	
For Warm Water Method	
y = 1.16x + 5.65 (For OPC Based Concrete)	R^2 = 0.95
y = 12.65 + x (In IS 9013 Code For OPC Based Concrete)	-
y = 1.11x + 9.04 (For F.A. Based Concrete)	R^2 = 0.97
For Boiling Water Method	
y = 1.61x + 4.05 (For OPC Based Concrete)	R^2 = 0.86
y = 1.64x + 8.09 (In IS 9013 Code For OPC Based Concrete)	-
y = 1.56x + 6.28 (For F.A. Based Concrete)	R^2 = 0.93

Where,

X = Accelerated strength at 1 day (w.w. & b.w. method)

Y = Compressive strength of concrete at 28 day(N/mm^2)

Table 5.44: Relationship Between 1 Day & 28 Day Rebound Number To 28 Day Compressive Strength

Relationship between 1 day Rebound number and 28 day compressive strength	
For Warm Water Method	
y = 1.80x - 12.17 (For OPC Based Concrete)	R^2 = 0.92
y = 1.82x - 11.97 (For F.A. Based Concrete)	R^2 = 0.96
For Boiling Water Method	
y = 2.51x - 23.23 (For OPC Based Concrete)	R^2 = 0.92
y = 2.54x - 23.67 (For F.A. Based Concrete)	R^2 = 0.97
Relationship between 28 day Rebound number and 28 day compressive strength	
y = 1.68x - 20.24 (For OPC Based Concrete)	R^2 = 0.92
y = 1.83x - 24.98 (For F.A. Based Concrete)	R^2 = 0.94

Where,

X = Rebound number for (w.w. & b.w. method)

Y = Compressive strength of concrete at 28 day(N/mm^2)

Chapter 6

Summary, Conclusion And Future Scope of Work

6.1 Summary

The aim of the project is total 40 concrete mixes are cast. Among these mixes, 7 concrete mixes are directly obtained from RMC plant. On the other have 33 concrete mixes are cast in laboratory with mix design collected from different sites in Gujarat region. 21 concrete mixes consisted combination of OPC and fly ash in addition to other ingredients. Other 19 concrete mixes are cast using OPC along with other ingredients. For accelerated curing warm water and boiling water method is used.

By using the methodology of accelerated curing, the compressive strength of all 40 concrete mixes is evaluated at 1 day. 28 day compressive strength is predicted in case of all 40 concrete mixes. The NDT by means of rebound hammer is employed for all the 40 concrete mixes. Concrete cube specimens are tested by keeping position of rebound hammer vertical. Also, NDT by means of UPV is employed for all the 40 concrete mixes. For concrete cube specimens, direct method is adopted to find the UPV results. Rebound Hammer, UPV and compressive strength results are measured for concrete cube. The results are measured at 7 and 28 days as well as 1day by means of accelerated curing test.

The aim of present investigation is to established correlation curves between compressive strength and NDT testing for concrete of different grades obtained for various sites mixes. And conclued that warm water method is good to predict 28 day compressive strength for OPC based and fly ash based concrete.

6.2 Conclusion

Based on the work carried out till date, following conclusion can be made;

- For OPC based concrete the percentage difference in warm water method with respect to 28 day normal curing of concrete is 15% to 20% higher than 28 day normal curing of concrete.

- For OPC based concrete the percentage difference in boiling water method with respect to 28 day normal curing of concrete is 25% to 30% higher than 28 day normal curing of concrete.

- Similarly, for fly ash based concrete the percentage difference in warm water method with respect to 28 day normal curing of concrete is 2% to 5% higher than 28 day normal curing of concrete.

- For fly ash based concrete the percentage difference in boiling water method with respect to 28 day normal curing of concrete is 5% to 10% higher than 28 day normal curing of concrete.

- From all the results it is conclude that the predicted 28 day compressive strength of concrete by warm water method the predicted results is showing lower then boiling water method. So, warm water method is good to predict 28 day compressive strength for OPC based and fly ash based concrete.

6.3 Future Scope of Work

The study may be further extended to include following aspects in the work.

- Replacement of cement by different cementetious material like GGBFS, silica fume, metakaolin and same study may be repeated.
- Develop a new correlation equation between compressive strength and NDT techniques for different cementetious material like GGBFS, silica fume, metakaolin.
- To study the different types of concrete like SCC, HSC, HPC which are manufacture in RMC.
- Similar study may be repeated using different curing condition low pressure steam curing, high pressure steam curing (Auto claving), hot water method etc.

Bibliography

[1] Suraj T V and Dhanya Krishnan,*"Validation of accelerated curing tank"*, International Journal of Science Technology and Management, Kerala,(India), August-2015.

[2] M.Tokyay. *"Strength prediction of fly ash concrete by accelerated testing"*, Cement and Concrete Research, Turkey, July-1999.

[3] Poorav shah and Bhavnashah,*"Devlopment of mathematical model to predict early age strength for blended cement through accelerated curing"*, Natinal Conference on Recent Trends In Engineering & Technology, V.V. Nagar, Gujarat, May-2011.

[4] M.V. Krishna, Azhar M. khan, P. Rathish kumar,*"A study on the influence of curing on the strength of a standard grade concrete mix"*, Architecture and Civil Engineering, Vol.8, January 2010, NIT Warangal, A.P., India.

[5] Gokul. T, Arun. M, Arunachalam. N,*"Effects of different types of curing on strength of concrete"*, International Journal of Innovative Research in Science, Engineering and Technology, Vol.5, Issue 2, Fabruary-2016, Sathyamangalam, India.

[6] Abhijit J. Pawar, Jaguti S. Nikam, Pravinvhandra D. Dhake, *"Comparison of 28 days concrete compressive strengths by accelerated curing and normal curing"*, International Journal of Research in Engineering and Technology, Vol.4, December-2015, Nashik, India.

[7] Sirin Kurbetci and Erbil Oztekin,*"Application of Accelerated Curing to High Strength Concrete"*, Teknik Dergi, Vol.5, July-1994, Trabzon, Turkey.

[8] K.Shyamala and Shek Abdul manna, *"Comparison of strength for concrete with GGBS and cement using accelerated curing method"*, Andhra Pradesh, India, October-2016.

[9] Kanchan Mala, A.K. Mullick, K.K. Jain and P.K. Singh,*"Accelerated curing strength of concrete containing binary and ternary blends of OPC, silica fume and fly ash"*, The Indian concrete journal, April-2013.

[10] Ghalib Habeeb and Mohammed Mansour,*"The Effect of Accelerated Curing on Some Mechanical Properties of Self Compacting Concrete Containing Reactive Metakaolin"*, Vol.22, May-2015, Iraq.

[11] Samia Hannachi and M Nacer Guetteche,*"Review of the Rebound Hammer Method Estimating Concrete Compressive Strength on Site"*, Proceedings of International Conference on Architecture And Civil Engineering, December-2014, Dubai.

[12] Akroyd, T.N.W. and Smith Gander, R.G.,*"Accelerated Curing of Concrete test Cubes"*, Vol.81, Febrauary.1956, Engineering, London.

[13] IS: 9013-1978, *"Method of making, curing and determining compressive Strength of accelerated cured concrete test specimens"*

[14] IS: 13311-1992 (Part 1),*"Ultrasonic pulse velocity, Non-destructive testing of concrete methods of test"*, Bureau of Indian Standards, New Delhi, 1992.

[15] IS: 13311-1992 (Part 2),*"Rebound hammer, Non-destructive testing of concrete methods of test"*, Bureau of Indian Standards, New Delhi, 1992.

[16] IS: 516-1959, *"Method of tests for strength of concrete"*

[17] IS-10262:2009, *"Concrete Mix Proportioning Guidelines, Bureau of Indian Standards"*, New Delhi, 2002.