PERFORMANCE OF BLENDED CONCRETE ON BOILING WATER METHOD AND PREDICTION OF ITS COMPRESSIVE STRENGTH

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF DEGREE
OF

MASTER OF TECHNOLOGY
IN
STRUCTURAL ENGINEERING

Submitted by:

KUNAL VERMA

2K18/STE/07

Under the supervision of
Dr. ALOK VERMA
(Professor)

DEPARTMENT OF CIVIL ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Bawana Road, Delhi-110042

JULY, 2020

CANDIDATE'S DECLARATION

I, KUNAL VERMA (2K18/STE/07), student of M.Tech (Structural Engineering), hereby declare that the project Dissertation titled **"PERFORMANCE OF BLENDED CONCRETE ON BOILING WATER METHOD AND PREDICTION OF ITS COMPRESSIVE STRENGTH"** which is submitted by me to the Department of Civil Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of and Degree, Diploma Associate ship, Fellowship or other similar title or recognition.

Place: Delhi KUNAL VERMA

Date:

CERTIFICATE

I hereby certify that the Project Dissertation titled **"PERFORMANCE OF BLENDED CONCRETE ON BOILING WATER METHOD AND PREDICTION OF ITS COMPRESSIVE STRENGTH"** which is submitted by KUNAL VERMA (2K18/STE/07) to the Department of Civil Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place: Delhi

Date:

Dr. ALOK VERMA

SUPERVISOR

Professor

ACKNOWLEDGEMENT

“IT is not possible to work upon a project without the assistance & encouragement of other people. This one is certainly no exception.”

The success of a Minor I project requires help and contribution from numerous individuals and the organization. Writing the report of this project work gives me an opportunity to express my gratitude to everyone who has helped in shaping up the outcome of the project.

I express my heartfelt gratitude to my project guide **Dr. Alok Verma** for giving me an Opportunity to do my Minor I project work under his guidance. His constant support and encouragement has made me realize that it is the process of learning which weighs more than the end result. I take the privilege to extend my hearty thanks to the Head of Department of Civil Engineering **DR. Nirendra Dev** for his support and encouragement towards the project.

I am highly indebted to the panel faculties during all the progress evaluations for their guidance, constant supervision and for motivating me to complete my work. They helped me throughout by giving new ideas, providing necessary information and pushing me forward to complete the work.
I also reveal my thanks to all my classmates and my family for constant support.

KUNAL VERMA

INDEX

Abstract

Abstract: As it is well known Fly ash is a waste generated by thermal power plants. And it is a big environmental problem. In modern decades, there are various different techniques like industrialization and urbanization are two process that are being done at a large scale in all over the world. So, to consume these materials efficiently in a cost affective way cement of concrete mix is being replaced partially to reduce the amount of cement and also to utilize these waste. Also the fly ash is cost effective a reasonable amount of money can be saved in big projects like housing societies for poor people made by government . So, M30 mix with 0% , 10% ,20% and 30 % replacement of fly ash with cement is done to see the variation of strength in the concrete .similar work for GGBS replacement is done.

As we know that the goodness of concrete in construction works i.e. the quality of concrete is calculated as its 28 days compressive strength, and the procedure for measuring it 28 days strength requires 28 days of wet curing to gain significance strength before testing, but this process is too long of a period to be of any value. As we know that neither concrete construction control nor applying timely corrective measures are possible. Suppose If 28 days strength and the quality of concrete is not up to the mark then it would be very hard to remove that considerably hardened concrete and also a lot of concrete had been buried in by the subsequent construction of the structure. So the replacement of this concrete becomes very difficult and practically not possible. Also one other problem is, suppose the concrete mix possess excessive strength than required, then it will be wasteful use of cement on uneconomical concrete mix . Hence, the 28 days concrete testing of cubes is not a good quality control test. So to get quality control and in most cases early compressive strength accelerated curing of the concrete is done. Here we have done accelerated curing by boiling water method as prescribed by IS 9013 (1978).

Durability of concrete is now a days very hot topic for research . various test are being conducted by different concrete institute . Till now their no special code for durability tests in India , American codes are being followed. Acid attack test will be conducted on these different concrete mixes and the variation in weight of concrete and strength of concrete will be noted at intervals of 30, 60 , 90 and 120 days.

KEYWORD- FLYASH, GGBFS, COMPRESSIVE STRENGTH.

Chapter1- Introduction

As it is well known Fly ash is a waste generated by thermal power plants. And it is a big environmental problem. In modern decades, there are various different techniques like industrialization and urbanization are two process that are being done at a large scale in all over the world. So, to consume these materials efficiently in a cost affective way cement of concrete mix is being replaced partially to reduce the amount of cement and also to utilize these waste. Also the fly ash is cost effective a reasonable amount of money can be saved in big projects like housing societies for poor people made by government .

As we know that the goodness of concrete in construction works i.e. the quality of concrete is calculated as its 28 days compressive strength, and the procedure for measuring it 28 days strength requires 28 days of wet curing to gain significance strength before testing, but this process is too long of a period to be of any value. As we know that neither concrete construction control nor applying timely corrective measures are possible.

Suppose If 28 days strength and the quality of concrete is not up to the mark then it would be very hard to remove that considerably hardened concrete and also a lot of concrete had been buried in by the subsequent construction of the structure. So the replacement of this concrete becomes very difficult and practically not possible.

Also one other problem is, suppose the concrete mix possess excessive strength than required, then it will be wasteful use of cement on uneconomical concrete mix .

Hence, the 28 days concrete testing of cubes is not a good quality control test. So to get quality control and in most cases early compressive strength accelerated curing of the concrete is done. Here we have done accelerated curing by boiling water method as prescribed by IS 9013 (1978).

Durability of concrete is now a days very hot topic for research . various test are being conducted by different concrete institute . Till now their no special code for durability tests in India , American codes are being followed. Acid attack test will be conducted on these different concrete mixes and the variation in weight of concrete and strength of concrete will be noted at intervals of 30, 60 , 90 and 120 days

GENERAL

Concrete – concrete is a heterogeneous mixture of sand ,stone dust ,cement, water and coarse aggregates . Due to interlocking of materials by the hydrogen bond the concrete is much stronger then mortar mix. Also concrete needs low w/c ratio, which makes it thinner on mixing. Concrete is used in construction projects in forms of beams, slabs , columns foundations etc. it becomes hard of drying and gains significant strength which can hold lots of loads and used in high rise buildings.

Materials: These are the material used in the concrete mix - cement, stone dust (fine aggregates) , cement coarse aggregates, Fly ash , GGBFS and Water.

Fly Ash: Fly ash is basically produced by the combustion of anthracite or bituminous coal. The fly ash achieved contains pozolanic features and it have little silica dioxide plus aluminum oxide plus iron oxide.

Cement: Ordinary Portland Cement (opc43 Grade).

Whichever was present in nearby market was taken.

Fine Aggregate: The stone dust available in nearby DTU shop bought .it must pass through the IS sieve of 4.75mm size.

Coarse Aggregate: Granite which is in crushed from and have properties of IS 383 - 1987 must be taken for the study. The Coarse aggregate size requirements are it should pass through 20mm IS sieve and it must be retained on 12 mm IS sieve .

Water: pure drinking water available in the canteen or lab area of the campus must be used to mix in the concrete. Impurities may cause various defects in the concrete and may affect the quality of concrete.

Mix Proportion: The mix quantities for making a controlled concrete mix of any grade can be achieved by making trial mixes as stated in IS:10262-2009.

Curing- The concrete mix on leaving in air after construction may shrink and also the proper hydration of the concrete is achieved in the air .so to achieve a satisfactory degree of hydration to gain sufficient strength a process is used which is kniwn as curing. So in curing the moisture content and temperature of the concrete is maintained by applying sufficient moisture content on the concrete at a defined temperature for a period of time just after the placing and finishing of the concrete so the required properties will develop . the effects of Curing on concrete are on the hardened concrete which are- increased durability, increased strength, increased water tightness, higher abrasion resistance, volume stability, and higher freezing and thawing resistance.

Chapter 2- Research Significance

Fly ash is a waste generated by thermal power plants. And it is a big environmental problem. In modern decades, there are various different techniques like industrialization and urbanization are two process that are being done at a large scale in all over the world. So, to consume these materials efficiently in a cost affective way cement of concrete mix is being replaced partially to reduce the amount of cement and also to utilize these waste. Also the fly ash is cost effective a reasonable amount of money can be saved in big projects like housing societies for poor people made by government .

Also fly ash is cost effective in comparison to cement . so government is building a big housing project for poor people fly ash can be used as money saving material because a lot of money can be saved by replacing cement with fly ash partially.

As we know that the goodness of concrete in construction works i.e. the quality of concrete is calculated as its 28 days compressive strength, and the procedure for measuring it 28 days strength requires 28 days of wet curing to gain significance strength before testing, but this process is too long of a period to be of any value. As we know that neither concrete construction control nor applying timely corrective measures are possible. Suppose If 28 days strength and the quality of concrete is not up to the mark then it would be very hard to remove that considerably hardened concrete and also a lot of concrete had been buried in by the subsequent construction of the structure. So the replacement of this concrete becomes very difficult and practically not possible. Also one other problem is, suppose the concrete mix possess excessive strength than required, then it will be wasteful use of cement on uneconomical concrete mix . Hence, the 28 days concrete testing of cubes is not a good quality control test. So to get quality control and in most cases early compressive strength accelerated curing of the concrete is done. Here we have done accelerated curing by boiling water method as prescribed by IS 9013 (1978).

Durability of concrete is now a days very hot topic for research . various test are being conducted by different concrete institute . Till now their no special code for durability tests in India , American codes are being followed. Acid attack test will be conducted on these different concrete mixes and the variation in weight of concrete and strength of concrete will be noted at intervals of 30, 60 , 90 and 120 days.

Strength prediction by boiling water method for blended concrete is not yet included in the IS codes . Only plain concrete’s strength prediction equations are given, so strength prediction for blended concrete is also analyzed .

Chapter 3 – Review of literature and conclusions

EFFECT OF FLYASH ON FRESH CONCRETE

1- The replacement of cement by fly ash in concrete decreases the water demand for a required slump.
2- Due to the decreased water content the bleeding and drying shrinkage also gets reduced.
3- As the fly ash in comparison of cement is less reactive , the heat of hydration is also reduced by the partial replacement of fly ash.

EFFECT OF FLYASH ON HARDEND CONCRETE

1- Although the early strength of the fly ash mixed concrete is lower than that of normal concrete but the ultimate strength of the concrete may be higher than that of normal concrete strength. This is due to slow pozolanic reactions.
2- The texture of the concrete becomes dense by the addition of fly ash.
3- The dense texture results in reduced water and air permeability. But for these pozolanic reactions to take place sufficient moisture content must be available for significant time.

EFFECT ON DURABILTY

1- The addition of fly ash improves the durability of the concrete ultimately .
2- The addition of fly ash makes the concrete dense and reduces shrinkage which gives resistance to the corrosion and stops entering harmful substance in the concrete.

Paper 1 – Comparative Study of Compressive Strength of Concrete with Fly Ash Replacement by Cement.

Mohammad Abushad[1], Misbah Danish Sabri[2],

[1]Deptt. Of Civil Engineering, AFU, Faridabad, Haryana, INDIA.

[2]Assistant Professor Dept. of Civil Engineering, AFU, Faridabad, Haryana, INDIA.

International Research Journal of Engineering and Technology(IRJET)

Volume:04 Issue:07 /July-2017 e-ISSN: 2395-0056 , p-ISSN: 2395-0072.

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M30

S.NO.	% fly ash	Compressive strength		
		7 days	14 days	28 days
1	0	26.7	36.7	40.2
2	10	27.4	38.25	41.9
3	20	28.3	39.5	43.23
4	30	30.25	41.4	45.28
5	40	27.75	37.74	42
6	50	25.5	37.03	39.15

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 30% fly ash.

Paper 2- Comparison of Normal and High Volume Fly Ash Concrete.

[1]Tapeshwar Kalra, [2]Ravi Kumar

[1]M.Tech Student, Dept. of Civil Engineering, SDDIET, Barwala, Haryana, INDIA.

[2]Associate Professor, Dept. of Civil Engineering, SDDIET, Barwala, Haryana, India.

International Journal of Research in Electronics and Communication Technology (IJRECT 2016).
Vol. 3, Issue 1 Jan. - Mar. 2016 ISSN : 2348 - 9065 (Online), ISSN : 2349 - 3143 (Print)

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M25

S.NO.	Compressive strength		
	% fly ash	7 days	28 days
1	0	23	36
2	25	23	35.5
3	40	22	33
4	50	17.5	27
5	60	13	23

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 25% fly ash.

Paper 3- STRENGTH AND COST COMPARISON OF NORMAL AND HIGH VOLUME FLYASH CONCRETE.

Er. Bhupinder Singh[1] Er. AjayJasrotia[2]

[1]Assistant Professor, [2]Research scholar,

Civil Engineering Department, Indoglobal Group of Colleges, Mohali,(India).

International Journal Advanced Technology in Engineering and Science.

Vol.No.5, Issue No.. 05, May 2017 ISSN 2348-7550

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M40

S.NO.	% fly ash	Compressive strength		
		3 days	7 days	28 days
1	28	24.33	32.33	46.6
2	40	20	26.1	41
3	70	10.3	15	27

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 28% fly ash.

Paper 4- A Study on High Volume Fly Ash Concrete Exposed To Elevated Temperatures.

Dr. K. V. Ramesh[1], M. Dharma Raju[2],Kasi Rekha[3]

[1]**Professor, Department Of Civil Engineering, GITAM University, Andhra Paradesh, India.**

[2] **Post Graduate Student, Department Of Civil Engineering, GITAM University, Andhra Paradesh, India.**

[3] **Assistant Professor, Department Of Civil Engineering, GITAM University, Andhra Paradesh, India.**

American Journal of Engineering Research (AJER)

e-ISSN: 2320-0847 p-ISSN : 2320-0936 Volume-5, Issue-11, pp-227-238

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

.

Results :- M30

S.NO.	% fly ash	Compressive strength	
		7 days	28 days
1	0	47	50.5
2	30	34	53
3	40	32	48
4	50	30	45.6

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 30% fly ash.

Paper 5- Optimized Flyash in Concrete for Grade M15,M20, M25, M30, M35, M40 Using Portland Slag Cement.

Ram Jitendra Kumar[1], R. C. Singh[2]

[1]Post graduate student of Civil Engineering, [2]HOD Civil, RSR Rungta College of Engineering and Technology(CG)

. International Journal for Research in Applied Science & Engineering Technology (IJRASET).
Volume 5 Issue VI, June 2017, IC Value: 45.98 ISSN: 2321-9653

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M30

S.NO.	% fly ash	Compressive strength	
		7 days	28 days
1	0	36.74	43.59
2	15	32.78	41.37
3	20	29.21	39.75
4	25	27.75	36.06
5	30	24.80	34.58
6	35	22.49	32.25

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 20% fly ash.

Paper 6- ANALYSIS OF COST (M30 GRADE) OF CONCRETE BY PARTIAL REPLACEMENT OF FLY ASH WITH CEMENT AND ADDITION OF STEEL FIBER.

Samarul Huda* [1] , Anwar Ahmad[2] , Dr Syed Aqeel Ahmad[3] & Zishan Raza Khan[4]

*** [1] Student, M.Tech (Construction Technology and Management), Department of Civil Engineering, Integral University, Lucknow**

[2]Associate Professor, (Department of Civil Engineering, Integral University), Lucknow.

[3]Associate Professor, (Department of Civil Engineering, Integral University), Lucknow.

[4]Associate Professor, (Department of Civil Engineering, Integral University).

International Journal of Engineering Researches and Management Studies.

[Huda, 4(3), March, 2017] ISSN: 2394-7659 IMPACT FACTOR- 2.789

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M30

S.NO.	% fly ash +0.5% steel fiber	Compressive strength		
		7 days	21 days	28 days
1	0	27.43	33.57	40.39
2	10	25.63	40.2	41.2
3	20	22.07	31.67	33.09
4	30	23.3	35.6	36.7

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 10% fly ash.

Paper 7- EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF CEMENT WITH FLY ASH AND QUARRY DUST AS FINE AGGREGATE.

T.SAMBA SIVA RAO[#1]
K. ADITYA NANDINI, M.Tech [#2]
[#1] **M.Tech Student, Structural Engineering, MVR College of Engineering, India.**
[#2] **Assistant Professor, Department of Civil Engineering, MVR College of Engineering, India.**
November 2016, Volume 3, Issue 11 JETIR (ISSN-2349-5162)

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M30

S.NO.	% fly ash	Compressive strength		
		28 days	60 days	90 days
1	0	29	45.13	49.86
2	10	49.6	52.2	55.12
3	20	50.3	54.3	57.12
4	30	50.1	52.6	54.65
5	40	53.714	52.5	55.65
6	50	55.61	50.64	59.64
7	60	54	49.85	59.84

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 50% fly ash.

Paper 8- Study Of Various Fineness Of Fly Ash As A Partial Replacement Of Cement In Concrete.

DINESH.W. GAWATRE ,V.G.MESHRAM

International Journal of Scientific & Engineering Research Volume 4, Issue 1, January-2013 1 ISSN 2229-5518.

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M30

S.NO.	% fly ash	Compressive strength		
		7 days	28 days	90 days
1	0	31.11	41.78	43.26
2	12.5	29.03	32.15	35.70
3	25	27.7	34.97	40.59
4	37.5	20.74	28.75	40.00

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 25% fly ash.

.

Paper 9- Strength of Concrete Grade M30 & M35 By Partial Replacement of Cement with Paper ASH and Fly Ash.

Mukesh Yadav[1], Hemant Sain[2] , Anil Sharma[3]
[1]Assistant Professor, Civil Engineering, Arya College of Engg & Research Center, Rajasthan, India.
[2]Assistant Professor, Civil Engineering, Arya College of Engg & Research Center, Rajasthan, India.
[3]Assistant Professor, Civil Engineering, Arya College of Engg & Research Center, Rajasthan, India.
International Journal of Management, Technology And Engineering.
ISSN NO. : 2249-7455

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M30

S.NO	% fly ash	% paper ash	Compressive strength	
			7 days	28 days
1	0	0	24.55	38.62
2	5	5	27.07	39.87
3	10	10	29.44	41.73
4	15	15	31.24	41.67
5	30	0	28.45	37
6	0	30	26.33	34.28

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 10% fly ash.

Paper 10- FLY ASH CONCRETE: A TECHNICAL ANALYSIS FOR COMPRESSIVE STRENGTH.

Dr S L Patil[1], J N Kale[2], S Suman[3]

[1]Head, Applied Science Department, [2]Sr. Lecturer, [3]Lecturer, SSBT's College of Engineering and Technology,Bambhori, Jalgaon, MS.

Suman et al, International Journal of Advanced Engineering Research and Studies. E-ISSN2249–8974

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M20

S.NO.	% fly ash	Compressive strength					
		3 days	7 days	21 days	28 days	60 days	90 days
1	0	8.44	11.55	21.77	26.06	37.10	37.99
2	5	8	12.44	24.15	24.88	29.00	36.88
3	10	7.55	7.77	20.14	20.29	31.33	40.44
4	15	5.77	7.99	15.55	19.86	26.21	35.41
5	20	4.44	8.44	14.22	19.10	30.22	39.88
6	25	5.59	6.21	11.84	18.66	23.33	33.77

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 5% fly ash.

Paper 11- Effect of Fly Ash on Strength and Durability Parameters of Concrete.

Siddamreddy Anil Kumar Reddy[1], Dr. K. Chandrasekhar Reddy[2].
[1]P.G Student, Dept of Civil Engineering, Siddhartha Institute of Engineering & Technology, Puttur, A.P.India
[2]Professor of Civil Engineering & Principal, Siddharth Institute of Engineering & Technology, Puttur, A. P, India.
International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M20

S.NO.	% fly ash	Compressive strength	
		7 days	28 days
1	0	18.74	29.25
2	5	20.30	30.5
3	10	21.83	31.15
4	15	22.66	36.86
5	20	22.78	37.40

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 20% fly ash.

Paper 12- Partial Replacement of Cement with Fly Ash In Concrete And Its Effect.

Authors: Vinod Goud [(1)] Niraj Soni [(2)]
Corresponding Authors: [(1)] Goutam Varma, [(2)]Kapil Kushwah, [(3)]Sharad Chaurasia, [(4)]Vishwajeet Sharma.
IOSR Journal of Engineering (IOSRJEN) .
ISSN (e): 2250-3021, ISSN (p): 2278-8719 Vol. 06, Issue 10(Oct. 2016), ||V2|| PP 69-75.

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M25

S.NO.	% fly ash	Compressive strength		
		7 days	14 days	28 days
1	0	23.5	33.81	38.96
2	10	26.2	38.14	43.24
3	20	25.3	34.8	37.78
4	30	20.91	27.3	31.46

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 10% fly ash.

Paper 13- Combine Effect of Rice Husk Ash and Fly Ash on Concrete by 30% Cement Replacement.

Satish H. Sathawane[a*],Vikrant S. Vairagade[b] and Kavita S Kene[c].

[a,b]Assistant Professor,Civil Engineering Dept, J L Chaturvedi College of Engineering,Nagpur,Maharashtra, INDIA.

[c]Assistant Professor,Civil Engineering Dept, K. D. K. College of Engineering,Nagpur,Maharashtra, INDIA.

Chemical, Civil and Mechanical Engineering Track of 3rd Nirma University International Conference.

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M25

S.NO.	% fly ash	% rice husk	Compressive strength				
			7 days	14 days	28 days	56 days	90 days
1	0	0	35.56	39.11	45.78	48	49.78
2	30	0	32.89	33.33	39.11	42.22	44.89
3	27.5	2.5	31.11	31.33	35.11	37.33	39.56
4	25	5	31.56	32.44	40.44	43.11	45.78
5	22.5	7.5	22.67	34.67	41.78	44.89	46.67
6	20	10	22.22	26.22	33.78	35.11	37.78
7	17.5	12.5	18.22	24.89	33.78	32.00	34.67
8	15	15	17.78	24.00	28.89	30.67	33.78

Conclusions-

5- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

6- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

7- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

8- This paper gives optimum strength at 22.5% fly ash.

Paper 14- EXPERIMENTAL STUDY ON CONCRETE CONTAINING FLY ASH.

Aayush Choure[1], Dr. Rajeev Chandak[2].

[1]M.E.-scholar, (structural engineering), department of civil engineering , Jabalpur engineering college Jabalpur India.

[2] Head of the department, department of civil engineering, Jabalpur engineering College Jabalpur India.

International Research Journal of Engineering and Technology (IRJET)

e-ISSN: 2395 -0056 p-ISSN: 2395-0072 Volume: 04 Issue: 02 | Feb -2017.

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- M30

S.NO.	% fly ash	Compressive strength	
		7 days	28 days
1	0	26.81	40.74
2	5	28.89	41.63
3	10	30.65	42.37
4	15	31.85	43.25
5	20	33.34	44.01

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 20% fly ash.

Paper 15- Using Cementitious Materials Such as Fly Ash to Replace a Part of Cement in Producing High Strength Concrete in Hot Weather.

Gidion Turuallo,Harun Mallisa
Civil Engineering Department, Tadulako University, Palu, Indonesia.

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :-

S.NO.	% fly ash	Compressive strength			
		3 days	7 days	21 days	28 days
1	0	36.366	57.689	60.644	62.478
2	10	36.267	57.244	58.178	60.267
3	15	42.044	56.800	59.956	66.756
4	20	43.733	52.444	57.644	61.556
5	25	39.289	45.111	54.844	56.622

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 15% fly ash.

Paper 16- Comparison of Compressive Strength of M25, M30 Grades of Concrete by Partially Replacement of Fly Ash with Normal and Accelerated Curing.

Gowri Sankara Rao. G, Anil kumar. G, Lakshmi Ganesh. S
Associate Professor, Aditya institute of technology and management, Tekkali.
© June 2016 | IJIRT | Volume 3 Issue 1 | ISSN: 2349-6002.

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash.

Results :- m30

S.NO	% fly ash	Compressive strength		
		3 days	7 days	28 days
1	0	12	27.84	32.33
2	10	13.5	28.54	34.22
3	20	14	30.87	36.45
4	30	13.8	26.33	31.23
5	40	13.5	26.1	32

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives optimum strength at 20% fly ash.

Paper 17- Comparitive Study Between the Compressive Strength of Traditional Curing and Accelerated Curing of Concrete.

R.Sumathi, Shyamala Bhoomesh.

International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075, Volume-8 Issue-2S2 December, 2018.

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash on accelerated curing and normal curing.

Results :- m35 strength prediction equation ($R_{28} = 8.09 + 1.64R_a$)

S.NO.	W/C ratio	Normal cured compressive strength		28 days predicted strength
		7 days	28 days	28 days
1	.45	33.5	39.72	44
2	.5	29.78	35.88	41.56
3	.55	17	28.72	33.82
4	.6	15	26.56	29.17

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- This paper gives 28 days optimum strength at 0.45 water content.

5- Although the predicted strength is on higher side of the actual strength but these results are acceptable for various purposes.

Paper 18- PREDICTION OF COMPRESSIVE STRENGTH OF CONCRETE USING ACCELERATED CURING.

N.L.SHELKE[1], SANGEETA GADVE[2]

1. Research Scholar, Structural Engineering, Sardar Patel College of Engineering, Andheri (W),Mumbai-400 058
2. Faculty in Applied Mechanics, Visvesvaraya National Institute of Technology, Nagpur-440010.

Research Article ISSN: 2319-507X
Shelke NL, IJPRET, 2013; Volume 1(8): 90-99

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash on accelerated curing and normal curing.

Results :- m40

S.NO.	mix	Normal cured compressive strength		28 days predicted strength
		7 days	28 days	28 days
1	M1	43.34	52.94	62.82
2	M2	46.50	52.81	62.07
3	M3	43.37	56.07	61.51
4	M4	49.25	52.34	63.23
5	M5	39.65	48.27	46.35
6	M6	42.88	52.72	54.19
7	M7	40.47	54.44	46.93
8	M8	43.51	50.85	58.16

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- Although the predicted strength is on higher side of the actual strength but these results are acceptable for various purposes.

Paper 19- Comparison of Strength for Concrete with GGBS and Cement Using Accelerated Curing Method.

K. Shyamala*, Ch. Vinod **, Shek Abdul manna ***

*(P.G. Student, Department of Civil Engineering, Gokul institute of technology, piridi, bobbili, vizianagaram, Andhra Pradesh, India)
** (Assistant Professor, Department of Civil Engineering, Gokul Institute of technology , Pridi, Bobbili, Vizainagram,Andhra Pradesh, India)
***(Assistant Professor, Department of Civil Engineering, Gokul Institute of technology , Pridi, Bobbili, Vizainagram,Andhra Pradesh, India)
K. Shyamala et al. Int. Journal of Engineering Research and Application .
ISSN : 2248-9622, Vol. 6, Issue 10, (Part -2) October 2016, pp.96-100.

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash on accelerated curing and normal curing.

Results :- m30

S.NO.	% GGBFS	Normal cured compressive strength	Warm water cured strength	28 days predicted strength by boiling water
		7 days	28 days	28 days
1	0	39.26	18.22	20.52
2	10	45.19	22.52	23.04
3	20	42.22	20.96	21.48
4	30	38.89	21.48	20.07

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- Although the predicted strength is on higher side of the actual strength but these results are acceptable for various purposes.

Paper 20- A Comparative Study on Strength of Concrete by partial Replacement of Cement with FA and GGBS Using Various Curing Methods.

Parasa. Lakshmi Naga Saroja
Research Scholar, Department of Civil Engineering,
College of Engineering(A), Andhra University, Visakhapatnam 530 003, India.
lakshminagasaroja.parasa@gmail.com
Dr.B.Vijaya Saradhi
Professor, Department of Civil Engineering, College of Engineering(A),
Andhra University, Visakhapatnam 530 003, India
bvsaradhi70@gmail.com
S.K. Abdul Mannan
Structural Designer,Visakhapatnam 530 003, India. mannam_abdul80@yahoo.com
D. Srinivasa Rao
Research Scholar, Town Planning Officer, VUDA, Visakhapatnam 530 003, India
srinudavalatp@gmail.com
International Journal of Management, Technology And Engineering Volume 8, Issue XII, DECEMBER/2018. ISSN NO : 2249-7455.

Aim :- study to see the behavior of concrete mix on cement replacement partially with fly ash on accelerated curing and normal curing.

Results :- m30

S.NO.	% fly ash	% GGBFS	Normal cured strength	Warm water cured strength	Boiling water cured strength
1	0	0	39.26	30.87	39.74
2	10	0	43.26	34.06	41.56
3	20	0	42.96	31.98	40.59
4	30	0	34.52	28.80	34.03
5	0	0	39.26	30.87	39.74
6	0	10	45.19	35.17	39.38
7	0	20	42.22	32.80	43.02
8	0	30	44.74	32.21	46.66

Conclusions-

1- The study of this paper suggests that to PARTIALLY replace the cement with economical waste materials like FLY ASH , GGBFS AND SILICA FUMES in the view of compressive strength and economy is fruitful.

2- Use of such materials for replacement is acceptable. And this replacement can also solve big environmental problems and also reduce the quantity of cement to be used. Because the cement is not a environment friendly material to produce.

3- So, the use of waste materials is economically safe and also eco friendly. This replacement also enhances various properties of the concrete mix..

4- Although the predicted strength is on higher side of the actual strength but these results are acceptable for various purposes.

METHODOLOGY

Mix design

(note – IS456 2000 and IS 10209 is used as reference for mix design)

Before doing mix design following data is required-

1- Grade (taken M30)
2- cement taken (OPC43 grade ultra tech is used)
3- Maximum nominal size of aggregate (20mm)
4- Min cement content (300 kg/m^3 based on exposure condition (IS456 table5)).
5- Max water-cement ratio (=.5 (IS456 TABLE 5))
6- Workability (slump 100mm)
7- Exposure condition (moderate)
8- Method of transporting (pump able)
9- Max cement content (450 kg/m^3 as per 8.2.4.2 IS 456)
10- Admixure used (NONE)

-Apart from this data specific gravities of cement , fine aggregate ,coarse aggregate , GGBFS and fly ash used is to be found , for which test are done as per IS 2386-1963 PART 3.

Specific gravity and water absorption test on fine aggregates.

Reference from IS 2386-1963 PART 3 is taken.

APPARATUS REQUIRED - Pycnometer ,oven, enamel tray ,taping rod, filter paper ,funnel ,1000ml measuring cylinder etc.

PROCEDURE-

1. A sample of about 500 g shall be placed in the tray and covered with distilled water at a temperature of 22 to 32°C. Soon after immersion, air entrapped in or bubbles on the surface of the aggregate shall be removed by gentle agitation with a rod. The sample shall remain immersed for 24 ± l/2 hours.

2. The water shall then be carefully drained from the sample, by decantation through a filter paper, any material retained being return& to the sample. The fine aggregate including any solid matter retained on the filter paper shall be exposed to a gentle current of warm air to evaporate surface moisture and the material just attains a ‗free-running' condition. The saturated and surface-dry sample shall be weighed (weight A).

3. The aggregate shall then be placed in the pycnometer which shall be filled with distilled water. Any trapped air shall be eliminated by rotating the pycnometer on its side, the hole in the apex of the cone being covered with a finger. The pycnometer shall be dried on the outside and weighed (weight B).

4. The contents of the pycnometer shall be emptied into the tray, care being taken to ensure that all the aggregate is transferred. The pycnometer shall be refilled with distilled water to the same level as before, dried on the outside and weighed (weight C).

5. The water shall then be carefully drained from the sample by decantation through a filter paper and any material retained returned to the sample. The sample shall be placed in the oven in the tray at a temperature of 100 to 110°C for 24 f l/2 hours, during which period it shall be stirred occasionally to facilitate drying. It shall be cooled in the air-tight container and weighed (weight D).

6. Calculations— Specific gravity, apparent specific gravity and water &sorption shall be calculated as follows-

SPECIFIC GRAVITY = $\frac{D}{\{A-(B-C)\}}$

WATER ABSORPTION (%) = $\frac{100(A-D)}{D}$

HERE,

A= weight in g of saturated surface - dry sample,

B = weight in g of pycnometer containing sample and filled with distilled water,

C = weight in g of pycnometer filled with distilled water only, and

D = weight in g of oven - dried sample.

CALCULATIONS

Weight of saturated surface dry sample i.e. A = 500.9gram

Weight of pycnometer + water + fine aggregate i.e. B = 1866gram

Weight of pycnometer +water i.e. C = 1554gram

Weight of oven dried sample i.e. D = 496gram

Now , specific gravity = $\frac{\boldsymbol{D}}{[\boldsymbol{A}-(\boldsymbol{B}-\boldsymbol{C})]} = \frac{\mathbf{496}}{[\mathbf{500.9}-(\mathbf{1866}-\mathbf{1554})]} = 2.626 \approx 2.63$

Water absorption % = $\frac{\mathbf{100}(\boldsymbol{A}-\boldsymbol{D})}{\boldsymbol{D}} = \mathbf{100} * \frac{\mathbf{500.9}-\mathbf{496}}{\mathbf{496}} = 0.9879\% \approx 1\%$

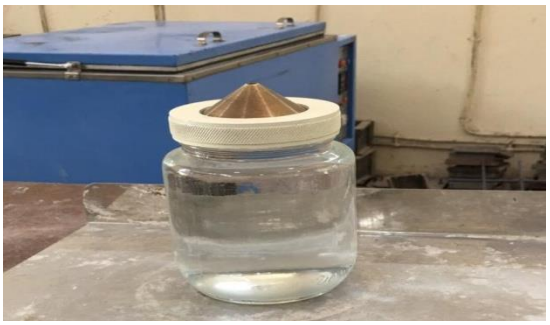
FIGURE OF TEST

[Fine aggregate left for 24 hrs after step 1]

[After step 3 of procedure]

[sample ready for oven]

[sample placed in oven]



[pycnometer filled with water only]

[filtering of water from the sample]

[oven dried sample]

Specific gravity of coarse aggregates

Reference from IS 2386-1963 PART 3 is taken. Here I have adopted **method 2** of IS 2386-1963 PART 3 , which is suitable for size 10 mm to 40 mm.

Apparatus - a) *Balance*- A balance or scale of capacity not less than 3 kg readable and accurate to 0.5 g, and of such a type as to permit the weighing of the vessel containing the aggregate and water.

b) Oven - A well ventilated oven, thermostatically controlled to maintain a temperature of 100 to ***1 10°C.***

c) Glass vessel or jar - wide-mouthed glass vessel such as a jar of about 1.5 litres capacity, with. a flat ground lip and a plane ground disc of plate glass to cover it, giving a virtually watertight fit.

d) Cloths- two dry soft absorbent cloths are used.

e) Tray – an shallow enamel tray of area not less than 325 cm^2.

f) container – an air and water tight container large enough to take the sample.

Sample- a sample of one kilogram may be used.

Procedure- a) The sample shall be passed through 20mm sieve and retained on a 10 mm IS sieve, thoroughly washed to remove fine particles of dust, and immersed in distilled water in the jar/vessel; it shall remain immersed at a temperature of 22 to 32°C for 24 hours. soon after immersion and again at the end of the soaking period, air entrapped in or bubbles on the surface of the aggregate shall be removed by gentle agitation. This may be achieved by rapid clockwise and anti-clockwise rotation of the vessel between the operator's hands.

b) Then the aggregate shall be placed on a dry cloth and gently surface dried with the cloth, transferring it to a second dry cloth when the first will remove no further moisture. It shall then be spread out not more than one stone deep on the second cloth, and left exposed to the atmosphere away from direct sunlight or any other source of heat for not less than 10 minutes or until it appears to be completely surface dry (which with some aggregates may take an hour or more) The aggregate shall be turned over at least once during this period and a gentle current of unheated air may be used after the first ten minutes to accelerate the drying of difficult aggregates. The aggregate shall then be weighed (C) .

c) Now the aggregates are putted into the vessel and the vessel shall be overfilled by adding distilled water and the mouth is close by lid so as to ensure that no air is trapped in the vessel. The vessel shall be dried on the outside and weighed (A).

d) The vessel shall be emptied and the aggregate allowed to drain. Refill the vessel with distilled water. Close the jar in position as before. The vessel shall be dried on the outside and weighed (B).

e) The difference in the temperature of water in the vessel during the first and second weighing shall not exceed 2°C.

f) The aggregate shall be placed in the oven in the shallow tray, at a temperature of 100 to 110°C for 24 hours. It shall then be cooled in airtight container and weighed(D).

Then ,

$$\text{Specific gravity} = \frac{D}{[C-(A-B)]}$$

$$\text{Water absorption \%} = 100 * \frac{C-D}{D}$$

HERE,

A = weight in gram of vessel containing sample and filled with distilled water.

B = weight in gram of vessel filled with distilled water only.

C = weight in gram of saturated surface-dry sample.

D = weight in gram of oven dried sample only.

CALCULATIONS

weight in gram of vessel containing sample and filled with distilled water i.e. A= 4470g

weight in gram of vessel filled with distilled water only i.e. B= 3824g

weight in gram of saturated surface-dry sample taken i.e. C= 1000g

weight in gram of oven dried sample only i.e. D= 996g

Specific gravity = $\frac{\mathbf{D}}{[\mathbf{C}-(\mathbf{A}-\mathbf{B})]} = \frac{\mathbf{996}}{[\mathbf{1000}-(\mathbf{4470}-\mathbf{3824})]} = 2.81356 \approx 2.81$

Water absorption % = $\mathbf{100} * \frac{\boldsymbol{C-D}}{\boldsymbol{D}} = \mathbf{100} * \frac{\mathbf{1000-996}}{\mathbf{996}} = .4016\% \approx 0.4\%$

FIGURES OF THE TEST

20mm and 10mm IS sieves respectively]

[Sample ready for sieving]

[Aggregates left for 24 hrs soaking]

[Surface dried aggregates]

[One kg SSD sample taken]

[Sample ready for oven]

[Sample after oven drying]

Specific gravity of cement

Refrence of IS 4031 part 11 is taken.

APPARATUS- Le Chaterliers flask OR measuring cylinder, weighing balance.

Materials - kerosene (free from water) ,water and opc cement.

Procedure –

1- Dried the measuring cylinder carefully and fill with kerosene to a point on the stem at as V1=150 ml.
2- Take 60 grams (w1) of opc cement and put it on a paper and then carefully slide it to the cylinder. care being taken to avoid splashing and to see that cement does not adhere to the sides of the above the liquid .
3- After putting all the cement to the cylinder, roll the flask gently in an inclined position to expel air until no further air bubble rises to the surface of the liquid.
4- Now read the new reading in the measuring cylinder as V2.

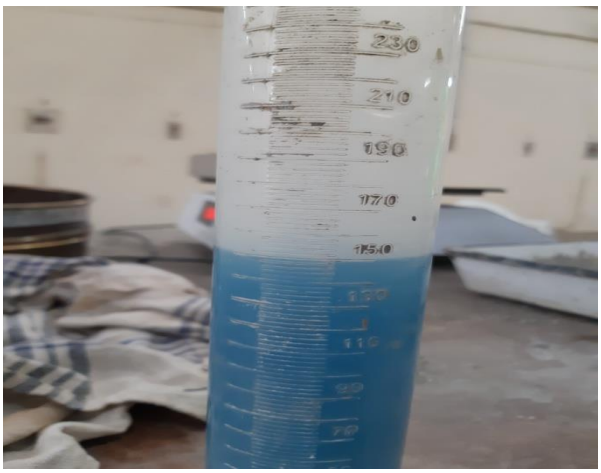
The specific gravity is given as = $\frac{W1}{V2-V1}$.

CALCULATION

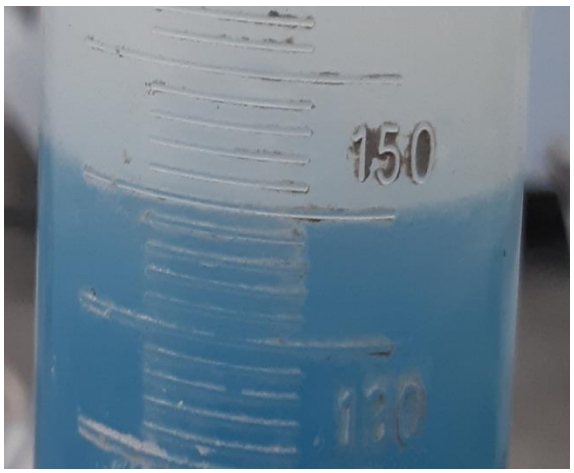
The specific gravity = $\frac{\boldsymbol{W1}}{\boldsymbol{V2-V1}} = \frac{\boldsymbol{60}}{\boldsymbol{169-150}} = 3.1579 \approx 3.15$

Note: - **as final reading is lying in between 168ml and 170 ml ,it is taken 169 . but in actual it may be 169.1 or 168.9 ml. but this much smaller fraction cannot be read in the measuring cylinder as every small gap it self represents 2 ml . for which 0.1ml is very small. And if actual reading is 169.1 ,then specific gravity of cement will be 3.14 . but for all my calculations I have used 3.15 as standard value..**

FIGURES OF TEST



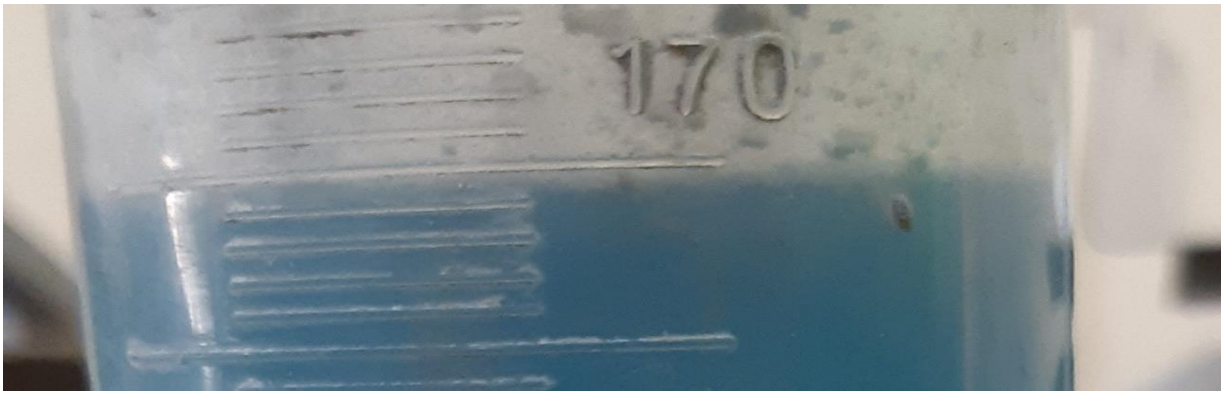
[150 ml kerosene taken in cylinder]



[the level is shown by zooming]

60 g cement sample taken]

[final reading after air removal]



[reading shown by zooming]

SPECIFIC GRAVITY OF FLYASH

APPARATUS- Le Chaterliers flask OR measuring cylinder, weighing balance.

Materials - kerosene (free from water) ,water and FLY ASH.

Procedure –

1- Dried the measuring cylinder carefully and fill with kerosene to a point on the stem at as V1=150 ml.
2- Take around 60 grams (w1) of fly ash and put it on a paper and then carefully slide it to the cylinder. care being taken to avoid splashing and to see that fly ash does not adhere to the sides of the above the liquid .
3- After putting all the fly ash to the cylinder, roll the flask gently in an inclined position to expel air until no further air bubble rises to the surface of the liquid.
4- Now read the new reading in the measuring cylinder as V2.

The specific gravity is given as = $\frac{W1}{V2-V1}$.

CALCULATION

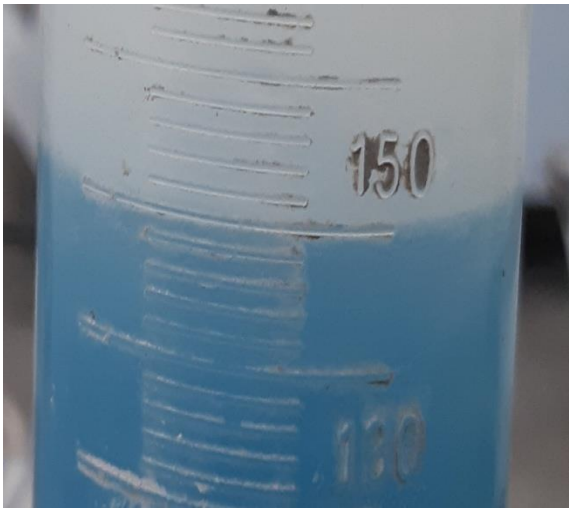
The specific gravity is given as = $\frac{W1}{V2-V1} = \frac{62}{178-150} = 2.2143 \approx 2.2$

Note :- Flyash sample weight is 62g and The final reading is 178ml.

Note- similar test is done for GGBFS and specific gravity is found to be = 3 , which was same as stated by the vender.

FIGURES OF TEST

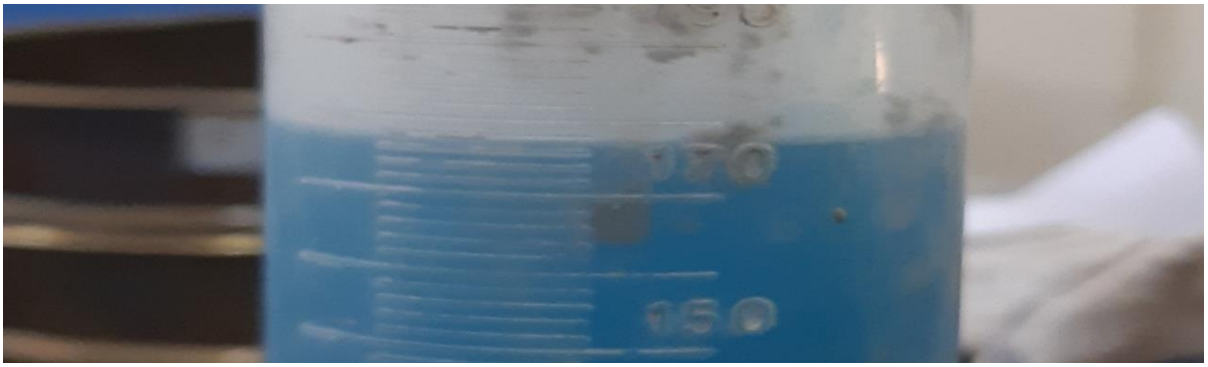
[150 ml kerosene taken]



[zoomed in reading of kerosene]

[62g flyash sample taken]

[final reading after air removal]



[final reading shown by zooming]

The following data is collected from above tests

Sr no.	Material	Specific gravity	Water absorption
1	Fine aggregates	**2.63**	**1 %**
2	Coarse aggregates	**2.81**	**0.4 %**
3	Cement	**3.15**	**n/a**
4	Fly ash	**2.2**	**n/a**
5	GGBFS	**3**	**n/a**

MIX DESIGNS

1- Mix design for conventional (normal) concrete i.e. 0% fly ash M30 concrete.

2- Mix design for 10 % replacement of cement with fly ash M30 concrete.

3- Mix design for 30 % replacement of cement with fly ash M30 concrete.

4- Mix design for 10 % replacement of cement with GGBFS M30 concrete.

5- Mix design for 30 % replacement of cement with GGBFS M30 concrete.

Mix design calculation for 0 % fly ash concrete or normal concrete of M30

Mix 1

STEP 1 :- To design any grade of concrete , target strength is found .according to IS10262 -2009 target strength is given as -

$Fck_{target} = Fck_{characteristic} + 1.65*S$; where S is standard deviation.

Fck_{target} and $Fck_{characteristic}$ are target strength and characteristic strength .

SO, $Fck_{target} = 30 + 1.65* 5$ i.e. Fck_{target} =38.25 Mpa.

Here S is taken from table 1 of IS 10262-2009 and it is also given in table 8 of IS 456-2000. (for m30 S =5).

NOTE:- This Fck_{target} signifies that if this target strength is achieved in controlled lab conditions then there is a very high probability of getting $Fck_{characteristic}$ in the field. i.e. if we get target strength more than or equal to 38.25 Mpa in lab than there is high probability of getting at least 30 Mpa in field.

Step 2 :- For moderate exposure conditions in reinforced concrete minimum cement content is 300 kg/m^3 and maximum water cement ration is 0.5 . this data is taken from table 5 of IS 456-2000.

As maximum water cement ratio is 0.5 , I am taking 0.45 for my design.

Step 3:- maximum water content for 20mm nominal size of aggregate from table 2 of IS 10262 -2009 is 186 kg for slump range 25 to 50 mm.

For slump range 75 to 100 mm the water content is increased as 3% for every 25 mm slump . i.e. for 75 to 100 mm range it is increased 6%.

Water content corrected for slump = $186 + 186 * \frac{6}{100}$ =197 kg or liter (specific gravity of water is one).

Step 4:- cement content using w/c ratio 0.45

Cement content $= \frac{197}{0.45}$ = 437.78 kg/m^3 (which is more than minimum cement content 300 kg/m^3 , hence OK)

Also as per clause 8.2.4.2 of IS 456-2000 , maximum cement content should not exceed 450 kg/m^3 (hence it is also OK).

Step 5:- Proportion of coarse aggregates out of total aggregates as per table 3 of

IS 10262-2009 for 20 mm max nominal size of aggregates and zone 2nd is 0.62.

This content is for 0.5 w/c ratio . for every 0.05 decrease in w/c ratio this proportion is increased by 0.01 and for every 0.05 increase in w/c ratio this proportion is decreased by 0.01 . so in our case it is increased by 0.01 as our w/c ratio is 0.45.

So , coarse aggregate fraction is 0.63 .

Now , for pump able concrete this fraction is reduced by 10 % .

So final coarse aggregate content is = 0.63*0.9 = 0.567 .

Which gives fine aggregates fraction as = 1- 0.567 = 0.433

Now, **Estimation of quantities for 1 m^3 of concrete.**

Volume of concrete = 1 m^3

Volume of cement = $437.78 * \frac{1}{3.15*1000}$ = 0.13899 ≈ 0.139 m^3

Volume of water = 197 liters = 0.197 m^3

Volume of aggregates = 1 – 0.139 -0.197 = 0.664 m^3

Coarse aggregates content = 0.664*0.567*2.81*1000

= 1058 kg/m^3

Fine aggregates content = 0.664*0.433*2.63*1000

= 756.16 kg/m^3

Following data is collected from above calculations.

Sr.No.	**Materials**	**Quantity**
1	Cement	437.78 kg/m^3
2	Water	197 kg/m^3
3	Fine aggregates	756.16 kg/m^3
4	Coarse aggregates	1058 kg/m^3
5	Fly ash	0 kg/m^3
6	w/c ratio	0.45
7	admixtures	0 kg/m^3

TABLE-7

Now , replacements of cement with fly ash is done .

Mix 2

10% replacement of cement with fly ash .

Fck_{target} = 38.25 Mpa (same as in mix 1)

w/c ratio = 0.45 (taking same as mix 1)

water content = 197 kg/m^3 (same as mix 1)

Now total cementious material content $= \frac{197}{0.45} =$ 437.78 kg/m^3

Increasing cementious material by 10 % i.e. =437.78 *1.1 = 481.6 kg/m^3

Now fly ash content for 10% replacement of cement = 481.6 * 0.1 = 48.16 kg/m^3

So cement content is = 481.6- 48.16 = 433.44 kg/m^3 (which is less than 450 kg/m^3 and more than 300 kg/m^3 hence OK)

Now coarse aggregates fraction out of total aggregates = 0.62 (from table 3 of IS10262-2009) , which is corrected for w/c ratio by increasing it to 0.63.

For pump able concrete coarse aggregates fraction is reduced by 10%

So final fraction of coarse aggregates = 0.9 *0.63 = 0.567

And fine aggregates fraction is =0.433

Now , **estimation of quantities for 1 m^3**

Volume of concrete = 1 m^3

Volume of cement = $\frac{433.44}{3.15*1000}$ = 0.1376 m^3

Volume of water = 0.197 m^3

Volume of fly ash = $\frac{48.16}{2.2*1000}$ = 0.022 m^3

Volume of aggregate = 1- 0.022-0.197-0.1376

= 0.6434 m^3

Coarse aggregates content = 0.6434*0.567*2.81*1000 = 1025.1 kg/m^3

Fine aggregates content = 0.6434*0.433*2.63*1000 = 732.7 kg/m^3

Admixture used = none

The Following data is collected .

Sr.no.	Materials	Quantity
1	Cement	433.44 kg/m^3
2	Water	197 kg/m^3
3	Fly ash	48.16 kg/m^3
4	Fine aggregates	732.7 kg/m^3
5	Coarse aggregates	1025.1 kg/m^3
6	w/c ratio	0.45
7	admixtures	0 kg/m^3

TABLE-8

Mix 3

30% replacement of cement with fly ash .

Fck_{target} = 38.25 Mpa (same as in mix 1)

w/c ratio = 0.45 (taking same as mix 1)

water content = 197 kg/m^3 (same as mix 1)

Now total cementious material content $= \frac{197}{0.45} =$ 437.78 kg/m^3

Increasing cementious material by 10 % i.e. =437.78 *1.1 = 481.6 kg/m^3

Now fly ash content for 30% replacement of cement = 481.6 * 0.3 = 144.48 kg/m^3

So cement content is = 481.6- 144.48 = 337.12 kg/m^3 (which is less than 450 kg/m^3 and more than 300 kg/m^3 hence OK)

Now coarse aggregates fraction out of total aggregates = 0.62 (from table 3 of IS10262-2009) , which is corrected for w/c ratio by increasing it to 0.63

For pump able concrete coarse aggregates fraction is reduced by 10%

So final fraction of coarse aggregates = 0.9 *0.63 = 0.567

And fine aggregates fraction is =0.433

Now , **estimation of quantities for 1 m^3**

Volume of concrete = 1 m^3

Volume of cement = $\frac{337.12}{3.15*1000}$ = 0.107 m^3

Volume of water = 0.197 m^3

Volume of fly ash = $\frac{144.48}{2.2*1000}$ = 0.0657 m^3

Volume of aggregate = 1- 0.0657-0.197-0.107

= 0.6303 m^3

Coarse aggregates content = 0.6303*0.567*2.81*1000 = 1004.24 kg/m^3

Fine aggregates content = 0.6303*0.433*2.63*1000 = 717.8 kg/m^3

Admixture used = none

The Following data is collected .

Sr.no.	Materials	Quantity
1	Cement	337.12 kg/m^3
2	Water	197 kg/m^3
3	Fly ash	144.48 kg/m^3
4	Fine aggregates	717.8 kg/m^3
5	Coarse aggregates	1004.24 kg/m^3
6	w/c ratio	0.45
7	admixtures	0 kg/m^3

TABLE-9

Now , replacements of cement with GGBFS is done .

Mix 4

10% replacement of cement with GGBFS .

Fck_{target} = 38.25 Mpa (same as in mix 1)

w/c ratio = 0.45 (taking same as mix 1)

water content = 197 kg/m^3 (same as mix 1)

Now total cementious material content $= \frac{197}{0.45} =$ 437.78 kg/m^3

Increasing cementious material by 10 % i.e. =437.78 *1.1 = 481.6 kg/m^3

Now GGBFS content for 10% replacement of cement = 481.6 * 0.1 = 48.16 kg/m^3

So cement content is = 481.6- 48.16 = 433.44 kg/m^3 (which is less than 450 kg/m^3 and more than 300 kg/m^3 hence OK)

Now coarse aggregates fraction out of total aggregates = 0.62 (from table 3 of IS10262-2009) , which is corrected for w/c ratio by increasing it to 0.63.

For pump able concrete coarse aggregates fraction is reduced by 10%

So final fraction of coarse aggregates = 0.9 *0.63 = 0.567

And fine aggregates fraction is =0.433

Now , **estimation of quantities for 1 m^3**

Volume of concrete = 1 m^3

Volume of cement = $\frac{433.44}{3.15*1000}$ = 0.1376 m^3

Volume of water = 0.197 m^3

Volume of GGBFS = $\frac{48.16}{3*1000}$ = 0.01605m^3

Volume of aggregate = 1- 0.01605-0.197-0.1376

= 0.64935 m^3

Coarse aggregates content = 0.64935*0.567*2.81*1000 = 1034.6 kg/m^3

Fine aggregates content = 0.64935*0.433*2.63*1000 = 739.47 kg/m^3

Admixture used = none

The Following data is collected .

Sr.no.	Materials	Quantity
1	Cement	433.44 kg/m^3
2	Water	197 kg/m^3
3	GGBFS	48.16 kg/m^3
4	Fine aggregates	739.47 kg/m^3
5	Coarse aggregates	1034.6 kg/m^3
6	w/c ratio	0.45
7	admixtures	0 kg/m^3

TABLE-8

Mix 5

30% replacement of cement with fly ash .

Fck_{target} = 38.25 Mpa (same as in mix 1)

w/c ratio = 0.45 (taking same as mix 1)

water content = 197 kg/m^3 (same as mix 1)

Now total cementious material content $= \frac{197}{0.45} =$ 437.78 kg/m^3

Increasing cementious material by 10 % i.e. =437.78 *1.1 = 481.6 kg/m^3

Now GGBFS content for 30% replacement of cement = 481.6 * 0.3 = 144.48 kg/m^3

So cement content is = 481.6- 144.48 = 337.12 kg/m^3 (which is less than 450 kg/m^3 and more than 300 kg/m^3 hence OK)

Now coarse aggregates fraction out of total aggregates = 0.62 (from table 3 of IS10262-2009) , which is corrected for w/c ratio by increasing it to 0.63

For pump able concrete coarse aggregates fraction is reduced by 10%

So final fraction of coarse aggregates = 0.9 *0.63 = 0.567

And fine aggregates fraction is =0.433

Now , **estimation of quantities for 1 m^3**

Volume of concrete = 1 m^3

Volume of cement = $\frac{337.12}{3.15*1000}$ = 0.107 m^3

Volume of water = 0.197 m^3

Volume of GGBFS = $\frac{144.48}{3*1000}$ = 0.04816 m^3

Volume of aggregate = 1- 0.04816-0.197-0.107

= 0.64784 m^3

Coarse aggregates content = 0.64784*0.567*2.81*1000 = 1032.18 kg/m^3

Fine aggregates content = 0.64784*0.433*2.63*1000 = 737.8 kg/m^3

Admixture used = none

The Following data is collected .

Sr.no.	Materials	Quantity
1	Cement	337.12 kg/m^3
2	Water	197 kg/m^3
3	GGBFS	144.48 kg/m^3
4	Fine aggregates	737.8 kg/m^3
5	Coarse aggregates	1032.18 kg/m^3
6	w/c ratio	0.45
7	admixtures	0 kg/m^3

Now for remembering these 5 mixes are named as the following.

Sr.no.	Specifications	Nominations
1	Normal concrete 0% fly ash	**N0**
2	10 % Fly ash replaced concrete	**F10**
3	30 % Fly ash replaced concrete	**F30**
4	10 % GGBFS replaced concrete	**G10**
5	30 % GGBFS replaced concrete	**G30**

TABLE-10

NOW, no of required cubes of each mix .

For 7 days normally cured compressive strength = 3 cubes

For 28 days normally cured compressive strength = 3 cubes

For 2 hrs and 3.5hrs accelerated curing by boiling water method = 6 cubes

So , 12 cubes from each of the 5 mixes are required i.e. total 60 cubes required.

Table of final quantities to be mixed for the 3 mixes

Sr.no.	Material	Content for N0 mix	Content for F10 mix	Content for F30 mix	Content for G10 mix	Content for G30 mix
1	Cement	437.78 kg/m^3	433.44 kg/m^3	337.12 kg/m^3	433.44 kg/m^3	337.12 kg/m^3
2	Fly ash	0 kg/m^3	48.16 kg/m^3	144.48 kg/m^3	48.16 kg/m^3	144.48 kg/m^3
3	Water	197 kg/m^3	197 kg/m^3	197 kg/m^3	197 kg/m^3	197 kg/m^3
4	Fine aggregates	756.16 kg/m^3	732.7 kg/m^3	717.8 kg/m^3	739.47 kg/m^3	737.8 kg/m^3
5	Coarse aggregates	1058 kg/m^3	1025.1 kg/m^3	1004.24 kg/m^3	1034.6 kg/m^3	1032.18 kg/m^3
6	w/c ratio	0.45	0.45	0.45	0.45	0.45
7	Admixture	0 kg/m^3	0 kg/m^3	0 kg/m^3	0 kg/m^3	0 kg/m^3

TABLE-11

Calculation for the amount required for making 12 cubes of each mix

Volume of one cube = 0.15*0.15*0.15 = 0.003375 m^3

So , volume of 12 cubes = 0.003375 * 12 =0.0405 m^3

For proper filling of the cubes extra 25 % material is made .

For **N0**

The weight of cement is = 437.78 * 0.0405 * 1.25 = 22.16 kg.

The weight of water is = 197 * 0.0405 * 1.25 = 9.97 kg.

The weight of fly ash is = 0 kg.

The weight of fine aggregates = 756.16 * 0.0405 * 1.25 =38.28 kg.

The weight of coarse aggregates = 1058 * 0.0405 * 1.25 =53.56 kg.

For **F10**

The weight of cement is = 433.44 * 0.0405 * 1.25 = 21.95 kg.

The weight of water is = 197 * 0.0405 * 1.25 = 9.97 kg.

The weight of fly ash is = 48.16 * 0.0405 *1.25 = 2.44 kg

The weight of fine aggregates = 732.7 * 0.0405 * 1.25 =37.1 kg.

The weight of coarse aggregates = 1025.1 * 0.0405 * 1.25 =51.9 kg.

Similarly for **F30**

The weight of cement is = 337.12 * 0.0405 * 1.25 = 17.07 kg.

The weight of water is = 197 * 0.0405 * 1.25 = 9.97 kg.

The weight of fly ash is = 144.48 * 0.0405 *1.25 = 7.32 kg

The weight of fine aggregates = 717.8 * 0.0405 * 1.25 =36.34 kg.

The weight of coarse aggregates = 1004.24 * 0.0405 * 1.25 =50.84 kg.

For **G10**

The weight of cement is = 433.44 * 0.0405 * 1.25 = 21.95 kg.

The weight of water is = 197 * 0.0405 * 1.25 = 9.97 kg.

The weight of GGBFS is = 48.16 * 0.0405 *1.25 = 2.44 kg

The weight of fine aggregates = 739.47 * 0.0405 * 1.25 =37.44 kg.

The weight of coarse aggregates = 1034.6 * 0.0405 * 1.25 =52.38 kg.

For G30

The weight of cement is = 337.12 * 0.0405 * 1.25 = 17.067 kg.

The weight of water is = 197 * 0.0405 * 1.25 = 9.97 kg.

The weight of GGBFS is = 144.48 * 0.0405 *1.25 = 7.314 kg

The weight of fine aggregates = 737.8 * 0.0405 * 1.25 =37.35 kg.

The weight of coarse aggregates = 1032.18 * 0.0405 * 1.25 =52.25kg.

NOTE :- all 12 cubes were not made on a single day . also a trial mix for 3 cubes is made for all FIVE mixes and slump and segregation was checked .

Than 9 cubes of mix N0 is made on (3 for 7 days, 3 for 28 days curing and 3 for 2 hrs boiling water curing) . then 2 days later of preparing these 9 cubes 3 more cube were prepared for 3.5 hrs boiling water curing.

Total amount of required material was summed and bought from nearby shop.

Total amount of required material was summed and bought from nearby shop.

Sr.no.	Material	Weight for N0 mix	Weight for F10 mix	Weight for F30 mix	Weight for G10 mix	Weight for G30 mix	Total weight
1	Cement	22.16kg	21.95 kg	17.07 kg	21.95 kg	17.07 kg	100.2kg
2	Fly ash	0kg	2.44kg	7.32kg	0kg	0kg	9.76kg
3	GGBFS	0kg	0kg	0kg	2.44kg	7.32kg	9.76kg
4	Water	9.97kg	9.97kg	9.97kg	9.97kg	9.97kg	49.85 kg
5	Fine aggregates	38.28kg	37.1kg	36.34 kg	37.44 kg	37.35 kg	186.51 kg
6	Coarse aggregates	53.56kg	51.9kg	50.84 kg	52.38 kg	52.25 kg	260.93 kg
7	w/c ratio	0.45	0.45	0.45	.45	.45	n/a
8	Admixture	0	0	0	0	0	0

TABLE-12

After checking trial mixes following steps were done .On the first day of a particular week 9 moulds were cleaned and prepared and N0 mix was made . on the next day after 24 hrs . 6 cubes were taken out from the moulds and putted into normal curing tank. And remaining 3 cubes along with the moulds was putted in the boiling water curing tank. In the mean time 3 more cubes of N0 mix were prepared . the methods of following is explained in detailed below.

Method of cube preparing

Step 1 : - Preparation of cubical moulds is done by proper cleaning them and then oil is applied at the jointed sections so that no concrete water leaves the cube and then proper tightening of the cubes is done . after this a thin layer of oil as lubricant on all the faces of the cube.

FIG-25 During preparation of moulds

FIG-26

FIG-27

When moulds were prepared and oiling was done.

Step 2 :- materials (except water) were weighed for 9 cubes accordingly from above table and putted into the batch mixture and mixed in dry state for 2 to 4 minutes.

FIG-28 Putting dry material one by one

FIG-29 During mixing in batch mixture

Then water is poured gradually from above after dry mixing and the mixing is done for suitable time not less than 3-4 minutes.

FIG-30 After dry mixing completion

FIG-31 After wet mixing completion

Then this mix is dropped into a big tray by rotating the handle of the batch mixture and transported near the moulds and shaking table.

Step 3:- soon as possible slump test is performed. The following procedure is followed for slump test.

Apparatus used:- Slump cone, tamping rod, metallic sheet.

Procedure:-

1- Firstly cleaning the internal surface of the mould thoroughly and place it on a smooth horizontal, rigid and non-absorbent surface, such as of a metal plate.

FIG-32[Cleaned apparatus ready to use]

FIG-33[After filling 1/4th and temping with rod]

2- Fill the mould to about one fourth of its height with concrete. While filling, hold the mould firmly in position .now temping is done about 25 strokes free falling uniformly over the concrete.

3- Fill the mould further in 3 layers each time by 1/4th height and tamping evenly each layer as above. After completion of the topmost layer strike of the concrete with a trowel or tamping bar, level with the top of mould .

4- Lift the mould vertically slowly and remove it. The concrete will subside. Measure the height of the specimen of concrete after subsidence.

FIG-34 [Concrete filled to the top **]** **FIG-35** [Measuring slump]

RESULTS- The slump of N0 mix was 8.1 cm i.e. 81 mm. the slump of F10 mix was 89mm and slump of F30 mix was 100.3 mm. so , our desired slump between 75 to100 mm is achieved approximately in all three mixes.

Now ,

Step 4 :- as soon as the mix is prepared i.e. water is mixed to the materials it should be filled into the moulds .

At the time of filling the moulds following two things should be kept in mind-

1- Full compaction of concrete happens.

2- Neither segregation nor excessive laitance should take place.To ensure full compaction I have used shaking table and to ensure that segregation not takes place the moulds was filled in 3 to 4 layers starting from 5 cm each and then compacting by vibration on shaking table .

FIG-36 **FIG-37**

[During filling and vibrating of first layer in the moulds]

FIG-38[**After complete filling and finishing]** **FIG-39** **[close look at one of the cube]**

Step 5- These cubes might be covered from top by putting plate over them for no loss of water or they might be stored in moist air of at least 90 percent humidity for 23 hours ± 15 min.

FIG-40 **FIG-41**

[After 24 hours the cubes are ready to be putted in curing tank]

Step 6- Now on this day firstly the boiling water curing tanks temperature is set to 100^0C and left for attaining the temperature . it took approx 2 hrs to reach the temperature to 100^0C . In the mean time 6 cubes (3 for 7 days testing and 3 for 28 days testing) out of 9 cubes are taken out of the moulds carefully and putted in the normal curing tank.

NOTE- the same procedure was followed for F10 and F30 mixes.

FIG-42 [N0 MIX cubes in normal curing tank] **FIG-43 [the left 6 cubes]**

On the other hand when the temperature of the accelerated curing tank attained a value of 100^0C ,the tank was opened carefully from the back side as shown in figure to ensure that no harm from the steam happens .

FIG-44 [the temperature attained 100^0C] **FIG-45 [carefully opening the tank]**

Now placing of the cubes along with the moulds is done very carefully so that no water splashes over us as it can cause severe burning of skin.

Note - the lifting and placing the cubes with moulds into the tank is done with the help of two people at least one must be lab technician and with all care taken that it do not drop from a height.

FIG-46 [the mould ready to be lifted**]** **FIG-47** [At the end of carefully placing]

Some points on boiling water curing as per IS 9013-1978

The temperature of water shall not drop more than 3^0C after the specimens are placed and shall return to boiling within 15 minutes.

So as I noticed during the curing the temperature was fluctuating between 99^0C to 101.2^0C . Hence it was okay.

Step 7- now at the completion of 2 hrs the cubes were taken out of the curing tank very carefully . (on the day when curing duration was 3.5 hrs they were taken out after 3.5 hrs for all three different mixes.)

After this the cubes are taken out from the moulds quickly and carefully , and immersed in cooling tank at 27 +/- 2^0C for 2 hours.

At the completion of 2 hrs in cooling tank the cubes are taken out and left on the ground not in the contact of direct sunlight for 10 to 15 min for surface moisture drying.

Now the cubes are ready for the testing.

As all the cubes are made and same procedure explained above was followed. And cubes of N0, F10 and F30 mixes were made and testing was done at the specified respective times. The method of testing will stated ahead.

FIG-48 [left 12 cubes in normal curing tank] **FIG-49** [cubes in boiling water curing tank]

The time and date of the making of the different cubes, putting into the normal curing tank , boiling water curing and also time and date of test is also noted and is written in a table ahead.

Before doing the test and noting the results further nominations of the cubes was done to accumulate the different curing and their time period as shown in the table below.

Table of nomination on the basis of curing

Sr.no.	MIX	Type of curing	Duration	Nomination
1	N0	Normal curing	7 days	N0N7
2			28 days	N0N28
3		Boiling water	2 hrs	N0B2
4			3.5 hrs	N0B3.5
5	F10	Normal curing	7 days	F10N7
6			28 days	F10N28
7		Boiling water	2 hrs	F10B2
8			3.5 hrs	F10B3.5
9	F30	Normal curing	7 days	F30N7
10			28 days	F30N28
11		Boiling water	2 hrs	F30B2
12			3.5 hrs	F30B3.5
13	G10	Normal curing	7 days	G10N7
14			28 days	G10N28
15		Boiling water	2 hrs	G10B2
16			3.5 hrs	G10B3.5
17	G30	Normal curing	7 days	G30N7
18			28 days	G30N28
19		Boiling water	2 hrs	G30B2
20			3.5 hrs	G30B3.5

TABLE-13

Timings and date of the formation and testing's of the cubes

Sr. no	MIX	Moulds prepared	Moulds filling completion		Start of curing		End of curing		Testing	
		DATE	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME
1	N0N7	30/09/19	01/10/19	10:50	02/10/19	11:10	9/10/19	11:00	9/10/19	11:30
2	N0N28	30/09/19	01/10/19	10:50	02/10/19	11:10	30/10/19	11:00	30/10/19	11:30
3	N0B2	30/09/19	01/10/19	10:50	02/10/19	11:20	2/10/19	01:20	2/10/19	03:40
4	N0B3.5	02/10/19	03/10/19	10:20	04/10/19	11:00	4/10/19	02:30	4/10/19	05:00
5	F10N7	04/10/19	09/10/19	11:15	10/10/19	11:30	17/10/19	11:30	17/10/19	12:00
6	F10N28	04/10/19	09/10/19	11:15	10/10/19	11:30	07/11/19	11:30	07/11/19	12:00
7	F10B2	04/10/19	09/10/19	11:15	10/10/19	11:20	10/10/19	01:20	10/10/19	03:50
8	F10B3.5	18/10/19	21/10/19	10:05	22/10/19	11:20	22/10/19	02:50	22/10/19	05:10
9	F30N7	11/10/19	14/10/19	11:50	15/10/19	12:00	22/10/19	12:00	22/10/19	12:30
10	F30N28	11/10/19	14/10/19	11:50	15/10/19	12:00	12/11/19	12:00	12/11/19	01:20
11	F30B2	11/10/19	14/10/19	11:50	15/10/19	12:00	15/10/19	02:00	15/10/19	04:30
12	F30B3.5	18/10/19	21/10/19	11:10	22/10/19	11:20	22/10/19	02:50	22/10/19	05:10
13	G10N7	13/1/20	14/1/20	10:50	15/1/20	11:10	22/1/20	11:30	22/1/20	12:00
14	G10N28	13/1/20	14/1/20	10:50	15/1/20	11:10	13/2/20	11:30	13/2/20	12:00
15	G10B2	13/1/20	14/1/20	10:50	15/1/20	11:20	15/1/20	01:20	15/1/20	01:50
16	G10B3.5	15/1/20	16/1/20	10.20	17/1/20	11.00	17/1/20	02:30	17/1/20	03:00
17	G30N7	20/1/20	21/1/20	10:50	22/1/20	11:00	29/1/20	11:30	29/1/20	12:00
18	G30N28	20/1/20	21/1/20	10:50	22/1/20	11:00	19/2/20	11:30	19/2/20	12:00
19	G30B2	20/1/20	21/1/20	10:50	22/1/20	11:00	22/1/20	01:00	22/1/20	01:30
20	G30B3.5	23/1/20	24/1/20	10:00	25/1/20	10:30	25/1/20	02:00	25/1/20	02:30

TABLE-14

Method of compression test on concrete cubes

Apparatus - compression testing machine of suitable loading capacity.

FIG-50 [Compression testing machine] **FIG-51** [Operating machine for CTM]

Procedure-

- At least 3 specimens from different mixes are to be tested and the average of three specimens is taken as compressive strength of the mix.
- The specimen must be surface dry only and not completely dry. If cube is completely dry than it is soaked in water for 24 hrs before testing and then surface dried by keeping it in normal air for 15 to 20 minutes.

FIG-52 [surface dried samples ready for testing in CTM] **FIG-53**

- At the time of testing the cubes surfaces are wiped out for any fine particle like sand or dust and the plate to be in contact of machine are cleaned properly with the help of a dry cloth.
- Sides of the cubes are measured before testing to get the correct idea of area under compression.

FIG-54

FIG-55

[as it can be seen from these two figures that dimensions are 150 mm each]

- The placing of the concrete cube should be in such a way that load should pass through its centre i.e. no eccentricity is encountered.

FIG-56

FIG-57

[properly placing the cube to ensure no eccentricity and then operating]

About CTM – the black handle in the operating machine is to move the upper plate up and down. And nearby two red buttons are for main and rapid pump respectively .

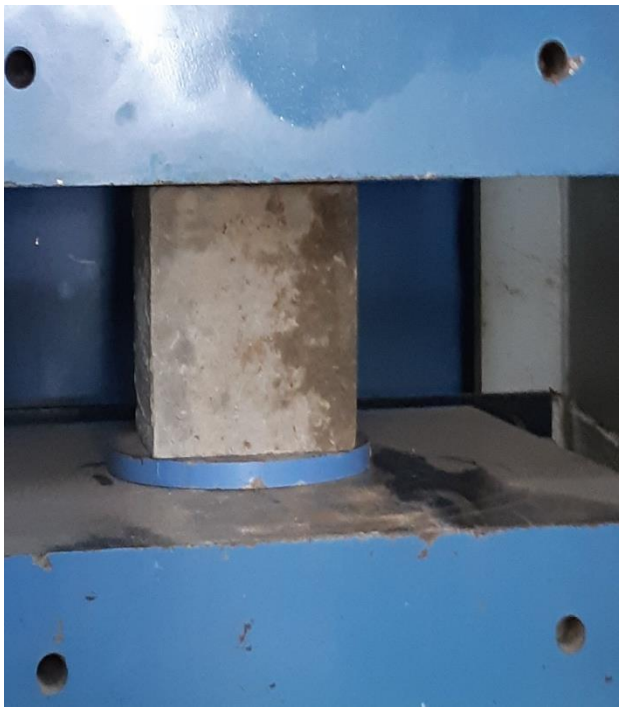
- The digital meter above this system which shows digital reading in red color is the load in KN . and nearby green reading box shows the different various functions of the machine and it also shows the capacity set for load . in our case max load was set at 3000 KN.
- The loading was applied at a constant rate of 5.2 KN/second.
- Load increases uniformly at this rate and reach to a maximum value at which first

crack occur , than it retards down quickly .

- After this the load is shown in display i.e. the max load reached during the testing . this load is noted down for calculation of the stress as-

  Compressive strength = (max load) / area under compression.
- These steps are repeated for all three cubes and the average of the three is taken as the compressive strength of the mix .
- IS CODE suggest if individual results of the cube vary more than + or – 15 % to the average strength than sample and results must be discarded and new mix should be prepared.

FIG-58



[cube placed just before the start of test] **FIG-59**

FIG-60 [cube samples after completion of test with visible cracks] **FIG-61**

FIG-62 [during the testing of the cubes reading of load increasing] **FIG-63**

FIG-64 [at the end of the test the cube looks like this] **FIG-65**

Note – Suitable samples from all the cubes were collected for microanalysis of these different mixes.

RESULTS AND CONCLUSIONS

Table for N0 MIX

Sr.no.	Cube name	Sample no.	Load(KN)	Compressive strength (N/mm^3)	Average compressive strength (N/mm^3)
1	N0N7	1	542.3	24.1	24.97
2		2	576.3	25.61	
3		3	567	25.2	
4	N0N28	1	907	40.31	40.27
5		2	927	41.2	
6		3	884.3	39.3	
7	N0B2	1	392.6	17.45	17.21
8		2	378	16.8	
9		3	391.1	17.38	
10	N0B3.5	1	456.8	20.3	21.2
11		2	483.5	21.49	
12		3	490.5	21.8	

TABLE-15

The above table contains results of normal concrete mix i.e. N0 mix .

Table for F10 MIX RESULTS

Sr.no.	Cube name	Sample no.	Load (KN)	Compressive strength(N/mm^3)	Average compressive strength N/mm^3
1	F10N7	1	603.4	26.82	25.66
2		2	561.4	24.95	
3		3	567	25.2	
4	F10N28	1	967.5	43	40.73
5		2	865.6	38.47	
6		3	916.2	40.72	
7	F10B2	1	392	17.42	18.06
8		2	404.3	17.97	
9		3	422.8	18.79	
10	F10B3.5	1	471	20.93	21.8
11		2	496.6	22.07	
12		3	504	22.4	

TABLE-16

Table for F30 MIX RESULTS

Sr.no.	Cube name	Sample no.	Load (KN)	Compressive strength(N/mm^3)	Average compressive strength(N/mm^3)
1	F30N7	1	512.6	22.78	23.12
2		2	531.2	23.61	
3		3	516.8	22.97	
4	F30N28	1	792	35.2	37.9
5		2	886.5	39.4	
6		3	879.8	39.1	
7	F30B2	1	333.5	14.82	15.31
8		2	353.3	15.7	
9		3	346.7	15.41	
10	F30B3.5	1	422.6	18.78	19.18
11		2	440.1	19.56	
12		3	432	19.2	

TABLE-17

Table for G10 MIX RESULTS

Sr.no.	Cube name	Sample no.	Load (KN)	Compressive strength(N/mm^3)	Average compressive strength(N/mm^3)
1	G10N7	1	604.5	26.86	25.72
2		2	562.6	25	
3		3	569	25.3	
4	G10N28	1	966	42.93	40.66
5		2	864.8	38.43	
6		3	914	40.62	
7	G10B2	1	391.2	17.39	15.1
8		2	303.5	13.5	
9		3	322	14.37	
10	G10B3.5	1	470	20.9	21.75
11		2	494.8	22	
12		3	503.2	22.36	

TABLE-17

Table for G30 MIX RESULTS

Sr.no.	Cube name	Sample no.	Load (KN)	Compressive strength(N/mm^3)	Average compressive strength(N/mm^3)
1	G30N7	1	518.85	23.06	23.40
2		2	537.5	23.89	
3		3	523.12	23.25	
4	G30N28	1	780.8	34.7	37.4
5		2	875.25	38.9	
6		3	868.5	38.6	
7	G30B2	1	335.25	14.9	15.4
8		2	355.5	15.8	
9		3	348.8	15.5	
10	G30B3.5	1	425.25	18.9	19.3
11		2	443.25	19.7	
12		3	434.25	19.3	

TABLE-17

Prediction of 28 days strength using IS CODE 9013- 1978

IS CODE 9013-1978 has used 28 days strength prediction equation as follows-

$$R_{28} = 8.09 + 1.64*R_a$$

Where, R_{28} = predicted strength of 28 days using 3.5hrs boiling water cured strength,

R_a = 3.5 hrs boiling water cured strength

Predicted values of strength on the basis of above equation

Sr.no.	Sample name	Average 3.5hrs strength	Predicted 28hrs strength
1	N0B3.5	21.2	42.858
2	F10B3.5	21.8	43.842
3	F30B3.5	19.18	39.545

TABLE-18

1-Strength of normal concrete

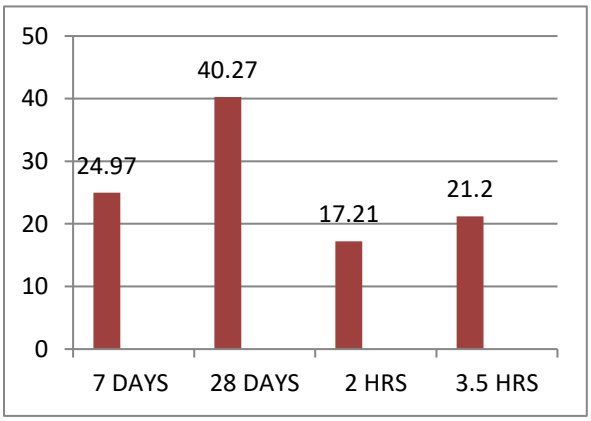
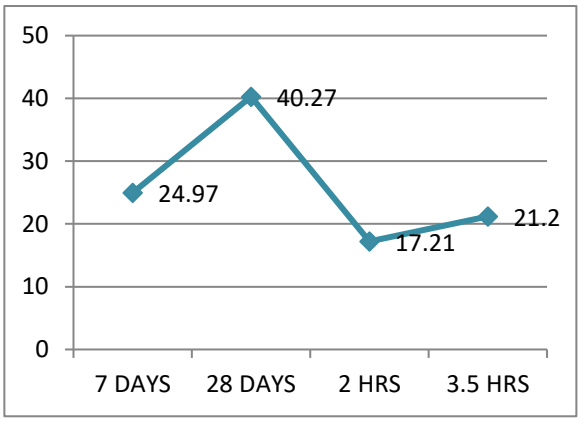


CHART-1



GRAPH-1

2-Strength of 10% FLY ASH replaced concrete

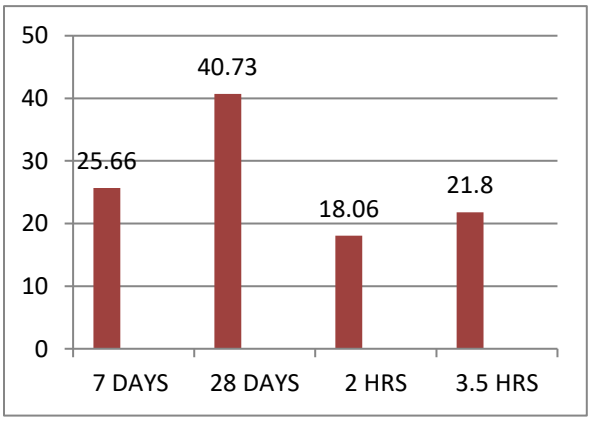
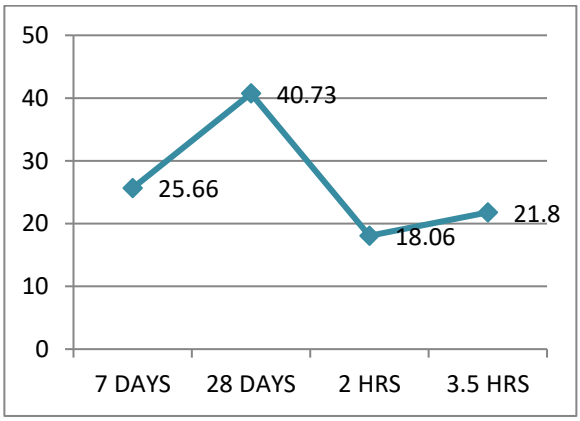


CHART-2



GRAPH-2

3-Strength of 30% FLY ASH replaced concrete

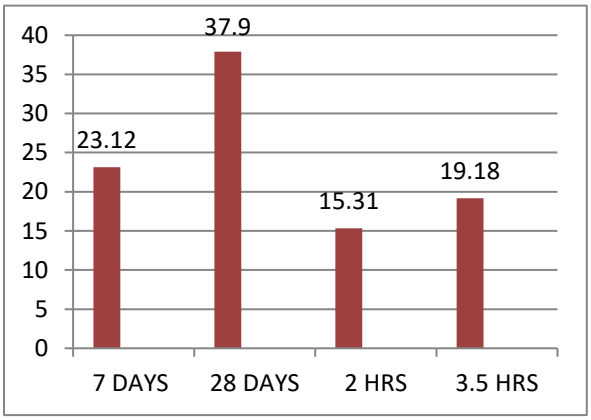
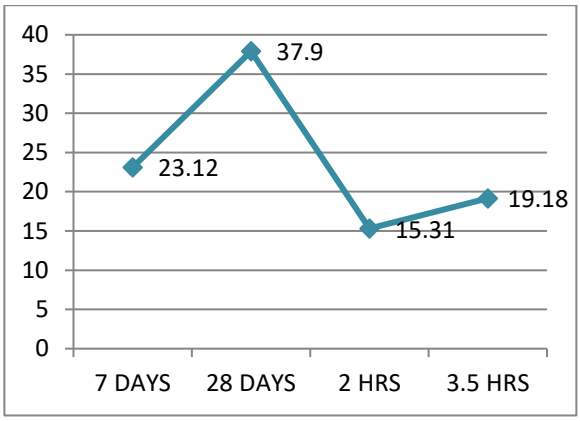


CHART-3



GRAPH-3

Variation of 7 days and 28 days of different concrete mixes

Sr.no.	Sample name	7 days strength	28 days strength	7 days strength as % of 28 days strength
1	Normal concrete	24.97	40.27	62%
2	10 % fly ash concrete	25.66	40.73	63.1%
3	30 % fly ash concrete	23.12	37.9	60.9%

TABLE-19

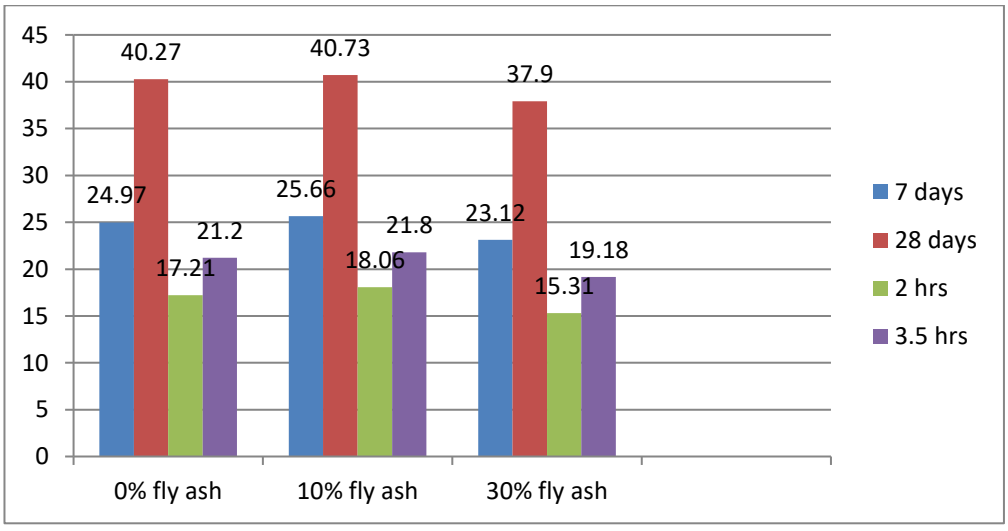
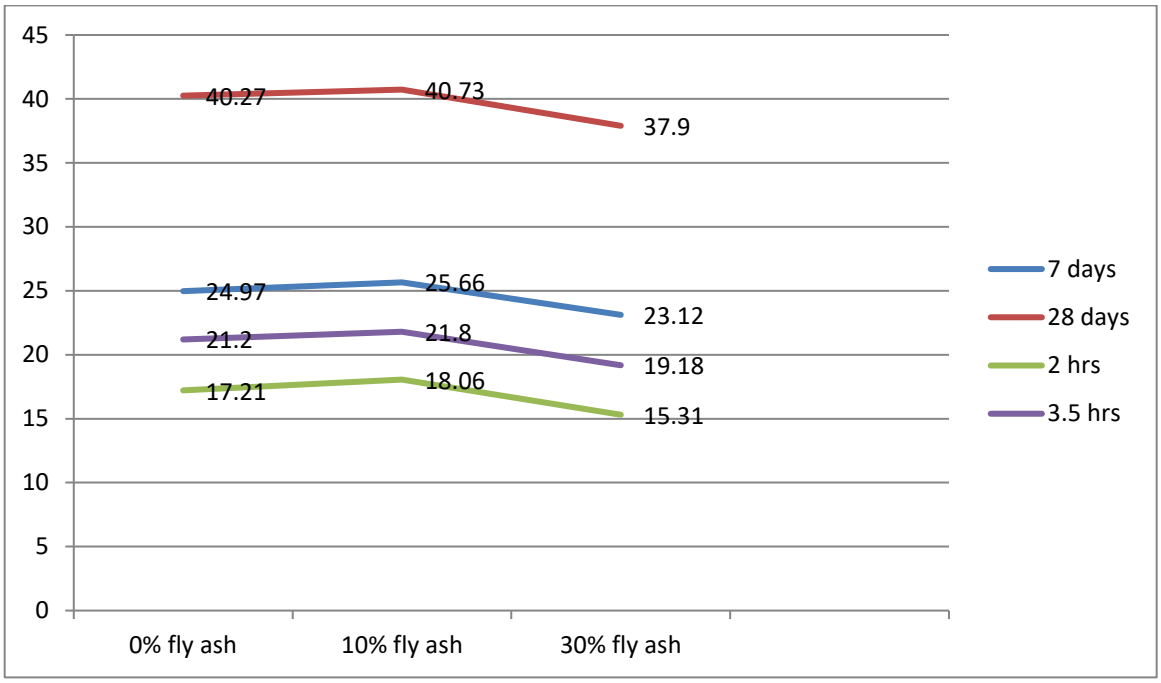


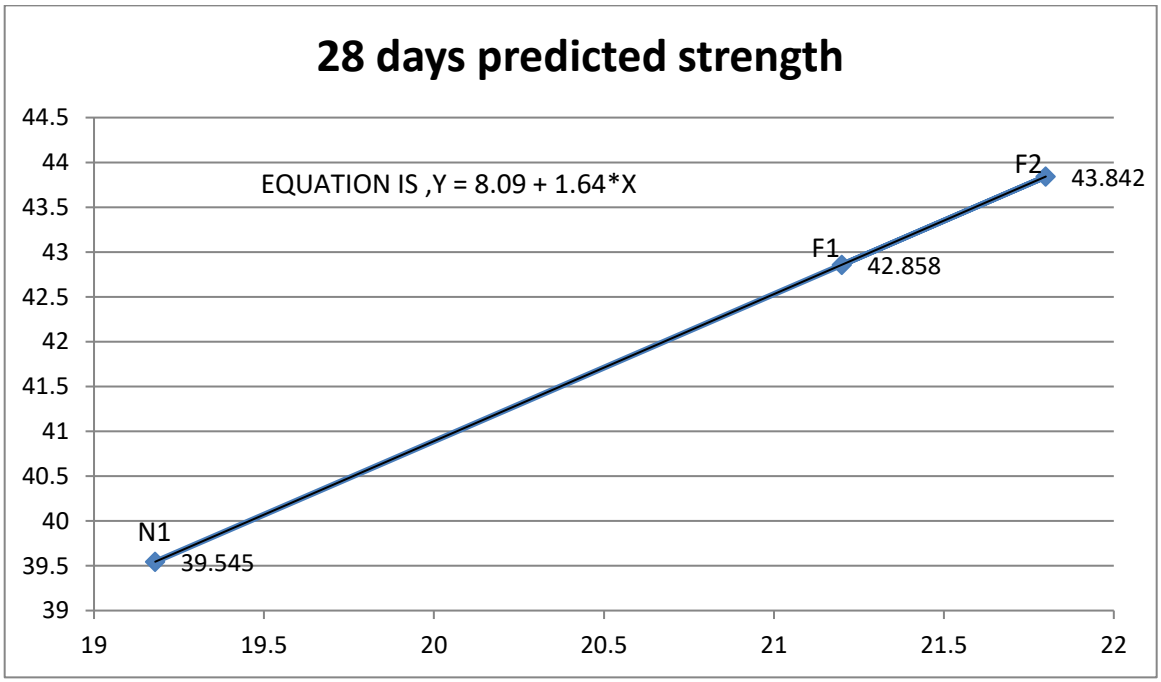
CHART-4

Trend line for the strength of different mixes



GRAPH-4

Relation between 3.5hrs cured strength and 28 days predicted strength



GRAPH-5

RELATIVITY BETWEEN 28 DAYS NORMAL CURED AND PREDICTED STRENGTH

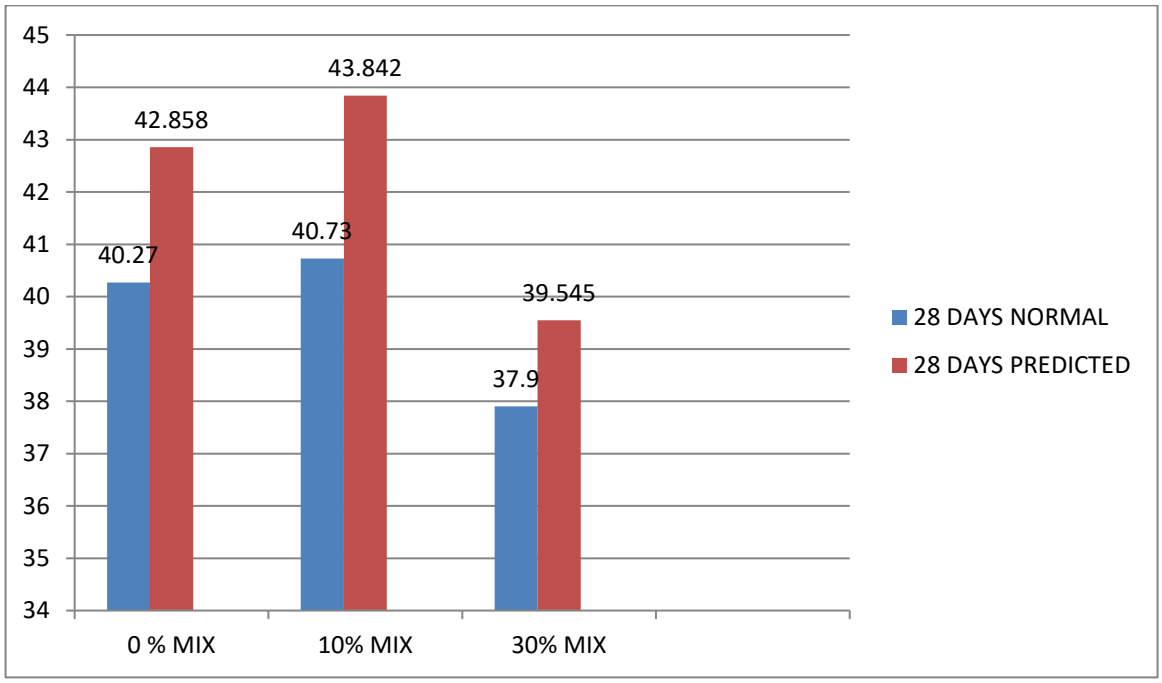
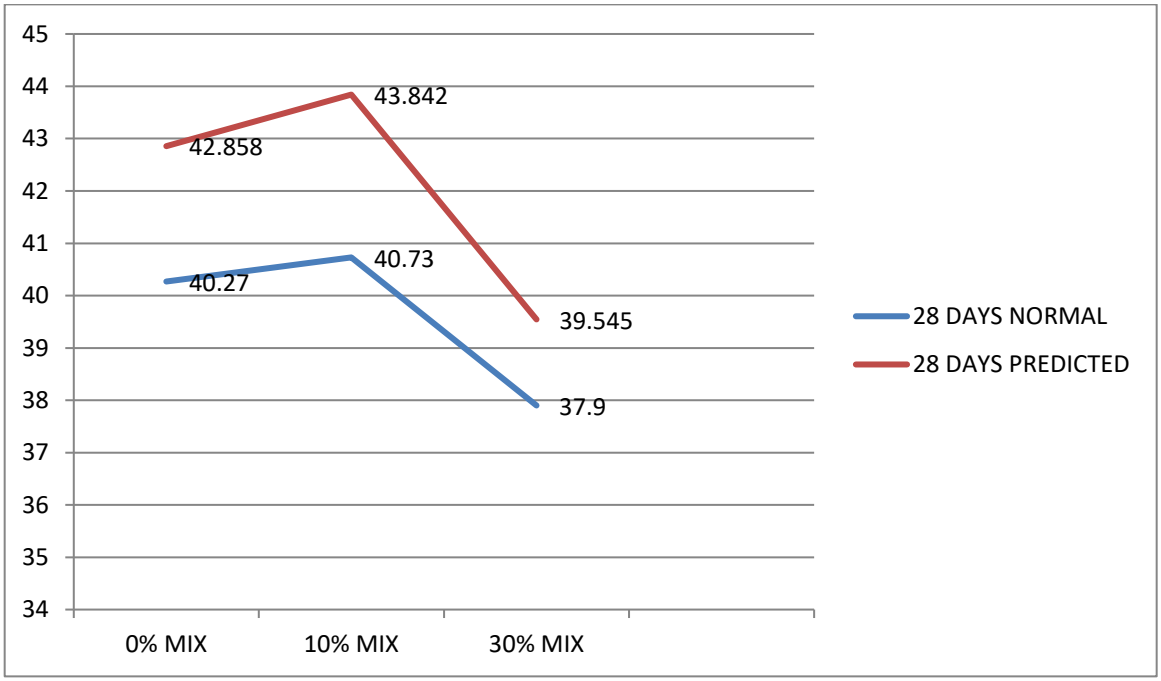


CHART-5

TRENDLINE VARIATION BETWEEN NORMAL AND PREDICTED VALUES



GRAPH-6

NOTE- Although IS code 9013-1978 suggest $R_{28} = 8.09 + 1.64*R_a$ for plain concrete only , I have tried to use the same equation for fly ash based concrete as well. The result shows almost similar different but a bit higher gap between normal cured strength and predicted strength in comparison of plain concrete.

As it can be seen from trend line graph that the predicted value of the strength is on the higher side of the normal value . so suitable care is needed to be taken for predicted the 28 days strength . In actual this variation depends on various mixes and the value of variation might change from mix to mix.

VARIATION OF NORMAL AND PREDICTED 28 DAYS STRENGTH FROM TARGET STRENGTH

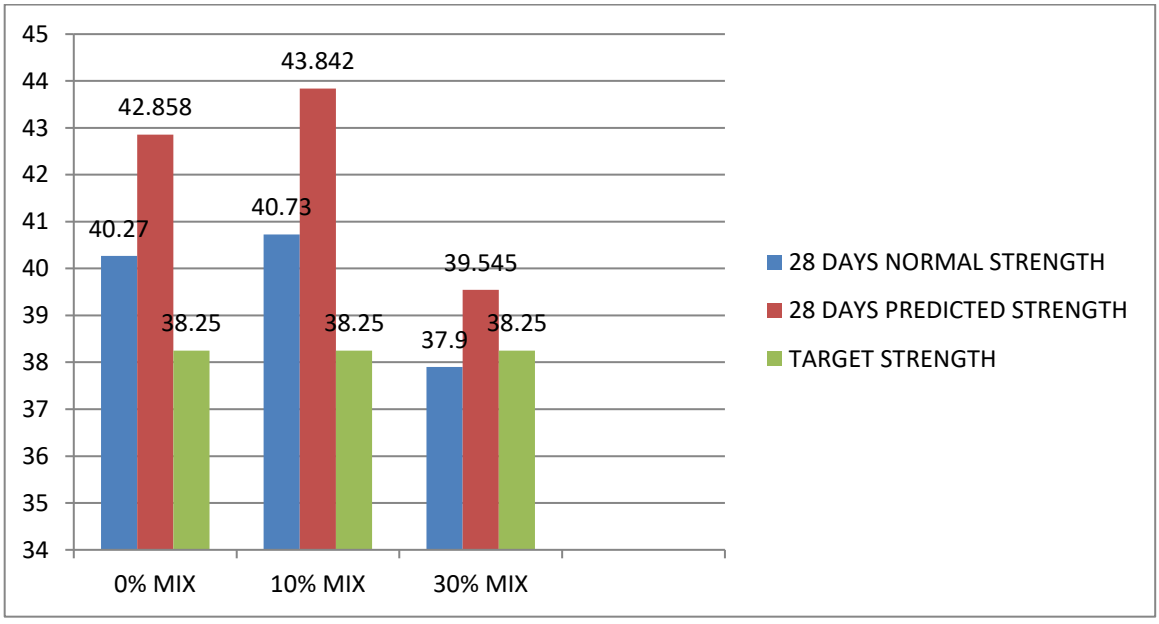
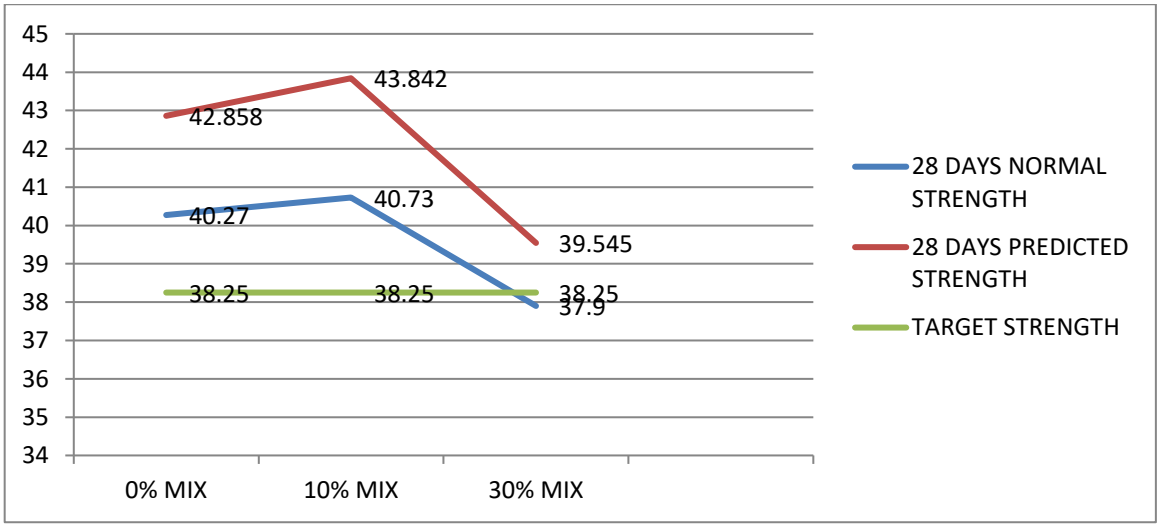


CHART-6



GRAPH-7

As it can be seen from graph-7, 0% mix and 10% mix values of normally cured concrete are higher than target mean strength and value of 30% mix is 37.9 which is a little lower than the target mean strength, but as the difference is very small so, this mix is also acceptable as m30 concrete mix.

The target mean strength's physical significance is that if we gets target mean strength in laboratory in controlled conditions then there is very high probability of getting at least characteristic strength (i.e. 30 mpa here in this case) in the field.

Various trends of strengths

1)- 2hrs strength and 7 days strength

Sr.no.	Sample name	2hrs strength	7 days strength	2hrs as % of 7 days strength
1	0%MIX	17.21	24.97	69%
2	10%MIX	18.06	25.66	70%
3	30%MIX	15.31	23.12	67%

TABLE-20

2)-3.5hrs strength and 7 days strength

Sr.no.	Sample name	3.5hrs strength	7 days strength	3.5hrs as % of 7 days strength
1	0%MIX	21.2	24.97	84.75%
2	10%MIX	21.8	25.66	84.75%
3	30%MIX	19.18	23.12	83.4%

TABLE-21

3)-2hrs strength and 28 days strength

Sr.no.	Sample name	2hrs strength	28 days strength	2hrs as % of 28 days strength
1	0%MIX	17.21	40.27	42.73%
2	10%MIX	18.06	40.73	44.2%
3	30%MIX	15.31	37.9	41%

TABLE-22

4)-3.5hrs strength and 28 days strength

Sr.no.	Sample name	3.5hrs strength	28 days strength	3.5hrs as % of 28 days strength
1	0%MIX	21.2	40.27	52.63%
2	10%MIX	21.8	40.73	53.47%
3	30%MIX	19.18	37.9	51%

TABLE-23

5)-2hrs strength and 3.5 hrs strength

Sr.no.	Sample name	2hrs strength	3.5 hrs strength	2hrs as % of 3.5hrs strength
1	0%MIX	17.21	21.2	81.2%
2	10%MIX	18.06	21.8	82.8%
3	30%MIX	15.31	19.18	80%

TABLE-24

XRD ANALYSIS

FIG-66 (Xrd machine)

Type sample for xrd sample-

-crushed sample in fine powder form was used for the test. The sample should be free from moisture i.e. completely dry sample is needed.

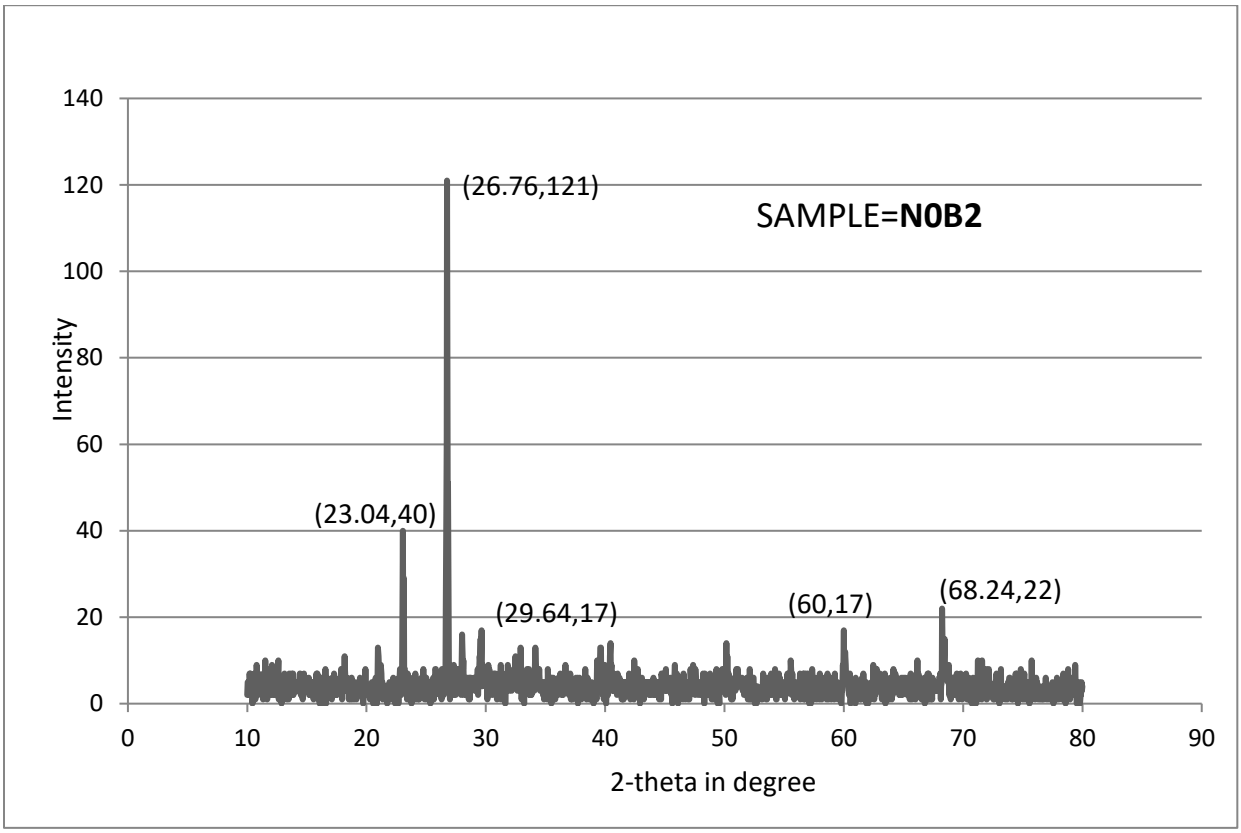
-A sample of 5 gram in weight is enough for the testing .

-utmost care must taken while crushing the sample , the sample should be crushed in such a way that no particle from the crushing material in contact come into the sample .

-no paper should be used to fill the sample or to collect the sample ,as cellulose from the paper might entrap into the sample which may alter the results.

-sample should be collected in polyethene zipper beg or in glass bottle of the required size.

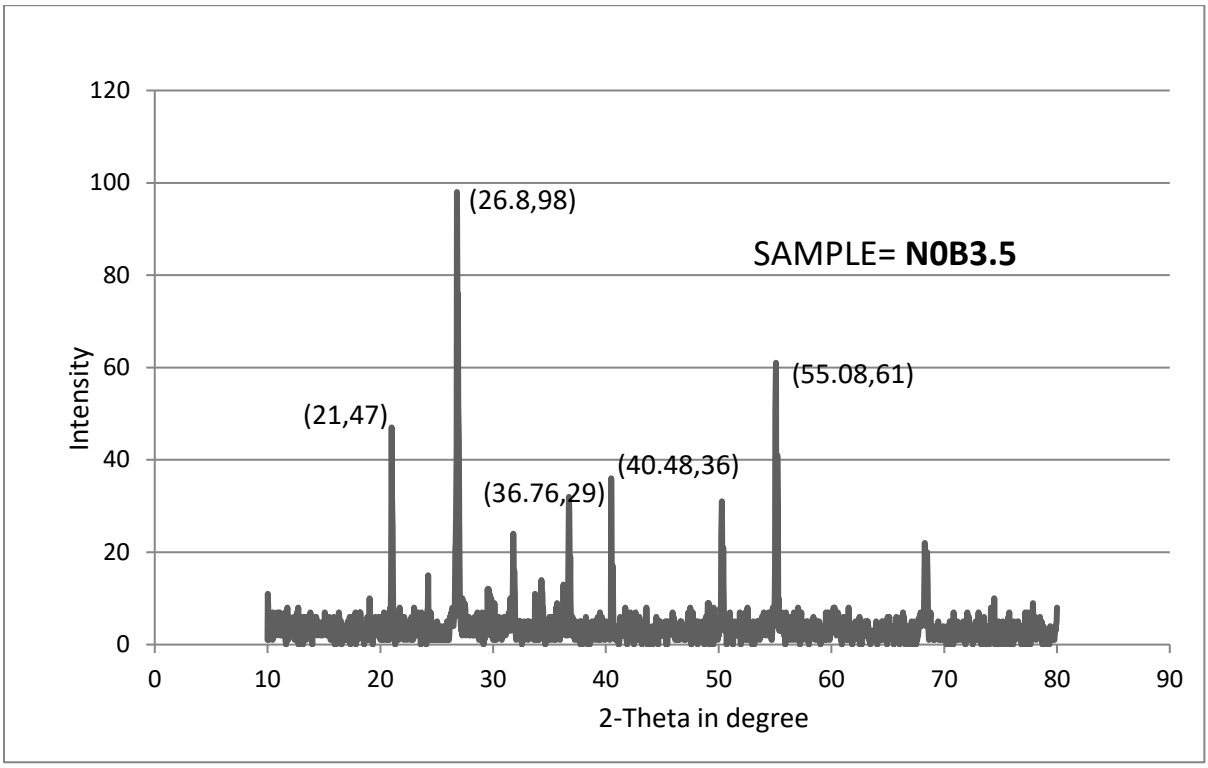
1)- XRD result of N0B2 SAMPLE



GRAPH-8

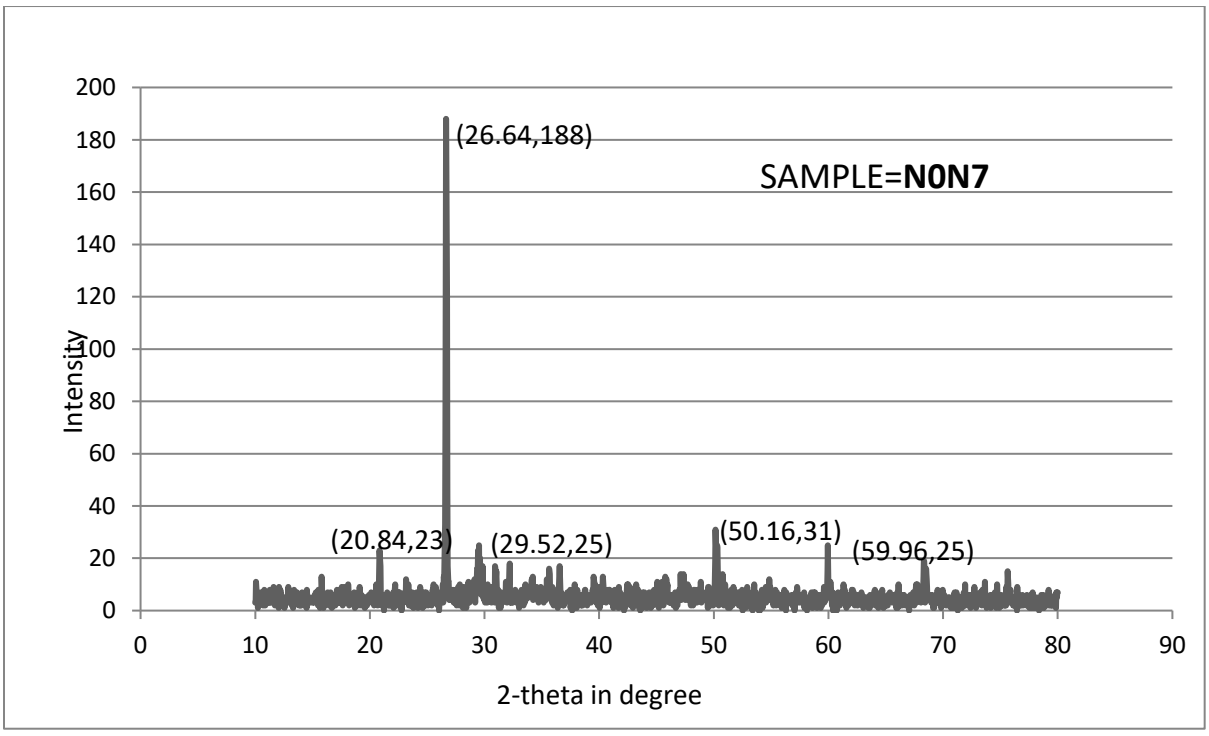
1) Sharp peaks shows that the structure of the material tested is in crystalline phase. As sharp peaks shows crystalline phase and wide broad peaks shows amorphous phase of the material.
2) This graph shows various peaks ,which is a indicator of the impurity presence in the crystalline phase. Sharp single peak shows that there are no or very less impurity in the material.
3) The base line of the graph is very noisy , this may be due to various products formed during hydration , which are not homogeneous and stable.
4) The peak for silica oxide i.e. Si (111) compound is achieved at 2-theta value of 26^0 to 28.5^0 . while peak for quartz is found near 20^0.
5) No qualitative and quantitative relation of material is done on the basis of this graph .separate software JCS database is used for xrd result analysis. We as civil engineer don't need to go that much deep. for chemical composition and materials other tests like FTIR is done.

2)- XRD result of N0B3.5 SAMPLE



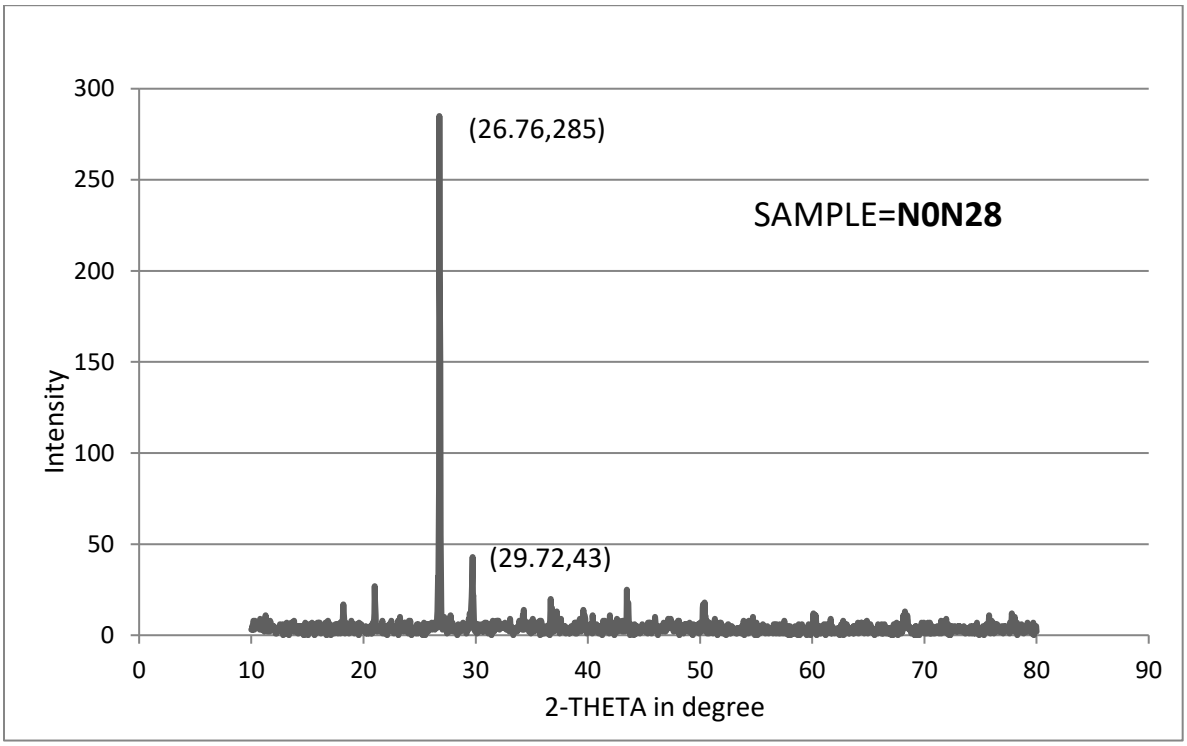
GRAPH-9

3)-XRD result of N0N7 SAMPLE



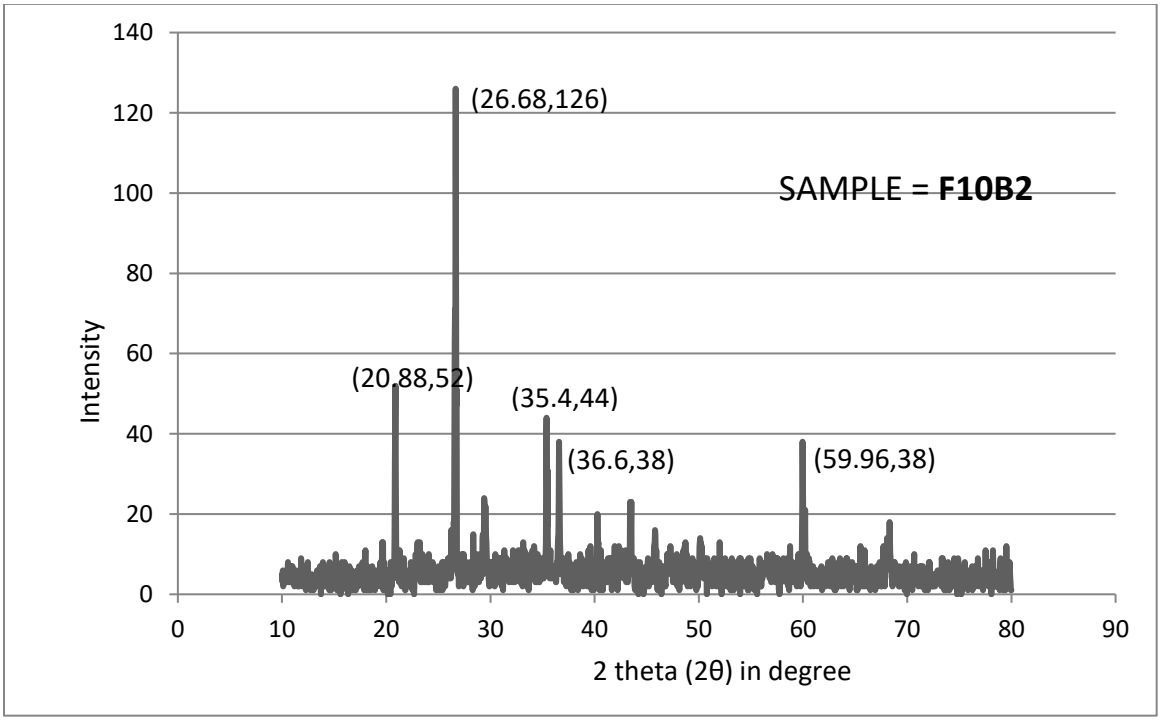
GRAPH-10

4)-XRD result of N0N28 SAMPLE



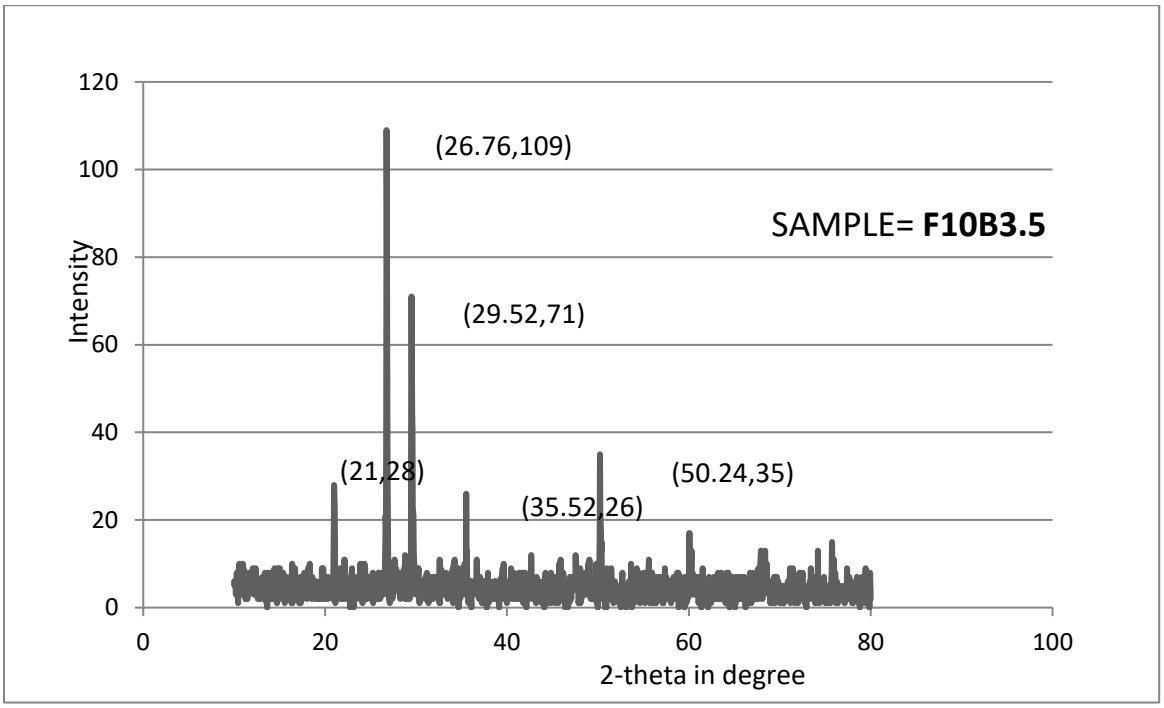
GRAPH-11

5)-XRD result of F10B2 SAMPLE



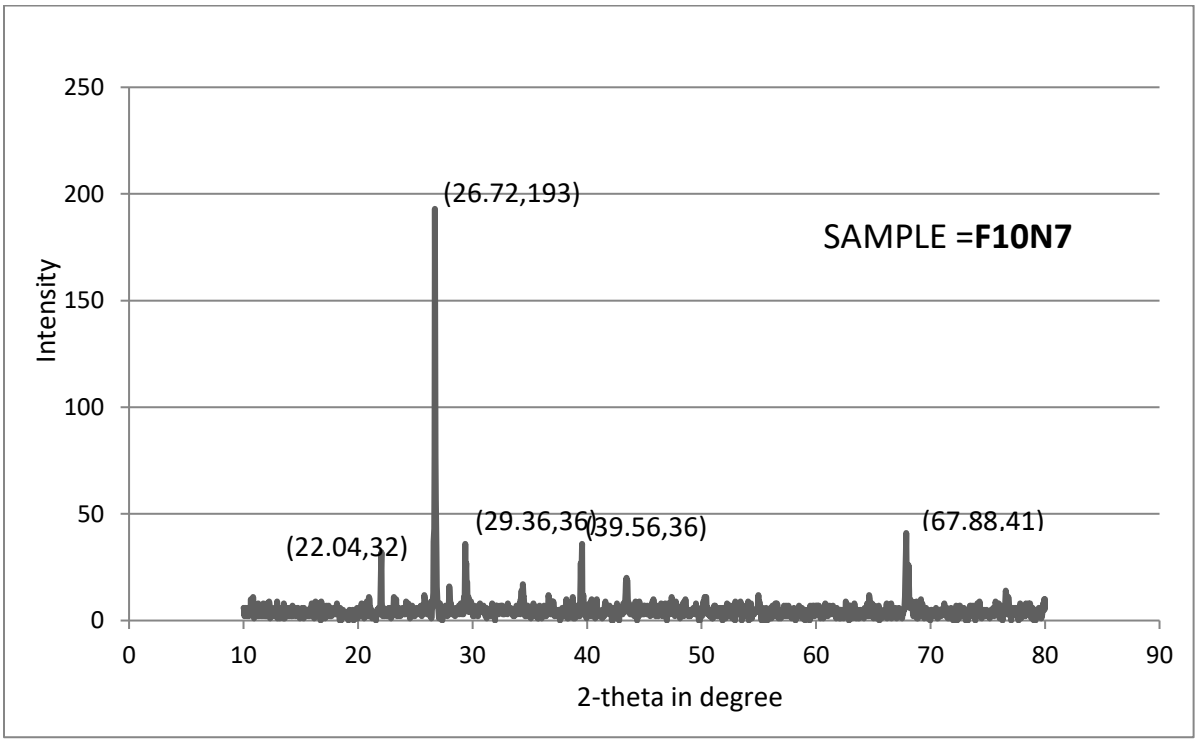
GRAPH-12

6)-XRD result of F10B3.5 SAMPLE



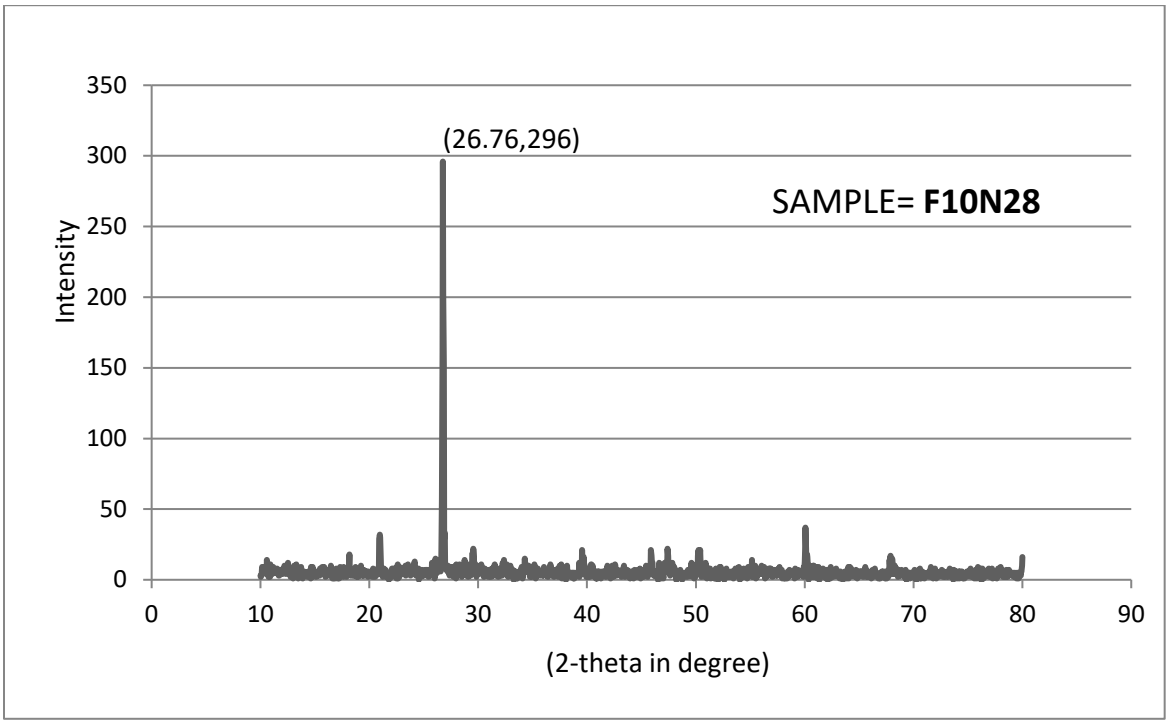
GRAPH-13

7)-XRD result of F10N7 SAMPLE



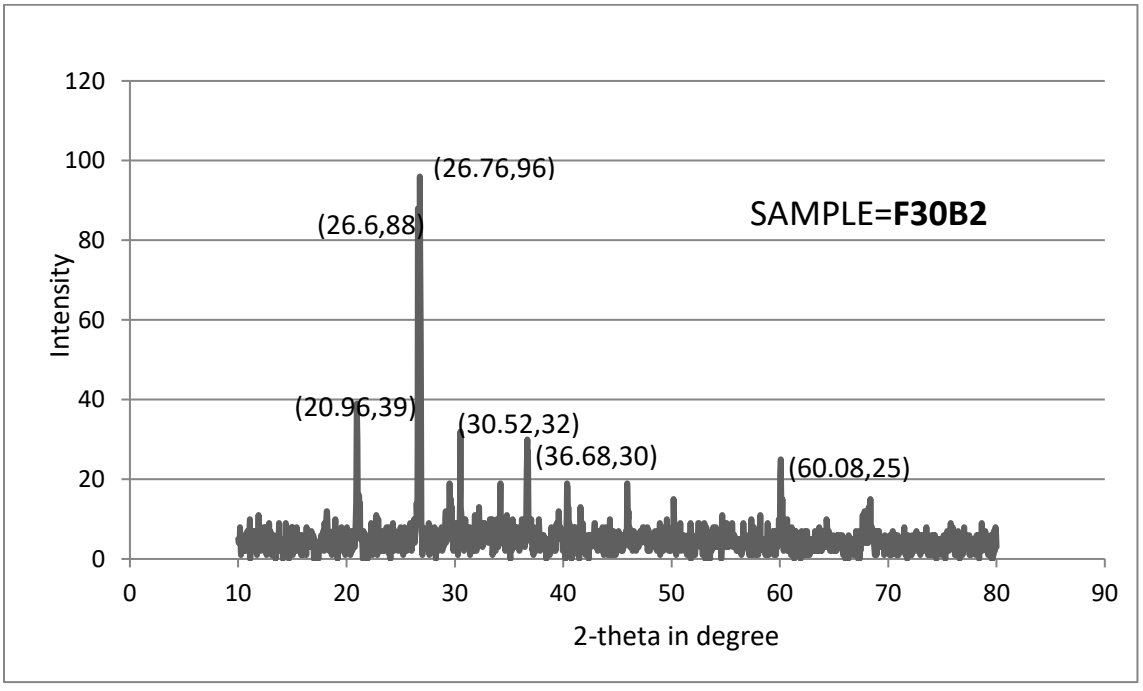
GRAPH-14

8)-XRD result of F10N28 SAMPLE



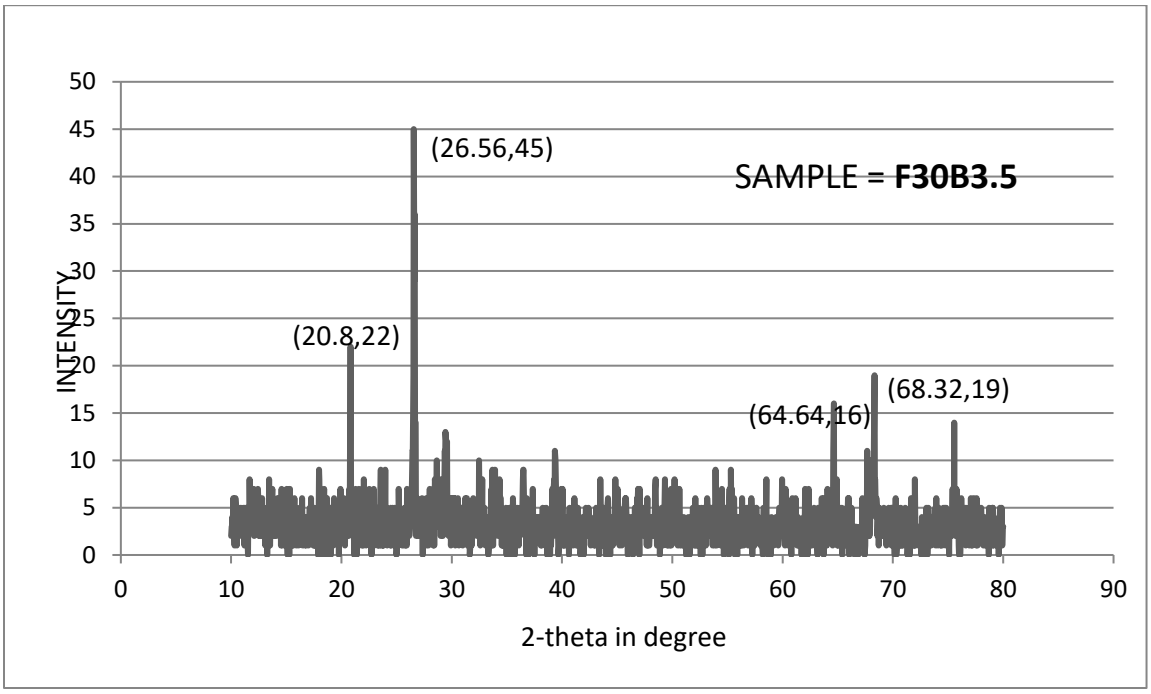
GRAPH-15

9)-XRD results of F30B2 SAMPLE



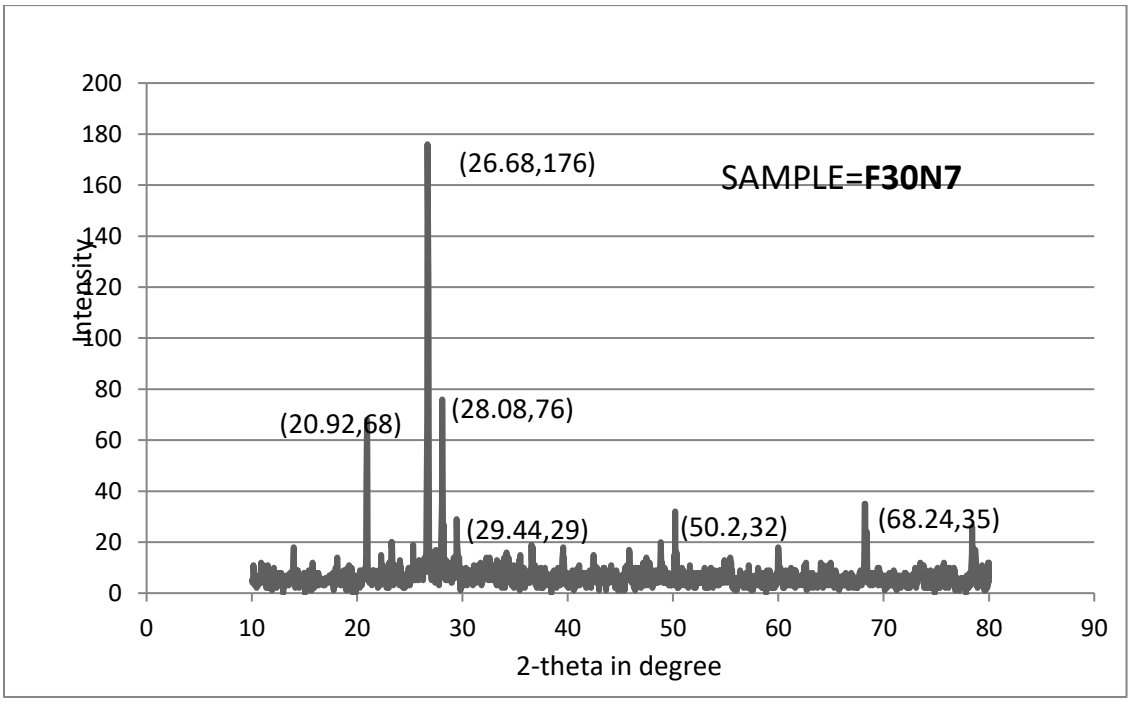
GRAPH-16

10)-XRD result of F30B3.5 SAMPLE



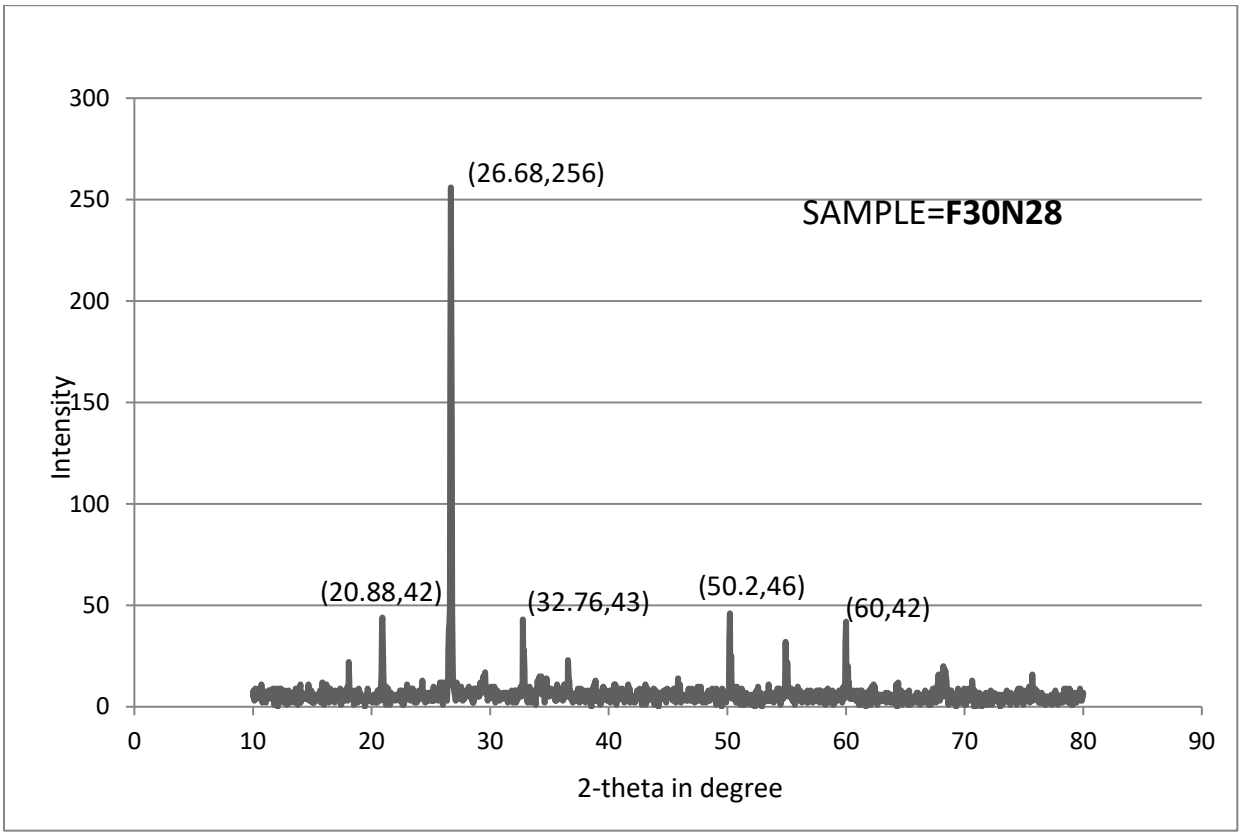
GRAPH-17

11)-XRD result of F30N7 SAMPLE



GRAPH-18

12)-XRD result of F30N28 SAMPLE



GRAPH-19

1) It is seen from the above results graphs for 28 days cured concrete have single peak . while all other graphs of lesser curing time shows various peaks .so we might conclude that at almost 99 % that is 28 days curing the impurity in the crystalline phase is gone. But no trend or direct relation can be assumed.

2) While in the other graphs it can be seen that various peaks shows that there is impurity in the crystalline phase of the structure.

3) It seen from all the graphs that peak value comes at 2-theta between 26^0 to 27.5^0 . which is the angle for silica (111) .

Peak intensity and 2-theta relation

Sr.no.	Sample name	Intensity(10^{-10} /m)	2Theta (in degree)	Descripton of peaks
1	N0B2	121	26.76	Many peaks
2	N0B3.5	98	26.8	Many peaks
3	N0N7	188	26.64	Many peaks
4	N0N28	285	26.76	Almost single
5	F10B2	126	26.68	Many peaks
6	F10B3.5	109	26.76	Many peaks
7	F10N7	193	26.72	Many peaks
8	F10N28	296	26.76	Almost single
9	F30B2	96	26.76	Many peaks
10	F30B3.5	45	26.56	Many peaks
11	F30N7	176	26.68	Many peaks
12	F30N28	256	26.68	Almost single

TABLE-25

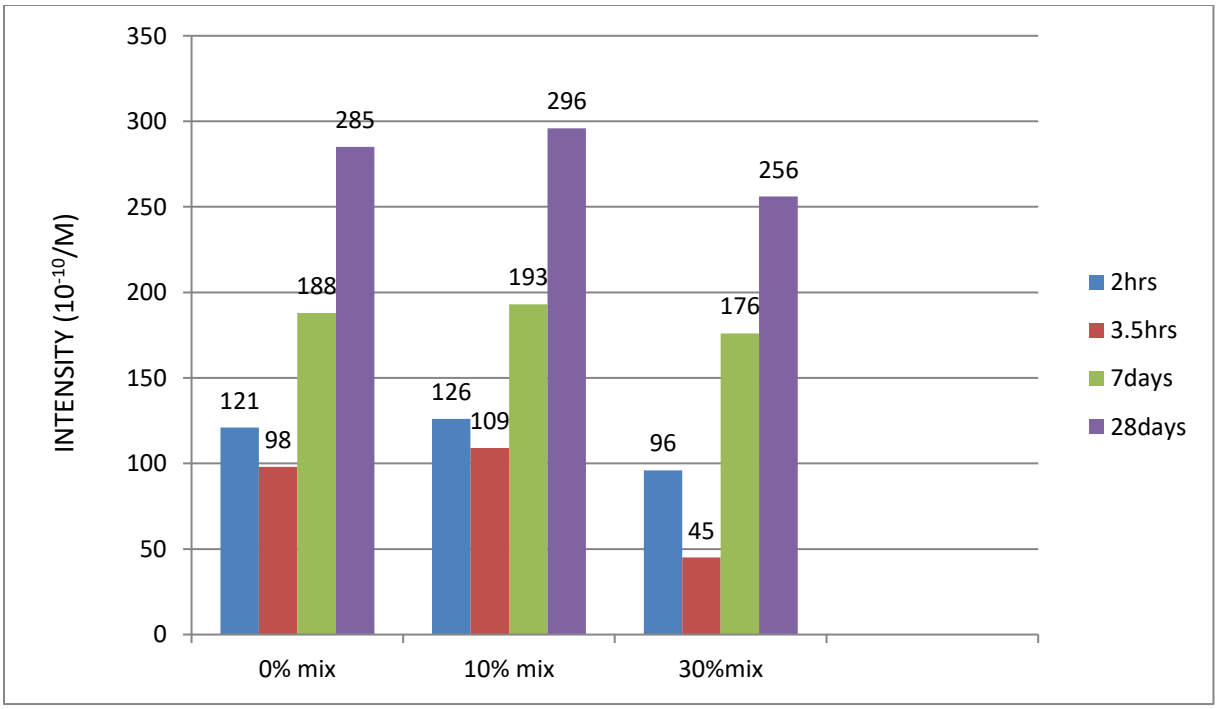
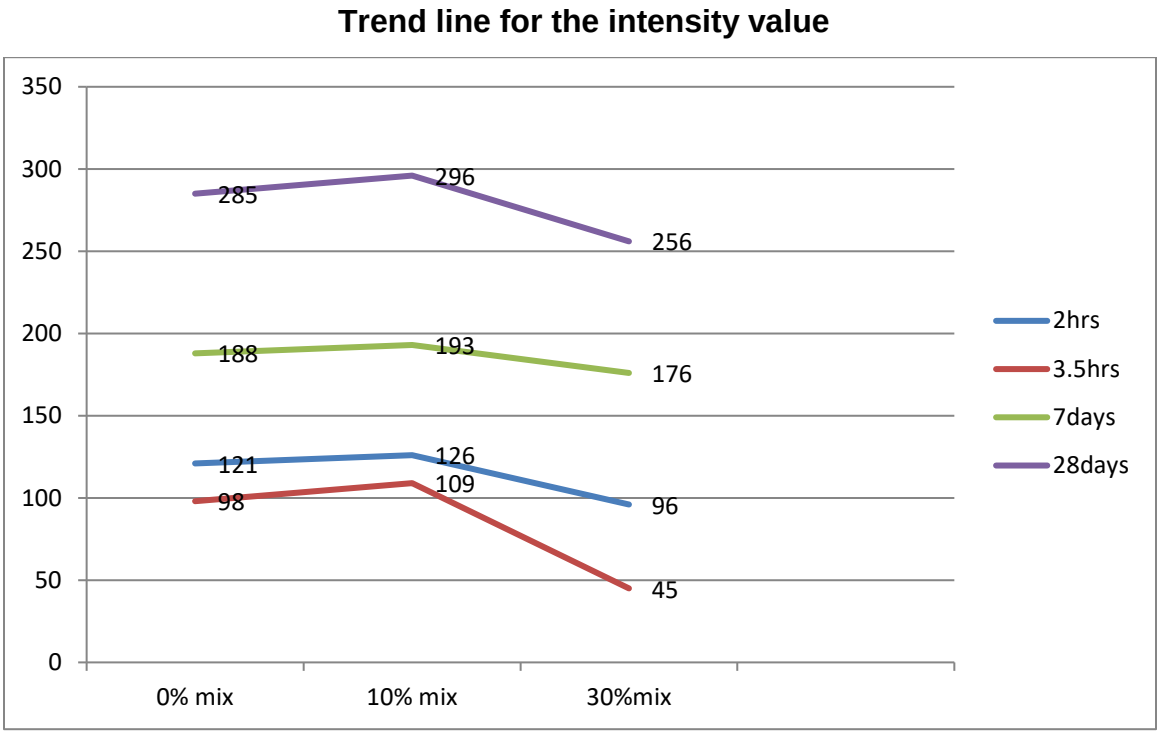


CHART-7



GRAPH-20

- Although the trendline for the peaks of intensity is quite similar to the compressive strength trendline , but they should never be related in this way . also their is no direct co relation in them.

CONCLUSIONS

1) Use of boiling water curing for predicting the strength of plain and fly ash concrete may be successfully made.
2) Relationship between the strength of different types of mixes and curing durations in ordinary water curing and boiling water curing seems to be related.
3) Graph for plain concrete and concrete with fly ash shows various peaks, many of which are found to be at nearly same 2-theta angle.
4) Strength development as per time duration of both in ordinary curing and boiling water curing are found on the expected lines.
5) It has been found that some fly ash mixes may give better strength at a particular time and in a particular curing environment. It seems to be due to pozzolanic action imparted by fly ash.

REFERENCES

IS CODES

1) IS 456 :2000 and IS 10262 : 2009 (IS 10262 :2019) are being used for mix design calculations and various data.
2) IS 2386 PART 3 :1963 are being used for tests of specific gravity on aggregates.
3) IS 4031 PART 11 :1988 are being used for specific gravity test on cement.
4) IS 9013 : 1978 are being used for methods of making cube and boiling water curing method of concrete .
5) IS 516 : 1959 are being used for compressive strength testing of the cubes .

BOOK

1) ms shetty (concrete techonology) are being used to study about materials.

RESEARCH PAPERS

Around 20 different papers were studied for this work and are reviewed in the literature review. Their details and conclusion are already added in the literature review.

___THE END