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EXPERIMENTAL INVESTIGATIONS ON TERNARY BLENDEDCONCRETE

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ABSTRACT

The paper is focused on the evaluation of the effect of concrete long-term maturity with respect to chloride ion ingress related durability. The binary and ternary high performance concrete mixtures have been analyzed. Many admixtures can be used for a ternary concrete, among which Fly ash, Silica fume and Recron fiber is used. Replacement of cement has been done by Fly ash and silica fume in various percentages. The optimum percentage for replacement of Fly ash and Silica fume with cement on the Durability properties of Ternary blended concrete and Expansion behavior of Ternary blended concrete exposed to various sulphate environments has been studied. The results show that addition of recron fibers along with flyash is more suited.

Keywords*: Ternary blended concrete, Recron Fiber, Silica fume, Flyash.*

I. INTRODUCTION

The major reason for choosing Ternary blend is Particle packing. In the case of fly ash, the particle is often finer that the cement, this means that the small silica fume particles can perform better in particle packing since the intermediate particle space, slightly smaller than cement, is filled by the fly ash. The chemical binding of chlorides by fly ash due to its content of aluminum works together with the pore refinement due to silica fume to give excellent performance in a chloride environment. Due to low reaction rate, fly ash has often been used in HPC to reduce the heat of hydration and will also give good flow in fresh concrete. However, this gives a problem in fly ash concrete is the early age, what to do until the fly ash has hydrated sufficiently to have strength and to protect against aggressive. In a triple blend, the silica fume takes care of properties in the early age, while fly ash adds its contribution at later ages.

It means micro silica or other cement replacement additives are to be used with OPC only. That is not strictly true and ternary mixtures comprise efficient -systems. The primary incentive of adding limited amount micro silica –for example 6 percent with fly-ash cement mixes was to ensure high early strength research has however, shown that ternary mixtures of OPC, micro silica and fly-ash result in synergic action to improve the micro structure and performance of concrete. When both micro silica and fly-ash are used, the resultant enhancement of strength or Pozzolanic activity was greater than super position of contributions of each, for the respective proportions. Such synergic effect results from strengthening the weak transition zone in aggregate cement interface, as well as segmentation and blocking of pores.
Depending upon the service environment in which it is to operate, the concrete structure may have to encounter different load and exposure regimes. In order to satisfy the performance requirements, different ternary compounds required. Such as cement, flyash, micro silica. Greater varieties are introduced by the corporation of additives like pozzolana, granulated slag are inert fillers this leads to different specifications of cements in national or international.

The main intention of this study was to reduce the deterioration rate of concrete when subjected to sulphate attack which examined the effect of fly ash, silica fume addition rate on durability and residual compressive strength. A major focus of this continued research is the development and characterization of silica fume & fly ash ternary-blended concrete.

The scope of present investigation is to study and evaluate the effect of replacement of cement by various percentages of silica fume (0, 6, 8, and 10) and fly ash (0, 15, 20, and 25) along with recron 3sfibres [0.2%] for water cement ratio 0.46 and to produce Ternary Blended Concrete. Cubes are cured at 28 days and are soaked in 5% Na2So4 and 5% MgSo4 solution for a period of 90 days and tested for residual compressive strength and weight loss.

In the present investigation M30 grade of concrete has been consider. Mix of concrete is designed by IS code method.

II. MATERIALS USED

Cement: Ordinary Portland cement (Ultra tech cement) of 53 grade confirming to IS: 12269-1987 was used. It was tested for its physical properties as per IS 4031 (part II)-1988 and chemical properties as per IS: 12269 at lucid laboratories, Hyderabad. The details of test results are given in Table 2.1

Table 2.1 Properties of Cement

S.NO.	Property	Test Result
1	Specific Gravity	3.51
2	Initial Setting time	40 Min
3	Normal Consistency	32%
4	Fineness	7%

Fine Aggregate: The locally available sand is used as fine aggregate in the present investigation. The sand is free from clayey matter, salt and organic impurities. The sand is tested for various properties like specific gravity, bulk density etc., and in accordance with IS 2386-1963[12]. The fine aggregate is conforming to standard specifications. The details of test results are given in Table 2.2

Coarse Aggregate: Machine crushed angular granite metal of 20mm nominal size from the local source is used as coarse aggregate. It is free from impurities such as dust, clay particles and organic matter etc. The physical properties of coarse aggregate were investigated in accordance with IS 2386 -1963[12]. The details of test results are given in Table 2.3.

Table 2.2 Properties of Fine aggregates

S.No.	***Property***	**Test Method**	**Test Results**
1	Fineness modulus	Sieve analysis (IS 2386-1963 Part 2)	2.49
2	Specific gravity	Pycnometer (IS 2386-1963 Part 3)	2.60
3	Bulk density (kg/m^3) - Loose Bulk density (kg/m^3) - Dense	(IS 2386-1963 Part 3)	1500 1633

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Table 2.3 Properties of Coarse aggregates

S.No.	*Property*	Test Method	Value
1	Fineness modulus	Sieve analysis (IS 2386-1963 Part 2)	7.7
2	Specific gravity	Pycnometer (IS 2386-1963 Part 3)	2.65
3	Bulk density (kg/m^3) - Loose Bulk density (kg/m^3) - Dense	(IS 2386-1963 Part 3)	1366 1513

Fly Ash: The fly ash obtained from Hyderabad Industries, Andhra Pradesh is used in the present experimental work. Details of test results are present in Table 2.4. The chemical composition of Flyash is rich in silica content which react with calcium hydroxide to form C-S-H gel. This gel is responsible for the strength mortar or concrete.

Table 2.4 Properties of Flyash

S.No.	Characteristics	Requirement As per IS:3812-1981
1	Silica, SiO_2	35%
2	Alumina, Al_2O_3	70%
3	Iron Oxide, Fe_2O_3	1.5%
4	Lime, CaO	5%
5	Magnesia, MgO	0.3-2.6
6	Sulphur Trioxide, SO_3	1.50%
7	Loss on ignition	12%
8	Specific gravity	2.5

Micro Silica: Micro Silica was tested for its physical properties as per IS: 4031 (Part 2)-1999 at lucid laboratories balanagar, Hyderabad.. The addition of silica fume (approximately 95% SiO2) to a Portland cement results in enhanced formation of C-S-H at the expense of $Ca(OH)_2$. If the addition is high enough, $Ca(OH)_2$ may be completely used up and the C-S-H is then progressively decalcified (i.e. lowering of Ca/Si molar ratio in the C-S-H). However, the addition of silica fume is normally not larger than 5-10 mass % to anhydrous cement, which is normally insufficient to remove all of the $Ca(OH)_2$. If $Ca(OH)_2$ is present as a stable phase in hydrated paste.

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Fibre: Recronfibre was used in the present investigation Recronfibre manufactured by Reliance Industries Limited the properties of fibre are given in Table 3.9 confirming to ASTM A820 STANDARD.

Table 2.6 Properties of Recron fiber

Densier	1.5d
Cut length	6mm,12mm,24mm
Tensile strength	About 6000 kg/cm^2
Melting point	>250^{0}C
Dispersion	Excellent
Acid resistance	Excellent
Alkali resistance	Good

Sulphates: Sodium sulphate (Na_2SO_4) of molecular weight 142.04,pH for 5% solution in water is 6.2, specific gravity 2.68 and Magnesium Sulphate ($MgSO_4$) of molecular weight 142.04, pH for 5% solution in water 6.5, specific gravity 1.12

III. EXPERIMENTAL PROGRAM & RESULTS

Results obtained from experimental investigation to study the Durability properties of Ternary blended concrete mixes in which Cement is replaced by Flyash and Silicafume at various percentages are presented here for discussion they are compared with the plain concrete. The study was conducted to find out the influence of Flyash and Silicafume on Durability Properties i.e; Sulphate resistance of ternary blended recron fiber reinforced concrete.

Sulphate attack on ordinary Portland cement matrix is generally characterized by sulphate ions with cement hydration products, which causes expansion, cracking and spalling as well as loss of mass and strength. Various studies to minimize the attack and prolong the service life of concrete structures exposed to sulphate environments have been carried out.

The effects of following parameters were studied.

- The partial replacement of cement by silica fume and Flyash in different percentages on 28 days compressive strength.
- The optimum percentage replacement of Flyash and Silicafume with cement on the Durability properties of Ternary blended concrete.
- Expansion behavior of Ternary blended concrete exposed to various sulphate environment.

Comparison of Compressive Strength:

Table 3.1 Residual Compressive Strength Corresponding to 15% Fly Ash

Period Of Immersion	**% of Silica fume**	**Water curing MPa**	**5% Na2So4 Sol MPa**	**5% MgSo4 Sol MPa**	**% loss of strength Na_2So_4**	**% loss of strength $MgSo_4$**
28 Days	OPC	39.1	-	-		
	SF 6	34.55	-	-		

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	SF 8	46.6	-	-		
	SF 10	38.06	-	-		
90Days	OPC	44.2	41.1	40.8	7 %	8%
	SF 6	38.9	37.9	37.1	3 %	5 %
	SF 8	48	47.2	46.9	2 %	3 %
	SF 10	41.8	40.2	39.9	4 %	5%

From the above table it was observed that the addition of silicafumeincreased compressive strength of ternary blended mix up to 10% when compared to control mix.Also it was observed that the percentage loss of strength decreased considerably in case of mix with 8% silicafume and 15% flyash.

- The increase in strength by addition of silicafume is due to the fact that silicafume makes the concrete more denser thus increasing its compressive strength, as well as making it more durable by decreasing its permeability.

Table 3.2 Residual Compressive Strength Corresponding to 20% Fly Ash

Period Of Immersion	% of Silica fume	Water curing MPa	5% Na_2So_4 Sol MPa	5% $MgSo_4$ Sol MPa	% loss of strength Na_2So_4	% loss of strength $MgSo_4$
28 Days	OPC	39.1	-	-		
	SF 6	37.6	-	-		
	SF 8	44.13	-	-		
	SF 10	38.03	-	-		
90Days	OPC	44.2	41.1	40.8	7 %	8%
	SF 6	50.7	49.2	48.8	3 %	4 %
	SF 8	52.8	51.9	51	2 %	4 %
	SF 10	51.1	47.4	46.1	8 %	10%

- From the above table it was observed that the addition of silicafume increased compressive strength of ternary blended mix up to 20% when compared to control mix.Also it was observed that the percentage loss of strength decreased considerably even in this case of mix with 8% silicafume and 20% flyash .

Table 3.3 ResidualCompressive Strength Corresponding to 25% Fly Ash

Period Of Immersion	% of Silica fume	Water curing MPa	5% Na2So4 Sol MPa	5% MgSo4 Sol MPa	% loss of strength Na_2So_4	% loss of strength $MgSo_4$
28 Days	OPC	39.1	-	-		
	SF 6	35.0	-	-		
	SF 8	35.6	-	-		
	SF 10	34.73	-	-		
90Days	OPC	44.2	41.1	40.8	7 %	8%
	SF 6	38.05	37.3	37	3 %	4 %
	SF 8	49.9	48.9	48	2 %	4 %
	SF 10	45.8	44.8	43.9	24 %	5%

- From the above table it was observed that the addition of silicafumeincreased compressive strength of ternary blended mix up to 12% when compared to control mix. Also it was observed that the percentage loss of strength decreased considerably in case of mix with 8% silicafume and 25% flyash .
- Considering the above values, the following graphs were ploted to get an idea about the optimum percentages of silicafume and flyash.

Residual Compressive Strength

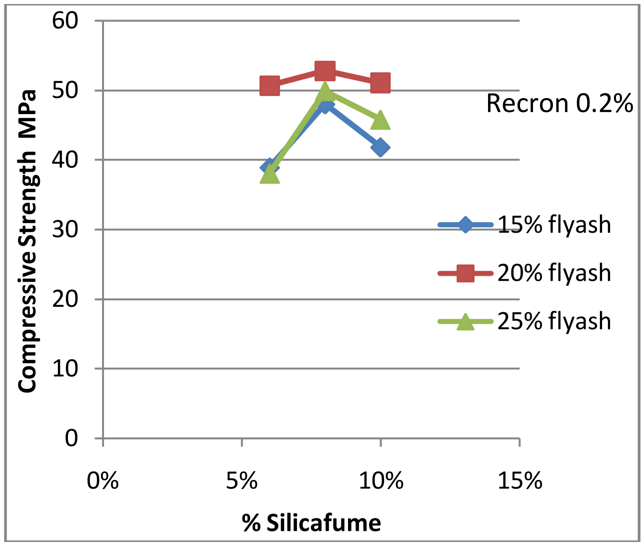

Figure- 1Residual Compressive Strength corresponding of specimens in water curing at 90 days

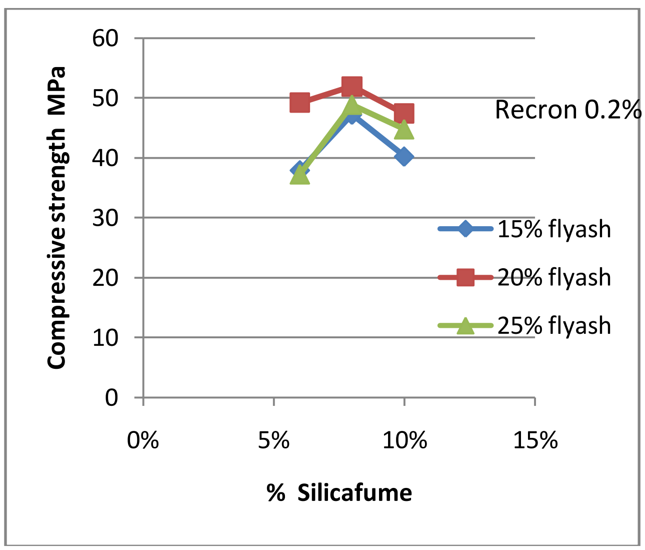

Figure-2 Residual Compressive Strength corresponding of specimens in Na_2So_4 Solution at 90 days

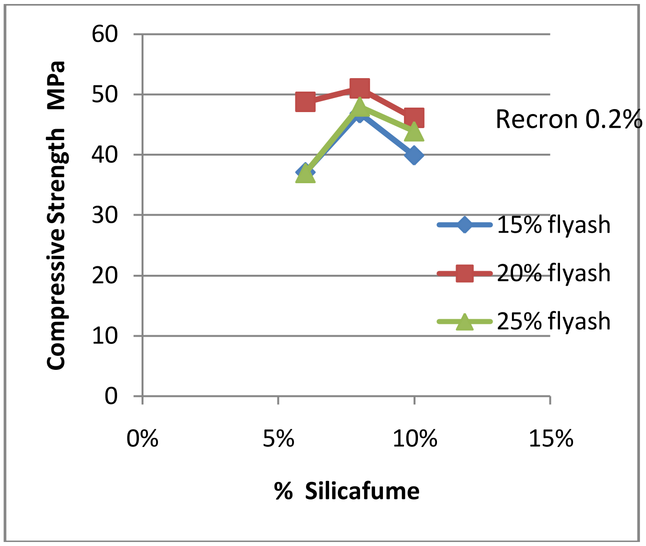

Figure-3 Residual Compressive Strength corresponding of specimens in $MgSo_4$ Solution at 90 days

- Fig-1, 2,3 shows the variation of silica fume on x-axis and the compressive strength variation of the ternary blended concrete subjected to various environments. While the strengths of the specimens in pure water increases with time.
-

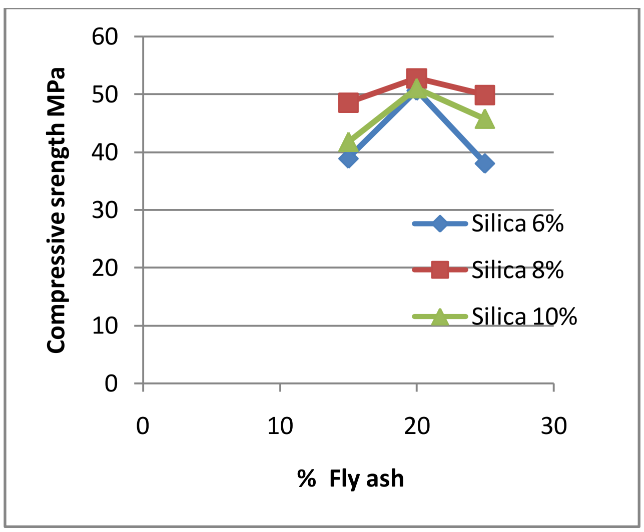

Figure-4Residual Compressive Strength corresponding of specimens in water curing at 90 days

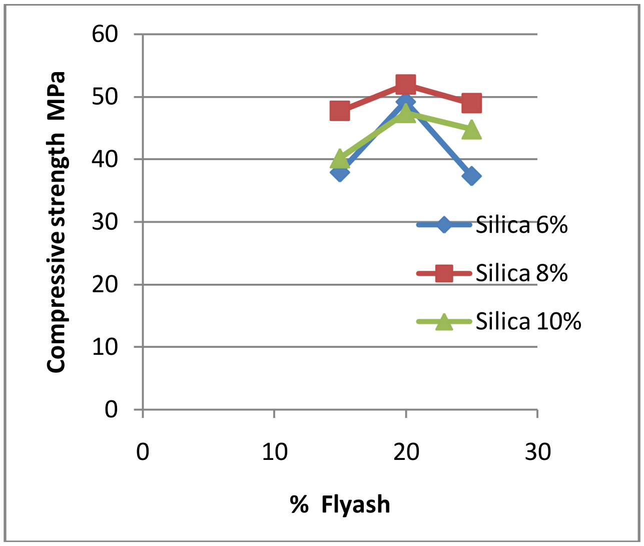

Figure-5Residual Compressive Strength corresponding of specimens in Na_2So_4 Solution at 90 days

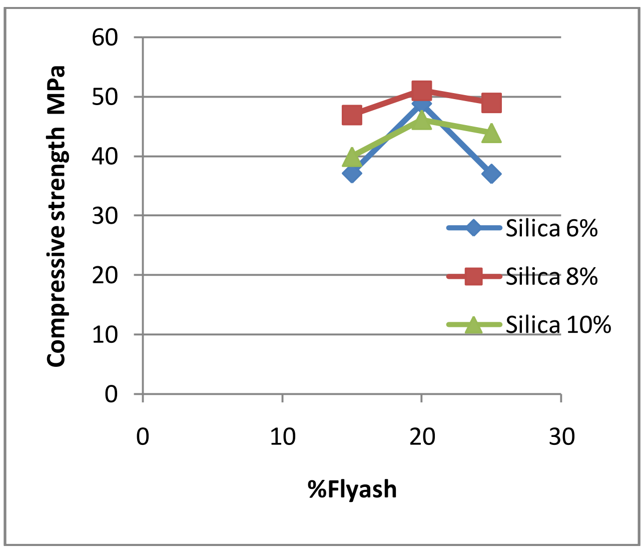

Figure-6Residual Compressive Strength corresponding of specimens in $MgSo_4$ Solution at 90 days

- Fig-4,5,6 shows the variation of Flyash on x-axis and the compressive strength variation of the ternary blended concrete subjected to various environments.
- It was found that at 20% flyashand 8% silicafume the compressive strength obtain was 52.8 MPa(Fig-4). It was found to be the optimum mix out of all the mixes.

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Figure 7Cubes Immersed in Sulphate Solution for 90 days

IV. CONCLUSIONS

Laboratory tests were performed to determine the deterioration induced by the chemical attack of magnesium sulphate and sodium sulphate on Ternary blended concrete. The results of the test are as follows:

- Optimum percentage of silicafume and fly ash as partial replacement of cement was found to be 8% and 20% respectively.
- The loss in compressive strength in $MgSo_4$ exposed concrete was more when compared toNa_2So_4 .In the case of optimum mix, the percentage loss in strength for $MgSo_4$ specimens was 2% percent more when compared to Na_2So_4.This due to the fact that $MgSo_4$reacts with C-S-H gel to form M-S-H gel which results in destruction of the cement bond.
- The Ternary blended concrete specimens immersed in Sulphate solution for 90 days have not shown any major change in weight loss.
- Addition of Recron fiber indicated a marginal increase in compressive strength, as well as decrease in percentage loss of compressive strength when exposed to Sulphate environment.
- Addition of Recron fiber and fly ash reduce the unit weight.
- The Recron fiber decreases the workability of concrete, while addition of Flyash improves workability.
- From the visual examination it was observed that the specimen subjected to sulphate attack showed Salt crystallization and also degree of deterioration was moderate, because the duration of sulphate attack was not enough for the attack of salts on concrete.

REFERENCES

1. *E. Rozière, A. Loukili , R. El Hachem, F. Grondin,(2009)"Durability of concrete exposed to leaching and external sulphate attacks."Research Institute of Civil Engineering and Mechanics (GeM), UMR-CNRS 6183, EcoleCentrale de Nantes, France. Cement and Concrete Research, vol. 39, pp:1188–1198.*
2. *Na Jin, B. E.(2010)"Fly Ash Applicability in Pervious Concrete" Graduate School of the Ohio State University;pp: 835-848.*
3. *Mansur Sumer,(2012)"Compressive strength and sulphate resistance properties of concretes containing Class F and Class C fly ashes."Sakarya University, Civil Engineering Dept, Sakarya, Turkey."Construction and Building Materials,vol 34, pp:531–536.*

4. *Jelica Zeli, Ivana Radovanovi, Dra`an Jozi, (2007)"the effect of silica fume additions on the durability of portland cement mortars exposed to magnesium sulphate attack." Faculty of Chemical Technology, University of Split, Teslina 10/5, HR-21 000 Split, Croatia jelica.zelic, pp 1580-2949*
5. *Chiara F. Ferraris, Paul E. Stutzman, and Kenneth A. Snyder, (2006)"Sulphate Resistance ofConcrete."PCA R&D Serial No. 2486.*
6. *C.Plowman and J. G. Cabrera,(1996)"The use of fly ash to improve the sulphate resistance of concrete."University of Leeds, Department of Civil Engineering, Leeds LS2 9JT, U.K.,Vol.16 No's 1-3, pp. 145-149.*
7. *BehrouzMohebimoghaddam, (2006)"The effects of sulphate solution on the behaviour ofreinforced concrete beams."Department of Civil Engineering, Islamshahr Azad UniversityDivision of Retrofitting of Existing Structures in National Land and Housing Organization Tehran, Iran. Electronic Journal of Structural Engineering,vol 6,pp: 339-345.*
8. *D. MARUTHACHALAM, (2012)"Studies Of Durability AspectsOf Fibre Reinforced Concrete."Assistant Professor, Department of Civil Engineering, Sri Krishna College of TechnologyCoimbatore,ISSN: 0975-5462.*
9. *Javed I. Bhatty and Peter C. Taylor,(2006)"Sulphate Resistance of Concrete Using Blended Cements or Supplementary Cementitious Materials."Portland Cement Association,Skokie, Illinois.PCA R&D Serial No. 2916a.*
10. *M.D.A. Thomasa,, M.H. Shehataa, S.G. Shashiprakasha,(1999)"Use of ternary cementitious systems containing silica fume andfly ash in concrete" a Department of Civil Engineering, University of Toronto, 35 St. George St., Toronto, Ontario, M5S 1A4, Canada bLafarge Canada Inc., Richmond Hill, Ontario L4B 3K3,pp: 1207-1214.*
11. *IS 12269-1987"Specifications for 53 Grade Ordinary Portland Cement", Bureau of Indian Standards, New Delhi.*
12. *IS 2386-1963"Method of Test for Aggregate for Concrete", Bureau of Indian Standards, New Delhi.*
13. *IS 456-2000"Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards New Delhi.*
14. *IS 516-1959"Method of Tests for Strength of Concreteb", Bureau of Indian Standards, New Delhi.*
15. *IS 383-1970"Specifications for Coarse and Fine Aggregate from Natural Source of concrete", Bureau of Indian Standards New Delhi.*
16. *IS 15388-2003"Micro Silica – Specifications", Bureau of Indian Standards, New Delhi.*
17. *IS 10262-1982"Recommended Guidelines for Concrete Mix Design", Bureau of Indian Standards, New Delhi.*
18. *S.T. Lee, H.Y. Moon, R.N. Swamy,(2005)"Sulphate attack and role of silica fume in resisting strength loss" Department of Civil Engineering, University of Toronto, 35 St. George St, Toronto, ON, Canada M5S 1A4, Cement & Concrete Composites ,vol 27, pp: 65–76*
19. *M.L.Gambhir "Concrete Technology", Third Edition TATA Mc. Graw. Hill Publishing Co. Ltd.*
20. *M.S. Shetty "Advanced Concrete Technology" Third Edition, S.Chand & Co. Ltd., New Delhi, 1992*