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An Experimental Study on Effect of Acid Attack & Mechanical & Durable Properties on Concrete with Different Admixtures

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ABSTRACT: Acidic attack represents a topic of increasing significance, owing to the spread of damages of concrete structures in both urban and industrial areas. Type of cement being used in the structure is an important factor affecting performance of cement constituents in an aggressive environment. The goal of this study is to compare the acidic resistance of ordinary Portland cement with different admixtures as part of constituents. The admixtures used are silica fume, fly ash, blast furnace slag and metakaolin. Standard procedures are employed to assess the performance of admixture cements with different organic and mineral acids. Compressive strength, Tensile strength, Rapid Chloride Permeability, Water absorption, tests are to be adopted as indicators under curing of 7, 14, 28, 56, 90 days. Acid attack test conducted on 30, 60 days under HCL, H₂SO₄, HNO₃ Acids

KEYWORDS: silica fume, fly ash, blast furnace slag and metakaolin, HCL, H₂SO₄, HNO₃ Acids

I. INTRODUCTION

Concretes made of Portland cement (OPC) are highly alkaline with pH values normally above 12.5 and are not easily attacked by acidic solutions. Acid attacks represents a topic of increasing significance, owing to the spread of damages of concrete structures in both urban and industrial areas. Type of cement being used in the structure is an important factor that affecting performance of cement constituents in an aggressive environment. This was adopted to examine cement based materials and impact of chemicals on cementization i.e., Aggressive action of CO₂ Attack by strong acids, Action of ammonia, Action of sulphates, Attack by strong alkalis, Bacterial corrosion with H₂S.

II. RELATED WORK

1. **N. K. Amudhavalli, Jeena Mathew** Effect Of Admixtures On Strength And Durability Parameters Of Concrete
2. **Emmanuel K. Attiogbe And Sami H. Rizkalla** Explored The Response Of Four Different Concrete Mixes To Sulphuric Acid Attack Was Evaluated
3. **Ali Allahverdi, Franti.Ek .Kvára** Tested The Performance On Mechanism Of Nitric Acid Attack On Hardened Paste Of Geopolymeric Cements, In Addition To The Leaching Process In Which The Soluble Contents Of The Material
4. **Chiara F. Ferraris, Paul E. Stutzman, And Kenneth A. Snyder** Has Shown A Approach On Sulphate Resistance Of Concrete Existing Performance Specifications And Test Methods On Sulphate Attack, To Provide The Technical Basis For Improved Performance Standards, And To Provide Criteria For Evaluation, Selection, And Use Of Concrete Materials For Sulphate Attack Resistance.

III. EXPERIMENTAL METHODOLOGY

1. **Flyash** :Fly ash is a by product of the combustion of pulverized coal in thermal power plants. A dust-collection system removes the fly ash, as a fine particulate residue, from combustion gases before they are discharged into the atmosphere. More than 85% of most fly ashes is comprised of chemical compounds and glasses formed from the elements silicon, aluminium, iron, calcium, and magnesium.

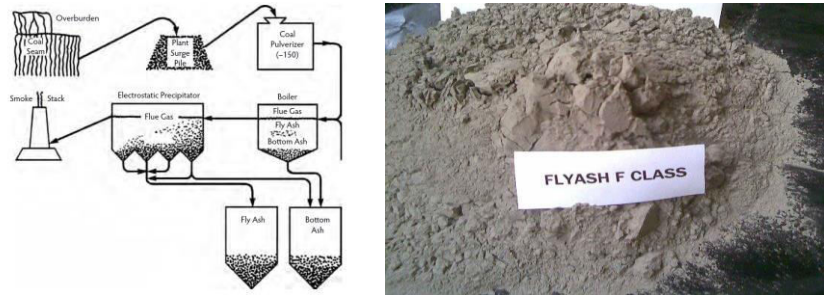


Figure 1 : Flyash

2. **Blast-Furnace Slag** : Blast-furnace slag is a by product of iron manufacture. When it is rapidly quenched with water to a glassy state and finely ground, it develops the property of latent hydraulicity. Most of the slags so produced are, in themselves, cementitious materials to a certain degree, whereas others become so in the presence of activators such as Portland cement and calcium sulfate.
- 3.

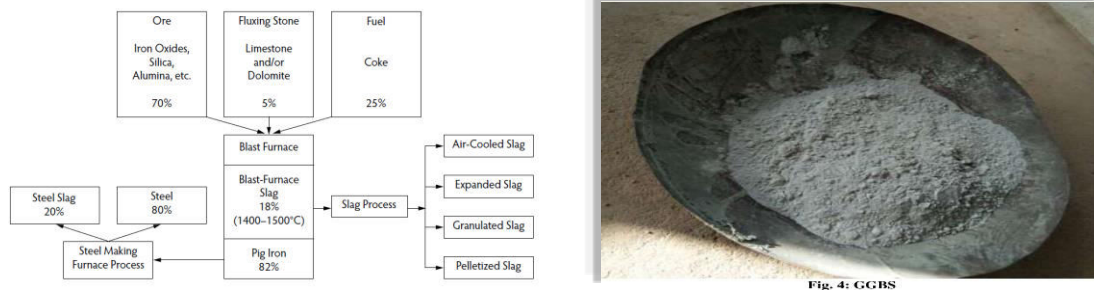


Figure 2. GGBS

4. **Silica Fume** : Silica fume is a byproduct of the manufacture of silicon or of various silicon alloys produced in submerged electric-arc furnaces. The type of alloy produced and the composition of quartz and coal. Most of the silica fume in cement and concrete are related to silica fume collected during the production of a silicon alloy containing at least 75% silicon.



Figure 3. Silica fume

5. **Metakaolin** : Highly reactive metakaolin has recently become available as a very active pozzolanic material for use in concrete. Unlike fly ash, slag, or silica fume, this material is not a byproduct but is manufactured from a

high-purity kaolin clay by calcination at temperatures in the region of 700 to 800°C .The material, ground to an average particle size of 1 to 2 μm, is white in color.

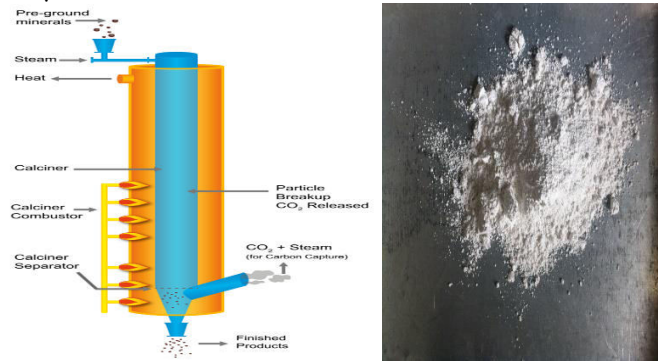
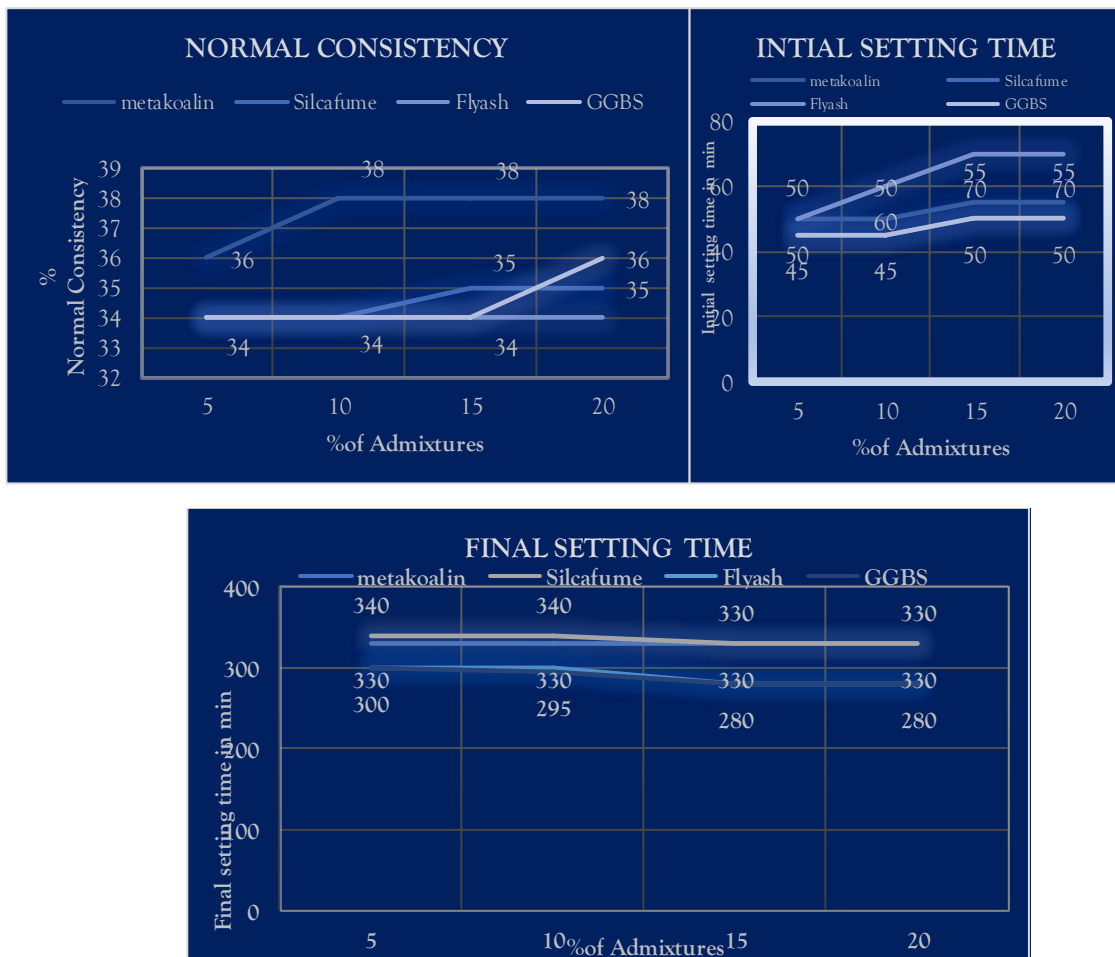


Figure 4. Metakaolin



Graph1. a.Normal Consistency b.Initial Setting time c.Final setting time

IV. MEHODOLOGY

The methodology involves the replacement of cement by fly ash, silica fume, blast furnace slag, metakaolin with appropriate proportions such as 5, 10,15,20%. And here we are adopting mix design for M25 grade concrete.Standard procedures are employed to assess the performance of admixed cement with organic and mineral acids.Method of Preparation of Test SpecimensCubes of size 150mm x 150mm x 150mm for Compressive strength were cast. Then the

specimens were demoulded and cured in water at a temperature of 20 prior to testing. The Compressive strength tests of concrete samples was determined at 3, 7, 28, 60, and 90 days as per IS: 516- 1959.



Figure 5. Specimens in Curing Tank

Mix Proportions

- ✚ Concrete mix design in this experiment was designed as per the guidelines specified in by ACI committee .
- ✚ All the samples were prepared using design mix.
- ✚ The Trail mix of (1:1.6:3.2) grade of concrete was used for the present investigation.
- ✚ Mix design was done based on I.S 10262-1982.

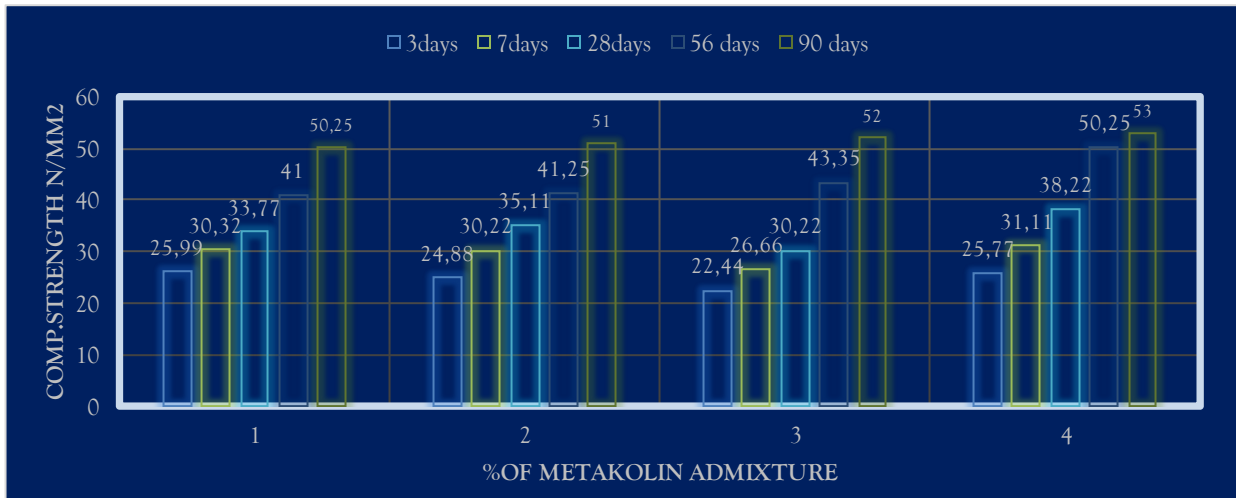


Figure 6. Tests conducted on Hardened concrete a. Compressive strength b. Split tensile strength c. RCPT Test.d. Water absorption Test.d. Acid attack test

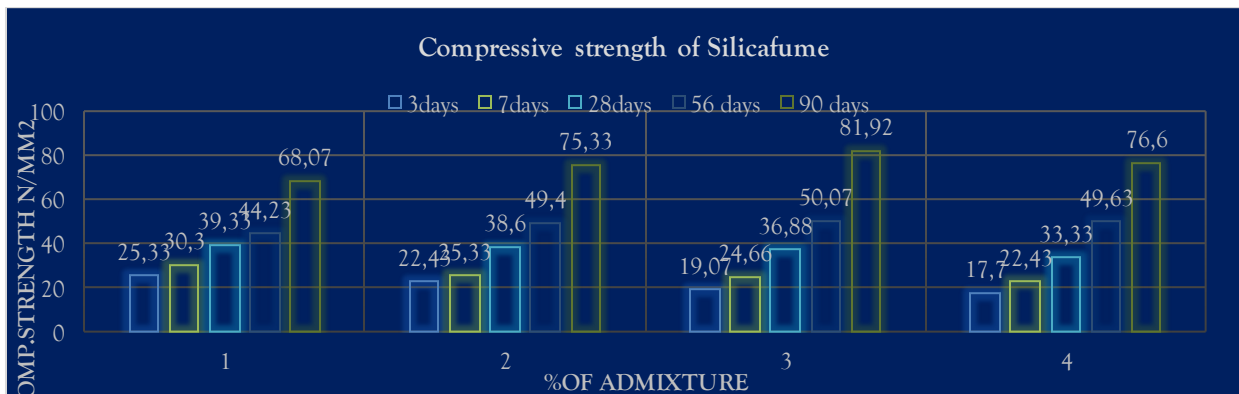
V. RESULTS

1. COMPRESSIVE STRENGTH TEST RESULTS

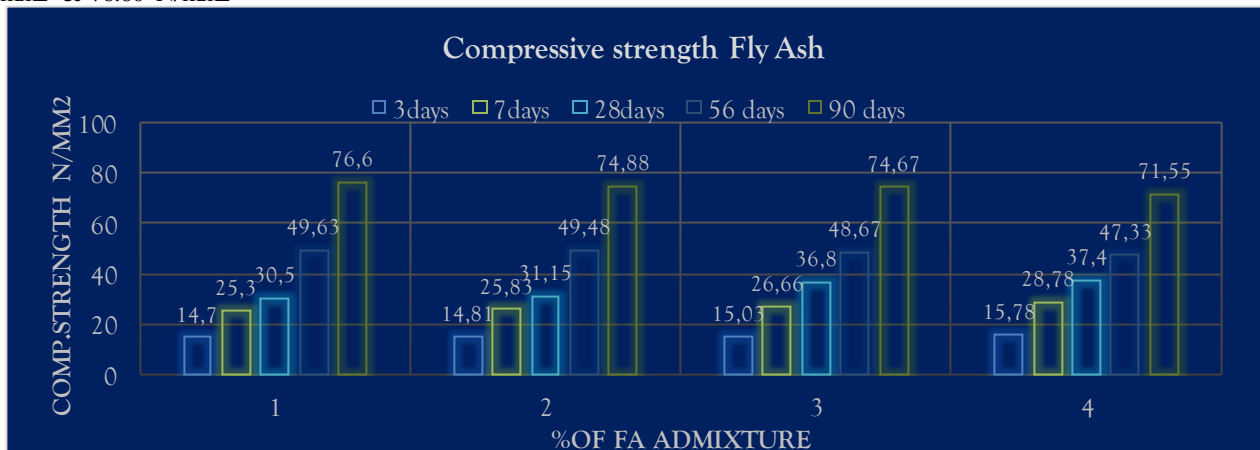
From below graphs it has been seen that, the comparison of compressive strength results of concrete for various replacements of Metakaolin .At 20 % Metakaolin gives maximum Compressive strength at 28 & 90 Days as 38.22 N/mm² & 53 N/mm²



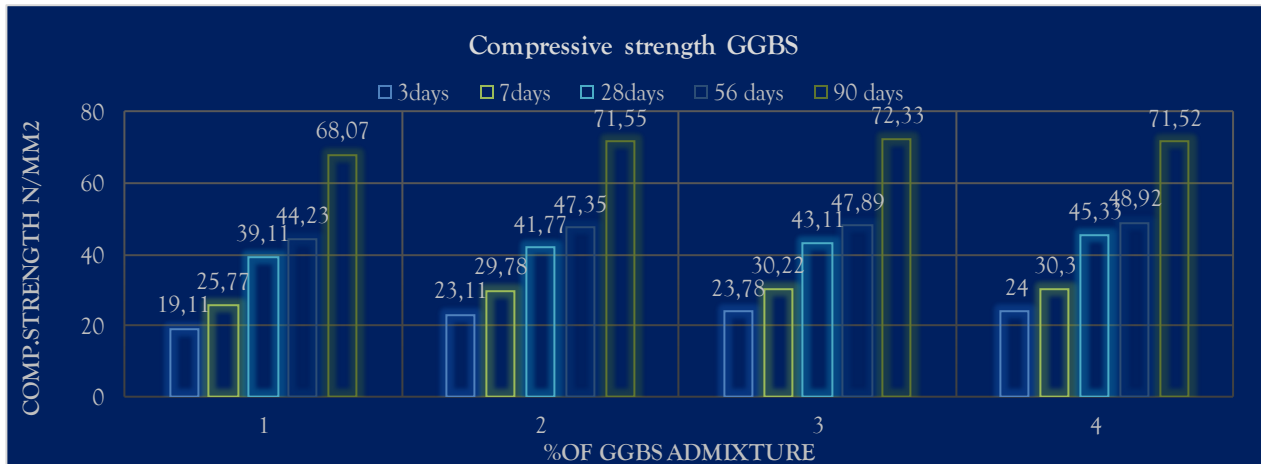
From below graphs it has been seen that, the comparison of compressive strength results of concrete for various replacements of Silica Fume .At 15 % Silica Fume gives maximum Compressive strength at 28 & 90 Days as 36.88 N/mm² & 81.92 N/mm²



From below graphs it has been seen that, the comparison of compressive strength results of concrete for various replacements of Flyash .At 5 % Flyash gives maximum Compressive strength at 28 & 90 Days as 30.50 N/mm² & 76.60 N/mm²

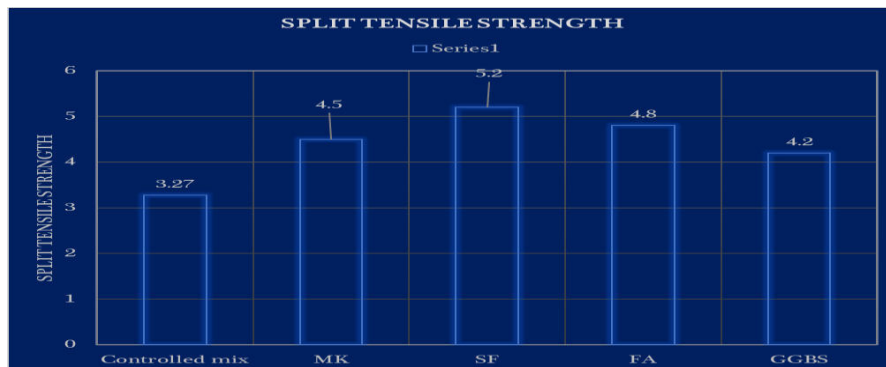


From below graphs it has been seen that, the comparison of compressive strength results of concrete for various replacements of GGBS .At 15 % GGBS gives maximum Compressive strength at 28 & 90 Days as 43.11 N/mm² & 72.33 N/mm²



2. SPLIT TENSILE STRENGTH RESULTS

From below graphs it has been seen that, the comparison of Split tensile strength results of concrete for various replacements of Metakaolin & Silica Fume & Flyash & GGBS. Silica fume got high tensile strength at 15 % replacement.



3. Water Absorption Test

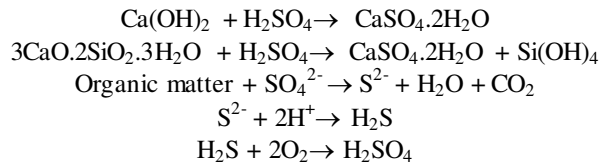
S.no	Sample	Wet weight(kgs)	Dry weight (kgs)	Water absorption in %
1	CC	9.56	9.40	1.70
2	MK	9.44	9.31	0.12
3	SF	9.53	9.45	0.84
4	FA	9.44	9.39	0.53
5	GGBS	9.44	9.35	0.96

4. Rapid Chloride Permeability Test

S. NO	SAMP LE	I ₀	I ₁	I ₂	I ₃	I ₄	I ₅	I ₆	I ₇	I ₈	I ₉	I ₁₀	I ₁₁	I ₁₂	I ₁₃	I ₁₄	I ₁₅	I ₁₆	I ₁₇	I ₁₈	I ₁₉	I ₂₀	I ₂₁	I ₂₂	I ₂₃	I ₂₄	I ₂₅	I ₂₆	I ₂₇	I ₂₈	I ₂₉	I ₃₀	I ₃₁	I ₃₂	I ₃₃	I ₃₄	I ₃₅	I ₃₆	I ₃₇	I ₃₈	I ₃₉	I ₄₀	I ₄₁	I ₄₂	I ₄₃	I ₄₄	I ₄₅	I ₄₆	I ₄₇	I ₄₈	I ₄₉	I ₅₀	I ₅₁	I ₅₂	I ₅₃	I ₅₄	I ₅₅	I ₅₆	I ₅₇	I ₅₈	I ₅₉	I ₆₀	I ₆₁	I ₆₂	I ₆₃	I ₆₄	I ₆₅	I ₆₆	I ₆₇	I ₆₈	I ₆₉	I ₇₀	I ₇₁	I ₇₂	I ₇₃	I ₇₄	I ₇₅	I ₇₆	I ₇₇	I ₇₈	I ₇₉	I ₈₀	I ₈₁	I ₈₂	I ₈₃	I ₈₄	I ₈₅	I ₈₆	I ₈₇	I ₈₈	I ₈₉	I ₉₀	I ₉₁	I ₉₂	I ₉₃	I ₉₄	I ₉₅	I ₉₆	I ₉₇	I ₉₈	I ₉₉	I ₁₀₀	I ₁₀₁	I ₁₀₂	I ₁₀₃	I ₁₀₄	I ₁₀₅	I ₁₀₆	I ₁₀₇	I ₁₀₈	I ₁₀₉	I ₁₁₀	I ₁₁₁	I ₁₁₂	I ₁₁₃	I ₁₁₄	I ₁₁₅	I ₁₁₆	I ₁₁₇	I ₁₁₈	I ₁₁₉	I ₁₂₀	I ₁₂₁	I ₁₂₂	I ₁₂₃	I ₁₂₄	I ₁₂₅	I ₁₂₆	I ₁₂₇	I ₁₂₈	I ₁₂₉	I ₁₃₀	I ₁₃₁	I ₁₃₂	I ₁₃₃	I ₁₃₄	I ₁₃₅	I ₁₃₆	I ₁₃₇	I ₁₃₈	I ₁₃₉	I ₁₄₀	I ₁₄₁	I ₁₄₂	I ₁₄₃	I ₁₄₄	I ₁₄₅	I ₁₄₆	I ₁₄₇	I ₁₄₈	I ₁₄₉	I ₁₅₀	I ₁₅₁	I ₁₅₂	I ₁₅₃	I ₁₅₄	I ₁₅₅	I ₁₅₆	I ₁₅₇	I ₁₅₈	I ₁₅₉	I ₁₆₀	I ₁₆₁	I ₁₆₂	I ₁₆₃	I ₁₆₄	I ₁₆₅	I ₁₆₆	I ₁₆₇	I ₁₆₈	I ₁₆₉	I ₁₇₀	I ₁₇₁	I ₁₇₂	I ₁₇₃	I ₁₇₄	I ₁₇₅	I ₁₇₆	I ₁₇₇	I ₁₇₈	I ₁₇₉	I ₁₈₀	I ₁₈₁	I ₁₈₂	I ₁₈₃	I ₁₈₄	I ₁₈₅	I ₁₈₆	I ₁₈₇	I ₁₈₈	I ₁₈₉	I ₁₉₀	I ₁₉₁	I ₁₉₂	I ₁₉₃	I ₁₉₄	I ₁₉₅	I ₁₉₆	I ₁₉₇	I ₁₉₈	I ₁₉₉	I ₂₀₀	I ₂₀₁	I ₂₀₂	I ₂₀₃	I ₂₀₄	I ₂₀₅	I ₂₀₆	I ₂₀₇	I ₂₀₈	I ₂₀₉	I ₂₁₀	I ₂₁₁	I ₂₁₂	I ₂₁₃	I ₂₁₄	I ₂₁₅	I ₂₁₆	I ₂₁₇	I ₂₁₈	I ₂₁₉	I ₂₂₀	I ₂₂₁	I ₂₂₂	I ₂₂₃	I ₂₂₄	I ₂₂₅	I ₂₂₆	I ₂₂₇	I ₂₂₈	I ₂₂₉	I ₂₃₀	I ₂₃₁	I ₂₃₂	I ₂₃₃	I ₂₃₄	I ₂₃₅	I ₂₃₆	I ₂₃₇	I ₂₃₈	I ₂₃₉	I ₂₄₀	I ₂₄₁	I ₂₄₂	I ₂₄₃	I ₂₄₄	I ₂₄₅	I ₂₄₆	I ₂₄₇	I ₂₄₈	I ₂₄₉	I ₂₅₀	I ₂₅₁	I ₂₅₂	I ₂₅₃	I ₂₅₄	I ₂₅₅	I ₂₅₆	I ₂₅₇	I ₂₅₈	I ₂₅₉	I ₂₆₀	I ₂₆₁	I ₂₆₂	I ₂₆₃	I ₂₆₄	I ₂₆₅	I ₂₆₆	I ₂₆₇	I ₂₆₈	I ₂₆₉	I ₂₇₀	I ₂₇₁	I ₂₇₂	I ₂₇₃	I ₂₇₄	I ₂₇₅	I ₂₇₆	I ₂₇₇	I ₂₇₈	I ₂₇₉	I ₂₈₀	I ₂₈₁	I ₂₈₂	I ₂₈₃	I ₂₈₄	I ₂₈₅	I ₂₈₆	I ₂₈₇	I ₂₈₈	I ₂₈₉	I ₂₉₀	I ₂₉₁	I ₂₉₂	I ₂₉₃	I ₂₉₄	I ₂₉₅	I ₂₉₆	I ₂₉₇	I ₂₉₈	I ₂₉₉	I ₃₀₀	I ₃₀₁	I ₃₀₂	I ₃₀₃	I ₃₀₄	I ₃₀₅	I ₃₀₆	I ₃₀₇	I ₃₀₈	I ₃₀₉	I ₃₁₀	I ₃₁₁	I ₃₁₂	I ₃₁₃	I ₃₁₄	I ₃₁₅	I ₃₁₆	I ₃₁₇	I ₃₁₈	I ₃₁₉	I ₃₂₀	I ₃₂₁	I ₃₂₂	I ₃₂₃	I ₃₂₄	I ₃₂₅	I ₃₂₆	I ₃₂₇	I ₃₂₈	I ₃₂₉	I ₃₃₀	I ₃₃₁	I ₃₃₂	I ₃₃₃	I ₃₃₄	I ₃₃₅	I ₃₃₆	I ₃₃₇	I ₃₃₈	I ₃₃₉	I ₃₄₀	I ₃₄₁	I ₃₄₂	I ₃₄₃	I ₃₄₄	I ₃₄₅	I ₃₄₆	I ₃₄₇	I ₃₄₈	I ₃₄₉	I ₃₅₀	I ₃₅₁	I ₃₅₂	I ₃₅₃	I ₃₅₄	I ₃₅₅	I ₃₅₆	I ₃₅₇	I ₃₅₈	I ₃₅₉	I ₃₆₀	I ₃₆₁	I ₃₆₂	I ₃₆₃	I ₃₆₄	I ₃₆₅	I ₃₆₆	I ₃₆₇	I ₃₆₈	I ₃₆₉	I ₃₇₀	I ₃₇₁	I ₃₇₂	I ₃₇₃	I ₃₇₄	I ₃₇₅	I ₃₇₆	I ₃₇₇	I ₃₇₈	I ₃₇₉	I ₃₈₀	I ₃₈₁	I ₃₈₂	I ₃₈₃	I ₃₈₄	I ₃₈₅	I ₃₈₆	I ₃₈₇	I ₃₈₈	I ₃₈₉	I ₃₉₀	I ₃₉₁	I ₃₉₂	I ₃₉₃	I ₃₉₄	I ₃₉₅	I ₃₉₆	I ₃₉₇	I ₃₉₈	I ₃₉₉	I ₄₀₀	I ₄₀₁	I ₄₀₂	I ₄₀₃	I ₄₀₄	I ₄₀₅	I ₄₀₆	I ₄₀₇	I ₄₀₈	I ₄₀₉	I ₄₁₀	I ₄₁₁	I ₄₁₂	I ₄₁₃	I ₄₁₄	I ₄₁₅	I ₄₁₆	I ₄₁₇	I ₄₁₈	I ₄₁₉	I ₄₂₀	I ₄₂₁	I ₄₂₂	I ₄₂₃	I ₄₂₄	I ₄₂₅	I ₄₂₆	I ₄₂₇	I ₄₂₈	I ₄₂₉	I ₄₃₀	I ₄₃₁	I ₄₃₂	I ₄₃₃	I ₄₃₄	I ₄₃₅	I ₄₃₆	I ₄₃₇	I ₄₃₈	I ₄₃₉	I ₄₄₀	I ₄₄₁	I ₄₄₂	I ₄₄₃	I ₄₄₄	I ₄₄₅	I ₄₄₆	I ₄₄₇	I ₄₄₈	I ₄₄₉	I ₄₅₀	I ₄₅₁	I ₄₅₂	I ₄₅₃	I ₄₅₄	I ₄₅₅	I ₄₅₆	I ₄₅₇	I ₄₅₈	I ₄₅₉	I ₄₆₀	I ₄₆₁	I ₄₆₂	I ₄₆₃	I ₄₆₄	I ₄₆₅	I ₄₆₆	I ₄₆₇	I ₄₆₈	I ₄₆₉	I ₄₇₀	I ₄₇₁	I ₄₇₂	I ₄₇₃	I ₄₇₄	I ₄₇₅	I ₄₇₆	I ₄₇₇	I ₄₇₈	I ₄₇₉	I ₄₈₀	I ₄₈₁	I ₄₈₂	I ₄₈₃	I ₄₈₄	I ₄₈₅	I ₄₈₆	I ₄₈₇	I ₄₈₈	I ₄₈₉	I ₄₉₀	I ₄₉₁	I ₄₉₂	I ₄₉₃	I ₄₉₄	I ₄₉₅	I ₄₉₆	I ₄₉₇	I ₄₉₈	I ₄₉₉	I ₅₀₀	I ₅₀₁	I ₅₀₂	I ₅₀₃	I ₅₀₄	I ₅₀₅	I ₅₀₆	I ₅₀₇	I ₅₀₈	I ₅₀₉	I ₅₁₀	I ₅₁₁	I ₅₁₂	I ₅₁₃	I ₅₁₄	I ₅₁₅	I ₅₁₆	I ₅₁₇	I ₅₁₈	I ₅₁₉	I ₅₂₀	I ₅₂₁	I ₅₂₂	I ₅₂₃	I ₅₂₄	I ₅₂₅	I ₅₂₆	I ₅₂₇	I ₅₂₈	I ₅₂₉	I ₅₃₀	I ₅₃₁	I ₅₃₂	I ₅₃₃	I ₅₃₄	I ₅₃₅	I ₅₃₆	I ₅₃₇	I ₅₃₈	I ₅₃₉	I ₅₄₀	I ₅₄₁	I ₅₄₂	I ₅₄₃	I ₅₄₄	I ₅₄₅	I ₅₄₆	I ₅₄₇	I ₅₄₈	I ₅₄₉	I ₅₅₀	I ₅₅₁	I ₅₅₂	I ₅₅₃	I ₅₅₄	I ₅₅₅	I ₅₅₆	I ₅₅₇	I ₅₅₈	I ₅₅₉	I ₅₆₀	I ₅₆₁	I ₅₆₂	I ₅₆₃	I ₅₆₄	I ₅₆₅	I ₅₆₆	I ₅₆₇	I ₅₆₈	I ₅₆₉	I ₅₇₀	I ₅₇₁	I ₅₇₂	I ₅₇₃	I ₅₇₄	I ₅₇₅	I ₅₇₆	I ₅₇₇	I ₅₇₈	I ₅₇₉	I ₅₈₀	I ₅₈₁	I ₅₈₂	I ₅₈₃	I ₅₈₄	I ₅₈₅	I ₅₈₆	I ₅₈₇	I ₅₈₈	I ₅₈₉	I ₅₉₀	I ₅₉₁	I ₅₉₂	I ₅₉₃	I ₅₉₄	I ₅₉₅	I ₅₉₆	I ₅₉₇	I ₅₉₈	I ₅₉₉	I ₆₀₀	I ₆₀₁	I ₆₀₂	I ₆₀₃	I ₆₀₄	I ₆₀₅	I ₆₀₆	I ₆₀₇	I ₆₀₈	I ₆₀₉	I ₆₁₀	I ₆₁₁	I ₆₁₂	I ₆₁₃	I ₆₁₄	I ₆₁₅	I ₆₁₆	I ₆₁₇	I ₆₁₈	I ₆₁₉	I ₆₂₀	I ₆₂₁	I ₆₂₂	I ₆₂₃	I ₆₂₄	I ₆₂₅	I ₆₂₆	I ₆₂₇	I ₆₂₈	I ₆₂₉	I ₆₃₀	I ₆₃₁	I ₆₃₂	I ₆₃₃	I ₆₃₄	I ₆₃₅	I ₆₃₆	I ₆₃₇	I ₆₃₈	I ₆₃₉	I ₆₄₀	I ₆₄₁	I ₆₄₂	I ₆₄₃	I ₆₄₄	I ₆₄₅	I ₆₄₆	I ₆₄₇	I ₆₄₈	I ₆₄₉	I ₆₅₀	I ₆₅₁	I ₆₅₂	I ₆₅₃	I ₆₅₄	I ₆₅₅	I ₆₅₆	I ₆₅₇	I ₆₅₈	I ₆₅₉	I ₆₆₀	I ₆₆₁	I ₆₆₂	I ₆₆₃	I ₆₆₄	I ₆₆₅	I ₆₆₆	I ₆₆₇	I ₆₆₈	I ₆₆₉	I ₆₇₀	I ₆₇₁	I ₆₇₂	I ₆₇₃	I ₆₇₄	I ₆₇₅	I ₆₇₆	I ₆₇₇	I ₆₇₈	I ₆₇₉	I ₆₈₀	I ₆₈₁	I ₆₈₂	I ₆₈₃	I ₆₈₄	I ₆₈₅	I ₆₈₆	I ₆₈₇	I ₆₈₈	I ₆₈₉	I ₆₉₀	I ₆₉₁	I ₆₉₂	I ₆₉₃	I ₆₉₄	I ₆₉₅	I ₆₉₆	I ₆₉₇	I ₆₉₈	I ₆₉₉	I ₇₀₀	I ₇₀₁	I ₇₀₂	I ₇₀₃	I ₇₀₄	I ₇₀₅	I ₇₀₆	I ₇₀₇	I ₇₀₈	I ₇₀₉	I ₇₁₀	I ₇₁₁	I ₇₁₂	I ₇₁₃	I ₇₁₄	I ₇₁₅	I ₇₁₆	I ₇₁₇	I ₇₁₈	I ₇₁₉	I ₇₂₀	I ₇₂₁	I ₇₂₂	I ₇₂₃	I ₇₂₄	I ₇₂₅	I ₇₂₆	I ₇₂₇	I ₇₂₈	I ₇₂₉	I ₇₃₀	I ₇₃₁	I ₇₃₂	I ₇₃₃	I ₇₃₄	I ₇₃₅	I ₇₃₆	I ₇₃₇	I ₇₃₈	I ₇₃₉	I ₇₄₀	I ₇₄₁	I ₇₄₂	I ₇₄₃	I ₇₄₄	I ₇₄₅	I ₇₄₆	I ₇₄₇	I ₇₄₈	I ₇₄₉	I ₇₅₀	I ₇₅₁	I ₇₅₂	I ₇₅₃	I ₇₅₄	I ₇₅₅	I ₇₅₆	I ₇₅₇	I ₇₅₈	I ₇₅₉	I ₇₆₀	I ₇₆₁	I ₇₆₂	I ₇₆₃	I ₇₆₄	I ₇₆₅	I ₇₆₆	I ₇₆₇	I ₇₆₈	I ₇₆₉	I ₇₇₀	I
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5. Acid Attack test**a. SULPHURIC ACID ATTACK**

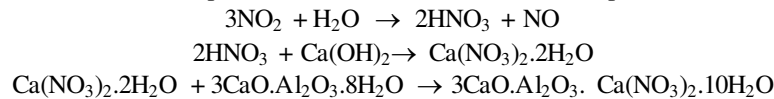
- Sulphuric acid attack causes extensive formation of gypsum in the regions close to the surfaces, and tends to cause disintegrating mechanical stresses which ultimately lead to spalling and exposure of the fresh surface. The chemical reactions involved in sulphuric acid attack on cement



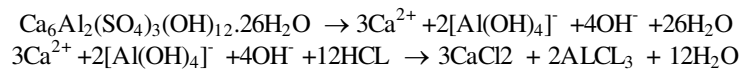
- Sulphuric acid is highly reactive and reacts with calcium compounds to form gypsum which causes the concrete to soften, ultimately leading to roof collapse.

b. NITRIC ACID ATTACK

- Nitric acid usually occurs in chemical plants producing explosives, artificial manure and similar products.
- Nitric acid can be formed from the compounds and radicals of nitrates in the presence of water



Pavlik reported that the corroded layer developed by the action of nitric acid solution with concentrations ranging between 0.025 to 0.5 mol l⁻¹ is soft, and porous with visible cracks

c. HYDROCHLORIC ACID ATTACK

the cross section of damaged prisms into three main zones; undamaged zone, hydroxide mixture zone or brown ring, and attacked zone. By hydroxide mixture zone, he referred to a layer formed by undissolved salts seen as a dark brown ring.



Figure 7. Acid Attack on concrete cubes

VI. CONCLUSION

- At 20 % Metakaolin gives maximum Compressive strength at 28 & 90 Days as 38.22 N/mm² & 53 N/mm²
- At 15 % Silica Fume gives maximum Compressive strength at 28 & 90 Days as 36.88 N/mm² & 81.92 N/mm²
- At 5 % Flyash gives maximum Compressive strength at 28 & 90 Days as 30.50 N/mm² & 76.60 N/mm²
- At 15 % GGBS gives maximum Compressive strength at 28 & 90 Days as 43.11 N/mm² & 72.33 N/mm²
- the comparison of Split tensile strength results of concrete for various replacements of Metakaolin & Silica Fume & Flyash & GGBS .Silica fume got high tensile strength at 15 % replacement.
- The percentage water absorption for different proportions of concrete varies with the silica fume and fly ash & metakaolin & GGBS replacement Metakaolin has low water absorption 0.12 %
- Water permeability of concrete with Metakaolin has medium by RCPT Test
- Immersion of cubes leads to drastic reduction in compressive strength as compared to sprinkling for any type of acid. The reduction in compressive strength due to complete immersion is almost double than that for sprinkling of



any particular acid (Hydrochloric or Sulphuric or Nitric acid) for particular exposure period (30 days or 60 days). As the exposure period increases, the effect on strength and reduction in mass of the cubes also increases.

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