ISSN: 0974-5823 Vol. 7 No. 8 August, 2022

International Journal of Mechanical Engineering

EXPERIMENTAL STUDY ON HIGHLY STRENGTH AND DURABLE SILICA FUME CONCRETE AT ELEVATED TEMPERATURES

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ABSTRACT: silicon metal or ferrosilicon alloys is obtained from the byproduct which is silica fume. It is most widely used in the concrete for construction. In this paper experimental study on highly strength and durable silica fume concrete at elevated temperatures is studied and implemented. The silica fume is investigated between 200°C to 800°C about 24 hrs of duration. This is compared wirh conventional concrete as well. Based on the color change, weight loss and residual compressive the mechanical properties are studied. Based on the test of X- Ray Diffraction experimental study is carried out. Design of M40 grade is done. In the same way by maintaining the 0.40 water binder ratio under different silica fume percentage10, 15 and 20 % replacement of cement is done. Hence the main objective of this paper is to test the durability of silica fume concrete at elevated temperatures.

KEY WORDS: Silica fume, Durable, X-Ray Diffraction test, M40 grade concrete, Conventional Concrete, Elevated Temperature.

I.INTRODUCTION

Because of high compressive strength and high capacity it is named as concrete which is most widely used across the world. On entire planet concrete is the second most consumed material. There is huge increment in the utilization of concrete. The rising shortage of unrefined components and an earnest need to safeguard the climate against contamination has emphasized the meaning of growing new structure materials.

X-Ray diffraction (XRD) is a quick scientific method essentially utilized for stage ID of a glasslike material and can give data on unit cell aspects. X-beam diffraction is generally broadly utilized for the distinguishing proof of obscure glasslike materials for example metals, minerals, inorganic mixtures. From the small region the reflected powers are estimated in XRD. Nuclear level dividing inside the gem grid of the example can be gotten by the outcomes. This assists us in understanding subtleties of the precious stone with organizing for the substance. XRD assists in recognizing various stages with indistinguishable organizations with better subtleties of the gem structure, for example, the condition of nuclear "request". Moreover, strain investigation and assurance of the level of crystallization can likewise be surveyed.

Concrete is a broadly involved development material for different kinds of designs because of its underlying soundness and strength. The use, conduct as well as the strength of substantial designs, worked during the last first 50% of the hundred years with Ordinary Portland Cement (OPC) and plain round bars of gentle steel, the simplicity of securing the constituent materials (anything that might be their characteristics) of concrete and the information that practically any blend of the constituents prompts a mass of cement have reared scorn. Strength was focused on without an idea on the toughness of designs. As a result of the freedoms taken, the strength of endlessly substantial designs is on a toward the south excursion; an excursion that appears to have picked up speed on its way to implosion. To develop cement one of the most important fixing is Ordinary Portland Cement (OPC) and there is no other way to develop the cement industries.

Significant energy and cost investment funds can result when modern side-effects are utilized as a halfway substitution of concrete. Fly debris can be utilized which is a side-effect from the warm plants fly is let be causes air contamination, land contamination and medical problems to the people. Utilization of fly debris in concrete is halfway substitution of concrete decreases these issues. More over fly debris is a cementations material which works on the exhibition of cement.

The utilization of silica exhaust and fly debris to some degree supplant the concrete is on the grounds that the creation of concrete emanates carbon dioxide gas to the climate. Architects and researchers are further attempting to expand its cutoff points with the assistance of imaginative synthetic admixtures and different Supplementary Cementitious Materials (SCMs). All the more as of late, severe ecological - contamination controls and guidelines have created an expansion in the modern Wastes and sub reviewed results which can be utilized as SCMs, for example, fly debris, silica exhaust, ground granulated impact heater slag and so on. The utilization of SCMs in substantial developments not just forestalls these materials to really look at the contamination yet in addition to improve the properties of cement in new and hydrated states.

II. REVIEW OF LITERATURE

AbidNadeem et al.[1] completed to assess the exhibition of High-performance Concrete (HPC) made with Silica Fume (SF) and Metakaolin (MK) at raised temperatures. They analyzed on fractional supplanting of concrete with SF from 10% to 40%, temperatures from 27oC to 800oC and two sorts of cooling strategies in air and water. They decided compressive strength, toughness and mass misfortune by utilizing chloride penetrability, water absorptivity tests and quantitative examination of the SEM picture test. Test results showed debasement in the mechanical and toughness properties of HPC at raised temperatures.

N. Vishwanath et al.[2] examined on the Silica seethe composite cement under supported raised temperature. Tried the proficient commitment of Silica Fume concrete (SFC) in keeping up with or working on the property of solidified concrete in pressure under supported temperature. With substitution levels of 35%, 40% and 45% by mass of concrete, 4 blends were projected. Subsequent to restoring they were presented to temperatures 200oC and 300oC supported for time of 5 hours. Compressive strength, elasticity and X-beam diffraction tests are led and contrasted and each other examples at various temperatures.

Shane Donatello et al.[3] introduced a report on The physical and synthetic changes in an extremely high volume Silica smolder concrete glue (SF-4) and CEM II/A-M Portland composite-concrete (MS) following openness to temperatures up to 1000oC. The fluid to strong proportions were 0.36 and 0.32 for the SF-4 and MS glues separately. Glues were blended physically for 3 min and cast into 1×1×6 cm hardened steel molds. Then, at that point, tests are set in relieving chamber then presented to 200, 400, 600, 800 or 1000oC for a time of 1 hr. In the wake of testing flexural strength a few pieces of each example bunch were ground to a fine powder and dissected by X-beam diffraction.

Harun Tanyildizi et al.[4] concentrated on the impact of high temperature on compressive and parting rigidity of lightweight cement containing Silica rage. They examined tentatively and genuinely. The blends integrating 0%, 10%, 20% and 30% Silica rage are ready. 100×100×100mm 3D shapes are casted and warmed at temperatures of 200oC, 400oC and 800oC, separately. Compressive strength and parting elasticity of light weight concrete was tried by utilizing analysis of variance (ANOVA) strategy.

Omer Arioz et al.[5]studied on Effects of elevated temperatures on properties of cement. Different substantial blends ready by OPC, squashed limestone, stream rock, test tests exposed to raised temperature from 200oC to 1200oC. After openness, weight not set in stone and afterward compressive strength was led.

George Mathew et al.[6] studied at different Elevated Temperatures of Laterized Concrete based on the Influence of Silica Fume. Cement is replaced with mineral admixtures (fly ash and GGBFS) at an increment of 5%, starting from 10% and going to 35%. Compressive strength, split tensile Strength and modulus of elasticity are performed on all types of Silica Fume specimens that are 28 days cured and exposed at 200oC, 400oC, and 600oC.

III. X-RAY DIFFRACTION

X-Ray Diffraction test was conducted at NISHKA LABS in uppal, hyderbad., the specimens were fine powdered to do XRD. Totally 6 samples are tested, 3 from C100 mix and another 3 from C85S15 mix at 27oC, 400oC, 800oC. The below shows the test results of X-Ray Diffraction.

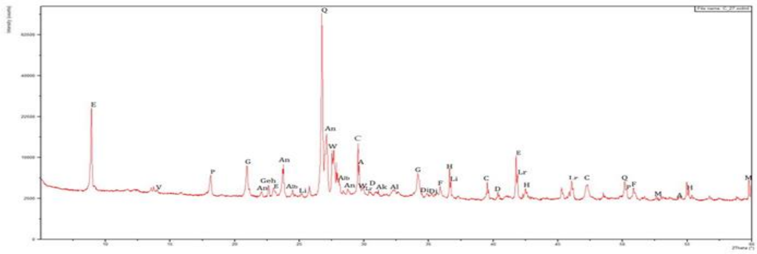

Fig. 1: AT 27ºC for C100 mix phase peak labels of XRD data

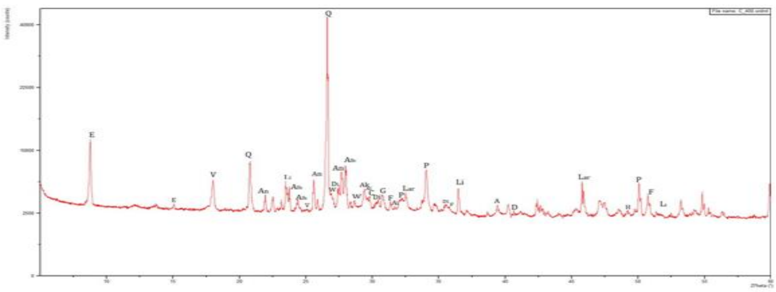

Fig. 2: AT 400ºC for C100 mix phase peak labels of XRD data

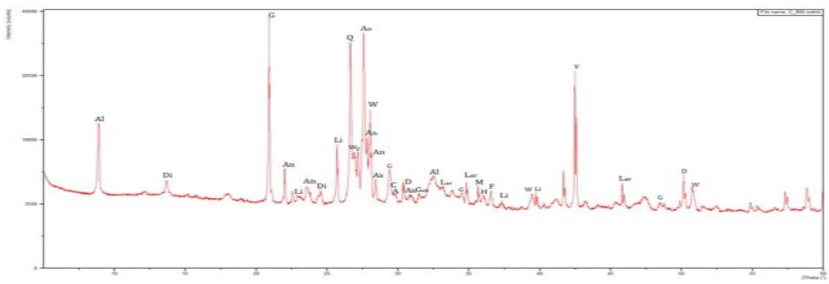

Fig. 3: AT 800ºC for C100 mix phase peak labels of XRD data

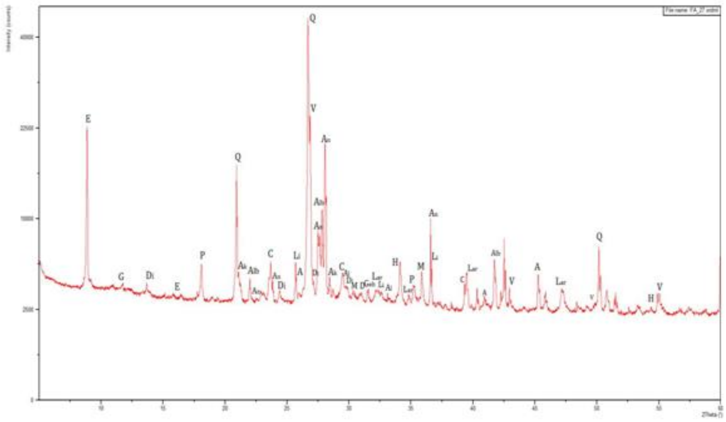

Fig. 4: AT 27ºC for C85S15 mix phase peak labels of XRD data

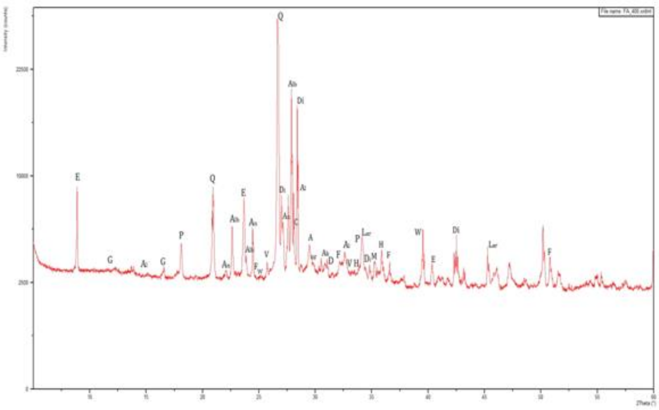

Fig. 5: AT 400ºC for C85S15 mix phase peak labels of XRD data

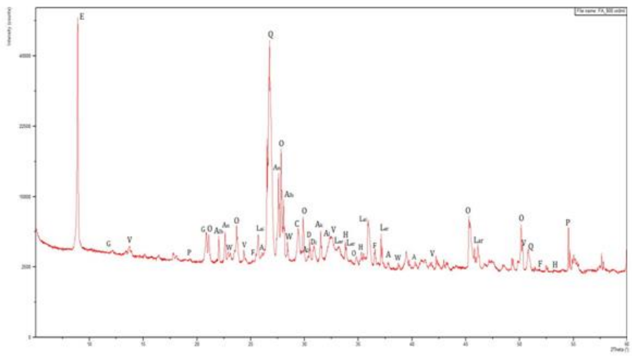

Fig. 6: AT 800ºC for C85S15 mix phase peak labels of XRD data

XRD ANALYSIS of C100 mix and C85S15 mix at different phases and temperatures is shown in below table (1).

Table 1: XRD ANALYSIS OF C100 mix and C85S15 mix AT DIFFERENT PHASES AND TEMPERATURES

PHASE NAME	CONTENT %					
	C100			SF15		
	27oC	400oC	800oC	27oC	400oC	800oC
QUARTZ	29.7	34	22.2	23.5	36.4	12.9
PORTLANDITE	2	3		2	2	1
ALITE	2	5	7.1	2	5.1	4
BELITE						
ALBITE	6.9	9	9.1	14.3	12.1	10.9
ETTRINGITE	2	7		1	5.1	2
ANHYDRITE	2	2	2		1	1
ANORTHITE	11.9	19	19.2	22.4	24.2	24.8
AKERMANITE	1	1	2	1	1	2
CALCITE	1		3	2		2
DIOPSIDE	3	6	1	2	12.1	2
FAYALITE	1	2	2		2	1
LAIHUNITE		4	4	2		2
GEHLENITE	6.9		1	1		
HEMATITE	1		1	1		
VATERITE			2	5.1		3
WOLLASTONITE	11.9	4	7.1			9.9
DOLOMITE		1	1	2		
MAGHEMITE	11.9					
GYPSUM	3		3			2

IV. RESULT ANALYSIS

Preparation is done based on the results. The main intent is to study when the color is changing because of silica fume concrete high volume. The high volume silica fume (C90S10, C85S15and C80S20) concrete mixes is compared with normal (C100) concrete which is shown in results. Hence by XRD there will be effect in the compressive strength of phase composition

At 27°C the compressive strength is high for Silica fume mixes compared with normal concrete mixes. This will increase the strength of Calcium Hydroxide (CH) by effecting micro filler pozzolanic reaction. At 200°C residual compressive strength will be high for normal concrete mix because of the micro structure of calcium hydroxide (CH) and unhydrated (UH) areas. There will be increment in the strength before hydration based on the phases of diopside, ettringite and quartz. At 400°C there is increment in the compressive strength of Fly ash mixes.

CHANGES OF COLOURS

Reason of Mineralogical

At temperatures 600°C to 800°C, there will be change in color from grey to red-orange because of mix samples of silica fume. Fe-silicates/hematite is the main reason for changing of color. In the Silica fume cement fly ash component is directly linked with Fe.

But in normal concrete there will be no drastic colour change observed. when the temperature is above 800°C then in normal concrete the color changes from Slightly yellowing because of the formation of suplhur.

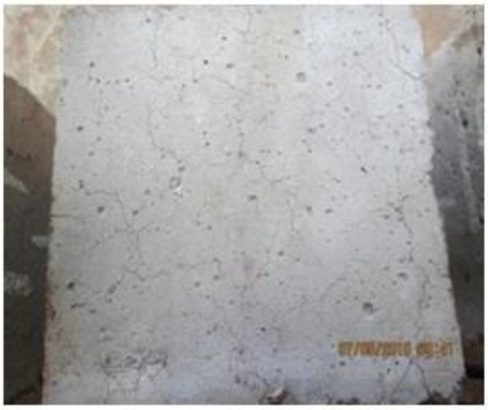

Fig. 7: At 800°C mix of C100

Fig. 8: 600ºC Mix of C80S20

CRACKS

Cracks occurred at elevated temperature due to the internal pressure of evaporable moisture. Cracks are visually observed at 600°C to 800°C. There is no visible effect on the surface of the specimen heated up to 400°C. The concrete started to crack when the temperature increased to 600°C. But the effect was not significant at this temperature level. The cracks become very pronounced at 800°C.

Mineralogical reason

Cracks occurred at elevated temperature due to hydration of chemical compositions. For example the formation of ettringite after hydration over the silica, it compresses the other minerals and forms cracks. Appreciable coarsening of pores are appeared due to heating at high elevated temperatures at 600°C and 800°C.

Fig. 9: Specimens exposed between 600°C to 800°C

XRD RESULT

In this unspecified pozzolanic additions are done while blending the MS cement at 27° at quartz peak with minor quantities. 2Ө is the result obtained for the MS cement. ettringite signals are obtained in crystalline phase when it is obtained after treatment and maintained at 400°C. Portlandite peaks are disappeared when temperature is maintained at 800°C after the treatment. In this there is huge reduction of calcite peaks. Between the diffracting temperatures 30° and 34° 2Ө is obtained.

V. CONCLUSION

The below shows the conclusion of durable silica fumes concrete at elevated temperatures:

- When temperature is between 600°C to 800°C, then it will change colour from grey to red orange in Fe-silicates/hematite which is formed from mixed samples of silica fume.
- When temperature is between 600°C to 800°C then from all mixes cracks were observed. Hence compared with silica fume concrete mixes, normal concrete mixes have much weight loss.
- At last because of this silica fume concrete cost is very reliable and material cost is loss.

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