International Journal of Scientific Research & Engineering Trends
Volume 9, Issue 2, Mar-Apr-2023, ISSN (Online): 2395-566X

# A High Grade Type Light Weights Concrete Design Using Epoxy Material

**Ajay Bhardwaj, Asst. Prof.Kishor Patil**
Sushila Devi Bansal College of Engineering,
Indore (M.P.), India.
akmrsonuptl@gmail.com, bhodce@sdbc.ac.in

**Abstract- The aim of this study is to determine the performance of concrete by adding the fly ash and silica fume in concrete by the partial replacement of cement and fine aggregate by some percentage and this will be done by different percentage at the gap of some percent and what will be effect on basic properties of concrete as from the other research paper it is noted silica fume and fly ash both are added separately in concrete by some partial replacement so result will be tremendous so here in this study by considering or reading all the previous data from the research paper the new work should also be positive fly ash is the waste product of coal combustion product also known as the fuel ash and silica fume is also known as the micro silica fume is nonmetallic and nonhazardous material.**

**Keywords- silica fume, fly ash, test on concrete.**

## I. INTRODUCTION

The cement industry is the second largest producer of the greenhouse gas. On an average, approximately 1 ton of cement is being produced each year for every human being in the world. Hence, in order to protect the environment, the main concern of minimizing CO2 emission can be realized by reducing the percentage of cement used in making concrete. Hence it is necessary either to search for another material or partly replace it by some other material.

The alternative material will lead to global sustainable development and lowest possible environmental impact. Due to substantial energy and cost savings industrial by products are used as a partial replacement of cement. Some of the pozzolanic materials like fly ash, Ground Granulated Blast furnace Slag, Rice husk ash, high reactive Metakaolin, silica fume (SF) that can be used in concrete as partial replacement of cement. Addition of silica fume to concrete has many advantages like high strength and durability.

## II. SILICA FUME

Silica fume is known in different names such as micro silica, silica dust, and condensed silica fume [16]. When SF is used as an additive in cement concrete, a heat of hydration is observed resulting in the formation of pozzolanic material and calcium hydroxide. Due to large surface area silica fume gets densely packed in the paste of cement and aggregate reducing the wall effect in the transition zone between the paste and aggregate. Silica fume shows improvement in both strength and durability properties of concrete. The main physical effect of silica fume in concrete is that it act as a filler and because of its fineness, silica fume fit in to the space between the cement grains just as sand fill the space between particles of coarse aggregate or cement grains fill the space between the sand grains [1-7]. Realizing the pozzolanic nature of the materials, this has been used successfully as an admixture in producing concrete. For the improvement of strength and durability of the concrete, the use of silica fume as a replacement of cement has been tried with success in concrete. The use of silica fume in concrete mix has engineering potential and economic advantage. The use of silica fume will not affect the weight of concrete. Silica fume will produce a much less permeable and high strength concrete [2].

Concrete is one of the most important and widely used man-made construction materials. In fact concrete is a composite construction material, composed of cement (commonly Portland cement), coarse aggregate made of gravels or crushed rocks, fine aggregate (sand), and water. Sometimes admixtures are added to give concrete some special characteristics as required. Concrete is an incredibly useful and flexible building material without which modern architecture and construction would not be possible. It can be easily poured into forms and moulds to create different shapes; it quickly hardens to become a durable stone-like material.

It is used in buildings, foundations, bridges, footings, roads and many other applications. Most normal concrete structures deteriorate rapidly especially when they face some challenging environments; consequently, they require costly repairs before their expected service life is reached to end. In order for a concrete to be good, it must meet two criteria, i.e. concrete has to be satisfactory both in its fresh and hardened state. Concrete in its fresh state must be consistent and cohesive, In other words, consistency of the mix should be such that it can be compacted easily without excessive effort, and also the mix should be cohesive enough so as not to produce segregation with a consequent lack of homogeneity of the finished product. The significant requirements from a concrete in its hardened state are satisfactory compressive strength and adequate durability. Since this research work mainly focuses on the effects of silica fume on the properties of high-strength concrete; therefore it is important to know more about high-strength concrete and silica fume.

## III. RESEARCH MOTIVATION

The fly ash and the silica fume both are mixed in terms of the comparison of their property with the simple casted concrete in terms of their property and the basic test which are done on concrete. It will be added in concrete by the replacement of cement and fine aggregate different percentage . It will be added in replacement of cement and fine aggregate. The fly ash and silica fume will be placed with same percentage if we have to mix 10 percent both then 5 percent silica fume and 5 percent fly ash will be replaced and the optimum percentage should be noted.

That at which percentage we achieve the better result. The cubes will be casted for 7 days or 28 days and result will be noted. So main thing is enhance the property and reduce the amount of cement and fine aggregate in concrete.

## IV. EPOXY

Epoxies are high-strength plastics with properties that meet or exceed those of concrete. Epoxy injection provides a permanent structural repair to cracked or fractured concrete; cracks just visible to the eye can be injected. The added benefit is that it waterproofs structures, prevents water infiltration and re-bars corrosion and spall formation. As a result, this process essentially preserves concrete and prevents continual damage. Epoxy injection is not limited to repairing cracks in concrete structures. Wood beams have been successfully injected, honeycombs and similar voids are also filled using injection techniques, floor overlays can be rebonded, and loosened metal plates and bolts can also be secured.

An epoxy crack injection grout comprising a base component containing solvent-free epoxide resin plus a low viscosity liquid hardener. Can be placed by free flow under gravity or may be injected using a suitable hand or mechanical pump. Grouting of gap dimensions 0.1mm to 10mm may be easily achieved. The system gives rapid strength gain obtaining mechanical properties several times those of high quality concrete. The material is non-shrink enabling complete fill of the grouting area. The hardened grout is resistant to most chemicals, stable to sea water, petroleum products and resists freeze-thaw cycles. Uses include crack injection applications, filling and bonding cracked concrete, structural support where thin section grouting is required, structural support where dynamic load resistance is required and bonding of lifted floor toppings. Epoxy injection is a resin based sealer that is forced into cracks within concrete to protect the rebar from becoming damaged, and to stop water from pooling into the foundation. Cracks and weak rebar will cause the concrete foundation to weaken, which will make the building affected unsafe for occupancy.

The epoxy that is injected into the cracks effectively seals them while allowing the concrete foundations to retain their original strength and integrity. Epoxy injection repairs are the only way to fix a cracked foundation without having to tear the building down and re-pour the concrete. The process involved in the epoxy resin process is precise and has to be done with an epoxy that is rated at least Grade A Type A for most applications. In order to effectively repair the crack, and to shield the rebar from premature deterioration, only the best products are used. The majority of epoxy injection repairs are done with injection machines or guns that are set at an air level suitable for the given application. There are maximum and minimum settings that are recommended, so all tools have to be adjusted before beginning each specific job.

The epoxy injection process can be performed in any weather and environment as long as special precautions are used to ensure that the temperature stays within the range for optimum application. Different chemicals can be added into the epoxy to allow for extremes in weather, such as hot or cold. Additives can also allow the epoxy to repair foundations cracks in dams and canals. In these specific cases, epoxy injection is the only type of feasible repair in order to prevent disastrous results if the foundation should fail.

## V. GOAL OF RESEARCH WORK

Following goals are perform given research work-

- Design a concrete using Epoxy and Nano Silica fume Materials.
- To observation of its compressive strength 7, 14 and 28 days.
- To identification of its Tensile and Water resistance capability to various test results.
- To analysis of its concrete performance comparison of previous mix design.

## VI. LITERATURE REVIEW

**Shamsad Ahmad, Effect of silica fume inclusion on the strength, shrinkage and durability characteristics of natural pozzolan-based cement concrete:** In the present work, effect of inclusion of silica fume on the performance of natural pozzolanbased cement concrete was investigated. Natural pozzolan, obtained from volcanic rocks, was used as the main supplementary cementitious material to partially replace the Portland cement. Silica fume was admixed at an optimum dosage, optimally selected based on the performance of several trial mixtures, in an attempt to improve the performance of the natural pozzolan-based cement concrete.

**Mohammad Nadeem Akhtar, Incorporation of recycled aggregates and silica fume in concrete: an environmental savior-a systematic review:** This review article has attempted to address the problems associated with river sand mining and the adverse impacts of CO2 emissions from the construction sector. The PRISMA framework employed a systematic literature review (SLR) methodology for the data extraction. The various strength parameters, such as relative compressive strength, relative splitting tensile strength, and relative flexural strength of concrete made from recycled aggregates (RAs) and silica fume (SF), were examined.

**Xinyan Wu, Performance of geopolymer concrete activated by sodium silicate and silica fume activator:** This study examined the properties (strength, workability and crack) of geopolymer concrete activated by sodium silicate and silica fume activator. Sodium silicate and sodium hydroxide (NaOH) are commonly activators used to make geological polymer composite. However, they will cause the decline of the performance of geopolymer concrete when it is prone to polymerization in the surrounding of alkaline. Silica fume can improve the workability and strength of geopolymer concrete.

**Musa Adamu, Modeling and optimization of the mechanical properties of date fiber reinforced concrete containing silica fume using response surface methodology:** Date palm fiber (DPF) has series of advantages when used as a natural fiber like availability, lower cost, and sustainability, and it is obtained as a waste from date tree. Due to its enormous advantages, DPF is applied in cement composites. However, the main disadvantage of DPF in cement composite is strength reduction and increased porosity. Therefore, for DPF to be effectively used as fiber in concrete, it should be used together with a material that can mitigate its adverse effect on the properties of the composites. Consequently, this work analyzed the effect of DPF on mechanical properties of the concrete where 0 %, 1 %, 2 % and 3 % DPF were added by weight of binder materials. Silica fume was utilized to partially replace cement at dosages of 0 %, 5 %, 10 % and 15 % to reduce the porosity and minimize the undesirable effect of the DPF on the strengths of the composite.

**ThanongsakNochaiya, Acidic corrosion-abrasion resistance of concrete containing fly ash and silica fume for use as concrete floors in pig farm:**The objective of this study is to investigate the resistance of concretes to organic acid corrosion and abrasive corrosion, which occurs in typical pig farms. For the concrete mixtures, cement was replaced by fly ash and silica fume with different weight percentages up to 30%.

The cubic mortar and concrete specimens were prepared and tested for compressive strength and mass loss due to organic acid corrosion. The test results indicated that fly ash and silica fume mixed together significantly enhance the compressive strength of the concrete, especially at longterm curing periods.

**A. Joshua Daniel, Study on Partial Replacement of Silica Fume Based Geopolymer Concrete Beam Behavior under Torsion:** The utilization of Ordinary Portland Cement (OPC) cause hazard due to emission of CO2. To avoid this, Pozzolanic material is used as a substituted for OPC. These are activated by alkaline to form a gel known as aluminosilicate which acts as a binder in concrete. In this study cement is partially replaced by Silica fume (SF). The torsional behaviour of the conventional concrete and SF based geo-polymer concrete is tested with varying percentage of longitudinal reinforcement. The results were compared in terms of torque, twist, stiffness degradation, curvature ductility, torsional toughness and crack width.

**Reni Suryanita, The effect of silica fume admixture on the compressive strength of the cellular lightweight concrete:**Foam concrete has practical and economic advantages in construction, including reducing the structure’s weight by building foundations. The market demand for foam concrete such as Cellular Lightweight Concrete (CLC) block has increased recently. One way to reduce the density of CLC is to add air pores to the cement paste or mortar mixture. However, the addition of pores can reduce the strength of lightweight bricks. Therefore, there is a need for innovation to improve the quality of CLC block by replacing some of the cement with other added materials. This study aims to obtain a good quality CLC block using silica fume to replace partial cement in a mortar mixture.

**Taekgeun Oh, Substitutive effect of nano-SiO2 for silica fume in ultra-high-performance concrete on fiber pullout behavior:** This study investigated the effect of substituting nano-SiO2 for silica fume on the fibermatrix interfacial bond performance of ultra-high-performance concrete (UHPC). In this study, silica fume was substituted by nano-SiO2 in the weight range of 0e50%. The degree of pozzolanic reaction of binder materials was evaluated using the thermogravimetric analysis (TGA) and compressive strength measurement. The single fiber pullout test was conducted along with a measurement of autogenous shrinkage to evaluate the interfacial bond. The degree of pozzolanic reaction of nano-SiO2 was found to be higher than that of other binder materials.

**Sahar Mokhtari, The performance effect of PEG-silica fume as shape-stabilized phase change materials on**

**mechanical and thermal properties of lightweight concrete panels:** Sustainable construction is of paramount importance and one of the methods is deployment of phase change materials (PCMs) in construction materials due to their large latent heat capacity. This study aims at investigating the mechanical and thermal properties of non-structural light weight concrete incorporating shapestabilized phase change materials (SSPCMs).

**Tao Luo, Effect of adding solid waste silica fume as a cement paste replacement on the properties of fresh and hardened concrete:** Due to the large-scale infrastructure construction and environmental protection pressure in China, the demanded cement is in short supply and the price is rising, and the overcapacity of silica fume has caused its price to fall, thus replacing cement paste by silica fume could achieve better economic and environmental benefits.

**Olatokunbo M. Ofuyatan, RSM and ANN modelling of the mechanical properties of self-compacting concrete with silica fume and plastic waste as partial constituent replacement:** In this study, Response Surface Methodology (RSM) and Artificial Neural Networks (ANN) was used to predict the mechanical properties of self compacting concrete (SCC) with silica fume as partial cement replacement and Polyethylene terephthalate (PET) solid waste as partial sand replacement. PET plastic was varied between 0 and 20 wt% while the silica fume was varied between 0 and 40 wt%.

**Ming Sun, Plastic and early-age shrinkage of ultra-high performance concrete (UHPC):** Experimental study of the effect of water to binder ratios, silica fume dosages under controlled curing conditions: The magnitude of early age shrinkage of Ultra High Performance Concrete (UHPC) is markedly different from normal and high strength concretes. A series of experiments were performed to determine the influence of water to binder ratio and silica fume content on the rate of hydration, stiffness development, chemical and external shrinkage under both sealed and unsealed condi- tions. Experimental apparatus, designed for shrinkage in normal strength concretes, were adapted to accommodate the larger volume changes and minimise the influence of boundary restraint. Continuously monitored internal temperature, and relative humidity conditions, along with pe- riodic measurements of hydration degree and stiffness are used to elucidate the volumetric deformation mechanisms. Results, from as early as three hours after water addition demonstrate significant volumetric changes occurring in the early plastic state of the material.

**Qiang Fu, Erosion behavior of ions in lining concrete incorporating fly ash and silica fume under the combined action of load** and flowing groundwater containing composite salt: In this study, the erosion behavior of ions in lining concrete incorporating fly ash and silica fume under the combined action of load and flowing groundwater containing composite salt. The results show that the transmission speed of Cl− and SO4 2− in lining concrete under different erosion conditions is: flowing groundwater–load action in the tension zone > flowing groundwater > static corrosion solution > flowing groundwater–load action in the compression zone. The addition of silica fume (SF) and fly ash (FA) can reduce the concentration of Cl− and SO4 2− in lining concrete, increase the ratio of combined Cl− to total Cl− , and reduce the ratio of combined SO4 2− to total SO42− . The addition of FA and SF can increase the lining concrete's resistance to Cl−corrosion by about 10–28%, and SO4 2− radical resistance by about 5–12%, and the more FA is added, the greater the increase.

**Manlin Shen, Effects of basalt powder and silica fume on ultra-high-strength cementitious matrix: A comparative study:** Understanding the effects of basalt powder on the microstructures and hydration products of ultra-high strength cementitious matrices (UHSCMs) can contribute to the application of basalt powder in ultra-high performance concrete.

## VII. CONCLUSION

For achievement of higher strength and workability in pervious concrete, it is not possible to get higher strength with conventional concrete mix. Modification is necessary in design. With use of silica fume, it can be possible to increment in strength of pervious concrete.

## REFERENCE


[1] Mohammad Nadeem Akhtar, Incorporation of recycled aggregates and silica fume in concrete: an environmental savior-a systematic review, Available online at www.sciencedirect.com,journal homepage: www.elsevier.com/locate/jmrt.

[2] Shamsad Ahmad, Effect of silica fume inclusion on the strength, shrinkage and durability characteristics of natural pozzolan-based cement concrete, Contents lists available at ScienceDirect Case Studies in Construction Material journal homepage: www.elsevier.com/locate/cscm.

[3] Xinyan Wu, Performance of geopolymer concrete activated by sodium silicate and silica fume activator, Contents lists available at ScienceDirect Case Studies in Construction Materials.

[4] Musa Adamu, Modeling and optimization of the mechanical properties of date fiber reinforced concrete containing silica fume using response surface methodology, Contents lists available at ScienceDirect Case Studies in Construction Materials journal homepage: www.elsevier.com /locate/cscm.

[5] ThanongsakNochaiya, Acidic corrosion-abrasion resistance of concrete containing fly ash and silica fume for use as concrete floors in pig farm, Contents lists available at ScienceDirect Case Studies in Construction Materials journal homepage: www.elsevier.com/locate/cscm.

[6] A. Joshua Daniel, Study on Partial Replacement of Silica Fume Based Geopolymer Concrete Beam Behavior under Torsion, Procedia Engineering 173 ( 2017 ) 732 – 739.

[7] Reni Suryanita, The effect of silica fume admixture on the compressive strength of the cellular lightweight concrete, Contents lists available at ScienceDirect Results in Engineering journal homepage: www.sciencedirect.com/journal/results-in-engineering.

[8] Burçin S¸enol S¸eker, Investigation of the effect of silica fume and synthetic foam additive on cell structure in ultra-low density foam concrete, Studies in Construction Materials journal homepage:www.elsevier.com/locate/cscm.

[9] Taekgeun Oh, Substitutive effect of nano-SiO2 for silica fume in ultra-high-performance concrete on fiber pull-out behavior, Available online at www.sciencedirect.com journal homepage: www. el sevier.com/locate/jmrt.

[10] Sahar Mokhtari, The performance effect of PEGsilica fume as shape-stabilized phase change materials on mechanical and thermal properties of lightweight concrete panels, Contents lists available at ScienceDirect Case Studies in Construction Materials journal homepage.

[11] Tao Luo, Effect of adding solid waste silica fume as a cement paste replacement on the properties of fresh and hardened concrete, Contents list available at Science Direct Case Studies in Construction Materials, journal homepage: www.elsevier.com/locate/cscm.

[12] Olatokunbo M. Ofuyatan, RSM and ANN modelling of the mechanical properties of self-compacting concrete with silica fume and plastic waste as partial constituent replacement, Contents lists available at ScienceDirect Cleaner Materials, journal homepage: www.elsevier.com/locate/clema.

[13] Ming Sun, Plastic and early-age shrinkage of ultrahigh performance concrete (UHPC), Contents lists available at ScienceDirect Case Studies in Construction Materials journal homepage: www.elsevier.com/locate/cscm.

[14] Qiang Fu, Erosion behavior of ions in lining concrete incorporating fly ash and silica fume under the combined action of load and flowing groundwater containing composite salt, Contents lists available at ScienceDirect Case Studies in Construction Materials, journal homepage: www.elsevier.com/locate/cscm.

[15] Manlin Shen, Effects of basalt powder and silica fume on ultra-high-strength cementitious matrix: A comparative study, Contents lists available at ScienceDirect Case Studies in Construction Materials journal homepage: