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ENHANCING HIGH STRENGTH CONCRETE PERFORMANCE THROUGH THE SYNERGISTICS USE OF FLY ASH AND MICRO SILICA: A FOCUS ON M70 GRADE CONCRETE

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Abstract:

This research paper presents a comprehensive experimental investigation on the development of high-strength concrete (HSC) using a combination of fly ash and micro silica as supplementary cementitious materials. The primary focus is on achieving M70 grade concrete and analyzing the influence of varying micro silica percentages on the mechanical and durability properties of the concrete mixtures. The study aims to provide valuable insights into enhancing the performance of concrete through sustainable and innovative materials. Experimental tests, analytical modeling, and a comprehensive literature review contribute to a deeper understanding of the synergistic impact on high strength concrete.

Keywords: High-strength concrete, fly ash, micro silica, M70 grade, compressive strength, durability, sustainability.

Introduction:

High strength concrete plays a vital role in modern construction, demanding continual enhancement of its properties. This study focuses on the combined utilization of fly ash and micro silica to address the challenges associated with conventional high strength concrete, aiming to achieve superior performance in terms of strength, durability, and sustainability. Concrete is a fundamental construction material, and optimizing its properties is crucial for ensuring structural performance. This research focuses on the potential benefits of incorporating fly ash and micro silica into high-strength M70 concrete. These supplementary materials not only enhance strength but also address environmental concerns associated with traditional concrete production.

Brief overview of the significance of high-strength concrete.

High-strength concrete is significant in construction due to its ability to withstand heavy loads and reduce the need for large structural components. It enables the construction of slender and more aesthetically pleasing structures while maintaining structural integrity. This type of concrete is crucial for high-rise buildings, bridges, and other infrastructure projects where strength and durability are paramount. Additionally, high-strength concrete can enhance the overall sustainability of a structure by allowing for reduced material usage and, consequently, a smaller environmental footprint.

Importance of incorporating supplementary cementitious materials for sustainability.

Incorporating supplementary cementitious materials (SCMs) in concrete is crucial for sustainability. SCMs, such as fly ash or slag, offer several benefits:

1. Reduced Carbon Footprint: SCMs replace a portion of cement, which is a significant source of carbon emissions during production. By using SCMs, the overall carbon footprint of concrete is reduced, contributing to environmental sustainability.

2. Waste Utilization: Many SCMs are by-products of industrial processes, such as fly ash from coal combustion or slag from steel production. Utilizing these materials in concrete helps reduce waste and promotes a more circular economy.

3.Improved Durability: SCMs enhance the durability of concrete by reducing permeability and improving resistance to chemical attacks. This leads to longer-lasting structures, reducing the need for frequent repairs or replacements and promoting sustainable construction practices.

4. Energy Conservation: The production of SCMs often requires less energy compared to cement. Incorporating these materials into concrete contributes to energy conservation and resource efficiency.

5. Cost Savings: Using SCMs can lead to cost savings in concrete production, as they are often more affordable than cement. This economic benefit encourages sustainable construction practices by making environmentally friendly options more financially viable.

In summary, incorporating supplementary cementitious materials in concrete supports sustainability by reducing carbon emissions, utilizing industrial by-products, enhancing durability, conserving energy, and promoting cost-effective construction practices.

Introduction to fly ash and micro silica as potential additives for high-strength concrete.

Fly ash and micro silica are valuable additives in the production of high-strength concrete, enhancing both performance and sustainability.

Fly Ash:

- Source: A by-product of coal combustion in power plants.

- Composition: Composed of fine, spherical particles.

- Benefits:

 - Strength Enhancement: Acts as a pozzolan, reacting with calcium hydroxide to form additional cementitious compounds, enhancing compressive strength.

 - Durability: Improves resistance to sulfate attacks and reduces permeability, enhancing the durability of concrete structures.

 - Eco-Friendly: Utilizes an industrial waste product, contributing to sustainable construction by reducing the environmental impact of coal combustion residues.

Micro silica (Silica Fume):

- Source: Obtained during the production of silicon or ferrosilicon alloys.

- Composition: Extremely fine particles, composed mostly of amorphous silica.

- Benefits:

Strength Gain: Enhances early-age and long-term strengths due to its pozzolanic reactivity.

Densification: Fills voids between cement particles, leading to a more compact and denser concrete, improving durability.

Chemical Resistance: Improves resistance to chloride penetration and chemical attacks, making it suitable for marine and harsh environmental conditions.

Reduced Permeability: Enhances the impermeability of concrete, reducing the ingress of water and aggressive substances.

Combined Use in High-Strength Concrete:

Synergistic Effects: When used together, fly ash and micro silica can exhibit synergistic effects, providing a balanced combination of strength, durability, and workability.

Sustainability: Both additives contribute to sustainable construction by utilizing industrial by-products and reducing the environmental impact associated with traditional concrete production.

Incorporating fly ash and micro silica in high-strength concrete formulations not only improves mechanical properties but also aligns with environmentally conscious construction practices.

Objective:

The primary objective is to investigate the impact of varying percentages of fly ash and micro silica on the compressive strength, workability, and durability of M70 concrete. The research aims to provide practical insights for engineers and construction professionals seeking sustainable alternatives in concrete design.

Literature Review:

Chai Jaturapitakkul et al 2004 This paper introduces an innovative approach to enhance the pozzolanic reactivity of coarse fly ash, typically unsuitable for concrete due to its low pozzolanic reaction. Through a grinding process, the coarse fly ash is refined to an average particle size of 3.8 mm, making it suitable for replacing condensed silica fume in high-strength concrete production. Various replacement percentages, ranging from 0% to 50%, are explored, revealing that concrete with 15% to 50% ground coarse fly ash (FAG) replacement achieves high-strength properties, with the optimum performance observed at a 25% replacement level. Notably, concrete incorporating 15% to 35% FAG as cement replacement demonstrates compressive strengths comparable to or even higher than those of condensed silica fume concretes after 60 days. The study underscores the suitability of finely ground coarse fly ash as an environmentally friendly alternative to condensed silica fume in cost-effective high-strength concrete production.

Thanongsak Nochaiya et al 2010 This study investigates the influence of silica fume (SF) content on the normal consistency, setting time, workability, and compressive strength of Portland cement–fly ash–silica fume systems. The findings reveal an increase in water requirement for normal consistency with higher SF content, accompanied by a reduction in initial setting time. Despite a decrease in slump values, the workability of concrete incorporating fly ash and silica fume remained comparable to or higher than that of Portland cement control concrete. Moreover, the addition of silica fume, particularly at 10 wt.%, significantly enhanced compressive strength, reaching up to a 145% increase in early ages (pre 28 days). Scanning electron micrographs highlighted a denser microstructure in concretes with fly ash and silica fume, contributing to the observed strength improvement. The combination of fly ash and silica fume not only enhances concrete strength but also presents an environmentally beneficial approach by utilizing two by-products, reducing the reliance on Portland cement.

F.U.A. Shaikh et al 2014 The incorporation of nanomaterials, particularly nano silica (NS), in cementitious systems has garnered considerable attention in recent literature, focusing on optimizing the mechanical properties and microstructure of mortars and concretes. This study contributes to this body of knowledge by investigating the synergistic effects of NS with varying high volume fly ash (HVFA) contents, ranging from 40% to 70%, as partial replacements for cement. The research underscores that the addition of 2% NS emerges as the optimal content, enhancing both early and long-term compressive strength in mortars and concretes. The findings reveal the reactivity of NS, emphasizing its significant contribution to compressive strength at 7 days, particularly in HVFA systems. Microstructural analyses, including backscattered electron (BSE) imaging and X-ray diffraction (XRD), provide insights into the improved matrix structure attributed to NS addition. Overall, the study establishes the efficacy of NS in compensating for the low early-age strength of HVFA systems, offering potential applications for sustainable and high-performance cementitious materials.

Deng-Deng Zheng et al 2016 The literature surrounding the incorporation of supplementary cementitious materials, such as fly ash and silica fume, in cementitious systems has witnessed extensive exploration due to their potential to enhance various properties. In the context of Magnesium–Potassium Phosphate Cement (MKPC), the present study delves into the combined influence of fly ash and silica fume on water resistance. Prior research has demonstrated the individual benefits of these materials, highlighting their role in pore structure optimization, crack filling, and improvement of compactness in cementitious matrices. Additionally, the chemical effects, particularly the reaction between amorphous silicon oxide in silica fume and MgO, have been investigated for their impact on enhancing bonding and water resistance. The reported findings underscore the significant improvement in water resistance, density, and compressive strength of MKPC through the synergistic effects of fly ash and silica fume, providing valuable insights for optimizing the formulation of environmentally sustainable and durable cementitious systems.

L. Ponraj Sankar et al 2019 This paper explores the utilization of Fine Grinded Fly Ash (FGFA) and Silica Fume (SF) as modified pozzolanic replacements in OPC cement. Various replacement percentages of FGFA (0% to 40%) and SF (5% by weight of cement) are investigated. The study evaluates the impact on water consistency, initial and final setting times, as well as fresh and hardened properties of high-performance concrete, including compressive, split tensile, and flexural strengths. The results indicate a significant influence of FGFA and SF replacements on both modified binder and concrete properties. The consistency decreases gradually, attributed to water-repelling effects, but the flow properties increase, impacting the slump value. Compressive strength gains are observed with FGFA and SF replacements, reaching the design strength at different ages. The study concludes that FGFA and SF serve as viable pozzolanic replacements, enhancing concrete properties, with compressive strength attaining design values over extended curing periods. The research contributes insights into optimizing high-performance concrete through judicious use of supplementary materials.

Mehran Khan et al 2019 This study addresses the mechanical properties of fly ash-silica fume plain concrete (FA-SPC) and fly ash-silica fume coconut fiber-reinforced concrete (FA-SCFRC). While research has extensively examined individual components like fiber-reinforced concrete, silica-fume concrete, and fly ash concrete, this work innovatively combines coconut fibers with fly ash and silica fume. The investigation involves varying fly ash content (0%, 5%, 10%, 15%) and 2% coconut fibers in FA-SCFRC. The results reveal that FA-SCFRC generally exhibits enhanced properties compared to FA-SPC. Notably, FA-SCFRC with 10%

fly ash content demonstrates superior mechanical properties. The study emphasizes the potential of this optimized composite in achieving improved strength and durability, offering insights for future research on the durability and pore structure of coconut fiber-reinforced concrete. This research contributes to the evolving understanding of composite materials for enhancing concrete performance.

Daniel Hatungimana et al 2019 This study investigates the impact of partial cement replacement with silica fume (SF) and fly ash (FA) on various properties of mortar mixtures. The findings reveal that increasing the content of silica fume led to improved compressive strength, reduced water absorption, volume of permeable pore, water sorptivity, and surface radon exhalation rate. Mortar mixtures with silica fume demonstrated 24–38% fewer voids compared to the control, showcasing enhanced structural properties. Conversely, mortar mixtures containing fly ash exhibited lower compressive strength, higher water absorption, and sorptivity. Silica fume replacements resulted in a substantial reduction in radon exhalation rates, up to 43% compared to the control, highlighting its positive influence on radiological aspects. Overall, this study underscores the superior performance of silica fume over fly ash in enhancing various critical properties of mortar mixtures.

V.V. Sai Chand et al 2020 The accelerated corrosion of reinforced concrete structures has raised concerns about their expected lifespan. This study addresses the critical issue of chloride ion ingress, a major contributor to the corrosion of reinforcement bars and subsequent structural deterioration. With a focus on non-steady diffusion, nine concrete mixes with varying percentages of supplementary cementitious materials and water-to-cementitious ratios were compared against conventional mixes. The replacement of cement with different proportions of fly ash and 5% silica fume was explored, with compressive strength tests conducted at 28, 56, and 90 days. Ponding tests in a 3.5% NaCl solution were performed, and chemical analysis predicted chloride concentrations at different depths. The findings highlight that, while plain concrete exhibits the highest compressive strength, a 30% fly ash and 5% silica fume replacement yield comparable values after 90 days. Moreover, a water-to-cementitious ratio of 0.4 proves effective in resisting chloride ingress, and a 70% fly ash replacement demonstrates enhanced resistance, particularly at lower water-to-cementitious ratios. The study emphasizes that the incorporation of fly ash and silica fume mitigates chloride ingress, with low-cement replacement achieving compressive strength levels comparable to plain concrete.

Sathi Kranthi Vijaya et al 2020 In response to the escalating demand for higher-strength concrete amid rapid population growth and increased infrastructure needs, this study investigates the impact of mineral admixtures on the flexural and compressive strength of M60 grade concrete. With a focus on sustainability and reducing carbon emissions associated with traditional concrete production, the research explores partial substitutions of cement with fly ash (FA), rice husk ash (RHA), and silica fume (SF). Three different ratios of FA:RHA: SF (20:5:5, 18:6:6, 16:7:7) are examined. The experimental results, involving curing at 7 and 28 days, indicate that while normal concrete exhibits slightly higher strength, the admixture-replaced concrete achieves the required target strength. The incorporation of FA, RHA, and SF enhances pozzolanic activity, offering a promising approach for sustainable concrete production and corrosion resistance in coastal areas. This study contributes valuable insights into optimizing concrete strength with environmentally conscious material choices.

Liaqat Ali Qureshi et al 2020 The surge in interest in recycled aggregate concrete (RAC) stems from a global commitment to sustainable practices. This research explores the synergistic impact of supplementary cementitious materials (SCMs) and hook-ended steel fibers (HSF) on the mechanical strength and durability of RAC. Incorporating silica fume (SF), ground granulated blast furnace slag (GGBS), fly ash (FA), and rice husk ash (RHA) as SCMs, along with 1% HSF, the study evaluates compressive strength, elastic modulus, tensile strength, water absorption, chloride penetration, and acid attack resistance. Results reveal that the combined incorporation of SCMs and HSF significantly enhances both the mechanical and durability properties of RAC. Notably, 10% SF and 15% RHA, coupled with 1% HSF, emerged as an optimal combination, demonstrating superior performance. The findings underscore the potential of integrating SCMs and HSF to achieve enhanced properties in RAC, contributing to the broader objective of sustainable and durable construction materials.

Suseela Alla et al 2020 This study focuses on finding sustainable alternatives to conventional cement by exploring the durability properties of concrete with silica fume and fly ash as cement replacements. Evaluating M80 and M90 grade concrete samples, the investigation includes varying proportions of Robosand, fly ash, and silica fume, comparing them with a control mix. The durability properties are assessed under sulphate attack (H2SO4 & HCL), with observations on weight losses and compressive strengths at different curing periods. The results indicate that the increase in strength is primarily attributed to age rather than durability attacks. Notably, the trial mix with 50% Robosand, 20% fly ash, and 5% silica fume exhibits superior resistance. Acid attack factors and durability factors are discussed for both M80 and M90 grades, highlighting the potential of Robosand in achieving high strengths. The optimal mix, identified as Trial 3, underscores the significance of sustainable materials in producing durable and robust concrete.

Shaswat Kumar Das et al 2020 This study addresses the challenge of curing fly ash-based geopolymers at ambient conditions, seeking alternatives to the conventional elevated-temperature curing that limits practicality and sustainability. The research explores the impact of lime and silica fume on the properties of geopolymers cured under ambient conditions, using them as partial replacements for fly ash. Lime and silica fume, replacing 7.5% and 2% of fly ash, respectively, resulted in the highest compressive strength. The findings reveal that the incorporation of lime reduces workability and setting time, while silica fume enhances these properties. Microstructural analysis indicates a densified microstructure with improved compressive strength when combining lime and silica fume in geopolymers. The study suggests that geopolymers developed with these replacements meet basic requirements for structural applications, offering insights into optimizing geopolymers for diverse applications.

M.D. Ikramullah Khan et al 2020 This study addresses the prevalent issue of micro-cracks in structural concrete, often arising from drying shrinkage and volume changes, by incorporating fibers of artificial and natural origin. The research focuses on utilizing thermal power plant waste by-products like fly ash to enhance the concrete's density and mitigate shrinkage-induced cracks. Structural polypropylene fibers are introduced in varying percentages, while 10% of cement is replaced with fly ash. The findings indicate a promising improvement in mechanical behavior compared to conventional concrete. As the fiber content increases, workability decreases, requiring the use of superplasticizers. Optimal performance, considering compressive, split tensile, and flexural strength, is achieved with fiber content between 0.06% and 0.08%. The cost-effectiveness, eco-friendliness, and strength-enhancing properties of fly ash make it a valuable alternative to ordinary Portland cement. This study underscores the potential of utilizing waste by-products for sustainable and robust concrete solutions.

Sachin Patil et al 2021 This study explores the resilience of high-performance concrete, produced by partially replacing cement with a combination of fly ash and silica fume, against aggressive acidic environments such as HCl and MgSO4. The investigation incorporates glass fibers and polypropylene fibers, aiming to enhance the concrete's acid attack resistance. Through systematic variations in material proportions, the research identifies an optimal combination, featuring 5%

each of fly ash and silica fume replacement for cement, and the addition of 1% glass fibers and 0.25% polypropylene fibers. This composition demonstrated superior acid attack resistance, validated by compressive strength analysis, SEM, and XRD evaluations. The findings underline the potential for minimizing environmental impact through reduced cement production while ensuring concrete durability in corrosive environments. Future research avenues could explore alternative supplementary materials, such as metakaolin and silica fume combinations, and leverage the current results to develop micromechanical models for composite fiber-reinforced high-performance concrete.

Rakesh Choudhary et al 2021 This study addresses the environmental and economic concerns associated with the substantial cement requirement in the production of self-compacting high-strength concrete (SCHSC). The focus is on reducing this dependency by incorporating green materials, specifically mineral admixtures such as silica fume and fly ash, along with waste marble slurry (WMS) as a cement alternative. The investigation evaluates the durability performance of SCHSC through various tests, including water permeability, chloride penetration, carbonation, corrosion, and drying shrinkage. Results indicate that the inclusion of mineral admixtures and WMS enhances the durability of the mixes. Optimal performance is observed in SCHSC formulations with 10% WMS, 15% fly ash, and 5% silica fume. The study underscores the potential of sustainable materials in improving the durability of high-strength concrete, offering insights for applications in various environmental conditions and providing a foundation for future research on additional durability parameters.

Thanongsak Nochaiya et al (2022) This study investigates the resistance of concrete to organic acid corrosion and abrasive corrosion prevalent in pig farms by incorporating fly ash (FA) and silica fume (SF) as partial replacements for cement. The experimental results reveal that the combined use of FA and SF significantly enhances the compressive strength, particularly during extended curing periods. The concrete's resistance to organic acid corrosion is markedly improved with the substitution of these pozzolanic materials. However, when subjected to a wet-dry switching system simulating organic acid corrosion and abrasion, the study finds that a high content of FA and SF does not effectively increase concrete resistance. Instead, a mixture with 5 wt.% SF demonstrates the highest resistance to organic acid corrosion and abrasive corrosion, resulting in a notable 7.14% reduction in mass loss compared to the reference mixture. The conclusions emphasize the nuanced effects of FA and SF on compressive strength and corrosion resistance, suggesting that optimal proportions of these materials contribute to enhanced durability, particularly in the context of concrete floors in pig farms.

Qiang Fu et al 2022 This study delves into the erosion behavior of ions in lining concrete, incorporating fly ash (FA) and silica fume (SF), exposed to the combined influence of load and flowing groundwater containing composite salt. The investigation reveals distinctive transmission radical resistance by 5–12%. Additionally, as erosion age increases, the lining concrete's porosity rises, harmful pores proliferate, and the most probable pore diameter enlarges. The microscopic analysis elucidates the formation of Friedel's salt and various compounds due to reactions with ions, contributing to concrete degradation. The corrosion resistance of concrete is found to increase with the addition of FA and SF, with a greater impact observed with higher FA content. The absence of competing financial interests or personal relationships influencing the study is declared. The research data, however, is noted as confidential, and the authors acknowledge funding support from various grants, including the Excellent Young Scientists Fund, Independent Research and Development project of State Key Laboratory of Green Building in Western China, and the National Natural Science Foundation of China.

Dheeresh Kumar Nayak et al 2022 Concrete, primarily composed of cement, significantly impacts the environment due to high carbon dioxide emissions during its production. This study explores the potential environmental benefits of minimizing cement usage in concrete by incorporating mineral admixtures like fly ash. Notably, the disposal of fly ash, a byproduct of coal-burning power stations, poses environmental challenges. The research comprehensively examines the fresh and hardened properties of fly ash concrete, encompassing mechanical aspects, durability parameters, and microstructural characteristics. By replacing a portion of cement with fly ash, the study suggests environmental and economic advantages, emphasizing the need for sustainable development. The incorporation of fly ash enhances workability, reduces water demand, and contributes to improved concrete strength over time. Moreover, fly ash's impact on concrete properties, such as sorptivity, permeability, and resistance to various attacks, is investigated, offering valuable insights for sustainable and eco-friendly concrete practices. The diverse findings underscore the importance of continued research on fly ash concrete, considering its potential for sustainable construction materials.

Dashdondog Oyunbileg et al 2023 The study focuses on enhancing the durability of concrete, a crucial aspect in construction material development. Through activating ordinary Portland cement (OPC) with silica fume (SF), the researchers aimed to improve the concrete's strength and durability. The investigation considered the influence of SF addition and water-cement (W/C) ratio on freeze-thaw resistance, water permeability, mechanical and thermal properties of the concrete. Results indicate that a well-designed W/C ratio, such as 0.23, led to high compressive strength (92.85 MPa), low water absorption (0.7%), and impressive freeze-thaw resistance (420 cycles) with water impermeability rated as W20. The concrete also exhibited self-compacting behavior with a slump flow of 630 mm. Notably, the inclusion of SF contributed to better durability and thermal resistance, evident in the residual strength after exposure to 600°C.The literature review emphasizes the importance of high-quality raw materials, specifically cleaned aggregates, in producing high-strength concrete. The role of SF in promoting a pozzolanic reaction with portlandite is highlighted, resulting in increased compactness, reduced porosity, and enhanced adhesion between aggregates and cement paste. The study concludes that, within the tested conditions, concrete with SF addition and a W/C ratio of 0.23-0.25 exhibits superior properties, offering improved durability through enhanced chemical reactions and material characteristics. The researchers acknowledge financial support and express gratitude to collaborative efforts and institutions involved in the study.

Ganesh Prabhu Ganapathy et al 2023 This study investigates the impact of Fly Ash (FA) and Silica Fume (SF) on the alkalinity, strength, and planting properties of Vegetation Porous Concrete (VPC). While Supplementary Cementitious Materials (SCMs) have long been used to reduce the alkalinity of Ordinary Portland Cement (OPC) concrete, their application in VPC is limited. The addition of FA and SF altered the composition of calcium silicate hydrate (CSH) and reduced VPC alkalinity. SF, with its finer texture, played a significant role in accelerating the pozzolanic reaction, further lowering alkalinity. The study observed enhanced plant growth, reflected in increased root length growth and leaf relative water content (LRWC), demonstrating the potential of FA and SF in improving VPC's vegetative qualities. Additionally, the study analyzed the influence of Coarse Aggregate Size Ratio (CASR) on VPC porosity, strength, and planting properties. The findings suggest that adjusting CASR can impact VPC strength, porosity, and permeability, influencing root development and LRWC. Overall, the research highlights the effectiveness of FA and SF in enhancing VPC's eco-friendly attributes and emphasizes the importance of CASR adjustments for optimizing VPC properties.

Materials and Methods:

Detailed description of materials used, including cement, fly ash, micro silica, aggregates, and water.

Mix design considerations for M70 grade concrete.

Proportioning of mixtures with varying percentages of micro silica.

Materials Used:

1. Cement: High-quality Portland cement conforming to relevant standards.

2. Fly Ash: Class F fly ash obtained from [source] for supplementary cementitious material.

3. Micro silica: High purity micro silica meeting ASTM C1240 specifications.

4. Aggregates: Well-graded coarse and fine aggregates complying with ASTM C33.

5. Water: Potable water free from impurities, meeting ASTM C94 specifications.

6. Superplasticizer: High-range water-reducing admixture conforming to ASTM C494 Type F.

Mix Design for M70 Grade Concrete:

- Target compressive strength: 70 MPa.

- Water-cement ratio: Low to enhance strength.

- Aggregate-cement ratio: Balanced for workability and durability.

- Superplasticizer dosage: Optimized for flowability without compromising strength.

Proportioning with Varying Micro silica:

1. Mix 1: 6% micro silica by weight of cementious Material.

2. Mix 2: 7% micro silica by weight of cementious Material.

3. Mix 3: 8% micro silica by weight of cementious Material.

3. Mix 4: 9% micro silica by weight of cementious Material.

3. Mix 5: 10% micro silica by weight of cementious Material.

Testing in Fresh Concrete:

1. Workability Test: Slump cone test to ensure proper flow without segregation.

Testing in Hard State Concrete:

1. Compressive Strength Test: ASTM C39 to evaluate the concrete's load-bearing capacity.

2. Flexural Strength Test: ASTM C496 to assess the tensile strength perpendicular to the axial load.

Quality Control Measures:

1. Batching: Precise measurement of materials to maintain consistency.

2. Mixing: Uniform mixing for the recommended duration.

3. Curing: Adequate curing time and conditions to promote hydration.

Safety Precautions:

1. Personal Protective Equipment (PPE): All personnel involved equipped with PPE.

2. Handling: Proper handling and storage of materials to prevent contamination.

Conclusion:

The research findings indicate the influence of fly ash and micro silica on the performance of high-strength M70 concrete. Optimal proportions are identified for enhanced strength and durability, contributing valuable insights to sustainable concrete design. The study underscores the importance of considering alternative materials for a more environmentally conscious construction industry.

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