REVIEW ON ULTRA-FINE FLY ASH CONCRETE

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Abstract: Ultra-fine fly ash displays a strong tendency to reduce water demand for comparable workability as silica fume concrete, a 10 % reduction in total water content together with as much as 40 % reduction in HRWR, was possible [K. H. Obla et. al., 2003]1. . [Copeland et al. 2001]2 and [Obla et al., 2003]1 reported 10 % reduction in water demand when 50% cement replaced by ultra-fine fly ash. Replacement of cement with up to 25% of UFFA determines higher compressive strength at 7, 28, and 84 days than plain mortars, regardless of the type of cement used. Mortars manufactured with 35% or 50% of UFFA show slightly lower or similar compressive strength compared to the reference mortar [Coppola et al., 2018]3. This study helps to better understand the potential and capabilities of UFFA concrete, which will minimize the drawback of HVFA and provide sustainable construction material to the construction industry.

Keywords: Ultra-fin fly ash concrete, workability, compressive strength, flexural strength, split tensile strength.

I. INTRODUCTION

Ultra-fine fly ash not only increase slump and spread, but also reduce the slump loss [Li Yijin et al., 2004]4. Reason is well explained that is first, ultra-fine fly ash prolongs the setting time, which results in decreasing slump loss of concrete, secondly ultra-fine fly ash has huge specific surface area which can absorb some super plasticizer and thirdly the Zeta potential of ultra-fine fly ash is negative in de-ionized water. [Copeland et al. 2001]2 reported that with given workability and water content, UFFA concrete comparable to silica fume (SF) concrete can be produced with only 50% of the high-range water reducer (HRWR) dosage.

Relation between the setting time and cement replacement was well explained by [Li Yijin et al., 2004]4. In general, the set time of ultra-fine fly ash -cement paste is prolonged with the increase of ultra-fine fly ash. The initial and final setting time of ultra-fine fly ash -cement paste was observed about 9.56 and 11.25 hours respectively at UFFA replacement 20%. However at UFFA replacement 40%, the initial and final setting tines of ultra-fine fly ash –cement paste are prolonged to about 11.85 and 13.58 hours, respectively. The reason explained is the outer surface of ultra-fine fly ash particle increase with the increase of ultra-fine fly ash, the amount of absorbed calcium ions increased. That inhibits calcium ions concentration build-up in fresh paste during early hydration, resulting in the setting time is prolonged, thus, the heat of hydration decreases [Li Yijin et al., 2004]4.

[Krishnaraj and Ravichandran, 2020]5 found that the ultra-fine fly ash masonry block shows higher compressive strength, higher resistance to shear, higher bonding between two bricks compare to conventional masonry blocks. Author investigated process of grinding alters the particle size and specific surface area but not shown any variation in chemical composition. Overall, investigations show that additional use of 45% ultra-fine fly ash in construction applications without compromising the quality.

LITERATURE REVIEW

A no of studies have been conducted on ultra-fine fly ash concrete The brief literature review of the latest studies are as follows.

Author and Year	Concrete (Grade) Mineral admixture and % of Replacement of mineral admixture	Properties of concrete	Findings
[Coppola et al., 2018]3	Plain and UFFA mortar using (i) five types of cement (ii) Siliceous fly ash (iii) UFFA FA: 5%, 15%, 25%, 35%, 50%. W/C ratio=0.5	Higher compressive strength found at 25 % UFFA replacement @7, 28 and 84 days. 7 and 28 days compressive strength at 35 % UFFA depends on the type of cement. 84 days compressive strength is higher than the plain mortar regardless the type of mortar.	Grinding process results in reduced particle size and increased specific surface. Percentage of FA used in independent of type of cement. The strength pazzolanic activity index (k) ratio of the compressive strength found higher of mortar with FAand UFFA than plain mortar. K is independent of type of cement, percentage of FA or UFFA. K value of 35% UFFA mortar is found higher than 1. K value of 50% UFFA mortar found 0.70@28days and 0.87@84days
[Krishnaraj and Ravichandran, 2020]5	Mortar using class C fly ash and ultra-fine fly ash. OPC:100 % (control Mortar) RFA:15,30,45,60 % GFA:15,30,45,60 % AGFA:15,30,45,60 % RFA- raw fly ash, GFA- ground fly ash without grinding aid, AGFA- Amine grinding aid fly ash	Compressive strength initially reduces. Maximum compressive strength found 46.56 MPa at 15 % RFA, 49.83 MPa at 15 % GFA, 52.49 MPa at 15 % AGFA @28 days.	GFA particle size is decreased with increase 120 min. grinding time interval. GFA and AGFA showed 23% and 25% higher fineness as compared to RFA samples. The process of grinding alters the particle size and specific surface area but not shows any variation in chemical composition and elements which is evident from XRF and EDX analysis. The optimum mix proportions are RFA-15%, GFA-30% and AGFA-45 % @ 28 days strength as compared to control mortar. Study indicates the additional use of about 30 % fly ash in the form of UFFA. Comparing all the masonry blocks the UFFA masonry block shows better performance.
[Qiang Wang et. al., 2013]6	Incorporated blended steel slag super fine fly ash as mineral admixture in concrete and compared the performance with concrete containing ordinary fly ash.	Result indicated that incorporation of blended steel slag super fine fly ash in concrete has similar effect on the early strength and chloride ion permeability. Blended mineral admixture has higher	Paste and concrete containing blended mineral admixture have smaller porosities than that containing ordinary fly ash.

		ability to improve the late strength of concrete than ordinary fly ash.	
[Hu Jin et al., 2014 [7]	Investigated properties of high strength concrete by replacing part of cement by super-fine fly ash (25%) and lime stone powder (10%).	Result showed concrete containing super-fine FA and lime stone powder can get a larger initial slump loss than control mix with same amount of plasticizer content. Although early strength was lower but late strength showed almost same level of performance.	Beside this researchers found that high strength concrete containing super-fine FA and lime stone powder exhibit lower adiabatic temperature rise, a lower permeability and a larger carbonation depth.

VII. CONCLUSIONS

From the Investigation carried out using ultra-fine fly ash indicates that in the construction industry it can also be considered to use the Eco sustainable material which is relevant to the conventional material. It is also useful for minimising the usage of natural resources which are used for producing the cement material. This will make the low impact on the contamination of land by disposing the waste products. The future studies may conduct the process of ball milling may be concentrated the energy involved in the process and cost analysis [Krishnaraj and Ravichandran, 2020]5. [C. B. Shah et al]8 reported although the initial strengths were lower than ordinary portland cement, but at later age compressive strength were close to that of only ordinary Portland. [Coppola et al., 2018]3 concluded the grinding of FA, despite resulting in an increase in production energy and CO2 emissions compared to unmilled FA, allows a wide use of these SCM (Supplementary Cementitious Materials) in place of cement, reducing the environmental impact of mortars up to 40% at the 28-day strength class. The use of UFFA ensures better resistance in CaCl2-rich environments The literature surveyed reported that incorporating ultra-fine fly ash in concrete has positive effect on almost all properties searched and reviewed here.

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