Utilization of Silica Fume as Partial Replacement of Sand in Concrete – A Review

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Abstract— Concrete can bear up the severest environmental conditions; however, in several conditions it may show very low characteristics. Hence, engineers worldwide are constantly trying to improve its characteristics with the aid of modern admixtures and waste materials, usually called as alternate building materials (ABM). Currently, concrete mixtures include different alternate building materials which produce part of the cementitious constituent. The major advantage of ABM is its capacity to substitute basic ingredients partially or wholly in concrete and still presenting the cementitious property. The use of waste material as ABM helps to consume these waste materials and also improves the properties of concrete in fresh and hydrated states. Most significant ABMs which are used very frequently are fly ash and silica fume as they enhance both compressive strength and durability of concrete. This paper reviewed several researches performed to observed the affect of using silica fume in concrete.

I. INTRODUCTION

As there is vast increase in the commercial and residential wastes and industry by-products such as fly ash, silica fume, ground granulated blast furnace slag etc. The use of these materials in concrete constructions is recommended not only to curtail the contamination, and also to get better properties of concrete.

The ABM can be categorized on the basis of reaction- hydraulic and pozzolanic. Hydraulic materials can react with water to make cementitious compound like Ground granulated blast furnace Slag (GGBS). Pozzolanic materials are not having any cementitious property, however, when used with cement or lime can form products possessing cementitious prosperities.

Silica fume (SF) is a byproduct of manufacturing silicon and ferrosilicon alloys which are finely segregated residue captured from the oxidized vapor on top of the electric arc furnaces. Silica fume consists of fine particles, with particles approximately one hundredth the size of the average cement, because of its intense fineness and high silica content, silica fume is a very effective pozzolanic material particle.

II. LITERATURE REVIEW

Many studies have been conducted in order to inspect the benefits of utilizing pozzolanic materials in constituting and improving the properties of concrete. Thomas and Shehata [1] studied the bending of cementitious materials such as Portland cement, fly ash and silica fume. These materials are having major advantages over other type blends and still much better improvements than plain Portland cement. An experimental study is done by Sandor [2] by using the Portland cement-fly ash – silica fume systems in concrete and finally concluded various beneficial effects of addition of silica fume to the fly ash cement mortar by comparing results in terms of workability, strength and ultra sonic velocity test. Bijen [3] performed study in order to understand the benefits of slag and fly ash if added to concrete. Lam et al. [4] calculate the Effect of fly ash and silica fume on compressive and fracture performances of concrete and concluded development of strength properties of concrete by mixing different proportion of fly ash and silica fume. A study has been conducted by Gonen and Yazicioglu [5] for inspecting the influence of binary and ternary blend of mineral admixtures on the short and long term performances of concrete and ultimately made a conclusion that concrete properties are improved in fresh and hardened states. An experimental work has been done by Mateusz and Nantung [6] whose title is Effect of mixture composition and Initial curing conditions on the scaling resistance of ternary concrete for finding the effect of varying proportions of constituents of ternary blend of binder mix on scaling resistance of concrete at low temperatures. Barbhuiya et al. [7] studied the properties of fly ash concrete modified with hydrated lime and silica fume recommended that adding up of lime and silica fume progresses the early days compressive strength and long term strength development and durability of concrete.

An experimental work carried out on Oxygen and water vapour transport in cement pastes has been done by Cabrera and Linsdale **[8]**, concluded that the flow of oxygen is takes place according to the Darcy equation, but the flow of water vapour is not. The different mechanisms of spreading cause the transmission rates for

oxygen to be spread over a far greater range than those for water vapour with some of the SF samples almost impermeable to oxygen.

An experimental work has been carried out by Patel [9] on application of steel slag aggregate in concrete and bring to a close that it has the ability to withstand under freeze-thaw environment, but in this study it was observed that the steel slag aggregates have expansive property and would cause cracking of concrete. The results revealed that there would not be much change in the durability of concrete if to 50 to 70 % of steel slag aggregates are included in the traditional concrete.

In order to check the influence of mineral admixtures on the short and long term performance of concrete, an experimental investigation has been done by Thanongsak [10] and came to a conclusion that silica fume is helpful in contributing both short and long term characteristics of concrete, while fly ash reveals its beneficial effect in a relatively longer time. As far as the crushing strength is concerned, by the addition of both silica fume and fly ash slightly increases compressive strength.

Patel et al. [11] did a research work in Utilization of steel slag as aggregates for stone mastic asphalt (SMA) mixtures and conclusion is that the test roads illustrates exceptional performances after 2 years service, with abrasion and friction coefficient of 55 BPN and surface texture depth of 0.8 mm.

An experimental work has been carried out by Yun-feng et al. [12] in order to compare properties of steel slag and crushed a limestone aggregate concrete which shows that durability of steel slag cement concrete is better than crushed limestone aggregate concrete.

III. CONCLUSIONS

The main conclusions drawn are insertion of silica fume in concrete in different proportions influences the various properties such as – this can enhances the characteristics of formed binder mixes. Inclusion of silica fume improves the strength of different types of binder mix by making them denser.

Addition of silica fume improves the early strength gain of fly ash cement whereas it increases the later age strength of cement concrete.

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