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REVIEW PAPER ON PARTIAL REPLACEMENT OF CEMENT WITH SILICA FUME AND ITS EFFECTS ON CONCRETE PROPERTIES

Ram Kumar[1], Er. Jitender Dhaka[2]
M.TECH Scholar, Asst. Professor, Department of Civil Engineering
Om Institute of Technology & Management, (Hisar), Haryana

ABSTRACT: The aim of this study is to evaluate the performance of Silica Fume an industrial by product as a admixture in concrete keeping in view the increasing market demand of cement which compel production of cement at large scale resulting in environmental problem and depletion of natural resources on one hand and rising prices on the other hand. To overcome these problem ideas developed to investigate the use of industrial by product/waste. The silica fume industrial by product found to be an attractive cementations material which is by product of smelting process in the silicon and ferrosilicon industry. The partial replacement of silica fume and its effects on concrete properties has been studies by adopting M-35 concrete mix in this dissertation. The main parameter investigated in this study M-35 concrete mix with partial replacement by silica fume with varying 0, 5, 9, 12 and 15% by weight of cement The paper presents a detailed experimental study on compressive strength, flexural strength and split tensile strength for 7 days and 28 days respectively. The results of experimental investigation indicates that the use of silica fume in concrete has increased the strength and durability at all age when compared to normal concrete. Hence the use of Silica Fume leads to reduction in cement quantity for construction purpose and its use should be promoted for better performance as well as for environmental sustainability.
KEYWORDS:-Silica Fume, Compressive Strength, Split tensile Strength, flexural Strength, review paper.

I. INTRODUCTION

Concrete is a mix of ingredient of cement, fine aggregate, coarse aggregate & water. It can be molded into any shape in plastic stage. The relative quantity of ingredient control the property on concrete in wet stage as well as in hardened stage. Before two or three decades ago, the production of concrete for construction of building with OPC with the ease of availability of ingredient of concrete irrespective of quality was in practice without considering the future of concrete structure. Now with the passage of time in the modern era investigation since last two to three decades made by the Engineers & scientists keeping in view the structural stability of structure which needs quality concrete with improved strength, durability & other characteristics of concrete. The demand of these characteristics derive the search for supplementary cementitious materials. Search for any suitable material in partial replacement of cement which is universally sustainable development and lowest possible environmental impact. Cement concrete is most construction material today. We can say that we are living in the era of concrete. Concrete is prepared by mixing cement, aggregates & water. It is easy to make concrete but actually concrete is complex material. It is site made material and a such its quality, properties and performance can vary to great extent due to use of natural material except cement. In the fast development of infrastructure in the country use of high strength & high performance cement (HPC) is now in common practice. In the journey of research Silica Fume, fly ash, ground granulated blast furnaces slag etc are found suitable and most commonly used cementations materials in partial replacement of cement. Substantially use of industrial by products save the cost and energy in addition to meet out the requirement of environmental awareness. Silica Fume pozzolanic materials is found most suitable industrial product as to be used in concrete as partial replacement of cement. A number of studies are going on in India as well as abroad to study the impact of use of these pozzolanic materials as cement replacements and the results are encouraging. Addition of silica fume to concrete has many advantages like high strength, durability and reduction in cement production. The optimum silica fume replacement percentage for obtaining maximum 28- days strength of concrete ranged from 5 to 15%. Cement replacement up to 12% with silica fume leads to increase in compressive strength, for M35 grade of concrete. When pozzolanic materials are incorporated to concrete, the silica present in these materials react with the calcium hydroxide released during the hydration of cement and forms additional calcium silicate hydrate (C – S – H), which improve durability and the mechanical properties of concrete.

II. LITERATURE REVIEW

(Bhanja and Sengupta, 2002) represents a mathematical model developed using statistical methods to predict the 28-day compressive strength of silica fume concrete with water-tocementitious material (w/cm) ratios ranging from 0.3 to 0.42 and silica fume replacement percentages from 5 to 30. Strength results of 26 concrete mixes, on more than 300 test specimens, have been analyzed for statistical modeling. The ratios of compressive strengths between silica fume and control concrete have been related to silica fume replacement percentage. The expression, being derived with strength ratios and not with absolute values of strength, is independent of the specimen parameters and is applicable to all types of specimens. On examining the validity of the model with the results of previous researchers, it was observed that for results on both cubes and cylinders, predictions were obtained within 7.5% of the experimentally obtained values.

(Heba A. Mohamed, 2011) presents an experimental study on self-compacting concrete (SCC) with two cement content. The work involves three types of mixes, the first consisted of different percentages of fly ash (FA), the second uses different percentages of silica fume (SF), and the third uses a mixture of FA and SF. After each mix preparation, nine cylinder specimens are cast and cured. Three specimens are cured in water for 28 days, three specimens are cured in water for 7 days, and three specimens are left in air for 28 days. The slump and V-funnel test are carried out on the fresh SCC and concrete compressive strength values are determined. The results show that SCC with 15% of SF gives higher values of compressive strength than those with 30% of FA and water cured specimens for 28 days give the highest values of compressive strength.

(Abdullah et.al, 2011). Concluded silica fume is very reactive pozzolana, while it is used in concrete because of its fine particles, large surface area and high SiO2 content. Silica fume is much fined separated silica obtained as a by-product in industry. It is used as an admixture in the concrete mix and it has significant effects on the properties of the resulting material. Simultaneously, silica fume can be also utilized in production of refectory and porcelain, to increase intensity and durability. In addition, it can improve the overall performance of the material as filler used in coating resin, paint, rubber and other high molecular materials.

(Pawade.P et.al. 2011) concluded the effect of silica fume with and without steel fibers on Portland Pozzolona cement. In this study we used concrete mixes with Silica Fume of 0%, 4%, 8%and 12% with addition of crimped steel fibers of two diameters 0.5 mm Ø and 1.0 mm Ø with a constant aspect ratio of 60, at various percentages as 0%, 0.5 %, 1.0 % and 1.5 % by the volume of concrete on M30 grade of concrete. The effect of mineral admixture as cement replacement material with and without steel fibers on mechanical properties were analyzed and compared with normal concrete as well as silica fume concrete. In comparison, with control concrete the replacement of 4%,8%,12% and 16% cement by silica fume showed 7.46%, 11.17%, 11.91%and 9.83% increase in compressive strength at 28 days of curing. The optimum combined effect at 8% silica fume and 1.5% steel fiber with normal concrete the maximum compressive strength increase at 0.5 mm Ø and 1.0 mm Ø steel fiber at 28 days of curing were 15.38% and 18.69%, the maximum flexural strength increase were 17.13% and 24.02%.The combined effect of silica fume at 4% & 12% with steel fiber at 0.5%, 1.0% & 1.5% of both diameters 0.5 mm Ø and 1.0 mm Ø at different ages of curing are presented.

(Dilip Roy and Amitava Sil, 2012) studied the nature of SF and its influences on the properties of fresh and hardened concrete. In the present study, an attempt has been made to investigate the strength parameters of concrete made with partial replacement of cement by SF. Very little or no work has been carried out using silica fume as a replacement of cement. Moreover, no such attempt has been made in substituting silica fume with cement for low/medium grade concretes (viz. M20, M25). Properties of hardened concrete viz Ultimate Compressive strength, Flexural strength, Splitting Tensile strength has been determined for different mix combinations of materials and these values are compared with the corresponding values of conventional concrete. The present investigation has been aimed at to bring awareness amongst the practicing civil engineers regarding advantages of these new concrete mixes.

(Debabrata Pradhan et.al, 2013) stated that the mix proportioning is intricate and the design parameters are increased due to the incorporation of silica fume in conventional concrete. The aim of this paper is to look into the different mechanical properties like compressive strength, compacting factor, slump of concrete incorporating silica fume. In this present paper concrete incorporating silica fume are cast for 5 (five) mixes to perform experiments. Different percentages of silica fume are used for cement replacement in order to carry out these experiments at a single fixed water-cementitious materials ratio keeping other mix design parameters constant. The cement replacement level by silica fume was 0%, 5%, 10%, 15% and 20% for a constant water-cementitious materials (w/cm) ratio for 0.50. 100 and 150 mm cubes are used to determine the compressive strengths for all mixes at the age levels of 24 hours, 7 and 28 days. Besides the compressive strengths other properties like compacting factor, slump of concrete are also determined for five mixes of concrete.

(T. Shanmugapriya, Dr. R. N. Uma (2013) concluded thatwith increased environmental awareness and its potential hazardous effects, utilization of industrial byproducts has become an attractive alternative to disposal. Silica fume (SF), which is by product of the smelting process in the silicon and ferrosilicon industry. The water binder ratio (W/B) adopted was 0.32 and the Super Plasticizer used was CONPLAST SP 430.Specimens such as cubes, beams and cylinders were cast for various mix proportions and tested at the age of 7,14 and 28 days. The investigation revealed that the partial replacement of cement by silica fume will develop compressive strength, flexure strength and split tensile strength sufficient for construction purposes.

(Kennouche.S.et.al, 2013) stated that Self-compacting concrete (SCC) was elaborated using local materials and silica fume (SF) as admixture in 15% of cement quantity, two different Portland cements (PC) and two different superplasticizer that the chemical nature is polycarboxylate and plynaphtalene, the aggregates used are (AG 3/8 mm, AG 8/15 mm), coarse and fine sand (SC, SF) witch fineness modulus 3.2 and 1 in the order. The dosage of the different super plasticizer used is chosen after experimental spreading tests of each self-compacting concrete formulation. Results of fresh concrete tests executed, as L-box and segregation resistance are on concordance whit values recommended by the French association of civil engendering. Also the mechanical characterization was conducted by compressive strength and splitting compression testing procedure, results values are in the range higher than 20 Mpa at the seven day by the compressive test for the all compositions, and the highest value was 40.93 MPa at the 28 day bay compressive test of the fourth's formulation specimens, the values of splitting compressive tests of al formulation specimens at 7, 14 and 28 days, was situated between 2.01 and 4.40 MPa. In order to determine the super plasticizer saturation assay in of cement pasts used in self-compacting concrete, the study was completed by a rheological study with a variable velocity gradient, so as to estimate the quantity of saturation assay of superplasticizer and the formulation, also the flow models of cement paste.

(Ghutke and Bhandari, 2014) concluded that Portland cement can be partially replaced by silica fume. Silica fume is non-metallic and non-hazardous waste of industries. It is suitable for concrete mix and improves properties of concrete i.e. compressive strength etc. The main objective of this research work is to determine the optimum replacement percentages which can be suitably used under the Indian conditions. To fulfill the objective various properties of concrete using silica fume have been evaluated. Further to determine the optimum replacement percentage comparison between the regular concrete and concrete containing silica fume is done .It has been seen that when cement is replaced by silica fume compressive strength increases up to certain percentage (10% replacement of cement by silica fume).But higher replacement of cement by silica fume gives lower strength.

III. CONCLUSION

High performance concrete produced by partial replacement of cement with silica fume in thisstudy. The achievement of the present study obtained with the replacement of cement by 5%,9%,12% and 15% silica fume The Compressive strength split tensile strength and the flexural strength test were observed for the mixes at the age of 7 days and 28 days. Thus high performance concrete obtained by replacement of cement up to 12% silica fume leads to increase in compressive strength, and the flexural strength of concrete. The compressive strength mainly depend on percentage of silica fume. High performance concrete with silica fume can be effectively used in high rise building since high early strength is required with the reduced construction period. The percentage of increase in compressive strength is 17.76%, split tensile strength 20.74% and the flexural strength is 40.67%at the age of 28 days by replacing partial replacement of cement with silica fume. The optimum percentage of partial replacement of cement with silica fume is 12% for compressive and flexural strength and 9% for split tensile strength of concrete.

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