A literature review on study of silica fume as a partial replacement material of cement in concrete

1 Pallavi chawale, 2 Shubhnagi gole, 3 Sayali hirve,
4 Pranita kumbhar, 5 Monika sarvade, 6 Sheetal sahare.

{Department of Civil Engineering, VIIT, Pune}1,2,3,4,5&6

Abstract- In the recent past, there has been considerable attempts for improving the properties of concrete with respect to strength and durability, especially in aggressive environments. High performance concrete appears to be better choice for a strong and durable structure. A large amount of by-product or wastes such as fly-ash, copper slag, silica fume etc. are generated by industries, which causes environmental as well as health problems due to dumping and disposal. Proper introduction of silica fume in concrete improves both the mechanical and durability characteristics of the concrete. This paper present literature review on replacement of Cement by Silica Fume which includes current and future trends of research.

Keywords- Silica fume, Cement, pozzlanic.

I. INTRODUCTION

Concrete is one of the material which is widely used in all over the world in construction industry. Concrete is proportionate mixture of coarse aggregates, fine aggregates, cement and water. Coarse aggregates are obtained by crushing natural stone to required size. Normally natural sand which can be obtained from river bed is used as fine aggregate. Cement is manufactured in the industry. India is the second largest producer of cement in the world. There are about 188 large & 365 small cement plants in India. Total installed capacity is 366millions tonnes/annum. Actual cement production in the year 2016-17 is 420 Million tonne. Unfortunately production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere; a major contributor for greenhouse effect and the global warming upto 7-8%. Hence considering the effect of cement manufacturing on environment it is inevitable either to search for another material or partly replace it by a new material.

Silica fume is also known as a micro silica or condensed silica fume, is used as an artificial pozzolanic admixtures. It is a material resulting from reduction of quartz with coal in an electric arc furnace in the manufacture of silicon or ferrosilicon alloy. Chemical composition of silica fume contains more than 90% silicon dioxide. Other constituents are carbon, sulphur and oxide of aluminium, iron calcium, magnesium, sodium and potassium. The physical composition of silica fume Diameter is about 0.1micron to 0.2micron, surface area about 30000sq.meter/kg and density varies from 150 to 700kg/Cu.m
II. REVIEWS OF ARTICLES

1. Hanumesh, Varun & Harish (2015) observes the Mechanical Properties of Concrete Incorporating Silica Fume as Partial Replacement of Cement. The main aim of this work is to study the mechanical properties of M20 grade control concrete and silica fume concrete with different percentages (5, 10, 15 and 20%) of silica fume as a partial replacement of cement. The result showed that the compressive strength of concrete is increased by the use of silica fume up to 10% replacement of cement. From 10% there is a decrease in compressive strength and the split tensile strength of concrete is increased by the use of silica fume up to 10% replacement of cement. From 10% there is a decrease in split tensile strength. The optimum percentage of replacement of cement by silica fume is 10% for M20 grade of concrete.

2. Kumar & Dhaka (2016) write a Review paper on partial replacement of cement with silica fume and its effects on concrete properties. 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 indicate that the use of silica fume in concrete has increased the strength and durability at all ages when compared to normal concrete.

3. Ghutke & Bhandari (2014) examine the Influence of silica fume on concrete. Results showed that the silica fume is a good replacement of cement. The rate of strength gain in silica fume concrete is high. Workability of concrete decreases as increase with % of silica fume. The optimum value of compressive strength can be achieved in 10% replacement of silica fume. As strength of 15% replacement of cement by silica fume is more than normal concrete. The optimum silica fume replacement percentage varies from 10 % to 15 % replacement level.

4. Shanmugapriya & Uma (2013) carried an Experimental Investigation on Silica Fume as a partial Replacement of Cement in High Performance Concrete. The concrete used in this investigation was proportioned to target a mean strength of 60 MPa and designed as per A The water cement ratio (W/C) 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 7,14and 28 days CI 211.4R-08.The investigation revealed that the partial replacement of cement by silica fume will develop sufficient compressive strength, flexure strength and split tensile strength for construction purposes. The optimum dosage of silica fume found to be 7.5% (by weight), when used as partial replacement of ordinary portland cement.

5. Roy & Sil (2012) Studied the Effect of Partial Replacement of Cement by Silica Fume on Hardened Concrete. From the study it has been observed that maximum compressive strength (both cube and cylinder) is noted for 10% replacement of cement with silica fume and the values are higher (by 19.6% and 16.82% respectively) than those of the normal concrete (for cube and cylinder) whereas split tensile strength and flexural strength of the SF concrete (3.61N/mm2 and 4.93N/mm2 respectively) are increased by about 38.58% and 21.13% respectively over those (2.6 N/mm2 and 4.07 N/mm2 respectively) of the normal concrete when 10% of cement is replaced by SF.
6. Jain & Pawade (2015) studied the Characteristics of Silica Fume Concrete. The physical properties of high strength silica fume concretes and their sensitivity to curing procedures were evaluated and compared with reference Portland cement concretes, having either the same concrete content as the silica fume concrete or the same water to cementitious materials ratio. The experimental program comprised six levels of silica-fume contents (as partial replacement of cement by weight) at 0% (control mix), 5%, 10%, 15%, 20%, and 25%, with and without superplasticizer. It also included two mixes with 15% silica fume added to cement in normal concrete. Durability of silica fume mortar was tested in chemical environments of sulphate compounds, ammonium nitrate, calcium chloride, and various kinds of acids.

7. Amarkhail (2015) observed Effects of Silica Fume on Properties of High-Strength Concrete. He found that up to 10% cement may be replaced by silica fume without harming the concrete workability. Concrete containing 10% silica fume replacement achieved the highest compressive strength followed by 15% silica fume replacement with a small difference. Concrete with 15% silica fume content achieved the highest flexural strength. 10% and 15% silica fume content as replacement of cement were found to be the optimum amount for significantly enhancement of compressive strength and flexural strength respectively.

8. Ajileye (2012) Cement replacement up to 10% with silica fume leads to increase in compressive strength for M30 grade of concrete. From 15% there is a decrease in compressive strength for 3, 7, 14 and 28 days curing period. Compressive strength of M30 grade of concrete was increased from 16.15% to 29.24% and decrease from 23.98% to 20.22%

9. Sharma & Seema (2012) examined the effect of partial replacement of cement with silica fume on compressive strength of concrete. M20 grade of concrete with W/C ratio as 0.5 and percentage replacement was 0%, 10%, 20%. The optimum compressive strength is obtained at 20% cement replacement by a Silica Fume at all age levels (i.e. 24 hours, 7 & 28 days). The 28 days compressive strength at 20% replacement was found to be 32.29 mpa with a slump value of 21mm.

10. Pradhan and Dutta (2013) investigated the effects of silica fume on conventional concrete. The optimum compressive strength was obtained at 20% cement replacement by silica fume at 24 hours, 7 days and 28 days. Higher compressive strength resembles that the concrete incorporated with silica fume was high strength concrete.

III. CONCLUSION

The review of earlier studies related to partial replacement of Cement with Silica fume reveals that there is a significant change in the strength properties of concrete such as compressive strength, flexural strength, split tensile strength. These experiments were carried out in various grade concrete to find out the result. From the above literature reviews optimum percentage of Silica Fume varies from 5% to 15%. Up to these Percentage Replacement improvement in the strength of concrete has been observed in terms of Compressive Strength, Flexural Strength and Tensile Strength on partial replacement of Cement with Silica fume. Previous studied also shows that Silica Fume concretes possess superior durability properties.