

Effect of Silica Fumes used as replacement of cement on compressive strength of concrete

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ABSTRACT

The world is progressing and this progress requires both technological and infrastructure development. Still this development should not be on the cost of non-renewable resources, moreover it should not result in biological waste. Concrete is a major concentration material which is the combination of many materials may consist of the byproducts of the other processes called Supplementary cementitious material (SCM). The SCMs have the ability to switch specific amount of cement and still ready to show building material property, therefore reducing the value of victimization hydraulic cement. The waste materials, which can be used as SCMs like ash, silica oxide fume, ground granulated blast furnace slag, steel slag etc. The use of those byproducts not solely helps to utilize these waste materials however also enhances the properties of concrete in fresh and hydrated states. Micro silica or silica fumes, a very fine non-crystalline material is very good as filler material to provide good strength. In this study a trial has been created to extend the strength of concrete by exchange cement with 0%, 5%, 10%, 15% and 20% for silica fumes. The compressive strength was checked for the mentioned design mixes. It is found that an optimum replacement of V-day of small silica oxide to it of cement (by weight) will increase the strength of concrete to half-hour. Further addition of small silica oxide shows a decreasing trend.

1. Introduction

The history of concrete dates back to therein of the Greeks and Romans, since thentill today in the fields of concrete technology developments strive towards the achievement of higher and higher strength concrete. Concrete may be a material that basically consists of cement, coarse mixture (CA) offers the amount to the concrete, fine aggregate (FA) for filling the voids and water for setting the cement. The properties of concrete in terms of its strength, durability and economy depends on the varied properties of its ingredients, conjointly on the combination style standards, method of preparation, handling and curing conditions. Economization is nowadays done by replacing cement with cheap, waste and recycled products. Micro-silica is a by-product from the silicon carbide and metallic industries where it is recovered from the exhaust of electric furnaces. Silica fume is an ultrafine airborne material with spherical particles less than 1µm in diameter, the average being about 0.1 µm, acts as a filler and as cementitious agent. The silica fume also combines with calcium hydroxide to the form additional calcium hydrate which is denser, stronger and less permeable material. Verma et al. found that silica fume increases the strength of concrete more 25%. Pandit et al. concluded that addition of micro silica to concrete increases the strength of more than 17% due to their pozzolanic properties and reduces the permeability of concrete. Ghutkezet al. found that silica fume has been recognized as apozzolanic admixture that's effective in enhancing the mechanical properties to an excellent extent.

2. Materials And Methodology

The detailed of the properties of the materials used, the method followed to design the experiment and the test procedures followed have been explained here.

2.1 Materials

2.1.1. Cement

The cement used is Ordinary Portland Cement of ACC brand of 43 grade in the present study which surpasses BIS Specifications (IS 8112-1989) on compressive strength levels. The specific gravity was 3.0%, fineness was 2.05%, normal consistency was 34%

2.1.2. Fine Aggregate

Locally obtainable silica sand (IS: 383-1970) has been used. The bulk density of sand is 2640 kg/m³, specific gravity was 2.57, fineness was 3.08.

2.1.3. Water

Tap water was brought into use for this experiment having specific gravity 1.00.

2.1.4. Superplasticizer: -

In this experiment for improvement of the workability of concrete, super plasticizer- CONPLAST-SP 430 in the form of sulphonated Naphthalene polymers

2.1.5. Silica Fumes: -

Silica fume used was the by-product of the semiconducting material and ferrosilicon alloy production having spherical particles with a median particle diameter in the range of 120-200 nm. Prepared by reduction of high purity quartz (SiO₂) in electric discharge furnaces at temperatures in more than a 2200°C.

2.2 Preparation of Concrete: -

Concrete was prepared having different concentrations of silica fumes starting from 5% upto 20% in the succession of 5% by weight. The coarse aggregate had more concentration than the fine aggregate. For Compressive strength test the specimens were cubical having 15cm X 15 cm X 15 cm dimension was prepared with the help of mould. Tempering was done to avoid the voids. After 24 hours these moulds were removed specimens were placed in water for curing. These specimens are tested by compression testing machine when set for 28 days curing. Durability test was performed by acid attack test, the concrete cube specimens of assorted concrete mixtures of size 150mm were solid and after 28 days of water solidifying, the specimens were removed from the solidifying tank and allowed to dried. The weights of concrete cube specimens were taken. The acid attack check on concrete cube was conducted by immersing the cubes within the acid

water for thirty days once twenty eight days of curing. Concentrated HCL with of regarding at 5% weight of water was added to water in which the concrete cubes were held on. The resistance of concrete to acid attack was found by the loss of weight of specimen.

3. Results and discussions

3.1 Test results

3.1.1 Compressive Strength of concrete: -

The compressive strength test was performed according to IS 516-1959, to get compressive strength of concrete at the age of seven and twenty-eight days. The cubes were tested using the Compression Testing Machine (CTM). The compressive strength had been increased as the time of curing increased.

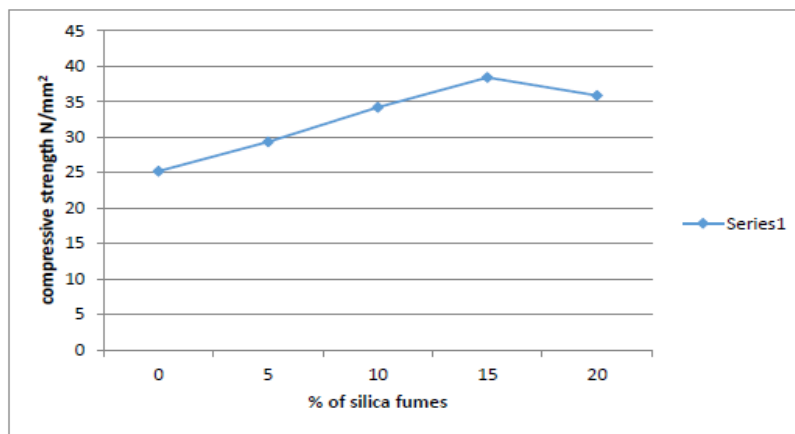


Figure 1: Variation in compressive strength after 7 days

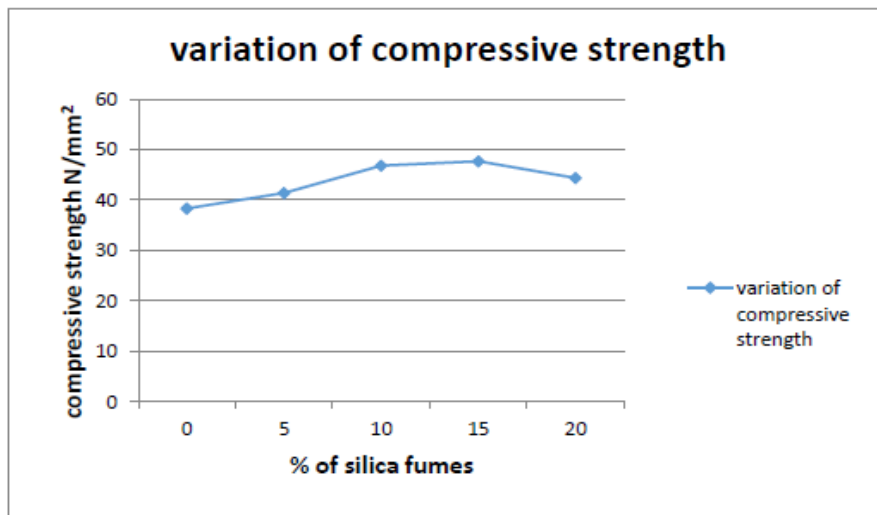


Figure 2: Variation in compressive strength after 28 days

The compressive strength of 15% replacement of silica fume was recorded highest which gives the optimum concentration of silica fumes. The silica fumes increased further decreased the strength of the concrete.

3.1.2 Durability Test

3.1.2.1 Acid Resistance

Cubes of sizes 150mm were solid and cured for twenty eight days. Once twenty eight days natural action cubes were

taken out and allowed for drying for twenty-four hours and weighs were calculated. For acid attack dilute hydrochloric acid is employed. The cubes were to be immersed in associate degree acid solution for a amount of thirty days. The concentration is to be maintained throughout this period. once thirty days the specimens were taken from the acid resolution. The surface of specimens cleansed and weights were measured. The specimen was tested within the compression testing machine beneath an even rate of loading 140Kg/cm² as

per IS 516. The mass loss and strength of specimens because of acid attack decided.

3.1.2.2 Acid attack

The action of acids on concrete is that the conversion of metal compounds into calcium salts of the assaultive acid. These reactions destroy the concrete structure. The

percentage of loss in compressive strength was 11.91%, 8.18% respectively. Thus replacement of silicon oxide fume is found to possess exaggerated the sturdiness against acid attack. This is because of the silicon oxide gift in silica fume which mixes with metal hydroxide and reduces the number vulnerable to acid attack.

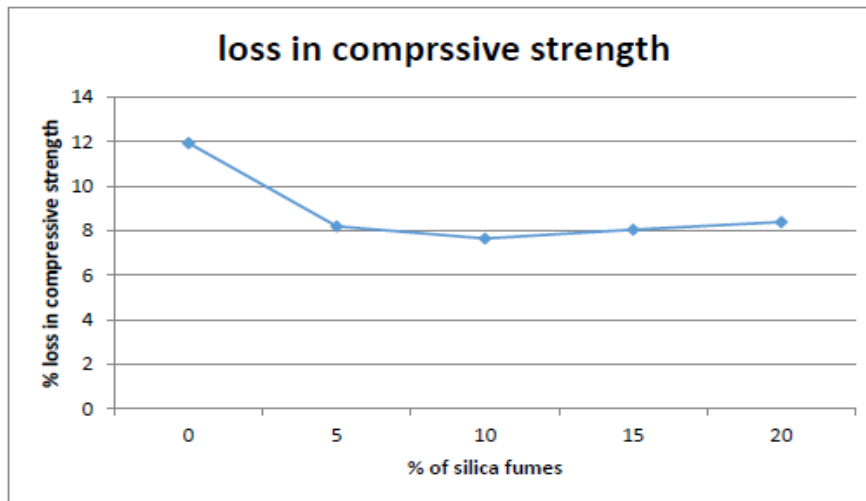


Figure 3: Percentage decrease on compressive strength due to acid attack

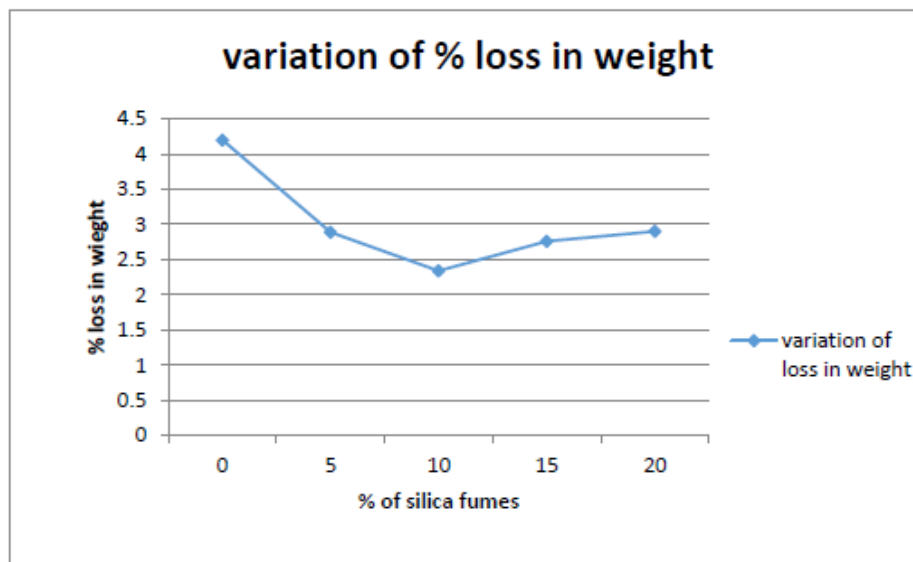


Figure 4: Percentage decrease weight due to acid attack

4. Conclusions

Silica fumes were mixed properly to form the concrete specimen for investigation. Inclusion of silica fumes enhanced the compressive strength of the concrete. Inclusion of 15% silica fumes showed maximum compressive strength. The

silica fumes inclusion increased the acid resistance of the concrete and the loss in compressive strength and weight loss was less in case of silica fumes. The inclusion of 10% silica fumes showed maximum resistance to acid attack.

References

- Nochaiya, T., Wongkeo, W. and Chaipanich, A., 2010. Utilization of fly ash with silica fume and properties of Portland cement-fly ash-silica fume concrete. *Fuel*, 89(3), pp.768-774.
- Patel, A., Singh, S.P. and Murmoo, M., 2009. Evaluation of strength characteristics of steel slag hydrated matrix. In *Proceedings of Civil Engineering Conference-Innovation without limits (CEC-09)*, 18th-19th September.

3. Li, Y.F., Yao, Y. and Wang, L., 2009. Recycling of industrial waste and performance of steel slag green concrete. *Journal of Central South university of technology*, 16(5), p.768.
4. Velosa, A.L. and Cachim, P.B., 2009. Hydraulic-lime based concrete: Strength development using a pozzolanic addition and different curing conditions. *Construction and Building materials*, 23(5), pp.2107-2111.
5. Barbhuiya, S.A., Gbagbo, J.K., Russell, M.I. and Basheer, P.A.M., 2009. Properties of fly ash concrete modified with hydrated lime and silica fume. *Construction and Building Materials*, 23(10), pp.3233-3239.
6. Mandeep Sindhu, Paramjeet Malik, "Research Paper on Risk Analysis of BOT Scheme", *International Journal of All Research Education and Scientific Methods (IJARESM)*, ISSN: 2455-6211, Volume 4, Issue 7, July- 2016.
7. Gonen, T. and Yazicioglu, S., 2007. The influence of mineral admixtures on the short and long-term performance of concrete. *Building and Environment*, 42(8), pp.3080-3085.
8. Radlinski, M., Olek, J. and Nantung, T., 2008. Effect of mixture composition and initial curing conditions on scaling resistance of ternary (OPC/FA/SF) concrete. *Journal of Materials in Civil Engineering*, 20(10), pp.668-677.
9. Mandeep Sindhu, "Study of Waste Polythene in Road Construction and its Methodologies", *IJRAR- International Journal of Research and Analytical Reviews*, Volume 5 , Issue 2, April – June 2018, E ISSN 2348 –1269, P ISSN 2349-5138, 2018.
10. Wang, C.L., Qi, Y.M. and He, J.Y., 2008, December. Experimental study on steel slag and slag replacing sand in concrete. In 2008 International Workshop on Modelling, Simulation and Optimization (pp. 451-455). IEEE.
11. Patel, J.P., 2008. Broader use of steel slag aggregates in concrete.
12. Rajamane, N.P., Peter, J.A. and Ambily, P.S., 2007. Prediction of compressive strength of concrete with fly ash as sand replacement material. *Cement and concrete composites*, 29(3), pp.218-223.
13. Mandeep Sindhu, "Effects of Road Accidents and Safety Concerning Adolescent", *IJRAR- International Journal of Research and Analytical Reviews*, E ISSN 2348-1269, Volume 5 , Issue 2, April – June 2018.
14. Türkmen, İ., 2003. Influence of different curing conditions on the physical and mechanical properties of concretes with admixtures of silica fume and blast furnace slag. *Materials Letters*, 57(29), pp.4560-4569.
15. Thomas, M.D.A., Shehata, M.H., Shashiprakash, S.G., Hopkins, D.S. and Cail, K., 1999. Use of ternary cementitious systems containing silica fume and fly ash in concrete. *Cement and concrete research*, 29(8), pp.1207-1214.
16. Mandeep Sindhu, "Design and study of motor sports and racing car setups", *International Journal of Advanced Science and Research*, ISSN: 2455-4227, Volume 2; Issue 4; July 2017; Page No. 145-148.
17. Papadakis, V.G., Fardis, M.N. and Vayenas, C.G., 1992. Hydration and carbonation of pozzolanic cements. *Materials Journal*, 89(2), pp.119-130.
18. Lam, L., Wong, Y.L. and Poon, C.S., 1998. Effect of fly ash and silica fume on compressive and fracture behaviors of concrete. *Cement and Concrete research*, 28(2), pp.271-283.
19. Mandeep Sindhu, "Effect of Efficient and Productive Transport in Economic Development of a Country", 3rd International Conference on Emerging Trends in Engineering, Technology, Science and Management ICETETSM-2017, IETE Lodhi Road, Delhi, India, 11th June 2017, ISBN: 978-93-86171-48-1.
20. Cabrera, J.G. and Lynsdale, C.J., 1988. A new gas permeameter for measuring the permeability of mortar and concrete. *Magazine of Concrete Research*, 40(144), pp.177-182.
21. Popovics, S., 1993. Portland cement-fly ash-silica fume systems in concrete. *Advanced Cement Based Materials*, 1(2), pp.83-91.