

A Review on Effect of Silica Flume on Steel Slag Cement

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Abstract- Concrete is the most versatile construction material because it can be designed to withstand the harshest environments while taking on the most inspirational forms. Engineers are continually pushing the limits to improve its performance with the help of innovative chemical admixtures and supplementary cementitious materials. Nowadays, most concrete mixture contains supplementary cementitious material which forms part of the cementitious component. These materials are majority byproducts from other processes. The main benefits of SCMs are their ability to replace certain amount of cement and still able to display cementitious property, thus reducing the cost of using Portland cement. The fast growth in industrialization has resulted in tons and tons of byproduct or waste materials, which can be used as SCMs such as fly ash, silica fume, ground granulated blast furnace slag, steel slag etc. The use of these byproducts not only helps to utilize these waste materials but also enhances the properties of concrete in fresh and hydrated states. Slag cement and fly ash are the two most common SCMs used in concrete. Most concrete produced today includes one or both of these materials. For this reason their properties are frequently compared to each other by mix designers seeking to optimize concrete mixtures. Perhaps the most successful SCM is silica fume because it improves both strength and durability of concrete to such extent that modern design rules call for the addition of silica fume for design of high strength concrete.

Index Terms- Physical Properties, Silica Flume, Concrete.

I. INTRODUCTION

Early SCMs consisted of natural, readily available materials like volcanic ash or diatomaceous earth. The engineering marvels like Roman aqueducts, the Coliseum are examples of this technique used by Greeks and Romans. Nowadays, most concrete mixture contains SCMs which are mainly byproducts or waste materials from other industrial processes. The Steel slag, a byproduct of steel making, is

produced during the separation of molten steel from impurities in steel making furnaces. This can be used as aggregate in concrete. Steel slag aggregate generally exhibit a propensity to expand because of the presence of free lime and magnesium oxides that have not reacted with the silicate structure and that can hydrated and expand in humid environments. This potentially expansive nature (volume changes up to 10 percent or more attributable to the hydration of calcium and magnesium oxides) could cause difficulties with products containing steel slag, and is one reason why steel slag aggregate are not used in concrete construction. Steel slag is currently used as aggregate in hot mix asphalt surface applications, but there is a need for some additional work to determine the feasibility of utilizing this industrial by-product more wisely as a replacement for both fine and coarse aggregates in a conventional concrete mixture. Most of the volume of concrete is aggregates. Replacing all or some portion of natural aggregates with steel slag would lead to considerable environmental benefits. Steel slag has high specific gravity, high abrasion value than naturally available aggregate apart from the drawbacks like more water absorption, high alkalis. Therefore with proper treatments it can be used as coarse aggregate in concrete. The production of a HSC may be hampered if the aggregates are weak. Weak and marginal aggregates are widespread in many parts of the world and there is a concern as to the production of HSC in those regions. Incorporation of silica fume is one of the methods of enhancing the strength of concrete, particularly when the aggregates are of low quality.

II. LITERATURE REVIEW

Many works have been done to explore the benefits of using pozzolanic materials in making and enhancing the properties of concrete. M.D.A. Thomas, M.H.Shehata et al. have studied the ternary

cementitious blends of Portland cement, silica fume, and fly ash offer significant advantages over binary blends and even greater enhancements over plain Portland cement. Sandor Popovics have studied the Portland cement-fly ash – silica fume systems in concrete and concluded several beneficial effects of addition of silica fume to the fly ash cement mortar in terms of strength, workability and ultra sonic velocity test results. Jan Bijen have studied the benefits of slag and fly ash added to concrete made with OPC in terms of alkali-silica reaction, sulphate attack. L. Lam, Y.L. Wong, and C.S. Poon in their studied entitled Effect of fly ash and silica fume on compressive and fracture behaviors of concrete had concluded enhancement in strength properties of concrete by adding different percentage of fly ash and silica fume. Tahir Gonen and Salih Yazicioglu studied the influence of binary and ternary blend of mineral admixtures on the short and long term performances of concrete and concluded many improved concrete properties in fresh and hardened states. Mateusz Radlinski, Jan Olek and Tommy Nantung in their experimental work entitled Effect of mixture composition and Initial curing conditions on the scaling resistance of ternary concrete have find out effect of different proportions of ingredients of ternary blend of binder mix on scaling resistance of concrete in low temperatures. S.A. Barbhuiya, J.K. Gbagbo, M.I. Russeli, P.A.M. Basheer studied the properties of fly ash concrete modified with hydrated lime and silica fume concluded that addition of lime and silica fume improve the early days compressive strength and long term strength development and durability of concrete. Susan Bernal, Ruby De Gutierrez, Silvio Delvasto, Erich Rodriguez carried out Research work in Performance of an alkali-activated slag concrete reinforced with steel fibers. Their conclusion is that The developed AASC present higher compressive strengths than the OPC reference concretes. Splitting tensile strengths increase in both OPCC and the AASC concretes with the incorporation of fibers at 28 curing days. Hisham Qasrawi , Faisal Shalabi, Ibrahim Asi carried out Research work in Use of low CaO unprocessed steel slag in concrete as fine aggregate. Their conclusion is That Regarding the compressive and tensile strengths of concrete steel slag is more advantageous for concretes of lower strengths. O. Boukendakdji, S. Kenai, E.H. Kadri, F.

Rouis carried out Research work in Effect of slag on the rheology of fresh self-compacted concrete. Their conclusion is that slag can produce good self-compacting concrete. Shaopeng Wu, Yongjie Xue, Qunshan Ye, Yongchun Chen carried out Research work in Utilization of steel slag as aggregates for stone mastic asphalt (SMA) mixtures. Their conclusion is that The test roads shows excellent performances after 2-years service, with abrasion and friction coefficient of 55BPN and surface texture depth of 0.8 mm. Tahir Gonen, Salih Yazicioglu carried out research work in the influence of mineral admixtures on the short and long term performance of concrete, hence concluded that silica fume contributed to both short and long term properties of concrete, where as fly ash shows its beneficial effect in a relatively longer time. As far as the compressive strength is concerned, adding of both silica fume and fly ash slightly increased compressive strength, but contributed more to the improvement of transport properties of concrete. M. Maslehuddin, Alfarabi M. Sharif, M. Shameem, M. Ibrahim and M.S Barry carried out experimental work on comparison of properties of steel slag and crushed limestone aggregate concretes, finally concluded that durability characteristics of steel slag cement concrete were better than those of crushed limestones aggregate concrete. Some of physical properties were better than of crushed lime stones concrete. J. G. Cabrera and P. A. Claisse carried out experimental work on Oxygen and water vapour transport in cement pastes, hence concluded that the flow of oxygen is described by the Darcy equation, but the flow of water vapour is not. The different mechanisms of transmission 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. Houssam A. Toutanji and Tahar El-Korchi carried out experimental work on Oxygen and water vapour transport in cement pastes, hence concluded that the increase in compressive strength of mortar containing silica fume as a partial replacement for cement, greatly contributes to strengthening the bond between the cement paste and aggregate. It was also demonstrated that super plasticizer in combination with silica fume plays a more effective role in mortar mixes than in paste mixes. This can be attributed to a more efficient utilization of super plasticizer in the

mortar mixes due to the better dispersion of the silica fume. Jigar p. patel carried out experimental work on broader use of steel slag aggregate in concrete, hence concluded that durability of steel slag aggregates concrete under freeze-thaw environment was the main goal in this research, as there was a belief that the steel slag aggregates have expansive characteristics and would cause cracking in concrete. The results proved that if up to 50 to 75 % of steel slag aggregates are incorporated in the traditional concrete, there would not be much change in the durability of concrete.

Following test are used in these

Capillary Absorption Test

- Porosity test of mortars.
- Experimental study on concrete
- Water /Cement ratio and slump
- Compressive Test By Pulse velocity Method
- Compressive Test By compression machine
- Wet and Dry Test.
- Flexural Strength.
- Porosity Test
- Capillary Absorption Test

III. CONCLUSION

1. Water Inclusion of silica fume improves the strength of different types of binder mix by making them more denser.
2. Addition of silica fume improves the early strength gain of fly ash cement whereas it increases the later age strength of slag cement.
3. The equal blend of slag and fly ash cements improves overall strength development at any stage.
4. Addition of silica fume to any binder mix reduces capillary absorption and porosity because fine particles of silica fume reacts with lime present in cement and form hydrates denser and crystalline in composition.
5. The capillary absorption and porosity decreases with increase dose up to 20% replacement of silica fume for mortar. indicates resistance to the flow through the voids of concrete as a result of reduction in their pore structure or blockage.

REFERENCES

- [1] ACI committee 211.1.81 (1984). Standard practice for selecting proportions for normal heavy weight and mass concrete. ACI Manual of Concrete Practice.
- [2] ACI committee (1995). Guidelines for the use of silica fume in concrete (ACI 234R).
- [3] ACI Materials Journal, 92, 437-440.
- [4] Almusallam, A. A., Beshr, H., Maslehuddin, M., Al-Amoudi, O. S. (2004). Effect of silica fume on the mechanical properties of low quality coarse aggregate concrete. Cement and Concrete Composites, 26, 891-900.
- [5] Alexander, M. G., Magee, B. J. (1999). Durability performance of concrete containing condensed silica fume. Cement and Concrete Research, 29, 917-922.
- [6] ASTM C 642 (2013). Standard Test Method for density, absorption, and voids in hardened concrete. ASTM International.
- [7] ASTM C 1202 (2012). Standard test method for electrical indication of concrete's ability to resist chloride ion penetration. ASTM International.
- [8] Holland, T. C. (2005). Silica Fume User's Manual. Silica Fume Association and United States Department of Transportation Federal Highway Administration Technical Report FHWA-IF-05-016.
- [9] Igarashi, S. I., Watanabe, A., Kawamura, M. (2005). Evaluation of capillary pore size characteristics in high-strength concrete at early ages. Cement and Concrete Research, 35, 513-519.
- [10] IS: 383 (1970). Specifications for coarse and fine aggregates from natural sources for concrete. Bureau of Indian Standards, New Delhi, India.
- [11] IS: 10262 (1982) Recommended guidelines for concrete mix design. Bureau of Indian standards, New Delhi, India.
- [12] IS: 516 (1959). Indian standard code of practice methods of test for strength of concrete.
- [13] Bureau of Indian standards, New Delhi, India.

- [14] Kelham, M. (1988). A water absorption test for concrete. Magazine of Concrete Research, 40, 143 – 148.
- [15] Khan, M. I. (2003). Isoresponses for strength, permeability and porosity of high performance mortar. Building and Environment, 38, 1051-1056.