



Review Paper- Experimental Investigation on Silica Fume as Partial Replacement of Cement for M-25 Concrete

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ABSTRACT

The waste materials which can be used as additional cementitious material like fly ash, micro silica, blast furnace, metakaolin, steel slag etc. From all these waste material the most successful cementitious material is silica fume. To decrease the amount of cement in concrete supplementary material are used. For this reason silica fume is replaced by 0%, 5%, 7.5%, 10%, 12.5%, 15% & 20% by the weight of cement. Water binder ratio is taken 0.45 for mix design of M-25 grade Concrete. Different tests were conducted in the investigate which showed the results of the same percentage at the different of 0%, 5%, 7.5%, 10%, 12.5%, 15% & 20% for the time period of 7, 14 & 28 days curing as a substitution of cement by micro silica on compressive strength, flexural strength, split tensile strength and durability.

Keywords: SF, Compressive Strength, Flexural Strength, Durability, Split Tensile Strength

1. INTRODUCTION

The method of selecting appropriate ingredients of concrete and determining their relative amount with the intention of producing a concrete of the necessary strength durability and workability as efficiently as possible is termed the concrete mix design. The compressive strength of harden concrete is commonly considered to be an index of its extra properties depends upon a lot of factors e.g. worth and amount of cement water and aggregates batching and mixing placing compaction and curing. The cost of concrete prepared by the cost of materials plant and labour the variation in the cost of material begin from the information that the cement is numerous times costly than the aggregates thus the intent is to produce a mix as feasible from the practical point of view the rich mixes may lead to high shrinkage and crack in the structural concrete and to development of high heat of hydration is mass concrete which may cause cracking. The genuine cost of concrete is related to cost of materials essential for produce a minimum mean strength called characteristic strength that is specific by designer of the structures. This depends on the quality control measures but there is no doubt that quality control add to the cost of concrete. The level of quality control is often an inexpensive cooperation and depends on the size and type of job nowadays engineers and scientists are trying to enhance the strength of concrete by adding the several other economical and waste material as a partial substitute of cement or as a admixture fly ash, silica fume, steel slag etc are the few examples of these types of materials. These materials are generally by-product from further industries for example fly ash is a waste product from power plants and silica fume is a by-product resulting from decrease of high purity quartz by coal or coke and wood chips in an electric arc furnace during production of silicon metal or ferrosilicon alloys. But nowadays silica fume is used in large amount because it enhances the property of concrete. The use of micro silica as a pozzolana material has enhanced in recent years because when mixed in definite proportions it improves the properties of both fresh and hard concrete like durability, strength, permeability and compressive strength, flexural strength and tensile strength.

2. REVIEW OF PAPERS

2.1 Review:

[1] Manikandan A et.al (2020): Material testing has been done to find out the physical properties of eco sand and silica fume. Together with these two combinations a series of varying percentage has been obtained. Casting of concrete has been done in the form of cube, prism and cylinder to obtain the compression strength, flexural strength and split strength respectively for 7 days and 28 days curing for the estimated varying percentages. With the obtained results from the tests the optimum percentage for the partially replacement of eco sand and silica fume has been determined.

[2] V. Gopi, K et.al (2019): In this study, the optimal percentage of these by-products for partial replacement of cement is studied in respect of their resulting concrete's strength properties. For fly-ash, 10%, 15%, 25%, and 35%, of replacement is tried and for silica fume, 0%, 4%, 6%, 8%, and 10%, of replacement is tried to arrive at their optimal replacement to get the desired strength and durability properties of the concrete.

[3] **Ashhad Imam et.al (2018)**: This paper presents a review on the use of Silica Fume (SF) as a mineral admixture in the concrete. Distinctive outcome from several researches have been demonstrated here, particularly emphasizing on the fresh and hardened properties of concrete when blended with Silica Fume (Micro-silica or Nano-silica). The results showed a substantial enhancement in the mechanical properties of concrete when replaced with SF.

[4] **Akshay Suryavanshi et.al (2018)**: The use of silica fume in the present days is to increase the strength of cement concrete. The silica fume was replaced by 0%, 2.5%, 5%, 7.5%, 10%, 12.5%, 15%, 20%, 25% and 30% for 7, 14 & 28 days for M20, M25 and M30 grade of concrete. Casted 150 mm X 150 mm X 150 mm cubes for Compressive strength, 100 mm X 100 mm X 500 mm beams for Flexural Strength, and Cylinder size 150 mm diameter and 300 mm height are casting for Split Tensile Strength and Slump cone for workability of concrete and other properties like compacting factor and slump were also determined for three mixes of concrete.

[5] **K.Vinothini et.al (2018)**: The present study aims at such strengths like Compressive, Flexural and Split Tensile of M40 grades of concrete along with usage of micro silica (5%, 7.5%, 10%, and 15%) and Nano silica (1.5%, 2%, and 2.5%) as partial replacement of cement.

[6] **Nasratullah Amarkhail (2015)**: They carried out to determine the optimum percentage of silica fume to replace cement in order to improve the properties of high-strength concrete. To complete the aim, some properties of concrete contain micro silica be evaluate after 7, 28 and 60 days of curing. Also, comparison between regular concrete and micro silica concrete containing various levels of silica fume content (5%, 10% and 15%) was conducted. It is mentionable that silica fume incorporation in the concrete mix significantly improved the properties of concrete such as, compressive and flexural strengths. Based on this research work, 10% and 15% silica fume content as replacement of cement were found to be the optimal amount for significantly enhancement of compressive strength and flexural strength respectively. Silica fume can significantly reduce concrete permeability and enhances its durability.

[7] **Nadeem Pasha et.al (2015)**: This paper presents a comparison of Compressive Strength, Split Tensile Strength, and Flexural Strength of the concrete made by Silica Fume replacing cement at different levels. A concrete mix of M30 grade is prepared through hand mixing (IS: 10262-2009). The Portland cement be partially replaced by Silica Fume and. Four mixes M-1, M-2, M-3 and M-4 are organized by combination of Silica Fume i.e. 0%, 12.5%, 15%, 17.5% respectively. For each mix 15 samples be casted, 12 cubes (150mm × 150mm × 150mm) 6 cubes used for compressive strength, 12 cylinders (150mm dia × 300mm height), used for split tensile strength and 12 prisms (100mm × 100mm × 500mm) used for flexural strength test at 7 and 28 days respectively.

[8] **Hanumesh B M, et.al (2015)**: these days high strength and high performance concrete are extensively used in various civil engineering constructions. To manufacture them it is essential to reduce the water/cement ratio and increase the cement content. Investigation has been carried out to study the produce of super plasticizer only and in conjunction with micro silica on some of the properties of fresh and hardened concrete. The major purpose is to calculate the compressive strength of conventional concrete of grade M20 and silica fume concrete formed by replacing cement in various percentages. To calculate the split tensile strength of conventional concrete of grade M20 and micro silica concrete formed by replacing cement in different percentage.

[9] **Debabrata Pradhan et.al (2013)**:- The main purpose of this paper have been prepared to investigate the unusual mechanical properties like compressive strength, compacting factor, slump of concrete incorporate micro silica. In this five mix of concrete incorporating silica fume are cast to complete experiments. These experiments are carried out by replacing cement with various percentages of silica fume at only constant water-binder materials ratio keep other mix design variables constant. Silica fume is replaced by 0%, 5%, 10%, 15% and 20% for water-binder materials (w/cm) ratio for 0.40. For all mixes compressive strengths be determined next to 24 hours, 7 and 28 days for 100 mm and 150 mm cubes. Other properties like compacting factor and slump were also determined for five mixes of concrete. They also worked on the increasing slump value by increasing dosages of super plasticizers.

[10] **Pratik Patel et.al (2013)**:- They investigated the study the effect of rheological and engineering properties of with partial replacement of OPC by silica fume. Silica Fume is used in concrete to get better its properties like compressive strength, bond strength, and abrasion resistance; decreases permeability; furthermore as a result helps in protecting reinforcing steel from rusting. It concluded that Compaction factor decreases when the percentage of cellulose fibre increases with silica fume. The values of compacting factor are within range of 0.86 to 0.95 which meets the requirement of BIS-456. 7% replacement of silica fume and 0.5% of cellulose fibre gives an optimum compressive strength. Beyond 7% silica fume and 0.5% cellulose fibre compressive strength decreases.

[11] **Verma Ajay et.al (2012)**:- In Present investigation we are using silica fume as a non-natural pozzolana. On adding 0%, 5%, 10%, 15% by wt of cement in concrete. Silica fume improves concrete through two mechanisms: Pozzolonic effect: Micro filler effect: Silica fume increases the strength of concrete more 25%. Silica fume is a material which can be a explanation of Air Pollution this is a by product of some Industries use of micro silica with concrete decrease the air pollution. Silica fume also reduce the voids in concrete. Addition of silica fume reduces capillary Absorption and porosity as fine particles of silica fume reacts by lime present into cement.

[12] **Dilip Kumar Singha Roy et.al (2012)**:- They worked on the strength parameters of concrete made with partial replacement of cement by SF. Compressive strength, Flexural strength, Splitting Tensile strength have been determined for different mix up combinations of materials and these values are compared with the related values of conventional concrete Investigation have been designed at to bring awareness along with the practicing civil engineers regarding advantages of these new concrete mixes. From the study it has been observed that maximum compressive strength (both cube and cylinder) is noted for 10% substitute of cement with micro silica and the values are higher (by 19.6% and 16.82% respectively) than those of the normal concrete (for cube and cylinder) where as split tensile strength and flexural strength of the SF concrete 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.

3. CONCLUSIONS

From the results it is concluded that the silica fume is a superior replacement of cement. The rate of strength increase in silica fume concrete is high. After performing all the tests and analyzing their result, the following conclusions have been derived:

1. The results achieved from the existing study shows that silica fume is great potential for the utilization in concrete as replacement of cement.
2. Workability of concrete decreases as proportion of silica fumes increases.

REFERENCES

- [1] Manikandan A.*, Vignesh M., Keerthana G., Mohan Ram Krishnan T. and Swathika D. Experimental study on mechanical properties of concrete using silica fume and eco sand Research Journal of Chemistry and Environment Vol. 24 (Special Issue I), (2020).
- [2] V. Gopi, K. Shyam Chamberlin. Experimental Investigation on Strength and Durability of Concrete Incorporated with Silica Fume and Fly Ash International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7, Issue-6C2, April 2019.
- [3] Ashhad Imam, Vikash Kumar and Vikas Srivastava. Review study towards effect of Silica Fume on the fresh and hardened properties of concrete Advances in Concrete Construction, Vol. 6, No. 2 (2018) 145-157 DOI: <https://doi.org/10.12989/acc.2018.6.2.145>
- [4] Akshay Suryavanshi¹, Siddhartha Nigam², Dr. S. K. Mittal³, Dr. Ram Bharosh⁴ An Experimental Study on Partial Replacement of Cement in Concrete by Using Silica Fume International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 02 | Feb-2018 p-ISSN: 2395-0072
- [5] K.Vinothini, R.Elangovan, R.Vinoth. EXPERIMENTAL INVESTIGATION ON STRENGTHENING OF CONCRETE BY PARTIAL REPLACEMENT OF NANO AND MICRO SILICA International Journal of Civil Engineering and Technology (IJCIET) Volume 9, Issue 7, July 2018, pp. 422–429, Article ID: IJCIET_09_07_043
- [6] Nasratullah Amarkhail EFFECTS OF SILICA FUME ON PROPERTIES OF HIGH-STRENGTH CONCRETE International Journal of Technical Research and Applications e-ISSN: 2320-8163 Special Issue 32 (September, 2015), PP. 13-19.
- [7] Nadeem Pasha¹ Mohammed Muqueem Ahmed² Mohammed Azeemuddin³ Shaikh Minhajuddin⁴ Waseem Ali⁵: Study on Strength Characteristics of Silica Fume and Fly Ash as Partial Replacement of Cement. IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 02, 2015 | ISSN (online): 2321-0613
- [8] Hanumesh B M¹, B K Varun², Harish B A³: The Mechanical Properties of Concrete Incorporating Silica Fume as Partial Replacement of Cement International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 5, Issue 9, September 2015)
- [9] Debabrata Pradhan, D. Dutt Influence of Silica Fume on Normal Concrete, Debabrata Pradhan et al. Int. Journal of Engineering Research and Applications Vol. 3, Issue 5, Sep-Oct 2013, pp.79-82
- [10] Pratik Patel Dr. Indrajit N. Patel Effect of Partial Replacement of Cement with Silica Fume and Cellulose Fibre on Workability & Compressive Strength of High Performance Concrete Volume : 3 | Issue : 7 | July 2013 | ISSN - 2249-555X
- [11] Verma Ajay, Chandak Rajeev and Yadav R.K. Effect of Micro Silica on The Strength of Concrete with Ordinary Portland Cement, Received 2nd June 2012, revised 10th June 2012, accepted 15th June 2012, ISSN 2278 – 9472 Vol. 1(3), 1-4, Sept. (2012) Res. J. Engineering Sci.
- [12] Dilip Kumar Singha Roy, Amitava Sil Effect of Partial Replacement of Cement by Silica Fume on Hardened Concrete International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, Volume 2, Issue 8, August 2012)
- [13] Siddharth Pastariya, Shanu Sharma (2017) “Experimental Investigation On Partial Replacement Of Cement With Marble Dust Powder on Properties Of Concrete” IJournals: International Journal of Software & Hardware Research in Engineering ISSN-2347-4890 Volume 5 Issue 9 September, 2017.
- [14] Siddharth Pastariya, Siddharth Nahar (2018) “Experimental Investigation on PEG Fume as Partial Replacement of Cement for M-25 & M-20 Concrete” iJournals: International Journal of Software & Hardware Research in Engineering ISSN-2347-4890 Volume 6 Issue 7 July, 2018
- [15] Siddharth Pastariya (2019) Experimental Investigation On The Strength Of Concrete By Replacement of Sand Using Granite Dust iJournals: International Journal of Software & Hardware Research in Engineering ISSN-2347-4890 Volume 7 Issue 5 May 2019.

[16] Siddharth Pastariya, Geetanjalee Lohar (2020) Effect of Silica Fume on Mechanical Properties of Hardened concrete as Partial Replacement of Cement for M-35 Concrete. International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 05 | May 2020 p-ISSN: 2395-0072