

# **A Review on the Comparison on Compressive Strength and Durability of Cement Mortar by Partial Replacement of Cement with Ceramic Waste Powder and Silica Fume**

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**ABSTRACT:** In this paper, the effect of ceramic powder and silica fume on strength and durability properties of cement mortar was investigated. Different types of replacement of ceramic powder and silica fume in cement of cement mortar of 1:3 grades and curing with H<sub>2</sub>SO<sub>4</sub> are determined. Strength and durability properties such as compressive strength and acid resistivity were evaluated for all the mixes of cement mortar. Results also show that the strength properties of cement mortar have improved having 20% ceramic powder and 5% silica fume replacement is responsible for minor strength loss but leads to outstanding durability.

**KEYWORDS:** Mortar, Ceramic powder, Silica fume, Acid attack and Compressive strength.

## **I. INTRODUCTION**

For past many years construction industry has been making some progress in the utilization of waste materials in concrete. Proper use of waste material provides viable economy and healthy environment.

Ceramic powder is one of the active research areas that encompass a number of disciplines including civil engineering and construction materials. In ceramic industry, about 15- 30 % waste material is generated from the total production. The wastage which is dumped in land filling and pit or vacant spaces causes environmental pollution which is dangerous for human health. This waste is not recycled in any form at present. However, the ceramic waste is durable and highly resistant to biological, chemical, and physical degradation of forces.

Silica fume is a by product resulting from the reduction of high purity quartz with coal or coke and wood chips in an electric furnace during the production of silicon metal or silicon alloy. Silica fume is known to improve both the mechanical characteristics and durability of concrete. The principle effect of silica fume in concrete is that of filler, which because of its fineness can fit into space between cement grains in the same way that sand fills the space between particles of coarse aggregate. As for chemical reaction of silica fume, because of high surface area and high content of amorphous silica in silica fume, this highly active pozzolans reacts more quickly than ordinary pozzolans. The use of silica fume in concrete has both engineering potential and economic advantage.

Acid attack is one of the world wide problems that may cause gradual but severe damage to concrete structures. Concrete can be attacked by the sulphates present in the soil or in the sea water, and by sulphuric acid produced from either sewage or sulphur dioxide present in the atmosphere of industrial cities. The degree of attack depends on the properties of the aggressive agent and its concentration.

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## II. CERAMIC POWDER IN MORTAR

Cement replacement with ceramic powder 20% in content gave maximum enhancement in pore refinement of pastes and compressive strength goes on increasing up to 25%. Ceramic powder provides good resistance to chemical attack. For ceramic partial replacement up to 10% partial replacement it is resistant against sulphate attack up to 1%, 2% and decreasing for 3%. By using ceramic powder as cement replacement the cost of construction is reduced to some extent.

Ceramic materials contribute the highest percentage of wastes in construction industries. In the ceramic industry, about 15%-20% production goes as waste. The current option for disposal of ceramic wastes is filling of land. This is due to unavailability of standards, avoidance of risk, lack of knowledge and experience in using ceramic wastes in construction. It is well known fact that ceramic waste can be used as a pozzolanic material. This ceramic waste is used to make M-30 grade concrete partial replacement with cement and fine aggregate. The waste of ceramic is available with different properties. In this research we have used of diverse ceramic waste received in different forms like wall tiles ceramic waste powder, vitrified ceramic waste powder and glossy tiles ceramic waste powder, received from different ceramic industries. This ceramic waste is added in range of 0%, 10%, 20%, 30%, and 40% by weight for M-30 grade concrete as partial replacement of cement and in range of 0%, 10% and 20% by weight for M-30 grade concrete as partial replacement of fine aggregate and results are compared with M30 grade concrete made with OPC for 7 days 14 days and 28 days. It was observed that replacement of cement up to 30% and replacement of fine aggregate up to 10% gives desired strength of M30 grade concrete and gives economic and environmental advantages, use of this waste reduction in the number of natural spaces employed as refuse dumps [5]

Ceramic waste powder is settled by sedimentation and then dumped away which results in environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health. Therefore, utilization of the ceramic waste powder in various industrial sectors especially the construction, agriculture, glass and paper industries would help to protect the environment. Let's see some waste materials that can be used as a building material and save our environment and earth [6].

An experimental study on replacement of (OPC) cement by ceramic waste powder in the range of 0%, 10%, 20%, 30%, 40%, by weight of cement. Concrete mixtures were produced, tested and compared in terms of compressive strength to the conventional concrete. These tests were carried out to evaluate the properties for 7, 14, 28 & 90 days. The moulds prepared are as follows 150mm X 150mm X 150mm cubes. This paper investigates the effect of  $\text{MgSO}_4$  and HCl over the strength characteristics of ceramic waste. In preparation of ceramic waste cement composition, natural was partial replaced with ceramic powder waste ceramic insulator and exposed to the 1, 3 and 5% mg  $\text{SO}_4$  and HCl in curing period. Due to the influence of  $\text{MgSO}_4$  and HCl compressive strength loss and weight loss of the concrete specimens were observed in the experimentation work [7].

The compressive strength of the ceramic waste aggregate concrete is better and there is no considerable change in compressive strength before and after chemical attack. This is due to the material properties of ceramic waste. Ceramic waste aggregate is hard and durable material than the conventional coarse aggregate. It has good thermal resistance and resistance to bio-degradation compare to conventional coarse aggregate. The durability properties of ceramic waste aggregate concrete are also good [8].

Ceramic slurry waste powder is replaced by cement in concrete. Concrete grade M25 was made by replacing by 0% to 30% of ordinary Portland 53 grade cement with ceramic slurry waste powder passing through 90 microns. Compressive strength, Flexural strength, Water absorption and sorptivity are determined with water cement ratio 0.48. The result shows core compressive strength achieved up to 30% replacement of ceramic waste powder without affecting the characteristic strength of M25 and no significant change in flexural strength. Water absorption and sorptivity increased compare to conventional concrete [9].

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## III. SILICA FUME IN MORTAR

The results of using marble powder and silica fume as partial replacement for cement on mortar. Four types of mortar mixture with same workability cement to sand ratio of 1:3 and water to cementitious materials of ratio of 0.4 were prepared marble powder and silica fume used in mixes separately, once as a partial replacement of cement content and another as an addition to the mix proportion. Results showed that the compressive strength increased by 31.4%, 48.3% at 7, and 28 days respectively at 15% replacement ratio of silica fume with cement content and in case of replacement marble powder with cement content the compressive strength increased by 22.7%, 27.8% at 7, and 28 days at 15% replacement ratio of marble powder with cement content respectively [1].

Cement mortar is partially replaced by silica fume and GGBS accordingly in the range of 0%, 10%, 20%, & 30% by 1:3 cement mortar. Specific gravity is done for silica fume and GGBS. Cement mortars are casted, tested and compared with conventional mortar. These tests were carried out to evaluate the strength properties for 7, and 28 days [2]. The replacement of sand/cement by certain percentage of silica fumes resulted in the improvement in compressive strength of the mortar. Silica fumes to the highly pozzolanic materials because it consists essentially of silica in non- crystalline form with a high specific surface. It is used to improve the mechanical properties of the concrete. The main objective of this paper is to study the effect of silica fume on the compressive strength of mortar. Three proportions of mixes viz mix 1:3 mix 1:4 and mix 1:6 with different percentages of silica fumes replacement with sand/cement were used. The maximum increase in strength at the age of 28 days when sand is replaced by 15% of silica fume has been observed as 40% and in case of cement replaced with 15% of silica fume the observed increase in compressive strength of mortar comes out to be 28%. A quantitative cost analysis shows that with the replacement of cement and sand by silica fume, the in cost is more when sand is replaced and it is less when cement is replaced [3].

Silica fume inclusion increases the compressive strength of concrete significantly 6 – 57 %. The increment depends upon the replacement level. . Silica fume is one such industrial by product which is being used and experimented upon to obtain a stronger and durable concrete. It is one of the pozzolans having very large surface area which results in better and uniform utilization of calcium hydroxide released during hydration of OPC. Also, because of its very fine size it act as filler material between the cement gel grains. This paper presents a review of silica fume utilization in concrete production and its effect on the concrete [4].

Silica fume were partially replaced from 5% to 25% and 0.1% of polypropylene fibre were added to test for its compressive and tensile strength. The result of 7th and 28th days of concrete were compared with those of conventional concrete, reveals that silica fume in combination with polypropylene fibre yields high strength both in compression and in tension [10]. As silica fume content increases the unit weight of concrete decreases. 2. For same % of addition of steel fibre, 15% silica fume gives lower density with 1.5% of chemical admixture. 3. Compaction factor of concrete increases with increase in silica fume content. 4. For high grade steel fibre reinforced concrete with silica fume must require more than 1.5% of chemical admixture to achieve homogeneous and workable mix. 5. Increment of silica fume content up to 15% given good result in terms of compressive strength and flexural strength. 6. The mix series S5 ((1.0%, 15% & 1.5%) gives high compressive strength and flexural strength [11].

## IV. CONCLUSION

From reviewing the above research papers related to ceramic powder and silica fume relevant conclusions are made:

- A. After replacing cement with 20% ceramic powder causes increase in strength compared to the control mix. However, using more than 20% ceramic powder as partial cement replacement does not cause further increase in strength compared with other ceramic mixes. The optimum level that causes a maximum enhancement in compressive strength.
- B. When cement is replaced by 5% silica fume causes increase in strength up to 20-30%.
- C. This paper confirms that the use of 20% ceramic powder and 5% silica fume based mixtures are responsible for minor strength loss but leads to outstanding durability improvement.

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## REFERENCES

1. Hassan A. Mohamadien "The effect of marble powder and silica fume as partial replacement for cement on mortar" International journal of civil and structural engineering, volume 3, No 2, 2012.
2. Etaveni.Madhavi, Praveen Mailaram, Nalla sharath kumar, Kadapa Vinod Kumar, Korra Ram Babu and Bomma Praveen Kumar " Strength properties of cement mortar when cement partially replaced with Silica fume and GGBS" Imperical journal of interdisciplinary research, volume 3, Issue -4 , 2017.
3. Harjinder singh, Shikha Bansal "Effect of silica fume on the strength of cement mortar" International journal of research in engineering and technology.
4. Vikas Srivastava, Alvin Harison, P.K. Mehta, Atul Rakesh Kumar " Effect of silica fume in concrete" National conference on recent advances in civil engineering (2013).
5. Chintan P Patel and Jay K Bhavsar "Enhancement of concrete properties by replacing cement and fine aggregate with ceramic powder" Journal of civil engineering and environmental technology, volume 3, Issue 3, January- March 2016.
6. Revu. Kiran kumar, Kaladi. Raju, Billa. Subhan Ramji, V.V.S. Sarma " Exposure Effect of  $MgSO_4$  and Hcl on strength properties of ceramic waste powder by partial replacement with cement" International journal of innovative research in science & technology, volume 3, Issue 09, February 2017.
7. Dhavamani Doss Sa and D. Gobinatha "Chemical resistance of concrete with ceramic waste aggregate" International journal of current engineering and technology. Vol 3, No 3, August 2013.
8. Hitesh kumar mandavi, vikas srinivasa, V.C.Agarwal "Durability study on concrete with ceramic waste as fine aggregate replacement.
9. Lalji prajapathi, I.N. Patel, V.V. Agarwal "Analysis of the strength and durability of the concrete with partially replaced by the ceramic slurry waste powder".
10. D.Prasanya, S. Vignesh, R.Gurulakshmi, B.Boomapriya "Effects of fibre and silica fume characteristics on mechanical properties of high strength concrete".
11. C.G. Konapure, V.S Dasari "Effect on Steel Fibre Reinforced Concrete with Silica Fume for High Grade".
12. Rama krishnanan V, and Srinivasan V, "Silica fume in fibre reinforced concrete" Indian concrete journal, December, 1982.
13. O.Zimbili, W.salim, M.ndambuki, "A review on usage of ceramic wastes in concrete production".
14. Amit kumar D.ravel, "Use of ceramic powder as partial replacement of cement", IJITEE ISSN: 2278-3075, Volume -3, Issue -2, July 2013.
15. I.S. 456 – 2000, Indian standard plain and reinforced concrete – Code of practice.
16. I.S. 4031-1988, (Part – 5) Methods for physical tests for hydraulic cements; determination of initial and final setting times.
17. I.S. 4031 – 1988, Methods for physical tests for hydraulic cements.
18. I.S. 8112:1989, Specification for 43 grade ordinary Portland cement.
19. G.A.Rao "Development of strength with age of mortars containing silica fume", India, Cement and concrete research, Vol 31(2001), pp 1141-1146.
20. R.J.Detwiler and P.K.Mehta (1989) "Chemical and physical effects of silica fume on the mechanical behaviour of concrete", Canada, Materials journal, Vol 86, pp 609-614.