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Evaluation of Compressive Strength Testing of A Concrete Block By Partially Replacing of Cement with Silica Fume

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ABSTRACT

This project is carried out by partially replacing of cement with silica fume and testing its compressive strength. The replacement is done by using different percentage of silica fume with concrete without using any admixture. The project is done only in a single mix proportion.

Firstly, all the raw material are collected which are need for the project. Followed by findings of specific gravity for both coarse aggregate and fine aggregate. With the help of IS code, concrete mix-design are set. After the mix-design was set, mixing of cement, fine aggregate (m sand), coarse aggregate (20 mm) and water are proceed. The replacement is done in 0%, 5%, 9%, 12%, 15% and 20%. 24 number of cubes are casting out of which, 12 number of cubes are for 7 days curing and the remaining, for 28 days curing. The curing is done in water.

Take the 0% replacement as normal concrete for the comparison with the others replacement. In the comparison between the normal and silica fume's concrete, the concrete with the silica fume has a strong compressive strength than the normal concrete.

Keywords: Partially Replacing, Compressive Strength, Silica Fume, Mix Proportion, Curing.

1. INTRODUCTION

Concrete is one of the most use materials in the construction project. Concrete blocks are precast building materials used for load-bearing and non-load-bearing walls. They are made by molding a precise mix of cement, aggregates (coarse and fine) and water with a specific mix-proportion and which is then cured either wet curing or dry curing. The standardized production gives faster construction and enhances structural stability and durability.

The project is done by using concrete blocks to check its compressive strength and durability by partially replacing cement with silica fume. In the construction work, strength and durability of a material using in it, is a must for its life span. Concrete blocks with silica fume give a higher strength and durability compare to normal concrete. Silica fume's concrete has higher strength because of the tiny particle for silica that fills the voids present in concrete which help in blocking water ingress inside the concrete resulting in corrosion of reinforced steel, concrete spalling, structural weakening, etc.

2. LITERATURE REVIEW

Silica fume has a high percentage of amorphous silica (SiO_2) which usually ranges from 89% to 97% that causes strong pozzolanic reactions in concrete. The ultra-fine particle size for silica fume helps in filling the voids present in the concrete, resulting in denser and stringer concrete. The research found out that the adding of silica improves the durability in concrete by reducing the porosity, permeability, water absorption and chloride ion penetration. It has high resistant against the attack from sulphate and chemical deterioration which was suitable for marine structure, bridges, tunnels and high-performance construction. The study show that silica is mainly used to increase concrete's durability, compressive strength, flexural strength and tensile strength, to increase sustainable construction practices. He also shows due to congestion of microstructure and reduced permeability resulting from silica fume, improvement in durability properties such as

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resistant to chloride penetration, absorption for water and chemical attack. However, the excessive content of silica fume with high fineness and water demand reduces the workability. The review concluded that silica fume is an effective material for producing high performance and sustainable concrete by reducing cement consumption.

The silica fume's effect on cement concrete based on natural pozzolan. The experiment is performed on concrete mixes with OPC, silica fume (SF) and natural pozzolan (NP). The results showed that replacement of 20% cement by natural pozzolan reduced the early compressive strength. His study was also concluded that using silica fume increase durability properties including resistance to water penetration, chloride resistant, reinforcement steel corrosion, sulphate attack, etc. The concrete with OPC, NP and SF showed lower permeability and improved resistance against severe environmental conditions than the normal concrete. In addition, he noted that using silica fume reduces the drying shrinkage and improves the overall performance of concrete. This study aimed to improve early age strength of NP-based concrete through the use of silica fume's materials. Silica fume's effect is found to enhance the water permeability and chloride diffusion substantially due to the ultra-fine particles which fill the voids and pores which are present in the concrete. He also knows that the silica fume reduces chloride penetration and increases the corrosion resistance of reinforced concrete.

3. MATERIALS AND MIX DESIGN

3.1 Materials

The following materials are used in this study

1. Cement: It is commonly a basic building material in modern society. It is a glue that binds aggregate materials (gravel and sand) together to form a strong and durable mass. The hydraulic character of cement gives it the property of being a binder. Hydraulic is an inorganic binder in form of a smaller powder which hardens in contact with water and undergoes a hydration process. Hydration is a reaction that sets and hardens the binder. This property with its lower cost had made the cement the base of all types of infrastructure including residential homes, commercial buildings, bridges, dams and roadways.
2. Silica Fume: It is the byproduct of the production of ferrosilicon alloys (SiO2) or silicon metal vapours are formed when high-purity quartz is reduced to silicon at temperatures up to 2000 °C. In the low-temperature zone, these vapours oxidise and condense to very small particles of non-crystalline silica. By-products of the production of ferrosilicon alloys and silicon metal containing 75% or more silicon are 85-95% non-crystalline silica.
3. Fine Aggregate (M sand): Manufactured sand or M Sand is a fine aggregate which are used as an alternative of river sand. M sand is a quality product of crushing stones, rocks and boulders into fine aggregates. It is widely used as material for concrete, plastering and masonry, and offers increased strength, uniformity and less impurities such as clay or silt than natural sand.
4. Coarse Aggregate (20mm): It is an inorganic granular material such as gravel, crushed stone or recycled concrete with particle size usually greater than 4.75mm.

3.2 Mix Design

Mix design for OPC M30 (grade 43) is done with reference to IS 10262 (2009) and 456 (2002). The mix proportion using in this project is 1:2:2.71 by partially replacing of cement with silica fume. The replacement percentage are 0%, 5%, 9%, 12%, 15% and 20%.

4. RESULTS AND DISCUSSION

4.1 RESULTS

The below tables (table- 1 & 2) are the compressive strength test results for 7 and 28 days of curing the concrete blocks in the water.

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Table-1: Compressive strength test values for 7 days of curing.

Sl. No.	Percentage of Silica Fume	Weight of Concrete's Block (Kg)	Max Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
1	0	8.060	412	18.37	18.26
		7.980	410	18.22	
2	5	8.075	418	18.57	18.55
		7.856	417	18.53	
3	9	8.075	424	18.84	19.08
		8.200	435	19.33	
4	12	7.995	439	19.51	19.69
		8.075	447	19.87	
5	15	7.880	494	21.95	21.89
		8.065	498	22.13	
6	20	7.950	404	17.95	18.01
		8.155	407	18.08	

Table-2: Compressive strength test values for 28 days of curing.

Sl. No.	Percentage of Silica Fume	Weight of Concrete's Block (Kg)	Max Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
1	0	8.110	671	29.82	29.73
		8.090	667	29.64	
2	5	8.010	676	30.04	29.95
		7.950	672	29.86	
3	9	7.945	686	30.48	30.66
		8.230	694	30.84	
4	12	7.990	698	31.02	31.05

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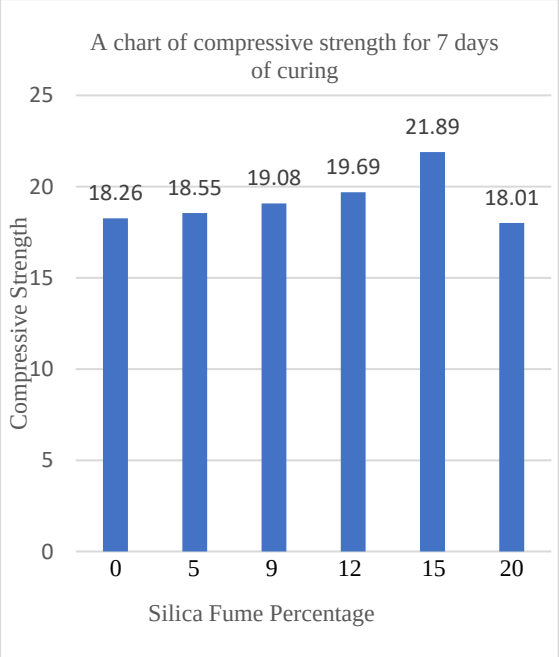
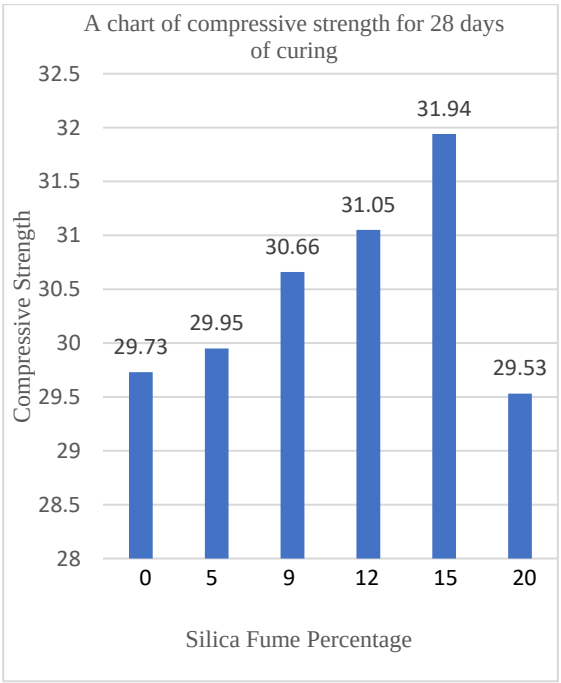
		8.145	709	31.51	
5	15	8.180	721	32.04	31.94
		8.020	717	31.86	
6	20	8.130	669	29.73	29.53
		8.040	660	29.33	

4.2 Discussion

The compressive strength test result for both 7 and 28 days of curing are given below as a graph. The 7 days compressive strength gain above 65% of its strength. The mean compressive strength in 7 days exceed the required 7 days strength for M30.





The compressive strength of 28 days exceeds 30MPa in silica fume's concrete blocks. With the increase in replacement percentage of cement with silica fume, it increases the strength of the concrete's block up to a certain value.

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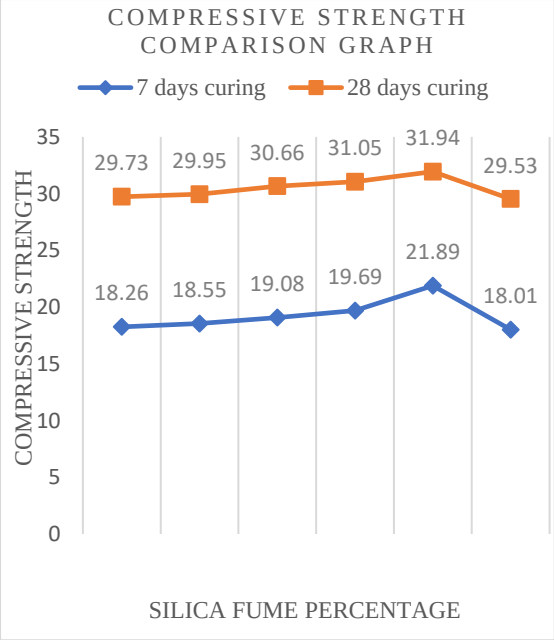

The above graph is the comparison of compressive strength between 7 and 28 days of curing. 58.62% gain of compressive strength is obtained between 7 and 28 days of curing.

5. CONCLUSION

In the 6 types of replacement of cement with silica fume, 15% replacement give the highest compressive strength value. Beyond the 15% replacement, the compressive strength decreases because of the excessive use of silica fume. So, a limit is set for the partially replacement of cement by silica fumes the that is in 15%. Uses of silica fume in concrete blocks cost more as compared to conventional concrete blocks.

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