

EXPERIMENTAL STUDY ON HIGH PERFORMANCE CONCRETE USING NANO SILICA AND COPPER SLAG

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ABSTRACT

High Performance Concrete (HPC) is gaining much popularity due to its excellent resistance to aggressive environments and safeguarding the concrete structures from premature deterioration. This is possible by proper selection and proportioning of the concrete constituents and usage of mineral and chemical admixtures. The improvement in the pore structure of HPC is the basis for increased strength and enhanced durability. The main objective of the study is to evaluate the possibility of using nano silica and silica fume as cement replacement materials and copper slag as partial fine aggregate in high performance concrete. The scope of the present study includes the investigation of workability, mechanical and durability properties of high performance concrete incorporating various replacement levels of above materials

Keywords: Copper slag, nano silica, CRM, HPC, chemical admixtures, fine aggregate

1. INTRODUCTION

Concrete is a mixture of cement, fine aggregate, coarse aggregate and water in predetermined proportion, produced to achieve desired strength at the specified age. The constituents of concrete are derived from various sources, such that, they differ in physical, chemical and reactivity properties. This necessitates the study of properties of the ingredients of concrete and the characteristics of concrete. With recent advancements in the field of construction, utilization of concrete is increased drastically. Concrete, a manmade material, is the second largest utilized material in the world, next to water. Utilization of such huge mass of concrete results in the depletion of natural resources, by using raw materials for cement production, river sand and coarse aggregate quarrying etc. Also, production of cement involves various operations from which CO₂ emissions are very high. About 80% of total CO₂ emissions from concrete are due to cement. It is estimated that, out of total CO₂ emissions in the world, cement industries contribute about 7%, which needs special attention.

Keyword- Cement, Missions, Utilization, concrete, production, fine aggregate, coarse aggregate

1.1 High Performance Concrete

As per American Concrete Institute, High Performance Concrete (HPC) is defined as a concrete meeting special performance and uniformity requirements which cannot always be achieved routinely using only conventional constituents and normal mixing.

2. LITERATURE SURVEY

Sharma Rahul et al. (2017) performed a study on durability assessment of self-compacting concrete incorporating copper slag as fine aggregates. Copper slag is used as a fine aggregate in concrete with different proportion ranges in 0%, 20%, 40%, 60%, 80%, 100% with constant w/b ratio. Various tests are performed on cubes including fresh properties, compressive strength, electrical resistivity, sulphate attack, ultrasonic pulse velocity, accelerated carbonation, initial surface absorption and sorptivity.

Chen et al., 2020 The Energy Dispersive Spectroscopy results depict that not only was the contents of silicon and calcium in the interfacial transition zone of Steel Slag Aggregate pervious concrete was higher. The ratio of silicon and calcium in Steel Slag Aggregate pervious concrete was also 42% higher it indicates that more CSH gel was formed. According to the change of element composition, the approximate width of the interfacial transition zone in Steel Slag Aggregate pervious concrete was also lesser than that of the limestone sample. In all, the interfacial transition zone enhancing mechanism of using Steel Slag Aggregate includes better strength, lesser width, and densified structure.

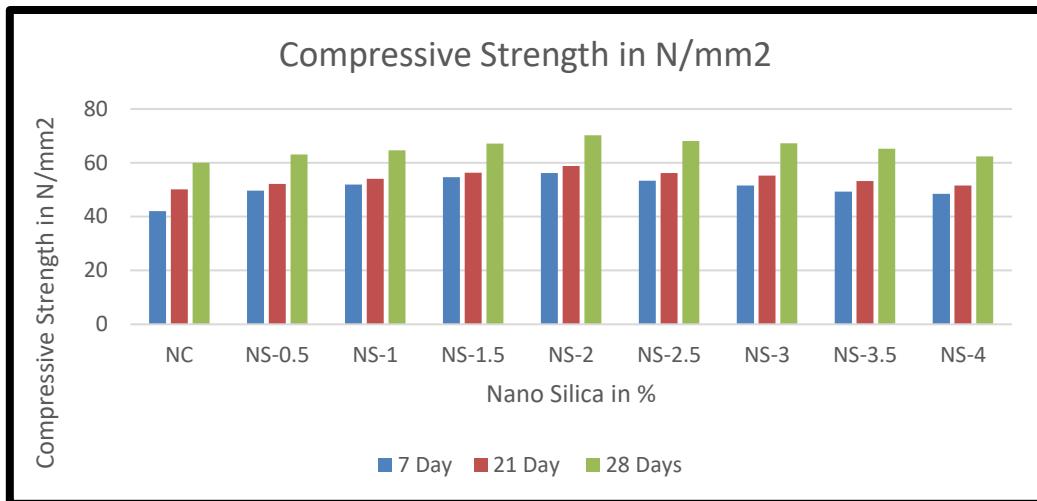
3. OBJECTIVE

- The viability of employing nano silica in place of cement to enhance the performance of high performance concrete and to check optimum percentage of nano silica to give maximum strength
- The potential to replace fine aggregate with copper slag in order to preserve environmental sustainability and get around the sand shortage.
- To check combine effect of nano silica and copper slag to give maximum strength.

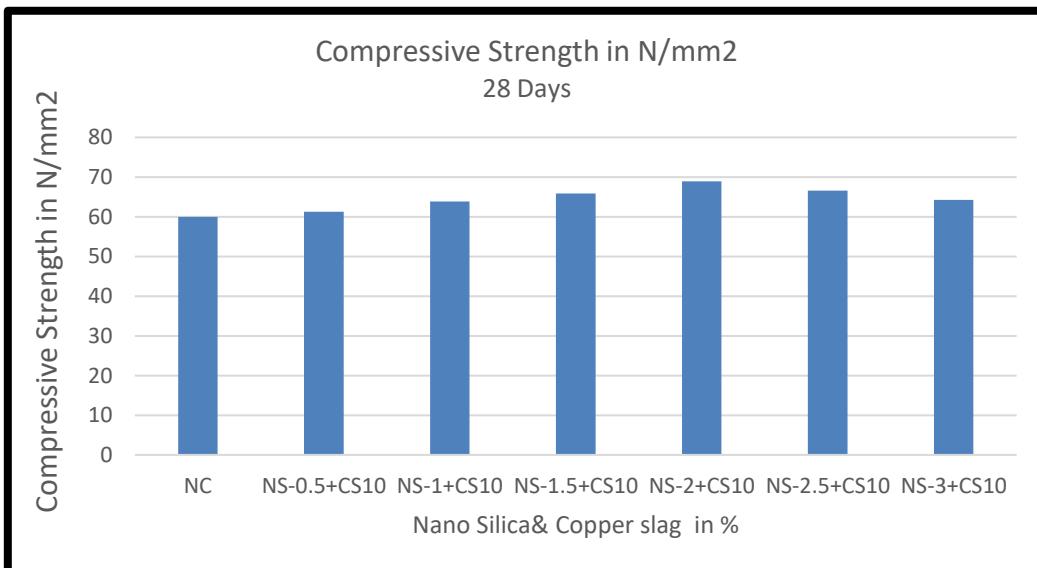
4. RESULTS AND DISCUSSIONS

4.1 Cube Compressive Strength

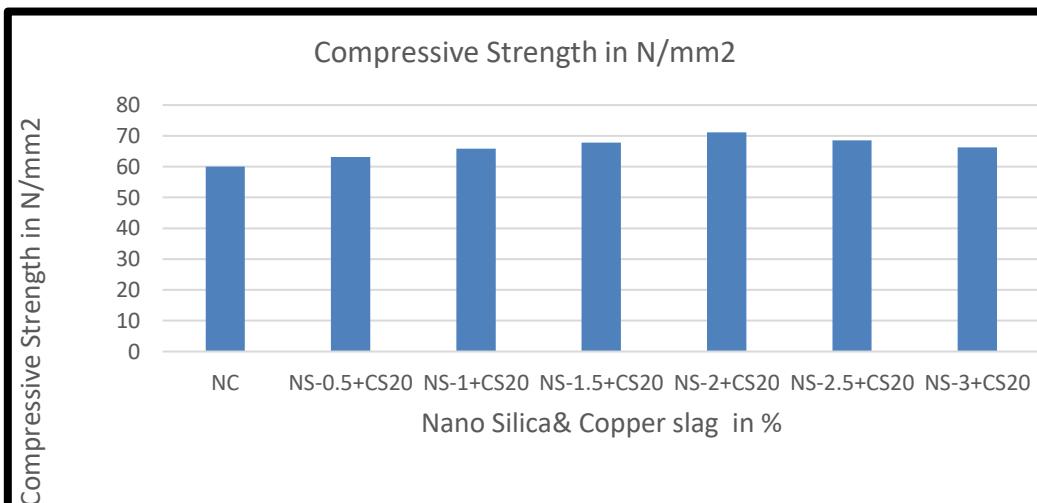
The cube compressive strength results at the age of 7, 21, and 28days for HPCmixes with 0%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3% ,3.5 4 % of nano silica, as partial replacement of cement and 0%, 10%, 20%, 30%, 40% and 50% of copper slag as partial replacement of fine aggregate are presented in Graph



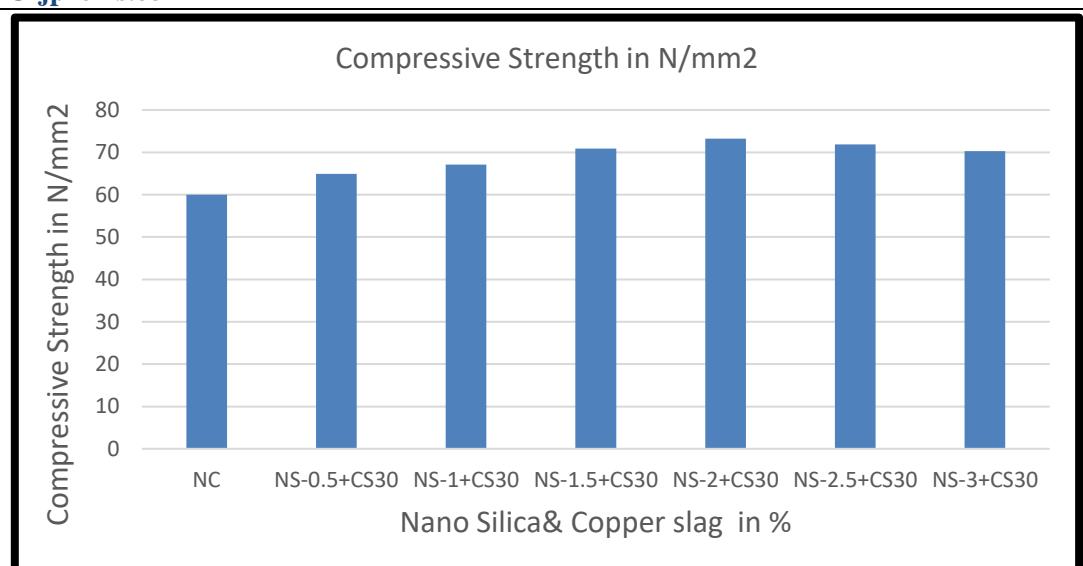
Compressive strength results at different ages



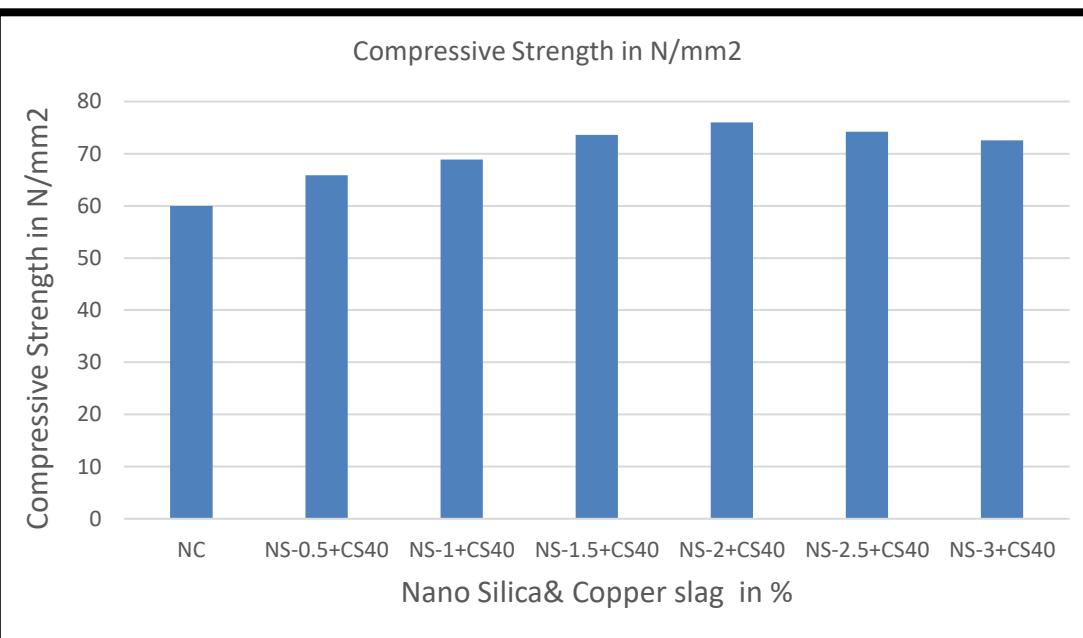
Compressive strength when nano silica concrete with10%copper slag



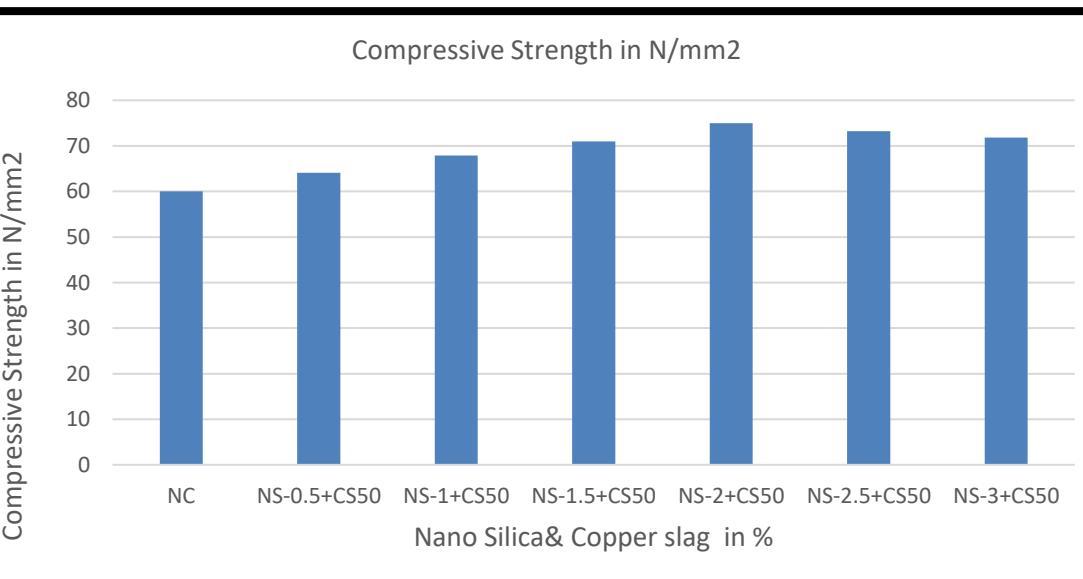
Compressive strength When nano silica concrete with 20%copper slag



Compressive strength When nano silica concrete with 30% copper slag



Compressive strength When nano silica concrete with 40% copper slag



Compressive strength When nano silica concrete with 50% copper slag

From the test results, it is observed that, the maximum compressive strength is obtained for mixes with 2 % nano silica, a combination of 2% nano silica and 40% copper slag, . Thus, the optimum replacement level of nano silica and silica fume is found to be 2%, 40% copper slag as fine aggregate replacement material. Significant improvement in compressive strength is noticed by inclusion of nano silica as a replacement of cement. The prime factors responsible for strength development are the increase in pozzolanic reaction and filler effects of nano silica . During hydration, additional C-S-H gel is produced due to the reaction of nano silica with calcium hydroxide liberated. In general, for HPC, the interfacial transition zone should be more strong, homogenous and dense for exhibiting excellent performances,

From the experimental results, it has been observed that the compressive strength of HPC mixes containing 2% nano silica is 17% and 14% higher than conventional concrete at 28 days of curing. The insufficient dispersion of nano silica above 2% leads to the formation of weak areas in the cement mortars resulting in decrease of strength.

5. CONCLUSION

- The addition of nano silica in concrete increases the compressive strength at 28 days due to their pozzolanic reaction and filler effects, the maximum compressive strength of nano silica concrete concrete was observed at a partial cement replacement level of 2% respectively.
- The incorporation of copper slag as partial fine aggregate in nano silica concrete \ showed improvement in compressive strength from 20% to 50% replacement level.
- The optimum replacement of copper slag in nano silica concrete and silica fume concrete was found to be 40% by weight of fine aggregate. The ultimate compressive strength was obtained for the mix with the combination of 2% nano silica and 40% copper slag as partial replacement material for cement and fine aggregate respectively
- The better performance of nano silica concrete was highly influenced by the mixing techniques, dosage nature and curing methods.

6. REFERENCE

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