EFFECT OF NANOSILICA ON MECHANICAL PROPERTIES OF FIBER REINFORCED CONCRETE ELIMINATING COARSE AGGREGATE

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ABSTRACT

Concrete is one of most commonly used material in the field of construction on Earth. Particularly nano-silica as supplementary cementations material offer the potential of producing materials enhanced strength properties. In this project, effect of nano silica addition on mechanical characteristics of cement mortar is studied. The crimped steel fibers used in the project are made of stainless steel. They are quite rigid materials and this rigidity imposes mechanical properties of High Strength Fiber Reinforced Concrete.Firstly Concrete of 30Mpa was designed by using cement, fly ash, fine aggregate, quartz powder, super plasticizer and water. Then Nano silica by different weight percentages (1%, 1.5%, 2%, 2.5%, 3%, 3.5%, and 4%) was added to determine the compressive, split tensile &flexural strength. After determing the optimum dosage of nano silica, from strength criteria crimped steel fiber with different proportions were added and mechanical properties were determined.To study the strength properties cubes, cylinders and beams of size 100X100X100mm, 150X300 mm & 150X150X700mm are cast, tested at 7,14 & 28 days. At 3% optimum dosage of nanosilica, crimped steel fiber were added and effect of nano silica and crimped steel fibers was studied.

INTRODUCTION

1.1 General

In Concrete, Portland cement concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid material that hardens over time most frequently a lime-based cement binder, such as Portland cement. It the roman's knew it, it was a new and easy material, Laid in the shape of arches and domes, it quickly hardened into a rigid substances, free from many of the internal thrusts and strains that troubled the builders of similar structures in stone or brick. However, due to the absence of reinforcement, its mode of application was different and also its tensile strength was far lower than modern reinforced concrete.

Concrete is a composite material, comprising a matrix of aggregates (typically a rocky material) and a binder (typically Portland cement or asphalt), which holds the matrix together. There are many types of concrete available, determined by the formulations of binders and the types of aggregates that are used to adapt to the application of the material. These variables determine the strength and density, as well as the chemical and thermal resistance of the finished product. Mineral compounds have been popularized in recent decades.

The use of recycled materials as concrete materials is becoming increasingly popular due to increasingly stringent environmental laws and the often-supplemented and valuable nature of such materials. The most prominent of these is fly ash, a by-product of coal-fired power plants. Pulverized blast furnace slag, by-product of steelmaking; and silica smoke, a by-product of industrial electric arc furnaces.

Because minerals act as a partial cement substitute, the use of these materials in concrete reduces the amount of resources required. This replaces cement production, a process that is energy-intensive and environmentally challenging, while reducing the amount of industrial waste to be disposed of. Mineral blends can be blended in advance with cement for sale and used as blended cement or mixed directly with other components when producing concrete.

Portland cement is the most common type of cement commonly used. It is the basic ingredient of concrete, mortar and many plasters. Joseph Aspdin, a British operator, patented Portland cement in 1824. It was named because of the similarity of colors to Portland limestone, which was taken from the Portland of Portland, England and extensively used in London architecture. It contains calcium silicate (alite, belite), aluminates and ferrites.

LITERATURE REVIEW

1. **Faiz Shaikh, Vimal Chavda, Naji Minhaj, Hasan S. Arel**

The effect of pretreatment of regenerated coarse aggregate (RCA) in nanosilica (NS) solution on the properties of recycled agglomerate concrete is compared to direct mixing of NS in concrete. Four series of concrete are considered in this study. The first and second series are the control series containing 100% natural rough aggregate (NCA) and 100% RCA, respectively. The third and fourth series are similar in all respects to the second series, except that 2wt% NS is added directly from the concrete via mixing and preliminary addition of RCA in each of the 24 hour 2wt% NS solutions. The results show that the 28-day compressive strength of recycled aggregate concrete containing pre-mixed RCA is higher than the direct mixing of NS with concrete.

EXPERMENTAL INVESTIGATION

3.1 Materials Used:

In order to study the mechanical properties of nano silica, quartz powder and fiber reinforced concrete made with different percentages by eliminating of coarse aggregate and replace them with fiber, respective experiment was conducted on cubes, cylinders. Each group consists of cubes of size 100mm x100mm x 100mm.

- The first group eliminating coarse aggregate and using quartz powder.
- The second group is adding steel fiber.

The following materials were used to prepare the cement mortar

- Cement.
- Fly ash.
- Fine aggregate.
- Quartz powder.
- Nano silica.
- Crimped steel fiber.
- Super plasticizer.
- Water.

3.2 Material Properties

3.2.1 Cement

Cement serves as a binder for the material. Applied to civil engineering industry Cement is produced by calcinations at high temperature. It is a mixture of calcareous, siliceous, aluminum material and crushes clinker of fine powder. Cement is the most expensive material in concrete and is available in a variety of forms. When cement is mixed with water, a chemical reaction takes place and cement paste cures into gypsum mass. Depending on chemical composition, hardening and hardening properties, cement can be broadly divided into the following categories.

- Portland cement.
- Special cement.

The cement used in this test is of grade 53 Portland cement. Storage of cement requires special care to maintain its quality and suitability for use. To prevent deterioration, it must be protected from rain, wind and moisture. In the United States, the curing time of Rosendale cement has been at least a month since World War I, making it unpopular with highway and bridge construction, and many state and construction companies have turned to Portland cement. By the end of the 1920s, only one of the 15 Rosendale cement companies survived due to the conversion to Portland cement. However, in the early 1930s, architects found that Portland cement was set up faster, but durability was slower, particularly in the case of highways, with cement not stopping to build highways and roads. Bertrain H. Wait, an engineer who helped build the Catskill Aqueduct in New York City, was impressed with the durability of Rosendale cement and had the advantage of mixing Rosendale and Portland cement. It was very durable and had a much faster set-up time. Wait until the New York Commissioner of Highways builds a highway test site near New Paltz, New York, using six Rosendale sacks in six Portland cement. For decades, the Rosendale-Portland cement blend has been used to build highways and bridges.

Table 3.1 Physical Properties of O.P.C

S.No.	PROPERTIES	TEST RESULTS
1	Specific Gravity	3.10
2	Initial Setting Time	58 min
3	Final Setting Time	10 hours

Fig: - 3.1 CEMENT

RESULTS AND DISCUSSIONS

5.1 Test Results on Hardened Concrete

Samples were prepared and cement motor using mix design procedures as mentioned in the previous chapters. A total of 99 cubes were cast and the specimens were tested for 7 days, 14 days and 28 days for compressive strength and results are obtained. At the same time cement motor cylinders are prepared with and without addition of nano silica in various percentages (i.e. 1%, 1.5%, 2%, 2.5%, 3%, 3.5%, 4%) and tested at various ages i.e. 7 days, 14 days & 28 days for split tensile strength and results were obtained. At the same time cement mortar beams are prepared with addition of crimped steel fiber in various percentages (i.e. 1%, 1.5%, and 2%) and tested at various ages i.e., 7 days, 14 days & 28 days for flexural strength and results are obtained in ambient curing condition.

In this research work the values of compressive strength for different proportions of nano silica which were immersed for 7 days, 14 days & 28 days. These values are plotted which show variation of compressive strength of cubes which were immersed in water at curing ages of 7 days, 14 days & 28 days respectively. Table 5.2 shows the compressive strengths and average compressive strength at ages 7 days, 14 days & 28 days respectively for grade of concrete, various mix proportions considered.

Concrete and Split Tensile Strength Cube Compressive strength tests are carried out. Concrete strengthening crimped steel fiber achieves the following results. The concrete sample, which strengthened both nano silica and crimped steel fiber, was treated with ambient curing (room temperature), dried up to the test date. Cubes' compression power was found as the average and average value of the three test cube as tabulated. The same split tensile strength for cylinders are obtained by taking average of three test specimen.

5.2 Tables.

5.2.1 Compressive Strength of Normal Concrete for Trial Mixes.

Mix Designation	**Average Compressive Strength (Mpa)**		
	At 7 days	At 14 days	At 28 days
Trial Mix - 1	10.25	15.09	19.33
Trial Mix - 2	12.32	18.06	24.07
Trial Mix - 3	15.07	22.34	**32.08**

5.2.2 Compressive Strength of Concrete For different Percentages of Nano Silica.

6.1 CONCLUSIONS

1. It can be concluded that fiber reinforced concrete of M30 grade can be obtained by eliminating coarse aggregate and using nano silica & quartz powder.
2. Compressive strength has increased by 53% at 3% of nano silica in concrete.
3. Split tensile strength has increased by 36% at 3% of nano silica in concrete.
4. Flexural strength has increased by 44% at 3% of nano silica in concrete.
5. Compressive strength has increased by 9.5% at 1% of crimped steel fiber in concrete with 3% of nano silica.
6. Split tensile strength has increased by 17.7% at 1% of crimped steel fiber in concrete with 3% of nano silica.
7. Flexural strength increased by 11.5% at 1% of crimped steel fiber in concrete with 3% of nano silica.

6.2 FUTURE SCOPE

1. The study can be further extended with different nano materials and study the effect on strength.
2. It can also be further extended to study the durability performance.

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