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Performance of Self Compacting Concrete with Partial Replacement of Cement with Nano-Silica

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Abstract: Self compacting concrete – a special concrete with an extra ordinary property of compacting itself, reduces the possibility of human error. With this, the combination of Nano-Silica gives a marvellous strength in the construction field. Though the use of self compacting concrete reduces the cost of manual compaction, the use of self compacting concrete along with Nano-silica particles helps in finishing the construction work faster by acquiring strength faster. This present study is about the influence of Nano technology on the properties of self compacting concrete. By adding Nano materials like Nano silica, the rate of hydration, permeability, durability, compressive strength, split tensile strength, flexural strength is increased with increase in concentration of Nano-silica. Application of nano materials in concrete technology can potentially change the service life and life cycle cost of construction infrastructure. This study presents the behaviour of self compacting concrete(SCC) with partial replacement of cement with Nano-silica. The objective of the investigation is to develop a reinforced concrete beam with Nano-silica as partial replacement for cement. Then the results are to be compared with conventional beams.

I. SELF COMPACTING CONCRETE

SCC is basically a concrete which is capable of flowing into the form work, without segregation and bleeding, reduces manpower, better finishes, easier placement, better durability, thinner concrete sections, lesser noise levels, no vibration, safe working environment, to fill uniformly and completely every corner of it by own weight without any application of vibration or other mechanism during placing of concrete. The advantages of SCC make this concrete more desirable all over the world which includes faster construction.

A. Aim

The aim of the present study is to investigate the mechanical and durability properties of concrete with fine aggregate is partially replaced with nano silica. The replacements are varied by various proportions such as 2%,4% and 6% by weight of fine aggregate.

B. Scope

The scope of this project is to produce concrete with usage of nano-silica as a replacement to cement and to study about the mechanical properties and durability properties where considered.

C. Main Objective

Based on the study the major objective of the project is identified as the investigation on properties of self compacting concrete by using various percentage of nano-silica and its possible results are determined in the sub-objectives to achieve the major goal.
To study the properties of self compacting concrete with natural coarse aggregates along with the effects of admixtures (Nano-silica) varying percentage 2%, 4% and 6%. To study properties of conventional concrete with Self compacting concrete using admixture. To investigate the properties of medium strength concrete incorporated with nano-silica as weight of cement quantity as per the construction practice. The behaviour is to be found by conducting hardened concrete test and compared with conventional concrete

II. METHODOLOGY

Initially, literature survey (collection of data) has been done. The main objective of this project is to improve the strength of concrete by using nanosilica partially as a replacement for cement. Detailed study about the materials has been carried out. The materials collected are Cement OPC 53 grade, nanosilica used as replacement up to lesser percentages and 20mm coarse aggregate is used for this project. Physical properties such as sieve analysis of aggregates, water absorption, initial and final setting time of cement and consistency of cement are tested. Calculation for various percentage of mix proportions are done. In Phase II, casting and testing of the concrete specimens are done.

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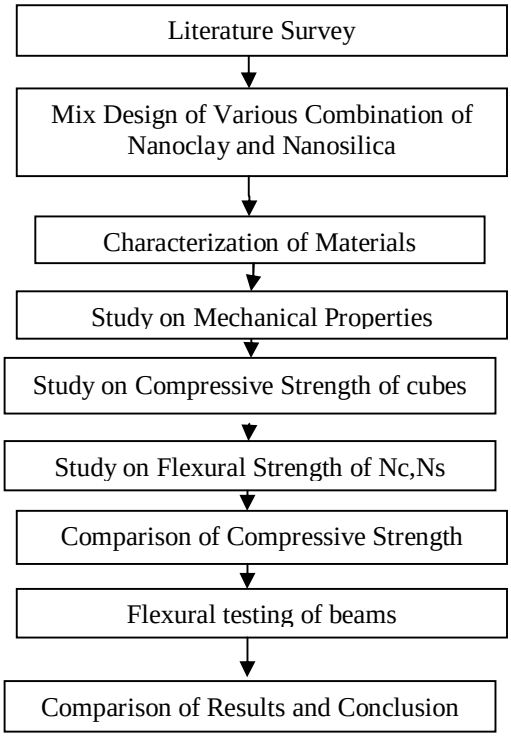
The specimens casted are 6 cubes of 150 x 150 x 150mm, 3 cylinders of 70 x 150mm, and 1 prism of 100 x 100 x 500mm are casted for each mix. The specimens will be tested at 7, 14 and 28 days. Mechanical properties such as compressive strength test, Split tensile test and Flexural strength tests are taken. In this mix design, fine aggregate is partially replaced by 2%, 4% and 6% nanosilica.



III. TESTING

A. Flow table test
B. Slump cone test
C. J-Ring test

IV. MIX DESIGN

A. Design

Many methods have been recommended for mix proportioning of concrete all over the world. Among these methods Indian Standard (IS10262 – 2009) method was selected. The design of mix used for the present work by IS method is given below.

B. Prelimary Data

Grade designation = M40
Type of cement = OPC 43 grade
Type of admixture = Nano-silica
Maximum nominal size of aggregate = 20 mm
Minimum cement content = 360 kg/m^3
Maximum water cement ratio = 0.4
Workability = 75-100 mm
Expose condition = Extreme (RC)
Method of concrete placing = Pumping
Degree of supervision = good
Type of aggregate = crushed angular aggregate
Maximum cement content = 450-500 kg/m^3
Chemical admixture type = super plasticizer

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V. CASTING AND CURING

A. General

The specimens were casted with concrete of characteristic strength 30N/mm^2, the size of cube mould is (150mm x 150mm x 150mm) and of prism mould is (750mm x 150mm x 150mm) and of cylinder is 150mm diameter and 300mm height, The mix design was computed according to the design specification mentioned in IS 10262 – 2009, The mix ratio thus obtained is
1: 1.86: 3.28 with water cement ratio 0.42. For standard concrete, for the partial replacement with metakaolin and flyash the mix ratio was 1: 1.77: 3.14 mixtures with 0, 10, 20, 30, 40 and 50 percentage substitutions of both metakaolin and flyash.

B. Mixing Of Concrete

Thus all the above materials with appropriate water cement ratio and chemical admixture were added for better workability and compaction of the concrete, here mixing was done by small compact mixing machine operated by hand (which is well design for testing operations) and well mixed concrete was transported to the place, were it is to be cast.

C. Casting

Iron-Steel mould was used for casting the specimen, before casting oiling was done on the inner surfaces of the moulds, Concrete was mixed well by machine and it was poured in to moulds in layers and compacting it adequately so that the concrete fills the entire volume. The first step is proper mixing to avoid loss of water ensure that the concrete is homogeneous, uniform in colour, consistency and entire amount of concrete is poured in to the mould without any air voids. The pouring of concrete is done in such a way to avoid segregation while being discharge in to the mould.

Fig. 7.2 Casting of moulds

D. Compaction

Compaction is the process adopted for expelling the entrapped air from the concrete, In the process of mixing, transporting & placing, air voids tends to get entrapped in the concrete. This will lead to reduction in strength, thus concreting is an essential part of concreting, here we use hand compaction for every batch of specimens of concrete were cast simultaneously. Compaction of concrete is an operation in which fresh concrete is compacted in forms and make it encircle reinforcement and other embedded object such as tubes in the mould, there are various problems arises, If compaction of concrete is not carried out properly such as honeycomb, steel corrosion and permeability issues.

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VI. SUMMARY AND CONCLUSION

From the experiment it is concluded that how the usage of nanosilica helps in improving the strength of the concrete. Nano silica is the important replacement in this project. The Nano silica are replaced by 2%,4%and 6% to the weight of cement content. Collection of the literatures are done and are studied carefully. The design mix and the tests were done as per IS 456 and IS 10262-2019 code books. The curing & testing were done at an interval of 7,14 and 28 days. After the specified curing period, the mechanical property of the specimens is tested. The strength parameters such as Compressive strength test, Split tensile strength test and Flexural strength tests were conducted and the results were arrived.

The maximum Compressive strength of concrete is obtained in Mix 1 (2% NS) of 54.12 N/mm^2 at 28 days.

The maximum Split tensile strength of concrete is achieved when the fine aggregate is replaced by 2% of NS (nanosilica) and the results states that it is 2.12 N/mm^2. When 4% of copper slag is replaced in place of fine aggregate the maximum Flexural strength exhibited is 14.43N/mm^2.

Hence it is clear that the cement can be appreciably replaced with nanosilica and thereby it increases the strength.

Finally, it can be concluded that a concrete with cement replaced by 2% and 4% will have good strength and is well suitable for high rise buildings. So for an high rise building an self compacting concrete with partial replacement of nano silica gives good strength and effective since there is no need for compaction.

Thus there is a scope for development of crack free concrete towards sustainable construction with reduction in water content.

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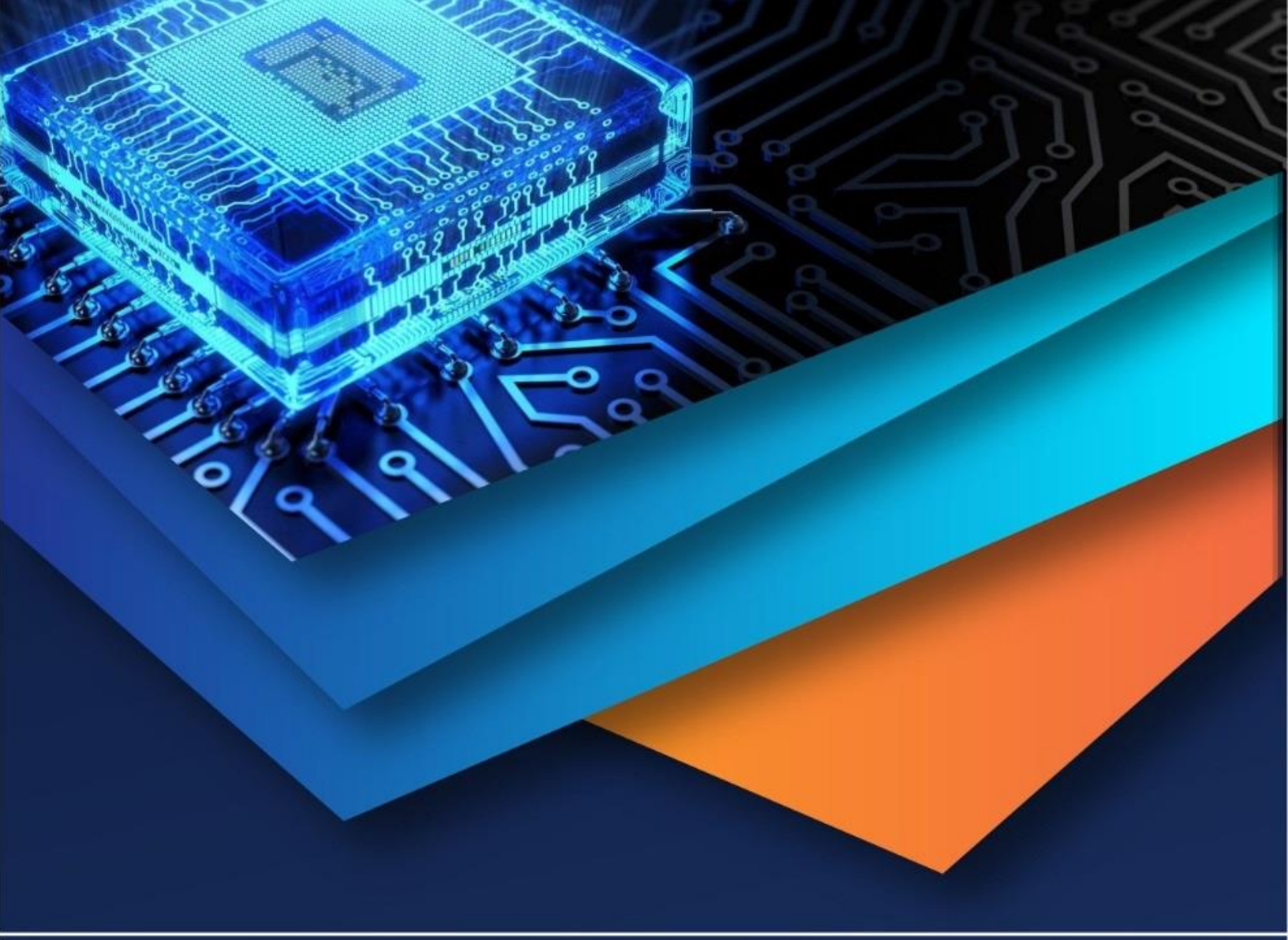

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