Use of Nano Silca And Metakaolin As Supplementary Cementitious Materials To Cement on M35 Grade of Synthetic Fibre Reinforced Concrete

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Abstract- *Cement is the most important ingredient of the concrete which produces carbon dioxide which is May harmful. So it is a main concern to reduce the usage of cement. The increase in price of the cement not only will increase the budget of a construction however additionally poses a significant threat to the country's development. It's known that some waste product like nano silica and metakaolin are having some building material and siliceous properties. The impact of carbon dioxide emission due to production of Portland cement can be reduced by partial replacement of cement with supplementary cementitious materials. Nano silica and metakaolin like waste materials comprise pozzolanic properties but their disposal is causing acute environmental setbacks. This project work is carried with sets of objectives, viz., and effect of metakaolin, nano silica and nylon on properties of M35 grade of concrete with different proportions of cement with metakaolin and nano silica together with 0%, 1%, 1.5%, and 2% of nylon fibers. Nylon was the first truly synthetic fiber to be commercialized. Metakaolin to replace cement in various percentage levels is 10%, 20%, 30% and 40%. The present project involves a comprehensive laboratory experimentation study for the application of new waste materials in the preparation of concrete. The main objective of investigation is to study the strength behaviour i.e. compressive strength and impact resistance of concrete with different percentages replacement of cement with metakaolin and nano silica and to study the tensile behaviour on adding with nylon fibres.*

Keywords- Nano silica, metakaolin, workability, compressive strength, split tensile strength test, water absorption test.

I. INTRODUCTION

In the last decades, environmental sustainability has become one of the most important issues. Cement is the most important ingredient of the concrete which produces carbon dioxide which is May harmful. So it is a main concern to reduce the usage of cement. The increase in price of the cement not only will increase the budget of a construction however additionally poses a significant threat to the country's development. it's known that some industrial waste product like nano silica are having some building material and silicious properties. So the use of the commercial and agricultural wastages in concrete part as cement replacement, scale back the price of constructing concrete, additionally causes improvement within the properties of concrete and scale back environmental pollution. Rapid industrial expansion produces severe difficulties all around the world, including as the depletion of natural resources and the creation of vast amounts of waste materials throughout the manufacturing, construction, and demolition stages; one option to mitigate this problem is to utilize wastes.

The impact of carbon dioxide emission due to production of Portland cement can be reduced by partial replacement of cement with supplementary cementitious materials. Nano silica and metakaolin do waste materials comprise pozzolanic properties but their disposal is causing acute environmental setbacks. The utilization of industrial and agricultural waste product in concrete has been a major step on waste reduction. Metakaolin and Nano silica can by effectively used in concrete as partial replacement of cement because of their high content of silica and pozzolanic properties which plays an important role in achieving high strength and durability in concrete.

Thus fibres are another to concrete to beat these disadvantages. The addition of fibres within the matrix has several vital effects. Fiber reinforced concrete has been recognized that addition of small, closely spaced and uniformly dispersed fibres to concrete would act as reinforcement to the concrete thereby improves the properties of concrete.

The Fibre concrete (FRC) could be a material primarily consisting of concrete strengthened by random placement of short discontinuous and distinct fine fibers of specific pure mathematics. It's currently well established that the addition of short, discontinuous fibers plays a vital role within the improvement of the mechanical properties of concrete. In the FRC, the fibers facilitate to transfer load to the inner small cracks. Within the recent past, several developments are created within the fiber concrete.

o reduce mainly the natural resource consumptions different production chains whose byproducts can substitute natural materials mixed with cement and/or concrete are investigated and, then, modeled. Hence, concrete and by-products production chains are jointly modeled to evaluate comprehensive and environmental benefits, the effective design of linked production chains, and to compare different economical and technical solutions. For instance, materials resulting from building demolition are proved to be effective also in terms of reduction of landfill space consumption.

The present project involves a comprehensive laboratory experimentation study for the application of new waste materials in the preparation of concrete. The main objective of investigation is to study the strength behaviour i.e. compressive strength and impact resistance of concrete with different percentages replacement of cement with nano silica and metakaolin and to study the tensile behaviour on adding with nylon fibres.

The objective of the present study was to investigate experimentally the properties of Concrete with the following test results

1. Workability
2. Compressive strength
3. Flexure strength
4. Tensile strength

II. REVIEW OF LITERATURE

A lot of work has been done to explore the benefits of using pozzolanic materials in making and enhancing the properties of concrete. Literature review of nano silica and metakaolin is presented in the following sections.

It has been noted that the sunshine fastness of banana fibre is inferior to cotton. this could be attributed to the impurities gift within the banana fibre within the variety of polymer and therefore the different insoluble matter. The revealed analysis works on flexural plasticity of nylon fiber ferroconcrete beam are studied by several researches few mentioned the influence of nylon fiber issue on flexural plasticity of beam and terminated that plasticity indexes increase with increasing of fiber issue.

D. Patil, Patil&Veshmawala Observed the Performance of Copper Slag as Sand Replacement in Concrete.M30 concrete was used and several tests like compressive, flexural, split tensile strength were taken for different portions of copper slag and sand from 0 to 100%. The outcome showed that workability increases with growth in percentage of copper slag. Maximum Compressive strength of concrete increased by 34 % at 20% replacement of fine aggregate with copper slag, and up to 80% replacement of copper slag, concrete gain more force than normal concrete strength. The flexural strength of concrete found to be increased by 14% with 30% substitution of copper slag.

A.N.Dancygier and Z.Savir studied the influence of nylon fiber on flexural performance of high strength concrete beam with low longitudinal reinforcement magnitude relation, that tried that nylon fiber enhance crispiness of beam compared to it of beam with minimum longitudinal reinforcement magnitude relation. Compared to nylon fiber concrete, the hybrid fiber with completely different kind and size will improve effectively strength and toughness of concrete, kind hybrid result throughout completely different fiber, play various useful influence from completely different level. However, few researches on flexural performance of hybrid fiber strengthened RC beam were studied.

Sasikumar&Tamilvanan Performed an Experimental Investigation on Properties of Silica Fumes as a Partial Replacement of Cement. The main parameters investigated in this study is M30 grade concrete with partial replacement of cement by silica fume0%, 25%, 30%, 40% and 50%. The normal consistency increases about 40% when the silica fume percentage increases from 0% to 25%. The optimum 7 and 28-day compressive strength has been obtained in the 25 % silica fume replacement level. As well the split tensile strength is high when using 25% silica fume replacement for cement.

Ghutke&Bhandari Examine the Influence of silica fume in concrete. Results indicated that the silica fume is a better replacement of cement. The rate of strength gain in silica fume concrete is high. Workability of concrete decreases as increase with % of silica fume. The optimum value of compressive strength can be achieved in 10% replacement of silica fume. As strength of 15% replacement of cement by silica fume is more than normal concrete. The optimum silica fume replacement percentage is varying from 10 % to 15 % replacement level.

III. MATERIALS AND METHODS

The experimental investigation work is started with various tests on the constituent materials. The constituent materials are given below.

1. Cement
2. Coarse aggregate
3. Water
4. Nano silica
5. Metakaolin

1. Cement

Ordinary Portland cement of 43 grades manufactured by Shree Ultratech Cement was used throughout the Experimental investigation. The quality of the cement was confirming to IS 8112:1989 was used in the field.

2. Fine Aggregate

Fractions from 4.75 mm to 150 microns are termed as fine aggregate. Locally available river sand passed through 4.75mm IS sieve is applied as fine aggregate conforming to the requirements of IS 383:1970.

3. Coarse Aggregate

Coarse aggregate shall be of hard broken stone of granite shall be of hard stone, free from dust, dirt and other foreign matters. The stone ballast shall be of 20mm and down and should me retained in 5mm square mesh and well graded such that the voids do not exceed 42 percent. Aggregate most of which is retained on 4.75-mmIS Sieve and containing only so much finer material as is permitted for the various types described in this standard.

4. Nano silica

Advance cement made by the investigation of concrete at Nano scale have demonstrated Nano silica superior to anything silica utilized in traditional cement, however engineering investigations demonstrates that likewise with silicon powder, additionally bring two issues, from one perspective is the cohesiveness increment of cement to development cause certain issue.

Table 3.1. Physical Properties of nano silica

S.No	Property	values
1	Specific gravity	2.2 – 2.4
2	Partial size	17 Nano
3	Ph value	3.7 – 4.5
4	Specific surface area	200 ± 20
5	Sieve residue	≤0.04

5. Metakaolin

Metakaolin is a white, amorphous, highly reactive aluminium silicate pozzoloan forming stabile hydrates after mixing with lime stone in water and providing mortar with hydraulic properties. It is a mineral admixture obtained from clay. Metakaolin is a highly pozzolanic material, it is in powder form and fineness of MK up to 700 to 800m²/kg. It is derived from the calcination of a high-purity kaolin clay. The product is then ground to between 1-2 gm. (about 10 times finer than cement). Indeed Metakaolin is not a by-product, one of the prominent use of MK is mixing with concrete because its physical and chemical properties are similar to the cement. As a raw material, it is rarely found in crystallized form and Kaolinite is a clay mineral found fairly commonly throughout the world.

IV. MIX DESIGN

The property of workability, therefore, becomes of vital importance. The mix design is done as per IS 10262-2009. Percentage dosage of super plasticizer (high range water reducers) is an additional parameter to be considered for designing an OPC mix. Percentage dosage of super plasticizer was fixed as per the mix design method described in IS 10262-2009. Mix proportion was arrived through various trial mixes. The grade of concrete prepared for the experimental study was M35.

V. RESULTS AND DISCUSSIONS

This session provides an outline of the experimental results and endeavors to draw some conclusions. The take a look at result covers the workability, mechanical properties and sturdiness properties of concrete with and while not admixtures. The results of the experimental investigation on nano silica and metakaolin concrete wherever nano silica and metakaolin has been used as partial replacement of cement in concrete mixes. On commutation cement with completely different percentages of nano silica the workability, compressive strength is studied then to the optimum share of nano silica ,keeping nano silica constant the bottom coarse furnace scum is replaced and studied the compressive strength, flexural strength for various mixes then studied the durability with addition of nylon fibres of varied percentages.

5.1 REPLACEMENT DETAILS

The replacement details of nano silica and metakaolin has been given in the below table. The replacement of cement percentages by 0, 5, 10, 15, 20% with nano silica and after getting optimum percentage keeping optimum nano silica constant varying the cement replacement percentages by metakaolin and further with addition of nylon fibre.

5.2 VARIATION OF SLUMP VALUES FOR PERCENTAGE REPLACEMENT OF NANO SILICA

Slump test was carried out to measure the workability of various mixes. The workability of various mixes was assessed as per the IS 1199:1959 specification. The minimum workability for MIX I may be due to the lesser fine particle size of cement which can result in higher water consumption thereby reducing workability. Critical mix has high workability compared to other mixes which may be due to the particle size of nano silica and metakaolin is lesser than cement. So in short, mixes with high percentages of nano silica are more workable than the control one.

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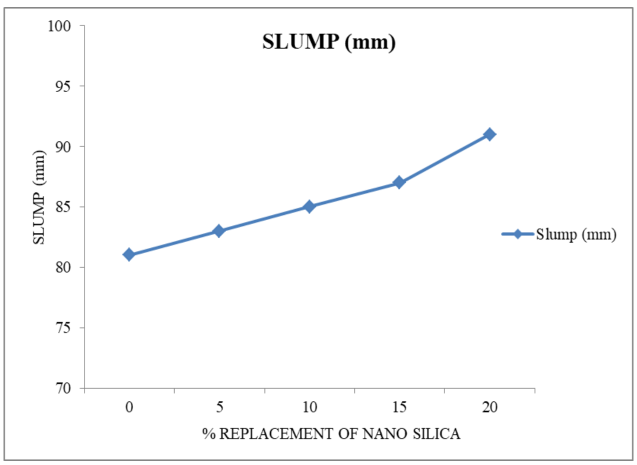
The slump of the freshly mixed concrete was measured by using a slump cone in accordance to ASTM C143. It can be observed from Table 5.1 that all mixtures have a slump of less than 45mm and are observed that slump values increasing with increase in slag content.



5.3.1 COMPRESSIVE STRENGTH

The main function of the concrete in structure is mainly to resist the compressive forces. When a plain concrete member is subjected to compression, the failure of the member takes place, in its vertical plane along the diagonal. The vertical cracks occur due to lateral tensile strain. A flow in the concrete, which is in the form of micro crack along the vertical axis of the member will take place on the application of axial compression load and propagate further due to the lateral tensile strain.

Cubes are prepared of size 150 mm x 150 mm x 150 mm are checked for compressive strength. The specimens tested for 7, 14 and 28 days. The specimen were tested for compressive strength parallel to the plane of the board by applying increasing compressive load until failure occur. The arrangement of load is applied to the specimen by placing the specimen length vertical between the surfaces of the testing machine. Prior to that, measurement for the thickness and width was carried out in order to get the values of cross section area for the test specimens.

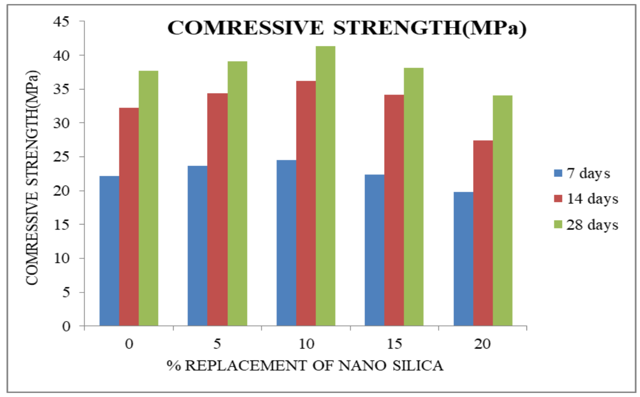


Fig 5.2shows the Variation in Compressive Strength for % Replacement of nano silica

5.4 VARIATION OF COMPRESSIVE STRENGTH FOR ADDITION OF METAKAOLIN TO OPTIMUM PERCENTAGE OF NANO SILICA

Compressive strength of concrete keeping 10% nano silica as constant and with different percentages of metakaolin for curing period of 7-days, 14-days and 28-days respectively and fig shows the summarized Compressive strength Results for different curing periods– M35 grade.

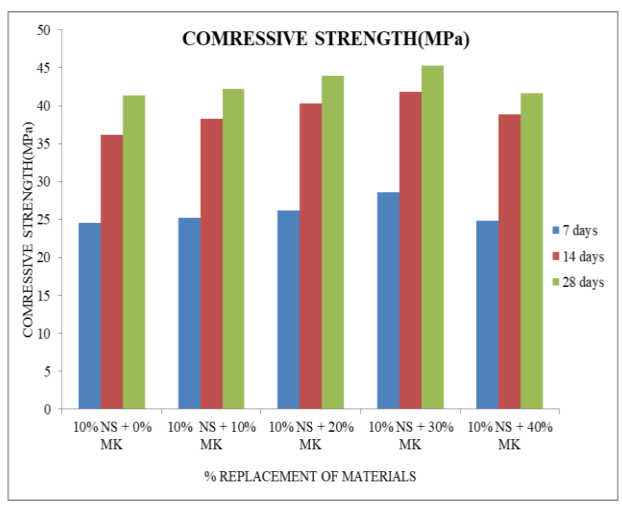


Fig 5.3 shows the variation in Compressive Strength for % replacement of metakaolin

5.5 EFFECT OF NYLON FIBER ON COMPRESSIVE STRENGTH USING NANO SILICA AND METAKAOLIN

Compressive strength of concrete keeping 10% nano silica and 30% metakaolin as constant and with different percentages of nylon fibre for curing period of 7-days, 14-days and 28-days respectively and fig shows the summarized Compressive strength Results for different curing periods– M35 grade.

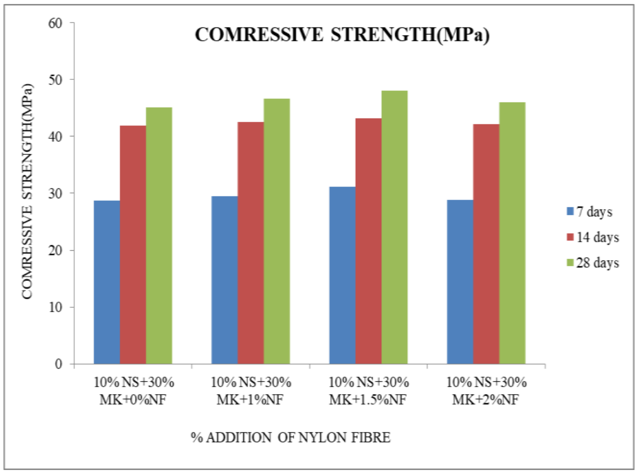


Fig 5.4 shows the Variation in Compressive Strength for percentages of nylon fibres

5.6 EFFECT OF NYLON FIBER ON COMPRESSIVE STRENGTH USING NANO SILICA AND METAKAOLIN

Split tensile strength of concrete keeping 10% nano silica and 30% metakaolin as constant and with different percentages of nylon fibre for curing period of 7-days, 14-days and 28-days respectively and figure shows the summarized Split tensile strength Results for different curing periods– M35 grade.

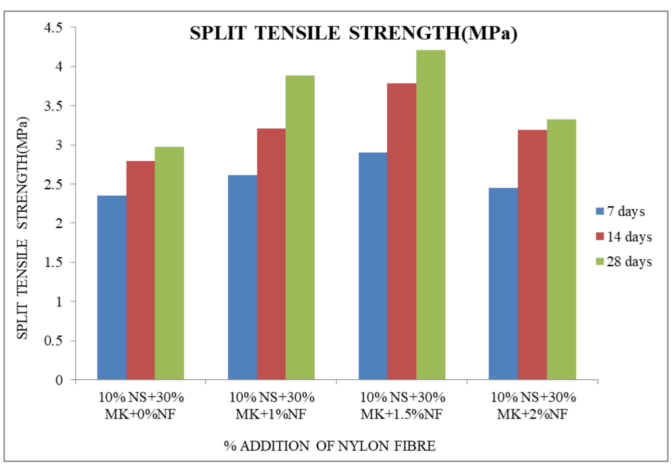


Fig 5.5 shows the Variation in Split Tensile strength for different percentages of nylon fibres

5.7 EFFECT OF NYLON FIBER ON FLEXURAL STRENGTH USING NANO SILICA AND METAKAOLIN

The Flexural strength of the concrete mix for M-35 with partial replacement of cement by nano silica and metakaolin respectively showed higher Flexural Strength after 7 and 28 days. The 7 days and 28 days Flexural strength of mix with 10% partial replacement of Nano silica, 30 % replacement of metakaolin and 1.5% of nylon fibre showed higher strength compared to other mixes.

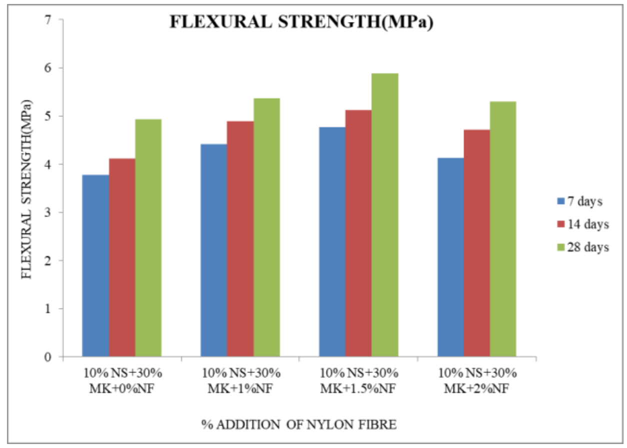


Fig 5.6shows the Variation in Flexural strength for different percentages of nylon fibres

VI. CONCLUSIONS

The Conclusions and Recommendations that could be drawn from the results of this project and experiments are summarized and the use of Nano silica and metakaolin as a cement replacing material in concrete production was studied and after the research work is done, the following conclusions were made:

- It has been observed that by the incorporation of Nano silica & Metakaolin as partial replacement to cement in fresh and plain concrete increases workability when compared to the workability.
- From the compressive strength results, it can be observed that increase in concrete strength is observed on addition of a certain minimum quantity of Nano silica. The increase in strength is maximum for 10% replacement of nano silica. The maximum compressive strength is 41.39 MPa. The strength is increased about 9.85% when compared to ordinary concrete.
- Upon further addition of metakaolin to optimum content of nano silica the mix with replacement of cement with 10% Nano silica and 30% Metakaolin has shown good strength properties like compressive

and tensile and flexural strength. This may be due to the fact that the CSH gel formed at this percentage is of good quality and have better composition.

- The highest compressive strength value i.e. 45.32 MPa, was obtained for a mix having 10% nano silica and 30% metakaolin. It is evident from the present investigation that the addition of nylon fibers to concrete improve compressive strength, split tensile strength, flexural strength etc. of the mix.
- There was a 24.49% increase in the compressive strength and 90% increase in the tensile strength because of the high elastic modulus of nylon fiber. Due to the high stiffness of Nylon fibres, resulted in a significant enhancement in split tensile strength.
- The use of Nano silica and Metakaolin combined is economic when compared to cement in concrete. Likewise saves a great deal of waste disposal problems and reduces the cement price rise and intensities of CO2 release by the cement production. Also these materials make the concrete more sustainable, light weight and low energy emitting which is noble.

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