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EXPERIMENTAL STUDY ON STRENGTH OF CONCRETE USING NANO SILICA

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ABSTRACT
Thetestonhardenedconcreteweredestructivetestoncubeforsize(150×150×150 mm) at 7, 14, 28 days of curing as per IS: 516-1959, flexural strength test on beam (100×100×500 mm) at 7, 14, 28 days of curing as per IS:516-1959 and split tensile strength test on cylinder (100mmφ×200mm) at 7,14,28 days of curing as per IS: 5816-1999.The main objective of this work is to study the suitability of the silica fume as a pozzolonic material for cement in concrete. However it is expected that the use of silica fume in concrete improve the strength properties of concrete. In this study the combination of 5% nano silica and 10%metakaolin which replaced part of the cement had the best results in the mechanical properties of concrete with a 15%increase in the compressive strength and 40%increase in the flexural and tensile strength of concrete.

1.INTRODUCTION

1.1 General

Concrete is one of the building materials widely used in civil engineering
Construction and their design consumes almost the total cement production in the world. Portland cement, one of the largest commodities consumed worldwide. Betterunderstanding and precise engineering of an extremely complex structure of cementbasedmaterials at the Nano-level will apparently result in a new generation of concretethat is stronger and more durable, with desired stress–strain behavior and possiblypossessing a range of newly introduced properties, such as electrical conductivity aswell as temperature, moisture and stress-sensing abilities.

The overall grading of the mix-containing particles from 300 nm to 32 mm-determines the mix properties of the concrete. The properties in fresh state (flow properties and workability) are for instance governed by the particle size distribution (PSD), but the properties of the concrete in hardened state, such as strength and durability, are affected by the mix grading and resulting particle packing. One way to further improve the packing is to increase the solid size range, i.e.by including particles with sizes below300 nm. Possible materials which are currently available are limestone and silica fines like silica fume (SF) and nano silica (nS).

Although cement is a man-made building material, its main hydrate C–S–H gel isa natural nano-structured material. The mechanical and durability properties of concreteare mainly dependent on the gradually refining structure of hardened cement paste andthe gradually improving paste–aggregate interface. Microsilica (silica fume) belongs tothe category of highly pozzolanic materials because it consists essentially of silica innon-crystalline form with high specific surface and thus exhibits great pozzolanicactivity.A new pozzolanic material produced synthetically, in the form of wateremulsion of ultra-fine amorphous colloidal silica (UFACS), is available in the marketand it appears to be potentially better than silica fume because of the higher content of amorphous silica (> 99%) and the reduced size of its spherical particles (1- 50 nm). Water permeability resistance and 28-days compressive strength of concrete were improved by usingnS. Addition of nS into high-strength concrete leads to an increase of both short-term strength and long-term strength.

At the same time, this new concrete should be sustainable as well as cost-and- energy effective, exhibiting qualities that modern society demands. These developments will revolutionalise the construction industry. One of the newest technologies to break into the concrete design arena is the use of nS in the concrete matrix. By using nS, the development of the strength bearing crystals of cement paste can be increased or controlled. Recent major achievements include the ability to observe the structure at its atomic level and measure the strength and hardness of microscopic and nanoscopic phases of composite materials.More-specific achievements are the discovery of a highly ordered crystal nanostructure of amorphousC-S-H gel. Hydration of nano-SiO2 in cement paste was studied using SEM and EDAX.

2.LITERATURE REVIEW

RenuTiwaret al (2016):

The research mainly focusing on the use of nano materials in concrete. Further researchers are continuing to improve the durability and sustainability of concrete and have realized significant increment in mechanical properties of concrete by incorporating nano silica. The review paper summarizes the effect of nano silica addition compressive strength on concrete 2% NS reduces initial and final setting time and compressive strength increases by 22% and 18% at 3 days and 7 days.

PranayLanjewar et al (2017):

Nanotechnology is one of the most active researches; Nano-Silica is used as a partial replacement for cement in the range of 1%, 1.5%, 2%, 3.5% and 4% for M20 mix. This study summarizes the influence of nano- silica on strength and durability of M20 grades of concrete with the used of nano-silica as a replacement of cement. The replacement of cement with nano-silica more than 3.5% results in the reduction of compressive strength of nano-concrete. From the experimental results, it can also be concluded that the permeability of concrete decreases with increase in the percentage of nano-silica up to 3.5 %.

Sakthivel et al (2017):

The influence of Nano-Silica on various properties of concrete is obtained by replacing the cement with various percentages of Nano-Silica and natural hybrid fibres. Nano-Silica is used as a partial replacement for cement in the range of 2%, 2.5%, 3%, 3.5%, 4% and hybrid fibre (coir fiber & human hair) of percentage 0.5%, 1%, 1.5%, 2% and 2.5% for M25 mix. Specimens are casted using Nano-Silica concrete. Laboratory tests were conducted to determine the strength and durability of Nano-Silica concrete at the age of 28 days. The replacement of cement with Nano-Silica results in higher strength and reduction in the permeability than the controlled concrete. The replacement of cement with Nano-Silica more than 3% results in the reduction of various properties of Nano-Silica concrete.

3. PROPERTIES OF MATERIALS

➢Cement

➢Fine Aggregate

➢Coarse Aggregate

➢Water

➢Nano Silica Fume

➢Metakaolin Powder

3.1 CEMENT

Cement is a key to infrastructure industry and is used for various purposes and also made in many compositions for a wide variety of uses Cements may be named after the principal constituents, after the intended purpose, after the object to which they are applied or after their characteristic properties. Cement used in construction are sometimes named after their commonly reported place of origin, such as Roman cement, or for their resemblance to other materials, such as Portland cement, which produces a concrete resembling the Portland stone used for building in Britain.

3.2 FINE AGGREGATE

Fine aggregate or material passing through an IS sieve that is less than 4.75mmas a fine aggregate Locally available sand is gauge usually natural sand is used as fine aggregate that places where natural sand is not available crushed stone is used as fine aggregate in the conventional concrete. River sand zone II was used in this study. The various results of testing carried out for fine aggregate is provided in table. According to 383: 1970 the fine aggregate is being classified into four different zone, that is Zone-l. Zone-II, Zone- III, Zone- IV. There is no chemical formula for the sand. By default, sand formula treated as sio2, Sand is a mixture of multiple different minerals.

3.3 COARSE AGGREGATE

The shape and particle size distribution of the aggregate is very important as if
affects the packing and voids content, water absorption, grading and variation in finescontent of all aggregate should be closely and continuously monitored order to produceconstant quality. Coarse aggregate of maximum size 20mm was used in thisexperimental study.

3.4 WATER

Water is a key ingredient in the manufacture of concrete. Water used in concrete mixes has two functions: the first is to react chemically with the cement, which will finally set and harden, and the second function is to lubricate all other materials and make the concrete workable. Although it is an important ingredient of concrete, it has little to do with the quality of concrete. One of the most common causes of poor- quality concrete is the use of too much mixing water. Fundamentally "the strength of concrete is governed by the nature of the weight of water to the weight of cement in a mix, provided that it is plastic and workable, fully compacted, and adequately cured".

3.5 NANO SILICA FUME:

Silica fume is also known as micro silica. It is an ultrafine powder collected as a By product of the silicon and ferrosilicon alloy production and consists of spherical Particlesof with an average particle diameter of 150nm. The main field of application is as pozzolanic material for high performance concrete.

3.6 METAKAOLIN POWDER:

Metakaolin is a dehydroxylated form of the clay mineral kalonite.Metakaolin is commonly used in the production of ceramics, but is also used as cement replacement inconcrete.Metakaloin has smaller particle size and higher surface area compared with Portland cement, but larger particle sizethan SF.

4.1 TYPES OF TESTS

➢Impact test

➢Specific Gravity &Water Absorption test

4.3 IMPACT TEST

For determination of the aggregate impact value of coarse aggregate, which passes 12.5 mm. IS sieve and retained on 10 mm. IS sieve. cylindrical steel cup is filled with 3 equal layers of aggregate and each layeris tamped 25 strokes by the rounded end of tamping rod and the surplus aggregatestruck off, using the tamping rod as a straight edge.The net weight of aggregate in the cylindrical steel cup is determined to thenearest gram (WA) and this weight of aggregate is used for the duplicate test onthe same material.The cup is fixed firmly in position on the base of the machine and the whole ofthe test sample is placed in it and compacted by a single tamping of 25 strokesof tamping rod.

TABLE 4.3.1 RESULTS OF IMPACT STRENGTH TEST FOR PAVER BLOCKS. (28 days) Table 5.2: Observations of Impact Test:

Observations	**Sample1**	**Sample 2**
Total weight of dry sample (W1gm)	336	380
Weight of portion passing 2.36 mm sieve (W2gm)	80	95
Aggregate Impact Value (percent) = W2 / W1 X 100	23.80	25
Mean = **24.4%**		

6. RESULT AND DISCUSSION

project shows partial replacement Nano materials like nano silica which improves the strength of concrete. The tests conducted on cubes, cylinders and beam which showscompressive, split tensile and flexural strength increased. The effects of different ratios of Nano-Silica to cement content were well investigated, and the optimum ratio of 3% was reported. From the above discussion we have conclude the points about silica fumeconcrete.Silica fume can be used

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manufacturing of concrete of very high strength at earlyage.Strengthsupto 200 Mpa can be achieved by using silica fume. The results obtained from water absorption test suggest that nS concrete ismore durable than conventional concrete. The addition of Nano silica Resistance to permeability was also higher inconcrete.

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