EXPERIMENTAL INVESTIGATION OF HYBRID FIBER CONCRETE WITH NANOSILICA

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Abstract - Concrete is characterized by quasi-brittle failure, the nearly complete loss of loading capacity, once failure is initiated. This characteristic, which limits the application of the material, can be overcome by the inclusion of a small amount of short randomly distributed fibers (steel, glass, synthetic and natural) and can be practiced among others that remedy weaknesses of concrete, such as low growth resistance, high shrinkage cracking, low durability, etc. The use of two or more types of fibers in a suitable combination may potentially improve the overall properties of concrete and also result in performance concrete. The fibers are able to prevent surface cracking through bridging action leading to an increased impact resistance of the concrete. The combination of two or more different types of fibres is becoming more common, with the aim of optimizing overall system behaviour. The intent is that the performance of these hybrid systems would exceed that induced by each fibre type alone. In this experiment, the behaviour of concrete using Hybrid Fiber and Nanosilica are determining. The mix design is done for M25 grade concrete as per Indian Standard. The different percentage of fiber (i.e.) steel fiber 0.7% and polypropylene fiber 0.3% by weight of cement were used in the investigation and the various percentage of nanosilica randing from 2.0% to 4.0% by weight of cement were used. The concrete specimen with different percentages will cast, cure and test for 7 and 28 days.

Keywords : Hybrid Fiber Reinforced Concrete, steel fiber, polypropylene fiber, nanosilica, compressive strength, flexural strength, split tensile strength.

I. INTRODUCTION

A hybrid fiber concrete is a composite of two or more fiber in concrete. In addition of hybrid fibers in concrete improves the tensile characteristics by inhibiting crack growth and increase in energy absorption capacity, flextural strength, and ductility. Different types of fibers were used in concrete such as artificial fibers, metallic fibers, polymeric fibers, glass fibers, lathe fibers, mineral fibers and naturally occuring fibers. Using Hybrid Fiber Reinforced Concrete (HFRC) one of the important properties of it is its superior resistance to cracking and crack propagation. Many experiments are taking globally for improving the strength of concrete suggests that cement replacement materials along with Mineral and chemical admixtures can improve the ability and durability characteristics of concrete. We introduce Steel fiber, and polypropylene fiber these materials that can be used to produce high strength as well as highly durable concrete composites, they also improve the compressive strength, workability, and fluidity of the mix. It also shows segregation resistance and durability of the concrete structures. Nanomaterials can be defined as those physical substances with at least one dimension between 1…150 nm (1 nm = 10–9 m). The nanomaterial's properties can be very different from the properties of the same materials at micro (10–6 m) or macro scale (10–6…10–3 m). The nano science represents the study of phenomena and the manipulation of materials at nano scale and is an extension of common sciences into the nano scale. The nanotechnologies can be defined as the design, characterization, production and application of structures, devices and systems by controlling shape and size at the nano scale. Nanotechnology requires advanced imaging techniques for studying and improving the material behaviour and for designing and producing very fine powders, liquids or solids of materials with particle size between 1 and 100 nm, known as nanoparticles.

Concrete is a macro-material strongly influenced by its nano-properties. The addition of nanosilica (SiO2) to cement based materials can control the degradation of the calcium-silicatehydrate reaction caused by calcium leaching in water, blocking water penetration and leading to improvements in durability. Nano-sensors have a great potential to be used in concrete structures for quality control and durability monitoring. (to measure concrete density and viscosity, to monitor concrete curing and to measure shrinkage or temperature, moisture, chlorine concentration, pH, carbon dioxide, stresses, reinforcement corrosion or vibration).

II. OBJECTIVE

The main objective of this project are :

- ✓ To improve the strength of concrete by adding fibers and nanomaterial.
- ✓ To determine the behavior of Hybrid Fiber Concrete with Nanosilica compared with control specimen and HFC.
- ✓ To conduct compressive strength test for HFC with nanosilica at various percentages are used.
- ✓ To facilitate the production of high quality concrete.

III. LITERATURE REVIEW

They investigated the use of steel fiber, short discontinues strips of specially manufactured steel and the polypropylene fiber which is the thermoplastic and the by – product of petroleum and tho study the compressive strength and compare it with control specimen. The cubes were weighted at 7, 14 and 28 days frim the date of demoulding and their behavior was plotted in graph against number of days of curing.

Vikrant S. Vairagade, Kavita S. Kene, International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, Issue 3, May-Jun 2012, pp.1037-

1041 **"Experimental Investigation on Hybrid Fiber Reinforced Concrete".** This paper studies that the Control and two-fiber hybrid composites were cast using different fiber proportions of steel and polypropylene. Compressive test and split tensile strength were performed and results were extensively analyzed to associated with above fiber combinations. Based on experimental studies, the paper identifies fiber combinations that demonstrate maximum compressive and split tensile strength of concrete.

N.Mohanraj, E.Arundhava Priya, A.Gopalan International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-6S, April 2019 **"Experimental Study on Hybrid Concrete Using Steel Fiber Polypropylene Fiber and Silica Fume"**. This paper studies that the mechanical properties of the hybrid concrete were carried out. The present study aims at producing the concrete specimen by reinforcing constant level of fibers (steel fibers of 0.7%, and polypropylene fibers of 0.3%) with the different percentage (5%, 10%, 15% and 20%) of silica fume and then comparing it with normal and fiber reinforced concrete. Different tests were carried out on the hybrid concrete specimen like compressive strength test, flexural strength test, and durability tests on normal concrete, the hybrid concrete exhibits series of crevice while loading and also has higher flexural and compressive strength than the normal concrete.

R. Sakthivel , International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 23 (2017) **, "Experimental Behaviour of Natural Hybrid Fiber Reinforced Slab with Nano Concrete under Static Loading".** This paper studied that concrete is enhanced by the addition of fibers and Nano silica. In this experimental the behavior of Reinforced concrete slab structures by using Natural Hybrid natural Fiber (coir & hair) and Nano silica (NHFRC) was determined. The design mix was done for M25 grade concrete as per Indian standard. The different percentages of fibers from 0.5% to 2.5% by weight of cement were used in the investigations and the various percentages of Nano silica ranging from 0.2% to 4.5% by weight of cement were used in this experimental research. The test results are compared with control specimen and NHFRC with Nano silica improves loading performance of slab under static loading.

Bimalendu Dash, Gorle Lokeswararao, B.P.R.V.S Priyatham, International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES) Volume 4, Issue 7, July-2018, **"EFFECT OF ADDITION OF DIFFERENT TYPE OF FIBERS ON MECHANICAL PROPERTIES OF CONCRETE-A REVIEW".** This paper studies that the effect of addition of different types of fibers on mechanical properties of concrete was studied. Reinforced fiber concrete symbolizes the current leaning to enforce more effective crack-resistant concrete. The result says that the usage of fibers in concrete mix increases the compressive strength, flexural strength, split tensile strength, ductility and impact strength.

Rattan A, Sachdeva P, Chaudhary A, International Journal of Latest Research in Engineering and Technology (IJLRET) Volume 02 - Issue 05 May 2016, **"Use of Nano materials in Concrete"**. This paper studies that The addition of nano silica (SiO_2) to cement based materials can control the degradation of the calcium-silicate hydrate reaction. Carbon nano tubes increase the compressive strength of cement mortar specimens and change their electrical properties which can be used for health monitoring and damage detection. The addition of small amounts (1%) of carbon nano tubes can improve the mechanical properties of mixture samples of portland cement and water. Oxidized multi-walled nano tubes show the best improvements both in compressive strength and flexural strength compared to the reference samples.

From the above literature survey it is understood that for all experiments the strength and also the characteristics of the nano silica, steel and polypropylene fibers given good results with comparing it with control specimen. It is summarized that the strength of the concrete after the investigation of all experiments are given good compressive strength, split tensile strength and also ductility. So that the use of fibers and nano silica will give better results and can give more strength to the normal concrete. In this investigation using hybrid fibers and nano silica for better strength.

IV. METHODS AND METHODOLOGY

CEMENT

Cement is a binding materials used in the preparation of concrete. It binds the coarse aggregate and fine aggregate with the help of water, to a monolithic matter and also it fills the voids in the concrete. There are two requirements for any cement in the concrete mix design. That is compressive strength development with time attainment of appropriate rheological characteristics, type and production of cement. It occurs when the cement has hardened to the point at which it can sustain some load. The specimen has to taken out of the mould are subjected to the compression of determining the strength.

OPC 53 grade sample was tested to obtain the following characteristics as per IS 12269 – 1987

1. Specific Gravity
2. Standard Consistency
3. Initial Setting Time
4. Final Setting Time
5. Fineness

PROPERTIES OF CEMENT

- It provides strength to masonry
- It is stiffness or hardens easily
- It was posses good plasticity
- An excellent building resistance materials
- Easily workable
- Good moisture resistance

FINE AGGREGATE

The fine aggregate used in manufacturing of concrete should be free from debris, fungi and chemical attack. It plays a vital role in concrete, so it should durable, angular and sharp edges then only it and gives a rich mix concrete and workability.

PROPERTIES OF FINE AGGREGATE

- It should be clean and coarse
- It should be free any organic or vegetable matter
- It is usually 3 to 4 % of clay in permitted
- It is chemically alert and well graded
- The finess modulus of sand should between 2 and 3

COARSE AGGREGATE

Aggregates are the important constituents in concrete. They give body to the concrete, reduces shrinkage and effect economy. Earlier aggregates were considered as chemically insert materials but now its as to been recogonized that some of aggregates are chemically active and also that certain aggregate exhibit chemical bon at interface of aggregate and paste. That more aggregate occupy 70-80 percentage of concrete: their impact on various characteristics and properties of concrete is undoubtedly.

PROPERTIES OF COARSE AGGREGATE

- Important parameter of coarse aggregate are shape, texture, grading, cleanliness and nominal maximum size
- Becomes increasingly important as target strength increases, particularly
  In the case of high strength lightweight aggregate concrete.
- Durability properties notwithstanding, important coarse aggregate properties to consider includes strength, stiffness, bonding potential, and absorption.
- Have found that using coarse aggregates with greater stiffness can increase the elastic modulus while at the same time decrease the strength capacity.
- Angular coarse aggregate provide mechanical bond and are generally more suitable for use in high strength concrete that smooth textured aggregates.

WATER

Water is an important in gradient of concrete as it activity participates in the chemical reactions with cement. The strength of cement concrete mainly from binding action of the hydradation of cement.

It get the requirement of water should be reduced that required chemical reaction of unhydrated cement excess water would end up in only formation undesirable voids (or) capillaries in the hardened cement paste in concrete.

It is important to have the compatible between the given cement and the chemical materials admixtures along with the water used for mixing. It is generally stated in the concrete codes and also in the literature that the water fit for making concrete. This may not to true always. BE suitable for drinking, as they good for cement concrete as the sugar would adversely affect the hydration process.

STEEL FIBER

Steel fiber are short discontinues strips of specially manufactured steel. Their inclusion in the concrete improves the mechanical properties of concrete significantly. As the most common matrix, which is now in use in construction industry is reinforced cement concrete.

PROPERTIES OF STEEL FIBERS

Properties of concrete which shows increases on inclusion of steel fibers.

- Toughness
- Flexural strength
- Fatigue endurance
- Impact strength
- Compressive strength
- Shear strength
- Abrasion and skid resistance

POLYPROPYLENE FIBER

Polypropylene is a 100% synthetic fiber which is transformed from 85% polypropylene. The monomer of polypropylene is propylene. Polypropylene is a by-product of petroleum. Polypropylene is a thermoplastic.

Polypropylene fibers are composed of crystalline and non-crystalline regions. The spherulites developed from a nucleus can range in size from fractions of a micrometer to centimeters in diameter.

NANOSILICA

Silicon dioxide nanoparticles, also known as silica nanoparticles or nanosilica, are the basis for a great deal of biomedical research due to their stability, low toxicity and ability to be functionalized with a range of molecules and polymers.

V. RESULT AND DISCUSSION

1. COMPRESSIVE STRENGTH

Compressive strength test out is completed at particular ages about cubes. The specimen of standard dice of (150 mm back button 150 logistik x one hundred and fifty mm) utilized to determine the compressive strength of concrete. Dice specimen of size 100mm x 100mm x 100mm can also be used. The fabric was assessed and the supplies were blended manually. The concrete was filled in distinct layers inside the mould and layer was compacted with the aid of tamping fishing rod. The example of beauty was taken out of mould following 24 hours, treated in tidy water to get 7 and 28 days and nights. After 1 week and twenty eight days of solving, the individuals are applied for, wiped dry out and then analyzed for compressive strength according to Indian Common in compression testing equipment. The dice is placed so that the load works perpendicular for the compacted aspect. Load can be applied before the failure in the specimen. The supreme load is certainly noted

Compressive strength of the specimen is calculated using the formula,

fck = P/A

Where, fck = Compressive strength (N/mm²)
P = Ultimate load (N)
A = Loaded area (150mm x 150mm)

2. FLEXURAL STRENGTH

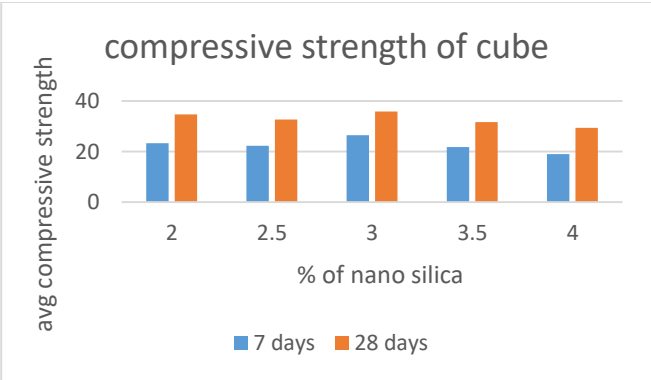
The example of standard crystal of 100 x 100 x 500mm was utilized to decide the flexural quality of cement. Three examples were tried for 7 and 28 days. The material was gauged and the materials were blended physically. The solid was filled in various layers in the shape and each layer was compacted with the assistance of packing pole. The example was expelled from form following 24 hours, relieved in clean water for 7 and 28 days .After 7 days and 28 days of restoring, the examples are taken out, cleaned dry and afterward tried for flexural quality according to Indian Standard in general testing machine. Flexural quality is discovered utilizing focus point stacking framework. The example is situated in the gear so that the weight is put on the best surface as cast inside the shape. The hub of example is typically cautiously agreed with the hub of the starting gadget. Burden is connected until the disappointment of the example. A definitive burden and breaking load is noted. The flexural quality of the example is communicated as modulus of burst, fb and is determined utilizing the equation

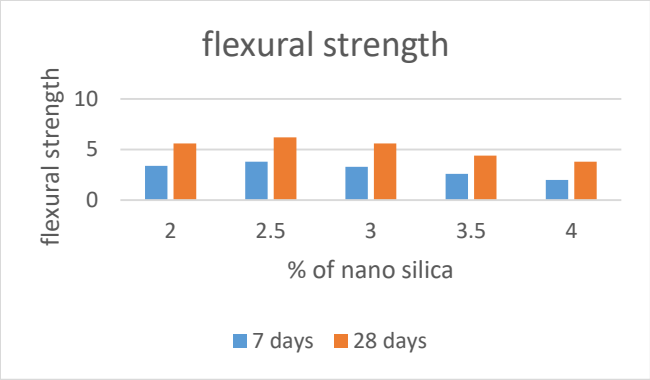
,fb = (N/mm²)

Where, P = Ultimate load (N)
L = Centre to centre distance between the supports (400mm)
b = Breadth of the specimen (100 mm)
d = Depth of the specimen (100 mm)

VI. RESULT AND DISCUSSION

Mix	% of nano silica	Average Compressive Strength (N/mm2)		Average Flexural Strength (N/mm2)	
		7 days	28 days	7 days	28 days
M1	2.0	23.29	34.66	3.4	5.6
M2	2.5	22.33	32.67	3.8	6.2
M3	3.0	26.48	35.78	3.3	5.6
M4	3.5	21.79	31.71	2.6	4.4
M5	4.0	18.96	29.40	2.0	3.8





CONCLUSION

The following conclusions were made :

1) The compressive strength initially decreases slightly and then increases.

2) It is observed that the compressive strength of cubes increases upto 3% replacing of cement with nanosilica.

3) The comparison chart shows that the compressive strength initially decreases slightly, and then reaches the optimum value for 3% replacement of cement with SF and then decreases for 3.5% and 4% replacement.

4) Cement replacement upto 3% with SF along with constant percentage of fibers leads to increase in flexural strength for M25 grade of concrete.

5) From 3.5% there is a decrease in flexural strength for 7 and 28days of curing.

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