Experimental behaviors of Nano Silica Concrete Beam under Torsion and Bending

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Abstract:- The present work deals with the results of experimental investigations on Nano Silica reinforced concrete. Effect of these Nano silica on various strengths of concrete are studied. Nano silica content at constant rate 1.0 % by weight of cement. Various strengths considered for investigation are compressive strength, flexural strength, split tensile, Shear and Torsion test. Results were observe and comparison of results of Nano Silica Reinforced Concrete with that of Conventional Concrete showed the significant improvements in the results of various strengths like as compressive strength, flexure strength, splitting strength, and behavior of strength in torsion and bending of concrete.

Key Notes:- Compresive Strength, Splite Tensile Strength Flexure Strength, Torsion And Bending

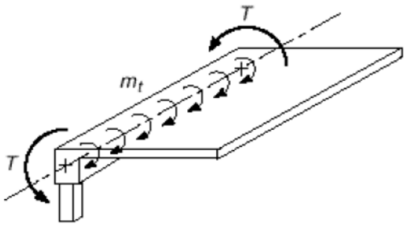
Introduction:-

The combined effect of shear and torsion on reinforced concrete (RC) beams is a critical consideration in structural engineering and the design of concrete structures. Shear and torsion are two different types of loads that can act on a beam simultaneously, and their combined effect can significantly impact the behavior and safety of the structure. Let's start with an introduction to shear and torsion in RC beams and then discuss their combined effects:

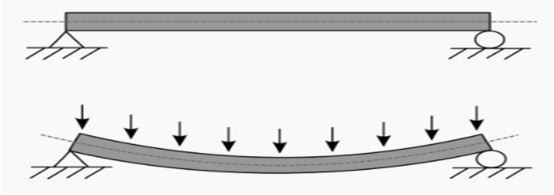
Shear in RC Beams: Shear is a force that acts perpendicular to the longitudinal axis of a beam, trying to slide one part of the beam relative to the other. In RC beams, shear can be caused by various factors, such as applied loads, uneven load distribution, or concentrated forces. Shear can lead to the diagonal cracking of the concrete and the potential failure of a beam if not adequately addressed in the design.

Torsion in RC Beams: Torsion is a twisting force applied to a beam, resulting in a rotation about its longitudinal axis. Torsional loading can be caused by asymmetric loads or eccentric applied forces, and it tends to twist the beam. Torsion can also lead to significant structural damage and must be considered in the design process The Combined Effect of Bending and Torsion on RC Beams: When shear and torsion act simultaneously on an RC beam, it can lead to complex stress patterns and potential failure modes. The combined effect of shear and torsion can be particularly damaging and needs to be carefully analyzed and accounted for in the structural design.

Here are some key points to consider:



Bending Moment In Concrte: Bending moment in a beam is a measure of the internal force that causes the beam to bend. When a beam is subjected to external loads, such as forces or moments, it experiences bending moments that vary along its length.



Nano Silica :- Nano materials are defined as a set of substances where at least one dimension is less than approximately 100 nanometers . Nanomaterials are of interest because at this scale unique optical, magnetic, electrical and other properties emerge .these emergent properties have the potential for great impacts in electronics madecine and other fields

As a concrete is a most usable material in a construction industry. It's been required to improve its quality. Improving concrete properties by addition of

nano particles have significant improvement than conventional concrete.

Some of main nano materials used in concrete:

1] Carbon Nanotubes

2] Nano Silica

3] Polycarboxylates

Methodology

The present research work test was conducted on RC Beam with various volume fraction of Nano silica

Compressive test of concrete.

The compressive strength of the concrete cube test provides an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. Concrete compressive strength for general construction varies from 15 MPa (2200 psi) to 30 MPa (4400 psi) and higher in commercial and industrial structures.

Spilt Tensile Strength

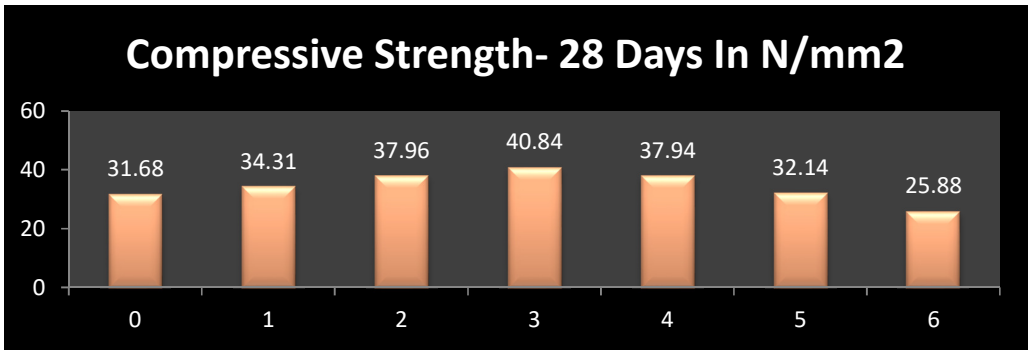
The split tensile strength of concrete is a measure of its ability to resist tensile forces. It's determined by applying a compressive force to a cylindrical concrete specimen until it fractures, and then measuring the tensile strength of the fractured surface perpendicular to the applied load. This test is typically performed according to ASTM C496 or similar standards.

Flexure strength

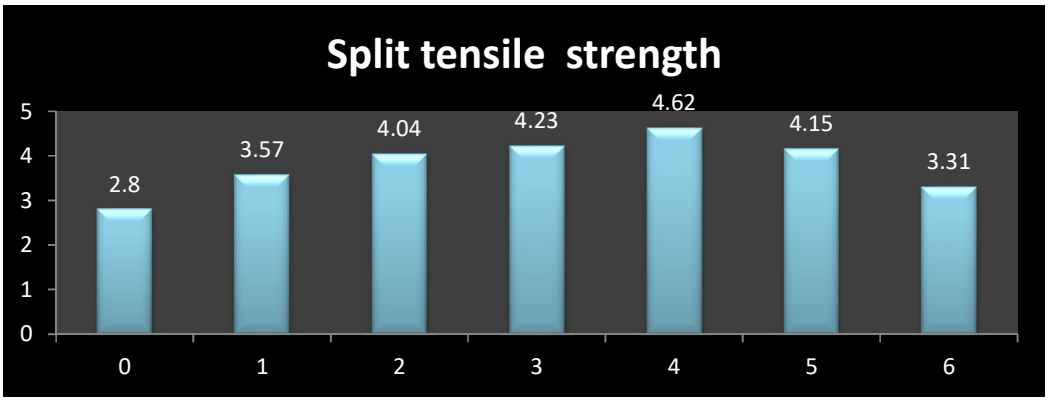
Flexure test is conducted on Digital Universal Testing Machine of 100 tones capacity.

Torsion And Shear Test

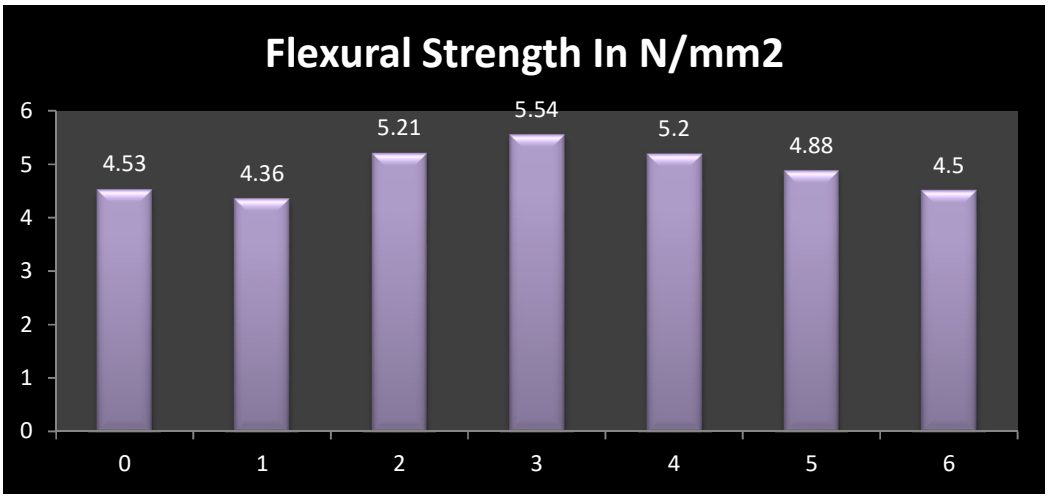
In Torsion & shear test, all the beams were tested in a specially casted test frame. The essential component of the test rig is loading frame (for loading and restraining) through a set of trusses. The test set up is capable to test the beam specimen up-to 1.0 & 2.0 m length.



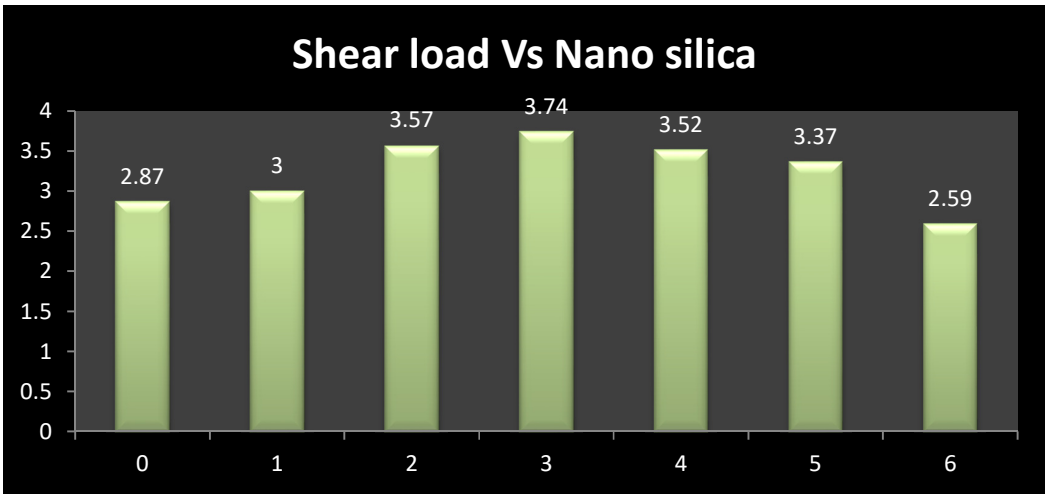
Graph-1 Compressive strength at 28 Days



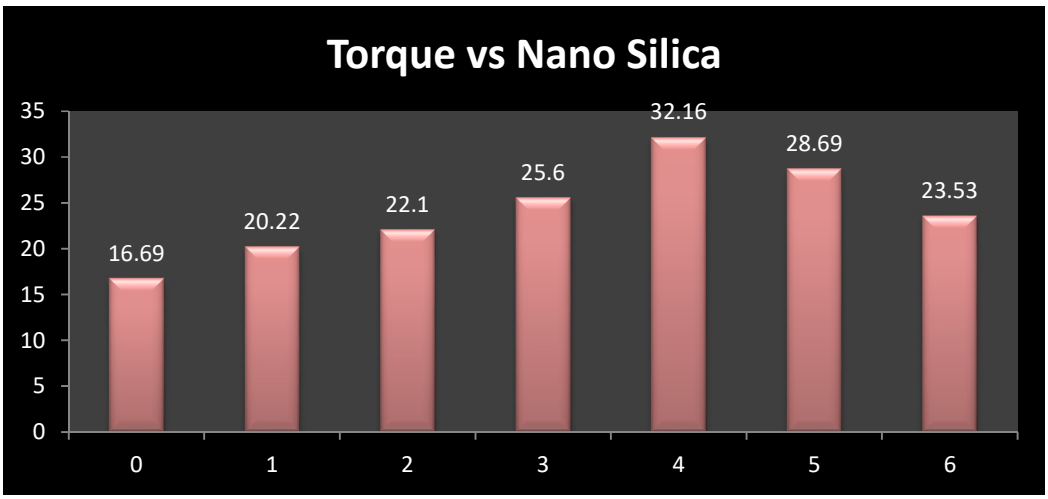
Graph-2 Splite Tensile strength at 28 Days



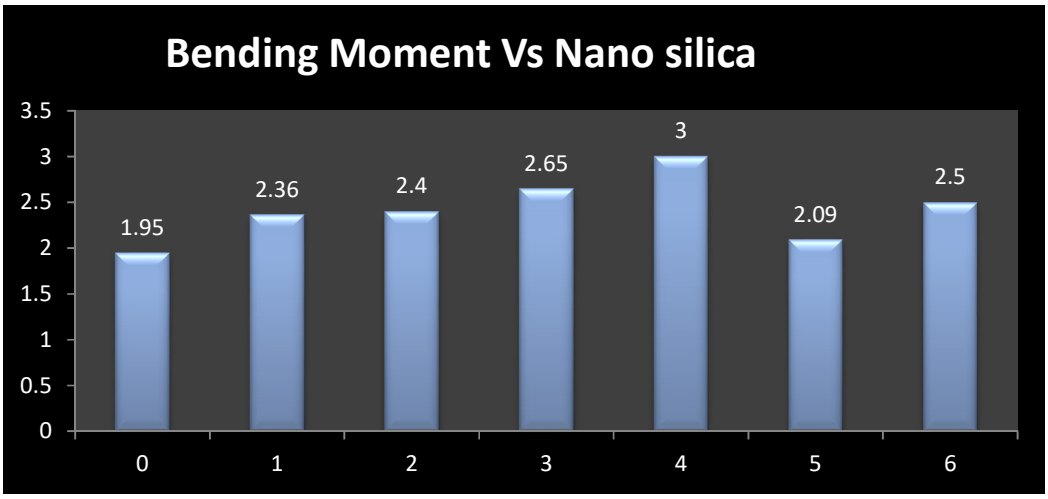
Graph-3 Flexure strength at 28 Days



Graph4- Shear Load Vs Nano Silica



Graph-5- Torque Vs Nano Silica



Graph-6- Bending Moment Vs Nano Silica

Conclusions

1. The wet and dry density at 7 and 28 days has increased marginally for nano silica concrete over normal PCC. This may be due to partial cement replacement by Nano Silica, which dandifies the concrete because of its micro filler effect due to the relatively finer particle size.
2. The mechanical properties of concrete are enhanced with the addition of Nano Silica. All the properties of concrete like compressive strength, split tensile strength and flexural strength is increased. Also there is reduction in porosity as well as reduction in absorption capacity of the concrete as compared with normal concrete.
3. In general, the significant improvement in various strengths is observed with the inclusion of Nano silica in the plain concrete. However, maximum gain in strength of concrete is found to depend upon the amount of Nano silica content.
4. The optimum percentage Nano Silica with volume fraction for compressive strength, flexural strength and split tensile strength is upto 2.825%.
5. With increasing Nano Silica content, mode of failure is changed from brittle to ductile failure when subjected to compression and bending.

Reference:-

1. Job Thomas and Ananth Ramaswamy, “Mechanical Properties of Steel Fiber-Reinforced Concrete”, Journal of Materials in Civil Engineering, Vol. 19, No. 5, May 1, 2007, pp. 385-389.
2. Fuat Koksal, Fatih Altun,Ilhami Yigit,Yusa Sahin, “ Combined effect of silica fume and steel fiber on the mechanical properties of high strength concretes”. Construction and Building Materials, Vol. 22, No. 8, 2008, pp. 1874–1880.
3. Semis Azoic, Gozde Inan and Volkan Tabak, “Effect of aspect ratio and volume fraction of steel fiber on the mechanical properties of SFRC”. Construction and Building Materials, Vol. 21, 2007, pp. 1250–1253.

4. Calogero Cucchiara, Lidia La Mendola and Maurizio Papia, “Effectiveness of stirrups and steel fibers as shear reinforcement”. Cement and Concrete Research, Vol.26, 2004, pp. 777-786.
5. Banthia N., Sappakittipakorn M., “Toughness enhancement in steel fiber reinforced concrete through fiber hybridization”. Cement and Concrete Research, Vol. 37, 2007, pp.1366 – 1372.
6. Sivakumar A., Manu Santhanam, “Mechanical properties of high strength concrete reinforced with metallic and non-metallic fibers”. Cement & Concrete Composites, Vol. 29, 2007, pp. 603–608.
7. Bayramov F., Tasdemir C. and Tasdemir M.A., “Optimizations of steel fiber reinforced concretes by means of statistical response surface method”. Cement & Concrete Composites, Vol. 26, 2004, pp. 665–675.
8. Fuat Koksal, Fatih Altun,Ilhami Yigit,Yusa Sahin, “ Combined effect of silica fume and steel fiber on the mechanical properties of high strength concretes”. Construction and Building Materials, Vol. 22, No. 8, 2008, pp. 1874–1880.
9. Padmarajaiah S.K. and Ananth Ramaswamy, “Flexural strength predictions of steel fiber reinforced high-strength concrete in fully / partially prestressed beam specimens”. Cement & Concrete Composites, Vol. 26, 2004, pp. 275–290.