EXPERIMENTAL INVESTIGATION ON COMPARISON OF CONCRETE STRENGTH USING STEEL FIBRE AND GRAPHENE

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Abstract – Concrete is the most extensively used material in construction world. However it has been known that concrete fails in tension. Weak tensile strength joined with brittle behavior causes sudden tensile failure without giving any threatening. Thus our experimental study investigate about the change in strength of the concrete by addition of steel fibre which can give tensile strength and graphene made from graphite powder which has extraordinary tensile strength and combination of both steel fibre and graphene in M25 grade concrete.

***Keywords*— High strength concrete using steel fibre and graphene.**

I. INTRODUCTION

Concrete is the most common material used in the civil engineering world. Concrete is the mixture of cement, coarse aggregate and fine aggregate together with water. It has high compressive strength however the tensile strength is low. Due to its low tensile strength, the structure is often subjected to damage and even collapse. In order to increase the tensile strength, several materials are used. This investigation involves the mixing of Steel fibre and Graphene in the concrete and to investigate the rise in tensile strength as both the steel fibre and graphene possess high tensile strength. The change in tensile strength is investigated in 7,14,21,28 days and it is compared with normal concrete. SFRC possess more strength when related to normal concrete. Graphene enhanced concrete also possess more strength than nominal concrete. Thus the use of both steel and graphene in concrete will possess very high tensile strength economically. These types of concrete can be used in heavy load bearing structures.

II. OBJECTIVES

The objectives of this project are:

1. To improve the tensile strength of concrete.
2. To reduce the thickness structural member in case of heavy load bearing structure.
3. To improve the strength in low cost.

III. MATERIALS USED

The various material used in concrete are

1. Cement
2. Fine aggregate
3. Coarse aggregate
4. Water
5. Steel fibre
6. Graphene

A. CEMENT

Cement is a binding material used in building. It stick to to other materials to join them together. It is manufactured by mixing of calcium, silicon, aluminium and other ingredients in a closely controlled manner. The plastic properties are high and the hardening is obtained in short time. The color of the high quality cement must be uniform without lumps. Portland cement is most frequently used in the construction world. 43 grade of cement is used to investigate this project which gives minimum compressive strength of 43N/mm2 in 28days.

B. FINE AGGREGATE

Fine aggregate is sand which is obtained from rivers or lakes. It consists of particles passing through 3/8 inch sieve. The purpose of this aggregate is to block the voids in coarse aggregate. It is also a workability agent. It is also used to reduce the cracks. The strength, size, shape, surface structure, grading and mineralogy affects the concrete strength. Manufactured sand act as the exact supplementary for river sand. But river sand is best for RCC concrete.

C. COARSE AGGREGATE

Coarse aggregate is the part of the concrete which is composed of larger stones. It consist of particles with more than 4.75 mm diameter usually called as gravel. Commonly used coarse aggregate are gravels and pebbles. The coarse aggregate should be in angular and irregular in shape.

D. WATER

Water is utmost important part in the whole Construction process. Either it may be concrete or cement mortar or curing, water is essential. It should contain any salt and solid particles. It causes hardening of concrete done by a process called hydration. The pH should be equal to the pH of drinking water.

E. STEEL FIBRE

Steel fibres are reinforcing material in concrete which provides certain advantages when compared with traditional reinforcement. It provides concrete with temperature crack and shrinkage crack control, greater flexural reinforcement, advanced shear strength and crack resistance of concrete.

Fibres are often referred as structural fibres and are proposed to carry load and therefore are used to exchange traditional reinforcement and also to minimize cracking. It has good impact strength, good ductility, and great load bearing capacity after cracks, more tensile strength and high shear strength. It reduces permeability of concrete and so the bleeding of water is reduced.

In fibres, flexural strength of SFR concrete was to found to rise with aspect ratio i.e. ratio of length to corresponding diameter. For increased aspect ratio the workability is reduced. Hence the aspect ratio is limited to achieve workability and strength. The steel we used is corrugated in nature in 1mm thickness.

F. GRAPHENE

Graphene is an arrangement consisting of carbon atoms that are in a hexagonal lattice. It is the building block of Graphite. It is a gifted nanomaterial because of its unique combination of outstanding properties: it is not only the thinnest material but also the strongest material. It is a good heat conductor better than all other materials. It is a greater conductor of electricity. It is

optically transparent. It has interesting light absorbing properties. It is about 200times stronger than steel. It is really a material that could modify the world with unlimited applications in all industry.

Graphene is an sensational material that is receiving a lot of attention-especially since the Nobel Prize in 2010 in physics was awarded to Andre Geim and Konstantin Novoselov, who was the first isolate Graphene in 2004. It is super strong- even stronger than Diamond. The melting temperature for isolated graphene to be remarkable as 4150K.

Graphene is the strongest material. 130,000,000,000 pascal or 130Giga pascal is the ultimate tensile strength of graphene related 375,700,000 for Aramid.

G. STEEL FIBRE REINFORCED CONCRETE

SFRC is a combined material. It has the additional ingredient fibre in it. The fibre is uniformly dispersed in small percentages, i.e. amongst 0.3% and 2.5% by volume. It is produced by adding steel fibres to the concrete ingredients in the mixer and by transferring them into the moulds. It is then and there compacted and cured. Segregation and balling is the major problem faced during mixing and compacting. This should avoided for uniform distribution of fibres. More energy is essential for mixing, conveying, placing and finishing of steel fibre reinforced concrete. Then the curing is done for 28days.

H. GRAPHENE ENHANCED CONCRETE

Graphene is suspended in water and added to normal concrete ingredients without replacing any ingredients. Then normal mixing is done and it is filled in moulds. The curing is done as per nominal concrete. It is well compacted and cured. This graphene in small amount gives very high tensile strength. This process is reportedly inexpensive and compactible with modern, large scale manufacturing requirements.

When tested, the compressive strength of graphene-enhanced concrete is found to be 146 percent increased when compared to regular concrete. The flexural strength is also increased to 79.5%. The permeability will be decreased to 400%.

IV. CONCRETE MIX DESIGN

Data Required for Mix Design of Concrete
(a) Characteristic compressive strength at 28 days- 25N/mm2
(b) Maximum size of aggregate-20 mm
(c) CA shape-Angular
(d) Degree of workability- 50-75 mm (slump range)
(e) Grade of quality control at site-As per IS: 456
(f) Exposure condition of the structure (as defined in IS: 456)-Mild
(g) Cement type: OPC conforming IS: 455
(h) Concrete placing method: pumpable concrete

(ii) Test data
(a) Cement Specific gravity-3.15
(b) FA Specific gravity-2.64
(c) CA Specific gravity-2.84
(d) Aggregate should be in saturated and in surface dry condition.
(e) Fine aggregates- Zone II of IS-383
(f) Size of the cube- 15cmX15cmX15cm.

A. CONCRETE MIX PROPORTION

FOR 15cm x 15cm x 15cm concrete cube
NOMINAL CONCRETE

Cement – 1.30Kg
Fine aggregate – 2.70Kg
Coarse aggregate – 3.67Kg
Water – 700ml.

STEEL FIBRE REINFORCED CONCRETE

Cement – 1.30Kg
Fine aggregate – 2.70Kg
Coarse aggregate – 3.67Kg
Water – 700ml
Ratio of Steel fibre used - 2.5%
Mass of Steel fibre used – 175g

GRAPHENE CONCRETE

Cement – 1.30Kg
Fine aggregate – 2.70Kg
Coarse aggregate – 3.67Kg

Water – 700ml
Ratio of Graphene used - 1%
Mass of Graphene used – 70g

GRAPHENE AND STEEL FIBRE REINFORCED CONCRETE
Cement – 1.30Kg
Fine aggregate – 2.70Kg
Coarse aggregate – 3.67Kg
Water – 700ml
Ratio of Steel fibre used - 2.5%
Mass of Steel fibre used – 175g
Ratio of Graphene used - 1%
Mass of Graphene used – 70g.

V. TESTING PROCEDURE

A. COMPRESSIVE STRENGTH TEST

The characteristics of concrete is analysed by Compressive strength test. This test depends on water-cement ratio, strength of cement, material quality and quality control during production. In this study, the compressive strength compared between normal concrete and steel fibre reinforced concrete, normal concrete and Graphene enhanced concrete, normal concrete and graphene steel fibre reinforced concrete. The test result is given in a pictorial representation.

1. TEST COMPARISON BETWEEN NORMAL CONCRETE AND STEEL FIBRE REINFORCED CONCRETE

DAYS	NORMAL CONCRETE	SFRC
DAY 7	18	20
DAY 14	22	26
DAY 28	25.6	33

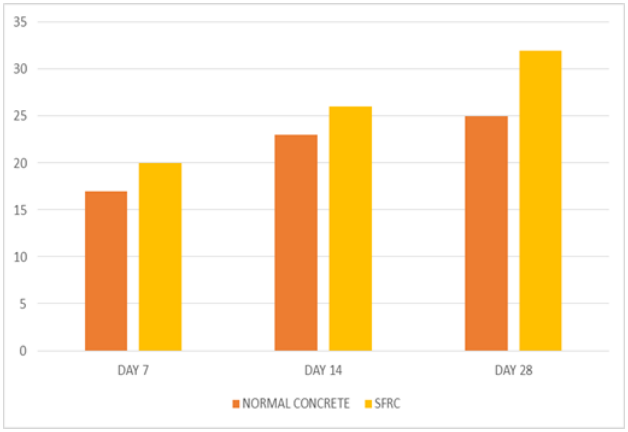

Fig-1

2. TEST COMPARISON BETWEEN NORMAL CONCRETE AND GRAPHENE ENHANCED CONCRETE

DAYS	NORMAL CONCRETE	GC
DAY 7	18	21
DAY 14	22	29
DAY 28	25.6	38

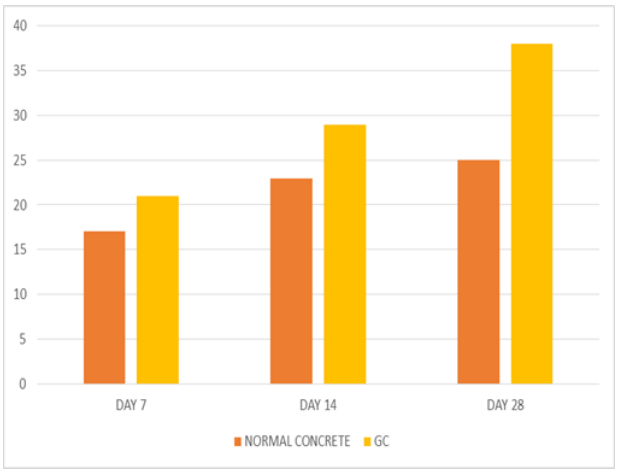

Fig-2

3. TEST COMPARISON BETWEEN NORMAL CONCRETE AND GRAPHENE- STEEL FIBRE REINFORCED CONCRETE

DAYS	NORMAL CONCRETE	GRAPHENE-SFRC
DAY 7	18	25
DAY 14	22	33.5
DAY 28	25.6	45.2

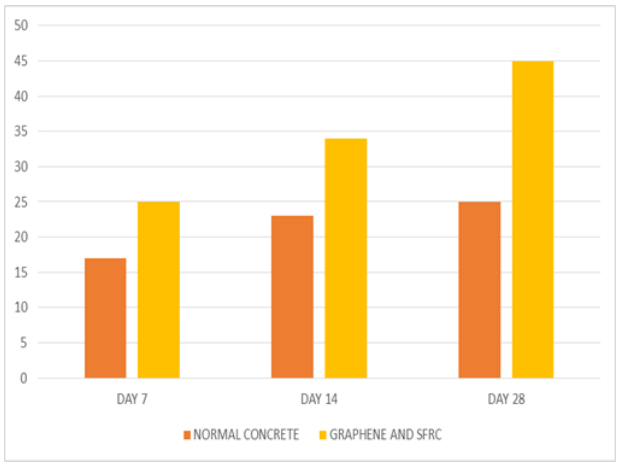

Fig-3

VI. CONCLUSION

From this study, it is clear that the concrete strength can be improved by mixing steel fibre and Graphene. The compressive strength is greatly increased and the tensile strength is considerably increased. Thickness of the structural member can be reduced for heavy load bearing structures. The permeability of the concrete is greatly reduced and this will reduce the cracks. Steel fibre has the capacity to stop or delay the propagation of cracks. Though the steel fibre reinforced concrete is already existing, the addition of graphene is conventional one. The graphene has more interesting applications in all field. Thus its contribution to construction world is unique.

REFERENCES

[1] Halvorsen, G.T., Kesler,C.E., Robinson,A.R., Stout, J.A. (1976). Durability and Physical Properties of SFRC. Report n° DOT-TST 76T-31, US, Department of Transportation, Federal railway administration.

[2] ohnston, C.D, Colin, D. (1982). "Fibre Reinforced Concrete." CANMET, Canada.

[3] Grzybowski, M. (1989). Determination of Crack Arresting Properties of FRC. Chapter 12, Royal Institute of Technology, Sweden.

[4] Romualdi. J.P. & Mandel. J.A. 1964. "Tensile Strength of Concrete is Affected by Uniformly Distributed Closely Spaced Short Lengths Wires".

[5] Johnston, C. D. 2001. Fibre Reinforced Cements and Concretes.

[6] Kawashima S Et al. Modification of cement-based materials with nanoparticles. Cem Concr Composite.

[7] IS 10262-2009: Concrete mix proportioning – guidelines, BIS.

[8] IS 456-2000, Plain and reinforced concrete code of practices.