IJMTST is UGC Approved Journal with Journal Id: 43137

International Journal for Modern Trends in Science and Technology, 8(S01):66-71, 2022

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST08S0110
Available online at: https://www.ijmtst.com/vol8si01.html

Steel Fiber Reinforced High Strength Concrete

Mavuri Satya Sai Sandeep[1] | Rajala Youngren Naveenson[1] | MothineniRam Sai Dilip[1] | A.Rajendra[2] | Dr. D. Venkateswarlu[3]

[1]B-Tech. Student, Civil Engineering, Godavari Institute of Engineering and Technology(A),Affiliated to JNTUK, Kakinada, Rajahmundry, A.P, India.
[2]Assistant Professor, Department of Civil Engineering, Godavari Institute of Engineering and Technology (A) , Affiliated to JNTUK, Kakinada, Rajahmundry, A.P, India.
[3]Professor, Head of Department of Civil Engineering, Godavari Institute of Engineering and Technology (A) , Affiliated to JNTUK, Kakinada, Rajahmundry, A.P, India.

To Cite this Article
Mavuri Satya Sai Sandeep, Rajala Youngren Naveenson, Mothineni Ram Sai Dilip, A.Rajendra and Dr. D. Venkateswarlu. Steel Fiber Reinforced High Strength Concrete. International Journal for Modern Trends in Science and Technology 2022, 8(S01), pp. 66-71. https://doi.org/10.46501/IJMTST08S0110

Article Info
Received: 01 May 2022; Accepted: 25 May 2022; Published: 30 May 2022.

ABSTRACT

The objective of present research work is to investigate experimentally mechanical behavior of steel fiber reinforced concrete (SFRC). In this the compressive, flexural strength and split tensile strength of steel fiber reinforced concrete has studied for high strength concrete mix with different volume fraction of steel fibers and compare the strength concrete to know the volume of steel fiber which has maximum effect on mechanical properties improvement. The main objective is to find out the optimum percentage of steel fibers and also the percentage of improvement of strength in both flexural and split tensile strength. It is also observed that warning is observed before the collapse of the structure.

KEYWORDS: steel fibers, high strength concrete, compressive strength, flexural strength, split tensile

INTRODUCTION

concretes used are lime-based concretes such asPortland cement concrete or concretes made with other hydraulic cements, such as calcium aluminate cements. However, asphalt concrete, which is frequently used for roadsurfacesis also a type of concrete where the cement material is bitumen, and polymer concretes are sometimes used where the cementing material is a polymer.Famous concrete structures include the Hoover Dam, the Panama Canal and the Roman Pantheon. The earliest large-scale users of concrete technology were the ancient Romans, and concrete was widely used in the Roman Empire. The Colosseum in Rome was built largely of concrete, and the concrete dome of the Pantheon is the world's largest unreinforced concrete dome. Today, large concrete structures (for example, dams and multi-storey car parks) are usually made with reinforced concrete.

After the Roman Empire collapsed, use of concrete became rare until the technology was redeveloped in the mid-18th century. Today, concrete is the most widely used human-made material (measured by tonnage).

HIGH STRENGTH CONCRETE

To increase the homogeneity of the concrete, smaller sized coarse aggregate is used. Generally, HSC can be produced only with lower water to binder ratio (W/B) to achieve the higher strength. Thus, high quality superplasticizer is required to increase the workability.

The ideal design of an HSC is to maintain a balance between the fluidity and the stability of the matrix. The right fluidity is achieved using high quality superplasticizer and the stability of the mix shall be achieved selecting the proper cement replacement materials like Ground Granulated Blast Furnace Slag. Ground Granulated Blast Furnace Slag (GGBS) is used in this study in various proportions to determine the mix with best stability and higher strength. A highly dense mix shall be achieved only by interlocking the right materials in proper gradation. Hence sub micrometre particles are the key to fill the pores between the larger particles of cement. Thus, the use of GGBS becomes essential to increase the interlocking of the materials.

APPLICATIONS OF HIGH STRENGTH CONCRETE

Applications of High Strength Concrete

Applications include bridge beams and decks, solid and perforated wall panels facades, urban furniture, louvers, stairs, large-format floor tiles, pipes and marine structures. The reason for selecting HSC is that it provides a more economical aspect while considering the entire cost incurred in the building. Generally, the cost of the HSC is higher than conventional concrete because HSC requires additional quantities of materials such as cement, fly ash, silica fume, GGBS, met kaolin, high range water reducing admixtures and retarders to meet the specified performance. However, concrete is one of the components in construction and the total cost of the finished product is more important than the cost of an individual material. However, HSC should not be specified if there are no economical or technical advantages to be gained from its use. The use of HSC in the columns of high-rise buildings have been known for many years. In simple terms HSC provides the most economical way to carry a vertical load to the building foundation. The three major components contributing to the cost of the column are concrete, steel reinforcement and form work. By using HSC, the column size is reduced. Consequently, less concrete and less formwork are required. At the same time, the amount of vertical reinforcement can be reduced to the minimum amount allowed in code. The net result is that the least expensive column is achieved with the smallest size column, the least amount of reinforcement and the highest readily available concrete strength.

2. LITERATURE REVIEW

- **Panini *et al.* (2011) & Duby *et. al.* (2012).**Many investigators have researched on replacement of GGBS with cement in concrete and found the encouraging results. It is observed that the curing period required for GGBS concrete is more as compared to normal concrete.
- **Y. Langlois and Y. Lévesque(2010),**This paper presents tests that were performed on square large-scale steel-fiber- reinforced high-strength concrete (HSC) columns under concentric compression loading. The experimental program was mainly designed to examine the effect of the volumetric steel-fiber ratio on the behaviour of reinforced HSC large-scale elements subjected to axial compression loading.
- **Khan & Usman (2003).**It is concluded by Khan & Usman (2003) that workability of GGBS concrete is more and thus water cement ratio may be reduced resulting in increase in compressive strength.
- **(Yazdani, 2002).** GGBS is used as a direct replacement for Portland cement, on a one-to-one basis by weight. Replacement levels for GGBS vary from 30% to up to 85%. Typically 40 to 50% is used in most instances.For on the ground concrete structures with higher early-age strength requirement, the replacement ratio would usually be 20 to 30%.
- **(Poon et al, 2001)** Alkali metal ions are present in granulated blast furnace slag as an integral part of the glass structure. Consequently, the water-soluble alkali content is low. There is generally a small amount of calcium sulphide in GGBS. The presence of such a small amount of sulphide can cause a colour change of the fresh concrete.

3. MATERIALS

GGBS(Ground-granulated blast-furnace slag):-It is obtained by quenching molten iron slag (a by-product of iron and steel- making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. The values of Particle size, Specific surface area, Relative density,

Conplast sp430:- It is used to provide excellent acceleration of strength gain at early ages major increases strength in all ages by significantly reducing water demand in a concrete mix. The values of Specific gravity, Water soluble chlorides, Alkaline

Steel Fibers:- Normal unreinforced concrete is brittle with a low tensile strength and strain capacity. The function of the irregular fibers distributed randomly is to fill the cracks in the composite. Fibers are generally utilized in concrete to manage theplastic shrink cracking and drying shrink cracking. The values of Yield strength, Tensile strength.

4. METHODOLOGY

The methodology used in the study is to design a high strength concrete of using packing density modulus and to achieve the higher strength, conventional methods of mix design is not suitable. Hence mechanical properties of the fillers and binders must be enhanced properly so as to enhance the total property of the matrix as a whole. The concept of high packing density has been recently rediscovered, as a key for obtaining high-performance cementitious materials. Reference is made to the Maximum Paste Thickness concept, which leads to choose a fine sand for optimizing the compressive strength of cementitious materials. Then, an optimal material is sought, based on the following requirements: fluid consistency, classical components
i.e. ordinary aggregate, sand, Portland cement, GGBS, superplasticizer, water.

Packing Density of Coarse Aggregate

Packing density for the coarse aggregate is initially found for the different particle sizes possible. This is done by collecting the samples passing and retained from different standard sieve sizes. The various samples corresponding to different particle sizes are then taken in a container of known volume to know its packing density. From the various journals, it is well known that for achieving the higher strength the size of aggregates should be reduced which will increase the density of

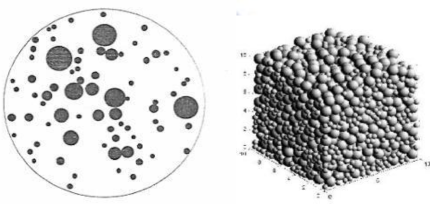


Fig 1 DENSITY OF CONCRETE

5. TESTS CONDUCTED:

The following list of experiments should be carried out:

- **TEST FOR CONCRETE**
- **COMPRESSIVE STRENGTH OF CONCRETE**
- **TENSILE STRENGTH OF CONCRETE**
- **FLEXURE STRENGTH OF CONCRETE**

6 . RESULTS AND DISCUSSIONS

PROCEDURE OF COMPRESSIVE TEST ONCUBES:

The test should be conducted on the specimen immediately after taken out of the curing condition so as to prevent surface drying which decline compressivestrength.

Fig .2 Loading pattern of cube

- Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cubecast.
- Align the specimen centrally on the base plate of themachine.
- Apply the load gradually without shock and continuously at the rate of 140 kg/cm^2/minute till the specimenfails
- Record the maximum load and note any unusual features in the type of failure.

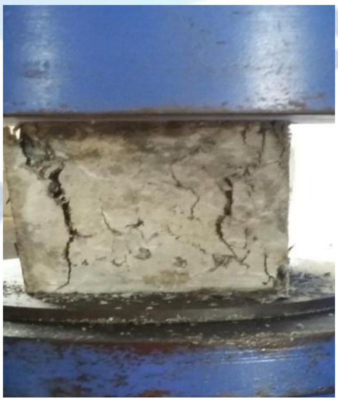
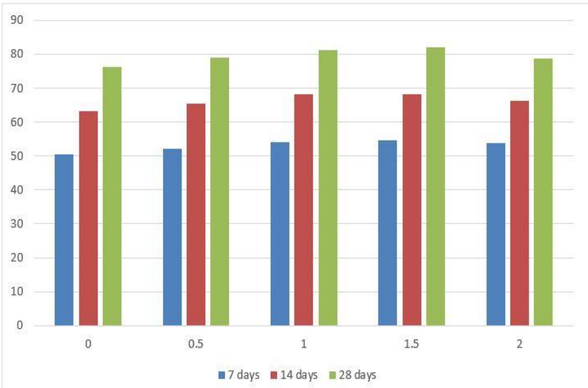


Fig.3 Failure Pattern of the concrete cube specimen under compressive load

Percentage of steel fibers	Compressive strength(MPa)		
	7 days	14 days	28 days
0	50.35	63.325	76.3
0.5	52.14	65.357	79
1	54.02	68.14	81.26
1.5	54.6	68.3	82
2	53.86	66.23	78.6

Table-1 Compressive strength for different percentage of steel fibers



GRAPH 1. COMPARISION OF COMPRESSIVE STRENGTH

PROCEDURE OF FLEXURAL TEST ONPRISM:

The test should be conducted on the specimen immediately after taken out of the curing condition so as to prevent surface drying which decline flexural strength.
Place the specimen on the loading points. The hand finished surface of the specimen should not be in contact with loadingpoints.

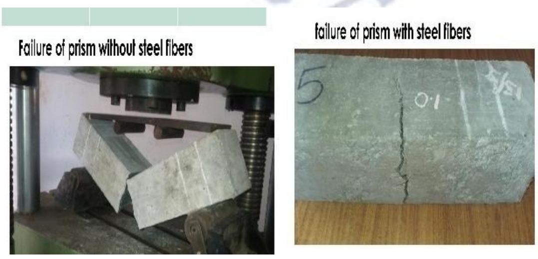


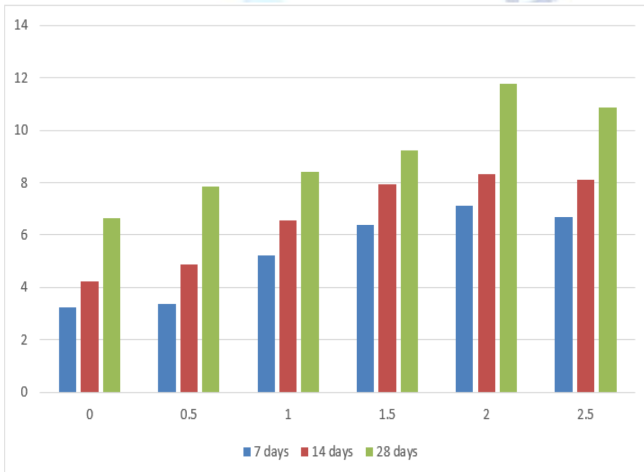
FIG 4 The loading system in relation to the appliedforce.

Applying 2-point load for computing ultimateload.

Load the specimen continuously without shock till the point of failure at a constant rate (Indian standard specified loading rate of 400 Kg/min for 150mm specimen and 180kg/min for 100mmspecimen).

Percentage of steel fibers	Flexural strength (MPa)		
	7 days	14 days	28 days
0	3.25	4.24	6.64
0.5	3.35	4.86	7.84
1	5.24	6.58	8.40
1.5	6.38	7.92`	9.24
2	7.12	8.32	11.76
2.5	6.68	8.12	10.88

Table-2Flexural strength for different percentage of steel fibers



GRAPH 2 FLEXURAL STRENGTH

PROCEDURE OF SPLIT TENSILE TEST ONCYLINDERS:

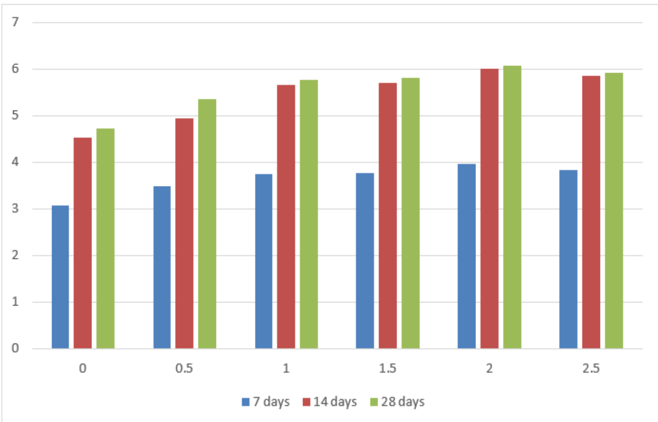
- The test should be conducted on the specimen immediately after taken out of the curing condition so as to prevent surface drying which decline flexuralstrength.
- Align the specimen in a way that the lines marked on the ends are vertical and centered over the bottomplate.

Fig. 5 Tensile strength

- Bring down the upper plate to touch therod.
- Apply the load continuously without shock at a rate of approximately 14- 21/cm²/min (which corresponds to a total load of 9900kg/min to14850kg/min).
- Record the maximum load and note the breaking load

Percentage of steel fibers	Split tensile strength (MPa)		
	7 days	14 days	28 days
0	3.07	4.52	4.73
0.5	3.48	4.95	5.36
1	3.75	5.65	5.77
1.5	3.77	5.71	5.80
2	3.952	6.01	6.08
2.5	3.841	5.85	5.91

Table-3 Split tensile strength for different percentage of steel fibers



GRAPH 3 TENSILE STRENGTH

6.CONCLUSION

- From the study, it is concluded that using the method of Packing Density Modulus maximum compressive strength of 79.28Mpa can be achieved by using a mix with 60% cement, and 40% GGBS for B/ T.A ratio of0.5.
- But for the above mix, it is found that the setting time was more, and also the quantity of binder (cement + GGBS) used is higher compared to othermix.
- From the study it is found that a compressive strength of 78.22 MPa can be achieved for a mix with 60 % cement and 40 % GGBS having B/ T.A of0.45.
- The above mix had produced good results and also the setting time required was less with goodworkability.
- From the study it is found that the optimum Water to Binder ratio is 0.26 which produces a stable mix with better compressivestrength.
- The dosage of SP should be maintained at 1.25% beyond which the mix become highly flowable and when reduced the mix becomesharsh.
- Highest compressive strength is achieved for control concrete, with addition of steel fibers, the compressive strength is reduced.
- The reduction in strength is due to loss of homogeneity, and the steel fibers does not offer any advantage in taking compressivestress.
- From the flexural strength results, it is found that with addition of steel fibers the flexural strength isimproved. However, after addition of 2% the flexural strength is reduced.
- From the split tensile strength results, it is found that with addition of steel fibers the split tensile strength isimproved.

  However, after addition of 2% the split tensile strength is reduced.

  From the study, it is understood that concrete exhibits better ductile behavior and it is also observed that it is capable of sustaining higher level of loads in post-cracking.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Chong Wang, Changhui Yang, Fang Liu, Chaujun Wan, Xincheng Pu, “Preparation of Ultra High-Performance Concrete with common technology and materials”, Cement and Concrete Composites, 2012, Vol 34, pp.538-544.

[2] R. Deeb, A. Ghanbari, B.L. Karihaloo, “Development of self-compacting high and ultra-high-performance concretes with

and without steel fibers", Cement and Concrete Composites, 2012, Vol 34, pp.185-190

[3] Seung Hun Park, Dong Joo Kim, Gum Sung Ryu, Kyung Taek Koh, "Tensile Behavior of Ultra High-Performance Hybrid Fiber Reinforced Concrete, Cement and Concrete Composites, 2012, Vol 34, pp.172-184

[4] Nguyen Van Tuan, Guang Ye, Klaas Van Breugel, Oguzhan Copuruglu, "Hydration and microstructure of ultra-high-performance concrete incorporating rice husk ash"- , Cement and Concrete Research, 2011, Vol 41, pp.1104-1111

[5] Tina Oertel, Frank Hutter, Ricarda Tanzer, Uta Helbig, Gerhard Sextl, "Primary particle size and agglomerate size effects of amorphous silica in ultra-high-performance concrete", Cement and Concrete Composites, 2013, Vol 37, pp.61-67