International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

A Study on Partial Replacement of Cement with Steel Fiber and Glass Fiber for M30 Grade Concrete

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Abstract

This study explores the effect of incorporating steel and glass fibers on the compressive strength of M30concrete. Steel fibers and glass fibers were added to the concrete mix in varying proportions (1%,1.5%,2%,2.5% by volume). The compressive strength of the fiber-reinforced concrete was evaluated at 7 and 28 days. The results indicate that the addition of steel fibers significantly enhances the compressive strength of M30 concrete with a maximum increase of 23.5% at 1.5% steel fiber content. Glass fibers also showed a notable improvement in compressive strength with a maximum increase a notable 17.2% at 1.5% glass fiber content. The study concludes that the use of steel and glass fibers can be an effective way to enhance the compressive strength of M30 concrete. The research methodology involves the preparation ofM30 grade concrete specimens with varying fiber content for each type. The concrete mixes are cured and subjected to a series of standard tests to evaluate their strength and durability. The study aims to understand the influence of steel fibers and glass fibers on the overall performance of M30 grade concrete and to identify the optimal fibers dosage for enhanced structural properties.

Keywords: **Fiber reinforced concrete, steel fibers, glass fibers, compression strength**

1. Introduction

The use of concrete as a structural material is limited to certain extent by deficiencies like brittleness poor resistant to impact durability and fatigue. The brittleness is compensated in structural members by introduction of reinforced or pre-stressing steel in the tensile zone of the strength concrete. However, it does not improve the characteristics of concrete. The main problem of low tensile still remains and it is to be improved by different means namely introduction of fibers of different materials. These challenges are to explore sustainable and innovative materials that can replace cement in concrete. Steel fiber and glass fiber have emerged as promising alternatives due to their exceptional strength, durability and resistance to corrosion. The incorporation of these fibers into concrete can significantly enhance its mechanical properties such as compressive strength, tensile strength and flexural strength while also improving its durability and resistance to glass fiber on the properties of M30 grade concrete. The use of

concrete as a structure material is limited to certain extent by deficiencies like brittleness poor resistant to impact durability and fatigue.

2. Literature Review

Kumar J.D et al in their studies found that the addition of glass fibers at 0.5%, 1%, 2%,and 3% of cement reduces the cracks under different loading conditions. It has been observed that the workability of concrete increases at 1% with the addition of glass fiber. The increases in compressive strength flexural strength split tensile strength for M30 grade of concrete at 7 and 28 days are observed to be more to be 1%. We can likewise utilize the waste product of glass as fiber.

Ragi Set alfound that the increasing percentage of compressive strength of hooked end steel fiber reinforced concrete cubes when compared to the conventional concrete cubes at 7 and 28 days is 7.3%. And the increasing percentage of compressive strength of crimped steel fiber reinforced concrete cubes when compared to the conventional concrete cubes at 28 days is 6.08% also the increasing percentage of split tensile strength of hooked end steel fiber reinforced concrete cylinders when compared to the conventional concrete cylinders at 28 days is 4.54%.

Khan. Y et al found that the compressive strength of fiber reinforced concrete composite with various mix designation found higher as compared to normal conventional concrete for 7 and 28 days of curing and the split tensile strength of fiber reinforced concrete composite with various mix designation showed higher strength as compared to normal conventional concrete,also the compressive strength of fiber reinforced concrete composite for mix designation with (steel 2% & glass 2.5%) showed higher strength compared to other mix designation and conventional concrete.

Varma A.U et alfound that the percentage increase of compressive strength of various grades of glass fiber concrete mixes compared with 7 and 28days compressive strength is observed from 10 to 20%. A reduction in bleeding improves its homogeneity and reduces the probability of cracks.

3. Methodology

- **Collection of Materials:**The process of creating mass concrete requires a careful blending of conventional concrete in ingredients with the addition of mass. This section offers a succinctsummary of the essential ingredients used to make mass concrete using into account both environmental and structural variables. The first step is the collectionfor materials for concrete mixes of M30 grade includes.
- **Cement:**Concrete is made with either regular Portland Cement (OPC) or alternative environmentally friendly cement formulas. Sustainability and its effect on the environment may be taken into account.
- **Aggregates:**Sand and gravel are examples of fine and coarse aggregates that give the concrete its structural integrity. The strength and workability of the concrete are largely dependent on the size and gradation of the particles.
- **Water:** Potable clean water is essential to the cement hydration process. To get the right strength and longevity out of the concrete the water to cement ratio must be carefully considered.
- **Concrete Mix:** Concrete mix design is the process of selecting the proportions of the various ingredients such as cement, coarseaggregates and fineaggregates,water and steel fibers and glass fibers. It is a crucial step in ensuring quality, strength, durability, and workability of the concrete. Materials required for concrete such as coarse aggregate, fine aggregate, cement was collected.Steel fibers and glass fibers are procured from steel and glass fabrications. Basic tests are conducted on

fineaggregate coarse aggregate,cement,fibers to check the sustainability concrete marking. The properties of fine aggregate and coarse aggregate, sieve analysis of the fine and coarse aggregate, tests on cement are found out. The study aims to investigate the strength related properties of concrete of M30 had determined by mix design as per IS code.Moulds were prepared to cast the specimen. Cube mould of size 150mmx150mmx150mm was cast adding fibers (steel fiber and glass fiber). Casted samples were tested after 7 days and 28 days of curing. Compressive strength test was performed and conclusions were drawn from it.

- **Casting of cubes:**Casting concrete cubes are a crucial step in testing the compressive strength of concrete is a fundamental property for ensuring the safety and reliability of structures. It involves a specific procedure to obtain accurate and reliable test results.
- **Curing of cubes:** It involves providing the cubes with the right conditions for complete hydrations for the cement which ultimately determines their strength.

Fig1: Casting of cubes

Fig2: Casting of cylinders

4. Types Of Fibers Used

Steel Fibers: Steel fibers are a type of reinforcement material made from steel wires or strands that are cut into short Lenths and dispersed throughout a concrete mixture. The use of steel fiber in concrete in 1960 s when it was first introduced as a means of improving the tensile strength and durability of concrete. In 1990 steel fiber become a widely Accepted reinforcement material in concrete with application in various industries including construction and industrial manufacturing.

- **Glass Fibers: T**he application of glass fibers may improve the mechanical capacity of concrete while also facilitating the disposal of industrial waste. Polyester resin is reinforced with glass fiber in glass-reinforced plastic composites. Construction aerospace automotive and locomotive sectors produce waste which is a discarded by production and is removed at the end of is service life.Glass fibers also known as glass reinforcement is a type of fiber made from that is used to reinforcement concrete and other materials. The use of glass fiber in concrete in 1950 when it was introduced as a means of improving the tensile strength and durability of concrete.

5. Compressive Strength Test

Compressive strength refers to the maximum load per unit area that a material can withstand under compression before it fails or fractures. In thiscontext , concrete compressive strength is a critical parameter as it indicates the ability of the concrete to withstand applied loads or pressure without undergoing significant deformation or failure. It is typically measured in megapascals (MPa) or pounds per square inch (psi) and is determined by conducting standardized compression tests on

concrete specimens. The compressive strength of concrete is influenced by various factors including the mix proportions, curing conditions age of the concrete and presence of any additives or reinforcements like fibers.

Fig3: Compressive strength test

6. Slump Test

The slump test is a standard test in Civil engineering construction to measure the consistency of freshly mixed concrete before it sets. It involves filling a cone shaped mould with concrete compacting it then removing the mould and measuring the settlement or slump of the concrete. This test helps to ensure the concrete whether the concrete has attained the desired workability and strength for its intended use.

Fig4: Slump cone test

7. Split Tensile Strength

Split tensile strength is a measure of the tensile strength of material typically concrete or mortar by applying a diametrical compressive load to a cylindrical specimen until it splits. The split tensile strength test is a common method used to determine the tensile strength of concrete as it isrelatively simple and inexpensive to perform. The test involvesin applying a compressive load to cylindrical specimen typically 150 mm (6 inches) in diameter and 300 mm (12 inches) in length.It splits along the diameter when fails.

8. Results And Discussion

The compressive strength of the concrete of mix proportion 1:2.00:2.27with the water-cement ratio of 0.4. The following tables and graphs describe the obtained results:

Table1:Cube Testing of Steel Fiber for 7days and 28 days

Percentage	Conventional	1%	1.5%	2%	2.5%
7 days	19.33N/mm^2	11.29 N/mm^2	23.11 N/mm^2	19.62 N/mm^2	19.4 N/mm^2
28 days	25.77N/mm^2	16.11 N/mm^2	29.55 N/mm^2	24.22 N/mm^2	25.33 N/mm^2

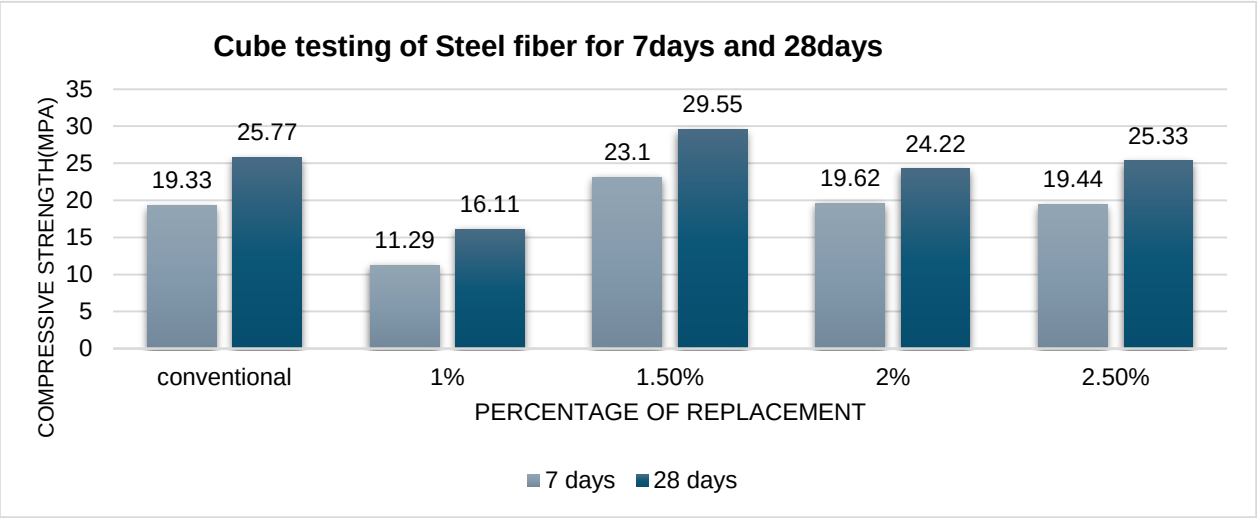


Table2: Cylinders Testing of Steel Fiber for 7 days and 28 days

Percentage	Conventional	1%	1.5%	2%	2.5%
7 days	1.24	1.95 N/mm^2	1.725 N/mm^2	2.05 N/mm^2	2.47 N/mm^2
28 days	2.336	2.04 N/mm^2	2.295 N/mm^2	2.62 N/mm^2	2.80 N/mm^2

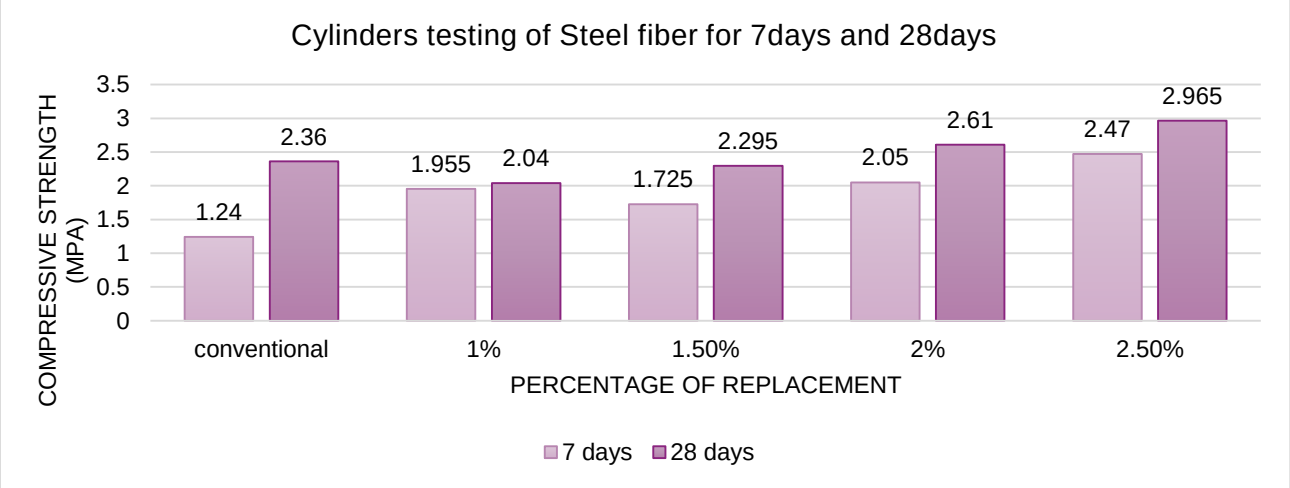


Table3: Cubes Testing of Glass Fiber for 7 days and 28 days

Percentage	Conventional	1%	1.5%	2%	2.5%
7 days	19.33 N/mm^2	19.4 N/mm^2	19.92 N/mm^2	17.55 N/mm^2	20.73 N/mm^2
28 days	25.77 N/mm^2	26.96 N/mm^2	27.85 N/mm^2	24.44 N/mm^2	28.44 N/mm^2

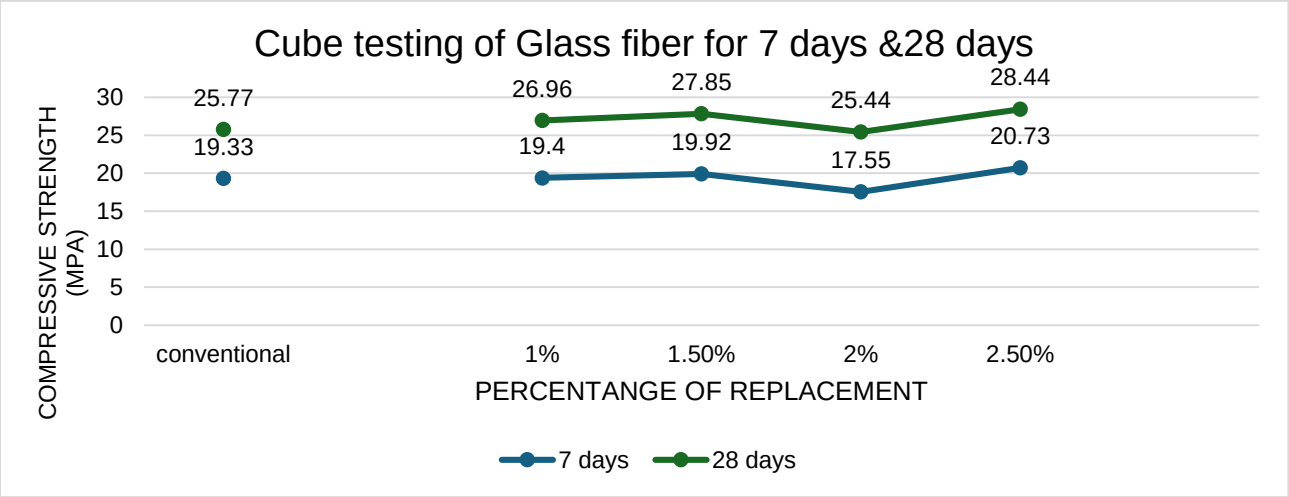


Table4: Cylinders Testing of Glass Fiber for 7 days and 28 days

Percentage	Conventional	1%	1.5%	2%	2.5%
7 days	1.24 N/mm^2	1.91 N/mm^2	1.85 N/mm^2	2.16 N/mm^2	2.79 N/mm^2
28 days	2.36 N/mm^2	2.19 N/mm^2	1.95 N/mm^2	2.26 N/mm^2	3.45N/mm^2

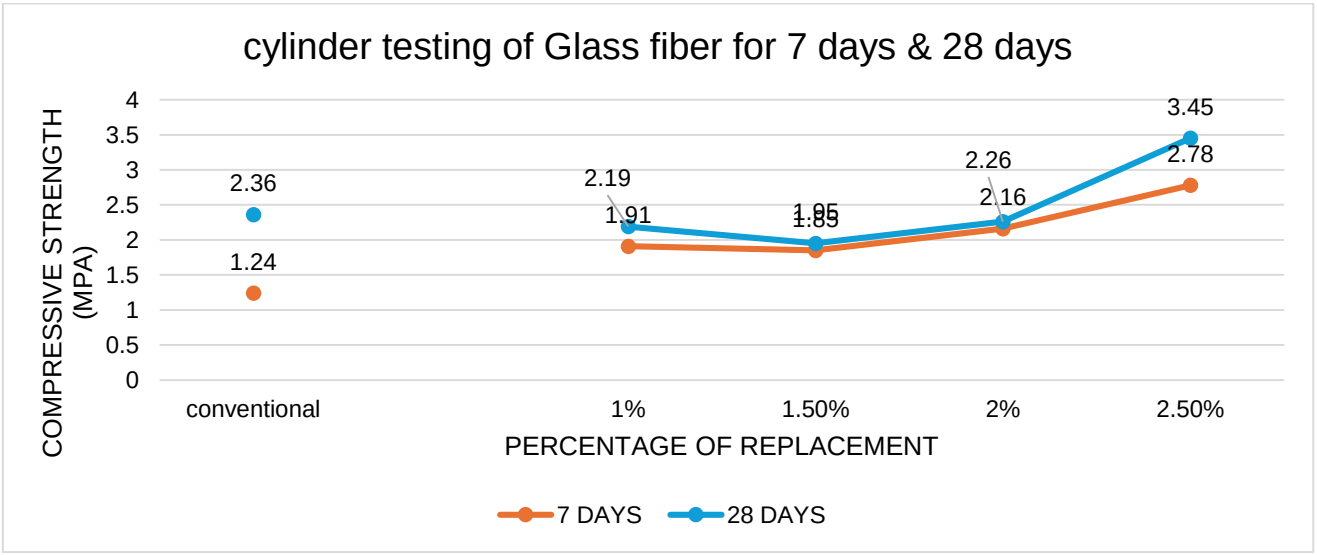


Table5: Combination Cubes for 7 days and 28 days

Percentage	Conventional	2.5%

7 days	19.33 N/mm^2	20.44 N/mm^2
28 days	25.77 N/mm^2	28.44 N/mm^2

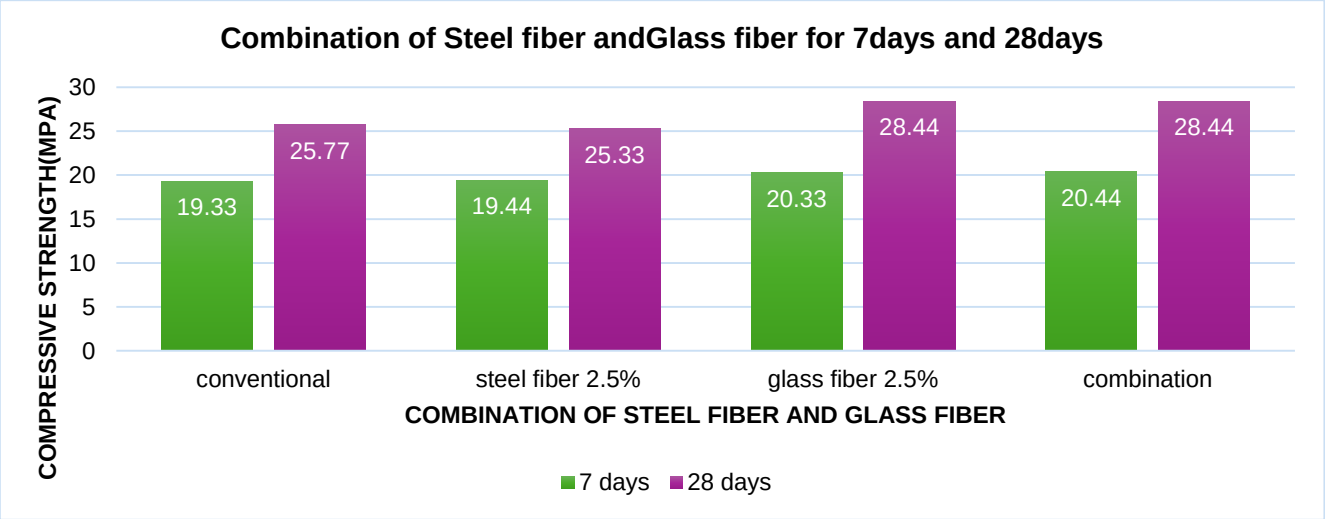
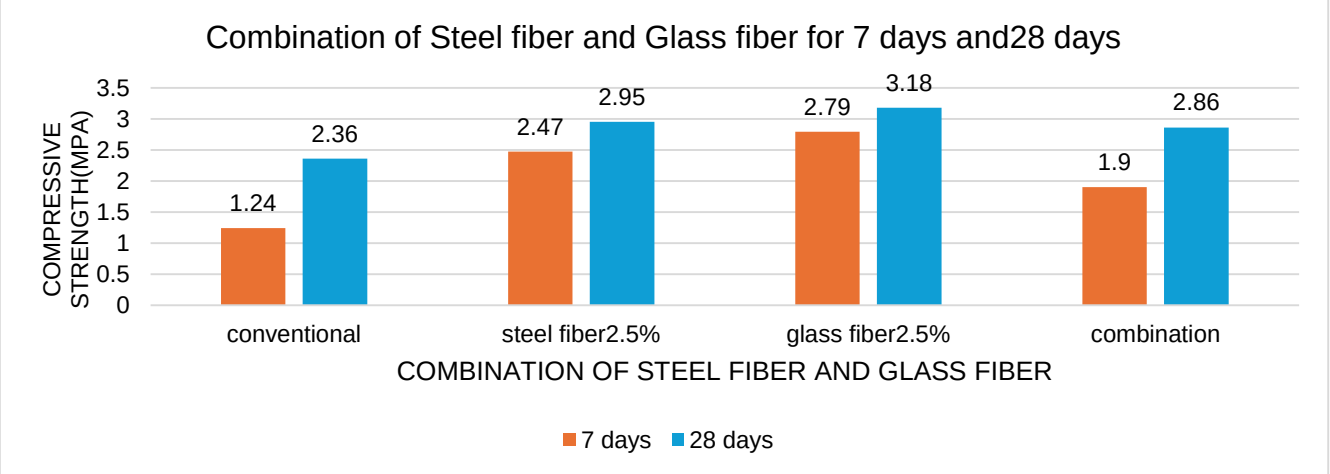


Table6: Combination Cylinders for 7 days and 28 days

Percentage	Conventional	2.5 %
7 days	1.24 N/mm^2	1.9 N/mm^2
28 days	2.36 N/mm^2	2.86 N/mm^2



9. Conclusions

From the results and discussions a few summaries can be drawn,

1. The workability decreased with the increasing percentage of fibers (steel fibers& glass fibers).
2. The addition of raw fibers shows a predominant increase in the compressive strength of the cubes and cylinders when compared to the conventional concrete.
3. It was observed that the compressive strength of the conventional concrete is 19.33 N/mm^2 7 days and 25.77 N/mm^2 28 days.

4. The addition of steel fibers at 1%, 1.5%, 2%, 2.5% for concrete has been observed that the workability of concrete has increased to 2.5%.
5. The addition of glass fibers at 1%, 1.5 %, 2%, 2.5% for concrete has been observed that the workability of concrete increased to 2.5%.
6. The increase in compressive strength of M30 grade of concrete for both steel and glass fiber at 7 days and 28 days are observed to be more at 2.5%.
7. It is observed that the workability of concrete increases with certain kinds of fibers.
8. There is also increase in compressive strength of M30 grade of concrete at 7 days and 28 days was observed to be more with the addition of glass and steel fibers.

10. Acknowledgment

I am profoundly thankful to Mr. G. Tirupati Naidu Head of the Department of Civil Engineering Dr. LankapalliBullayya College of Engineering, Visakhapatnam, India, who has served as my mentor and guide advising me on how to accomplish my goals.

11. References

[1]AS 1012 (2002) Compressive test of concrete specimen methods of testing concrete, Standards Australia.

[2]ACI Committee 544 (1996) State-of-the-Art Report on Fibers-Reinforced Concrete. American Concrete Institute.

[3]Banthia, N. Gupta R. & Kapadia, P. (2014). Steel fiber-reinforced concrete A review. Journal of Reinforced Plastics and composites 33(10), 831-844.

[4] Balaguru, P. N, & Shah, S. P (1992), Fibers-reinforced cement composites New York:Macgraw-Hill

[5] Owens Coming (August 2007) A Market Assessment and Impact Analysis of the Owens Coming Acquisition of Saint-Gobains Reinforcement and Composites Business.

[6] Lubin, George (Ed) (1975). Handbook of Fiberglass and Glass Technology: Energy-Friendly Compositions and Applications. Springer. Pp. 211

[7] Singh, S. P, Kumar, P, & Gupta, R (2018). Comparison of mechanical properties of steel fiber-reinforced concrete. Journal of Reinforced Plastics and Composites, 37(10), 731-744.

[8] Kumar, P, Singh, S.P, & Gupta, R. (2019). Durability of glass fiber-reinforced Plastics and Composites, 38(10), 831-844.

[9] Sreekumar, P., Joseph, K., & Unnikrishnan, G. (2015). Glass fiber-reinforced polymer composites: Journal of Reinforced Plastics and Composites, 34(10) 831-844