ISSN XXXX XXXX © 2017 IJESC

Research Article Volume 7 Issue No.10

Behaviour of Concrete Utilizing AR Glass Fibre as a Partial Replacement of Cement

Surendra Bahadur Shahi[1], Basant Kumar Bansal[2], Dr. Anju Sharma[3]
M.Tech Student[1], Assistant Professor[2, 3]
Sunrise Group of Institutions, India

Abstract:
Concrete is the construction material without the life of construction industry cannot be imagined. It has been known that concrete is stronger in compression and weaker in tension. Weak tensile strength combined with brittle behaviour, which results in sudden tensile failure of structural member without any warning. The aim of this investigation is to decrease environmental pollution & energy consumption use in cement production and to improve the tensile behaviour of concrete by using AR glass fibre as a partial replacement of cement in concrete. In this research work cement was replaced by AR glass fibre in different percentages-0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5% and 3.0% and the various mechanical and durability properties of concrete were determined. Super plasticizer was used to maintain the workability of concrete. The effects on different properties of concrete with AR glass fibre were evaluated in this study.

Key words: AR Glass fibre, Compressive Strength, Flexural Strength, SP-431

1. INTRODUCTION

Concrete is the most widely used construction material in the world. It is the homogenous mixture of binding material, sand and aggregates. The simplest reason for its extensive use in the construction of almost all civil engineering works is that the properties can be controlled which a wide range by using appropriate ingredients. It has been known that concrete is stronger in compression and weaker in tension. Fibres are commercially available and manufactured from steel, plastic, glass and other natural materials. The effect of the fibre in the composite leads to an increase in the tension and impact strength of the concrete glass fibre is a light weight, strong and waste materials. Fibre Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, sand, cement and discontinuous, discrete, uniformly dispersed suitable fibres. Fibre reinforced concrete is of different types and properties with many advantages. Continuous meshes, woven fabrics and long wires or rods are not considered to be discrete fibres.It reduces the air voids and water voids the inherent porosity of gel in concrete and it increases the durability of the concrete. Fibres such as graphite and glass have excellent resistance to creep, while the same is not true for most resins. Therefore, the orientation and volume of fibres have a significant influence on the creep performance of rebars/tendons. Reinforced concrete itself is a composite material, where the reinforcement acts as the strengthening fibre and the concrete as the matrix. It is therefore imperative that the behavior under thermal stresses for the two materials be similar so that the differential deformations of concrete and the reinforcement are minimized. Various types of fibres which can be used to produce concrete like steel fiber, polypropylene fiber, GFRC glass fiber, asbestos fibres, carbon fibres, organic fibres etc.Its properties would obviously, depends upon the efficient transfer of stress between matrix and the fibres. Factors affecting properties of fibre reinforced concrete includes relative fibre matrix stiffness, volume of fibres, aspect ratio of fibres, orientation of fibres, workability and compaction of concrete, size of aggregates and mixing. Literature shows that the use of fibre improves some properties like tensile strength, flexural strength, shock absorption capacity etc. It increases the tensile strength of the concrete.

2. LITERATURE REVIEW

2.1 Gupta et al (2017) evaluated the behaviour of light weight concrete containing glass fibre and fly ash. Replacement of Cement by Glass fibres in different fractions with 0%, 1%, 1.5%, 2%, 2.5%, 3% and 30% of Fly ash has been used, which satisfies the various structural properties of concrete like compressive strength, flexural strength. Workability was enhanced by the inclusion of super plasticizer in concrete which was adopted up to 0.5% by the weight of cement. As per Indian Standards, standard sizes of cubes and beams were casted and tested for compressive strength, flexural strength at age of 7days, 14 days and 28 days. From result it can be concluded that compressive strength does not improved but the flexural strength was improved with the addition of fibre.

2.2Hifzurrahman et al (2017) determined the behaviour of Glass Fibre Reinforced with Partial Replacement of Cement with Fly Ash. For that the glass fibres in different volume fraction with 20%, 30% and 40% replacement of cement by fly ash have been to study the effect on compressive strength, split tensile strength, of concrete and compared it to the conventional concrete. For each mix standard sizes of cubes, cylinders and as per Indian Standards were cast and tested for compressive strength and split tensile strength at age of 28days. Due to the addition of glass fibre split, tensile strength increased and is optimum when. 20% cement replaced with fly ash along with 2% glass fibre.

2.3Raja et al. (2014) investigated the mechanical behavior of fly ash impregnated E-glass fibre reinforced polymer composite (GFRP). Initially, the proportion of fibre and resin were optimized from the analysis of the mechanical properties of the GFRP. It is observed that the 30 wt% of E-glass in the GFRP without filler material yields better results. Then, based on the optimized value of resin content, the varying percentage of E-glass and fly ash was added to fabricate the hybrid composites. Results obtained in this study were mathematically evaluated using Mixture Design Method. Predictions show that 10% weight addition of fly ash with fibre improves the mechanical properties of the composites.

2.4 Kumar (2013) evaluated the mechanical properties of glass fibre reinforced concrete. Glass fibre improves the strength of the material by increasing the force required for deformation and improve the toughness by increase the energy required for crack propagation. The addition of about 1.5% chopped glass fibre (by cement weight) to the material increase the modules of rupture by about 20 % and fracture toughness by about 55%.many studied the effect of glass fibre on the mechanical properties of M35 grade of concrete.

2.5 Patel et al. (2013)analysed the effect of glass fibre in form of additive to increase the tensile strength of a concrete because it is weak in tension and glass fibre possess such properties that its particle connect to the particle of concrete and sealed together & not to be separated. Experiment concluded that the compressive strength, flexural strength increases with the addition of glass fibre and the optimum result was obtained at 0.1% glass fibre.

2.6 Murthy et al (2012) The experimental work dealt with the use of glass fibre in concrete which was obtained from the glass industry as a waste product. It was found that the compressive strength of concrete did not increase much but the flexural strength showed almost 30% increase in strength. The slump value found to be decreased with increase in fibre content. It was found that the use of fibre glass in concrete not only improved the properties of concrete but also small cost cutting.

3. Materials and Methodology

3.1 Materials: In this systematic experimental study, various ingredients like cement, fine aggregates, coarse aggregates, water and glass fibre were used to obtain concrete mixes, suitability of which were checked at laboratory by performing various tests. The properties of materials obtained in the laboratory are as follows:

3.1.1 Cement

The Ordinary Portland Cement of 43-grade was used for casting the specimens of all the concrete mixes**.**

3.1.2 AR –Glass Fibre

AR-glass fibre has been used to produce fibre concrete in construction work and laboratory for experiments. High-quality alkali-resistant glass fibre containing a high percentage of **zirconia (zro_2)**, which enhances its resistance to alkali in cement composites, can be used as an asbestos replacement available in a variety of strand lengths and sizing to meet specific applications and processing requirements excellent workability characteristics.

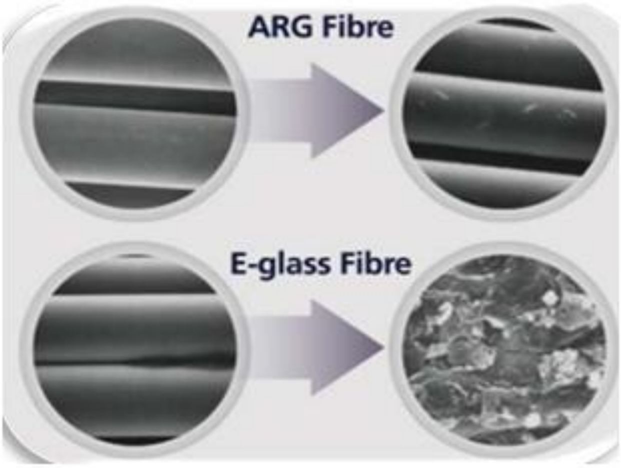

Figure.1. Effect And Production Of Ar- Glass Fiber

The physical properties of AR glass fiber like specific gravity, length, diameter is given below:

Table.1. Physical Properties Of Ar-Glassfibre

S. No.	Properties	Approximate Value
1	Specific gravity	2.68
2	Elastic moduius (GPa)	72
3	Tensile strength(MPa)	1700
4	Diameter (micron)	14
5	Length (mm)	12
6	No of fibre (millions / kg)	235

3.1.3 Fine Aggregates: Locally available fine aggregates were used for this study. The fine aggregate used for investigation was procured from the local fine aggregate suppliers. It should not contain organic matter, loam, silt, salt and clay. It stiffens the binder and fills the voids in the coarse aggregate

3.1.4 Coarse Aggregates: Coarse aggregate of size 20mm and 10mm was used in this study which was procured from the local coarse aggregate supplier as per IS: 383-1970.

3.1.5 SuperPlasticisers: Super plasticisers are increasing the workability of concrete as well as strength of concrete without increase the amount of water. Shaliplast SP-431 super plasticizer was used to produce workable concrete and the amount of super plasticizer was 0.5% by weight of cementing material.

Figure.2. Super Plasticisers Shaliplast

3.1.6 Water: Water quality plays a vital role in the production of concrete. The impurities in water may affect the setting of the cement and the final strength of the concrete.

3.2 Methodology:

Table.3. Mix Proportion Of Concrete Containing Ar Glass Fibre

Specimen no.	w/c ratio	Cement kg/m^3	% of replacement cement by Glass Fiber	Glass Fibre as partial replacement of cement Kg/m^3	Fine aggregates Kg/m^3	Coarse aggregates Kg/m^3
A1	0.40	405	0	0.0	660	1122
A2	0.40	402.9	0.50	2.02	660	1122
A3	0.40	400.9	1.0	4.05	660	1122
A4	0.40	398.8	1.5	6.07	660	1122
A5	0.40	396.8	2.0	8.1	660	1122
A6	0.40	394.8	2.5	10.1	660	1122
A7	0.40	392.8	3.0	12.12	660	1122
B1	0.50	405	0	0.0	660	1122
B2	0.50	402.9	0.50	2.02	660	1122
B3	0.50	400.9	1.0	4.05	660	1122
B4	0.50	398.8	1.5	6.07	660	1122
B5	0.50	396.8	2.0	8.1	660	1122
B6	0.50	394.8	2.5	10.1	660	1122
B7	0.50	392.8	3.0	12.12	660	1122

Table.4. Concrete Sample Testing Details

Test	Shape and Dimensions of the Specimens	Time Duration (in days)
Compressive Strength	Cube : 150mm×150 mm×150mm	28
Flexural strength	Beam : 150mm×150mm×500mm	28

4. RESULT AND DISCUSSION

4.1 Workability Test: Workability of control concrete and the concrete containing glass fibre was determined slump cone test (slump test as per Indian standard procedure IS:1199-1959).

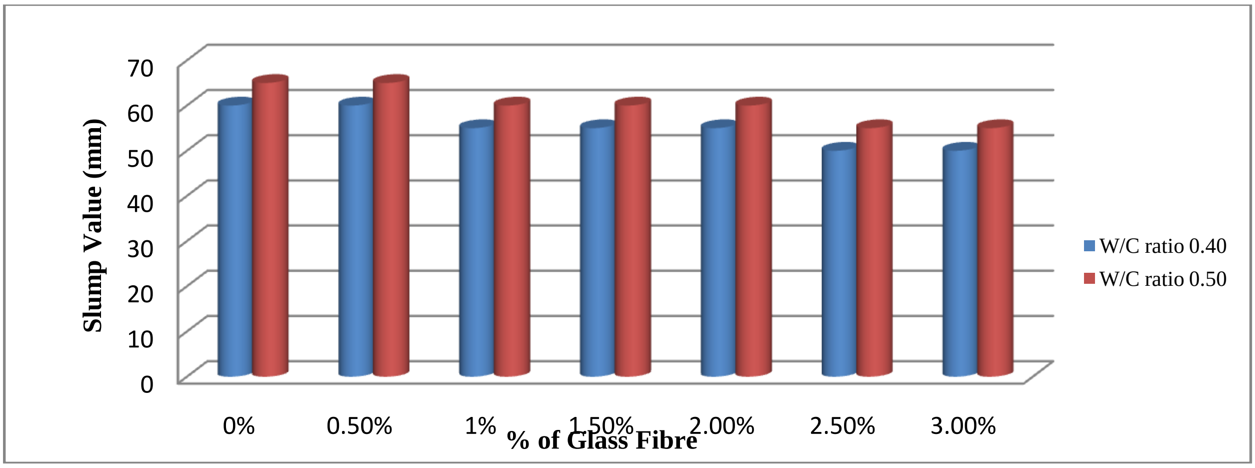

Figure .3. Slump Value At Various Replacement Levels

Figure the results of the slump test for the concrete containing super plasticizers at various replacement levels of glass fibre at w/c ratio of 0.40 and 0.50. It can be seen from figure 3, that for the given w/c ratio the slump value has been decreased with the increase % of AR glass fiber in concrete.

4.2 Compressive Strength

Figure 4 shows the compressive strength at 28 days of curing of concrete for w/c ratio 0.40 and 0.50 with replacement of cement by 0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5% and 3.0% glass fiber.

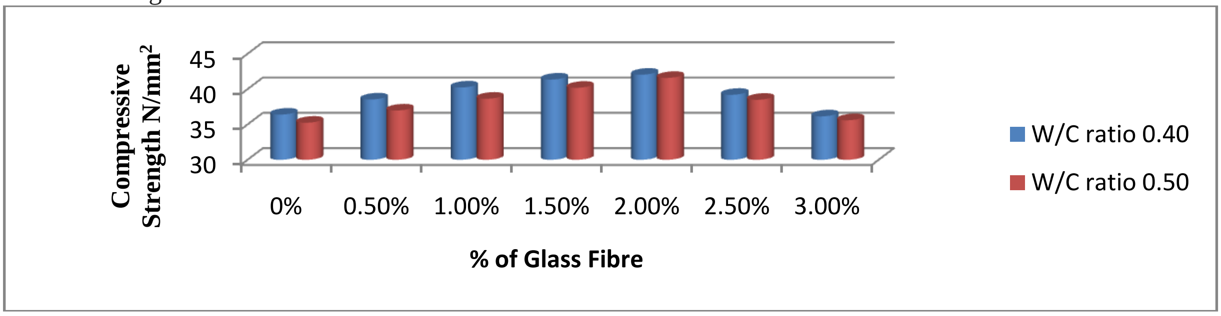

Figure.4. Compressive Strength At 28 Days Of Curing

The compressive strength increases with increase in the percentage of AR glass fibre up to 2.0% replacement level after that it starts to decreases. The compressive strength for concrete at 2.0% replacement of cement by AR glass fibre was obtained as 42.05 N/mm^2 for w/c ratio 0.40 and 41.6 N/mm^2 for w/c ratio 0.50. Compressive strength increases with 15.5% by additional replacement of cement by AR glass fibre up to 2% for w/c ratio 0.40 and 18.01% increases was obtained at 2% replacement level of AR glass fibre as compared to controlled concrete. Hifzurrahman et al (2017) also reported that an increase in compressive strength was observed with an increasing fibre percentage.

4.3 Flexural Strength: The flexural strength of concrete at 28 days of curing at w/c ratio 0.40 and 0.50 was shown in figure 5. The flexural strength of concrete for control mix was obtained as 6.6N/mm^2 and 6.45 N/mm^2 for w/c ratio 0.40 and 0.50 respectively. The flexural strength of concrete increases with increase in the percentage of AR glass fibre up to 2% replacement level after that it started to decreases. The flexural strength of concrete increases to 8.2 N/mm^2 and 7.95 N/mm^2 for w/c ratio 0.40 and 0.50 respectively at 2% replacement level of cement by AR glass fibre. Flexural strength of concrete at (3%) maximum replacement level of AR glass fibre was observed as 7.45 N/mm^2 for 0.40 w/c ratio and 6.3 N/mm^2 for 0.50 w/c ratio.

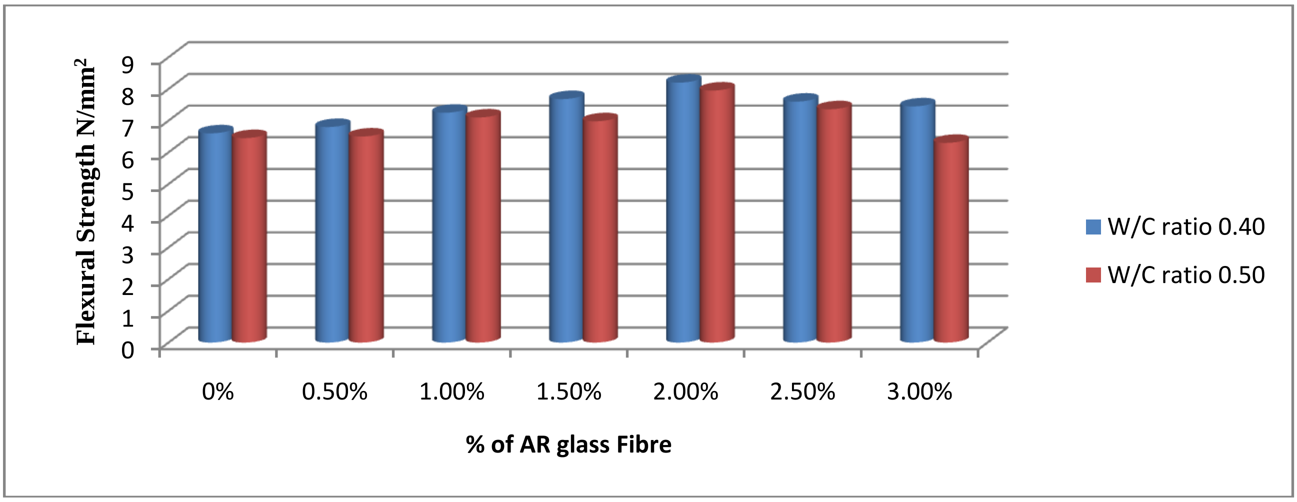

Figure.5. Flexural Strength At 28 Days Of Curing

The increase in flexural strength is due to increases in compressive strength. The fibre shows resistance against bending. Increases in flexural strength with increases in percentages of glass fibre (Gupta et al, 2017)

5. SUMMERY AND CONCLUSION

- The workability of concrete was found to be decreased with increase in the percentage of AR glass fibre but sufficient workability was achieved by the use of super plasticizers in concrete.
- The compressive strength of concrete containing AR glass fibre increases with the increasing amount of glass fibre up to 2% after that it started to decreases for both w/c ratio 0.40 as well as for 0.50.
- The flexural strength of concrete containing AR glass fibre continuously increases with increase in the percentage of glass fibre up to 2% after that it started to decreases for both w/c ratios.

Most of the properties of modified concrete were very comparable to reference concrete. This modified concretecan be used in situation which requires light weight concrete as well as for high strength concrete.

6. REFERENCES

[1]. Evangeline.K and , Neelamegam M. “Effect of Super plasticizer on Workability and Mechanical Properties of Self-Compacting Concrete”, *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE),* 18-29.

[2]. Figueiredo A.D and Ceccato M.R. (2015), “Workability Analysis of Steel Fibre Reinforced Concrete Using Slump and Ve-Be Test”, *Materials Research*.

[3]. Gupta S, Aakash, Ramola A, Arora J and Saini A (2017), “Partial Replacement of Cement by Flyash & Glass Fibre in Light Weight Fibre Reinforced Concrete” *International Journal of Engineering Research & Technology (IJERT)*, **6(7)**; 24-27.

[4]. Hifzurrahman, Khan Z. and Baig M. Aamir (2017), “Glass Fibre Reinforced with Partial Replacement of Cement with Fly Ash”, *International Journal of Advance Research, Ideas and Innovations in Technology*, **3(3);**1690-1695.

[5]. IS 1199, 1959: Methods of sampling and analysis of concrete.

[6]. IS 1237, 2012: Cement concrete flooring tiles-specification.

[8]. IS 383, 1970: Specification for coarse and fine aggregates from natural source for concrete.

[9]. IS 456, 2000: Code of practice-plain and reinforced concrete.

[10]. IS 516, 1959: Methods of tests for strength of concrete.

[11]. IS 8112, 2013: Ordinary portland cement, 43 grade — specification.

[12]. Kumar R.P. (2013), “A Study on Glass Fibre as an A delitive in Concrete to Increase Concrete tensile strength”, *Global Research Analysis International*, **2(2)**; 85-87.

[13]. Raja S. (2014) “Study on mechanical properties of fly ash impregnated glass fibre reinforced polymer composites using mixture design analysis, *Elsevier Materials and Design* 55, 499–508.

[14]. Singh A.P. (2013), “Strength and Permeability Characteristics of Steel Fibre Reinforced Concrete,”, World Academy of Science, Engineering and Technology *International Journal of Civil and Environmental Engineering.* 7(10); 733-738.

[15]. Tajne K.M., Bhandari P.S.(2014), “Effect of Glass Fibre on Ordinary Concrete” *International Journal of Innovative Research in Science, Engineering and Technology*, **3(11)**; 17632-17634