EXPERIMENTAL STUDY ON THE PERFORMANCE OF ALKALI RESISTANT GLASS FIBRERAINFORCED CONCRETE

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ABSTRACT: **Glass Fibre Reinforced Concrete is recent introduction in the field of concrete technology. The present day world is witnessing the construction of very challenging and difficult Civil Engineering Structures. Concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Concrete the most widely used construction material has several desirable properties like high compressive strength, stiffness, durability under usual environmental factors. At the same time concrete is brittle and weak in tension. Efforts are being made in the field of concrete technology to develop high performance concretes by using fibres and other admixtures in concrete up to certain proportions. To improve the concrete properties, the system was named alkali resistance glass fibre reinforced concrete in the present view the alkali resistance glass fibre has been used. In the present experimental investigation the alkali resistance Glass Fibres has been used to study the effect on compressive, split tensile and flexural strength on M30 grade of concrete**

***Keywords* – Alkali resistance glass fibres, admixtures, concrete, glass fibres, strength properties.**

INTRODUCTION

Concrete is the most widely used man made construction in the world. Concrete is the most widely used construction material has several desirable properties like high compressive strength, stiffness and durability under usual environmental factors. At the same time concrete is brittle and weak in tension. Plain concrete has two deficiencies, low tensile strength and a low strain at fracture. These shortcomings are generally overcome by reinforcing concrete. Normally reinforcement consists of continuous deformed steel bars or pre-stressing tendons. The advantage of reinforcing and pre-stressing technology utilizing steel reinforcement as high tensile steel wires have helped in overcoming the incapacity of concrete in tension but the ductility magnitude of compressive strength. Glass fibre reinforced concrete is one of the most versatile building materials available to architects and engineers. Composed principally of cement, sand and special alkali resistant (AR) glass fibres, GRC is a thin, high strength concrete with many applications in construction..

The concept of using fibers as reinforcement is not new. Fibers have been used as reinforcement since ancient times. Historically, horsehair was used in mortar and straw in mud bricks. In the 1900s, asbestos fibers were used in concrete. In the 1950s, the concept of composite materials came into being and fiber-reinforced concrete was one of the topics of interest. In the 1960s, steel, glass (GFRC), and synthetic fibers such as polypropylene fibers were used in concrete. Research into new fiber-reinforced concretes continues today.

GLASS FIBRE:

Glass fibre also called fiberglass. It is a material made from extremely fine fibres of glass Fiberglass is a lightweight, extremely strong, and robust material. Although strength properties are somewhat lower than carbon fibre and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk strength and weight properties are also very favorable when compared to metals, and it can be easily formed using moulding processes. Glass is the oldest, and most familiar, performance fibre. Fibres have been manufactured from glass since the 1930s.

Glass Fiber Reinforced Concrete (GFRC) or (GRC) is a type of fiber reinforced concrete. Glass fiber concretes are mainly used in exterior building façade panels and as architectural precast concrete. This material is very good in making shapes on the front of any building and it is less dense than steel.

GFRC is a form of concrete that uses fine sand, cement, polymer (usually an acrylic polymer), water, other admixtures and alkali-resistant glass fibers.

Many mix designs are freely available on various websites, but all share similarities in ingredient proportions.

Glass fibre reinforced cementations composites have been developed mainly for the production of thin sheet components, with a paste or mortar matrix, and~5% fibre content. Other applications have been considered, either by making reinforcing bars with continuous glass fibres joined together and
Impregnated with plastics, or by making similar short, rigid units, impregnated with epoxy, to be dispersed in the concrete during mixing.

Glass fibres are produced in a process in which molten glass is drawn in the form of filaments, through the bottom of a heated platinum tank or bushing. Usually, 204 filaments are drawn simultaneously and they solidify while cooling outside the heated tank; they are then collected on a drum into a strand consisting of the 204 filaments. Prior to winding, the filaments are coated with a sizing which protects the filaments against weather and abrasion effects, as well as binding them together in the strand [2].

TYPE OF GLASS FIBRE:

1. A-glass: With regard to its composition, it is close to window glass. In the Federal Republic of Germany it is mainly used in the manufacture of process equipment.
2. C-glass: This kind of glass shows better resistance to chemical impact.
3. E-glass: This kind of glass combines the characteristics of C-glass with very good insulation for electricity.
4. AR-glass: Alkali resistant glass. It is used as anti crade arresters.

PROPERTIES GLASS FIBRES

Properties	**Eglass**	**ARglass**	**Cglass**
Tensile Strength (Gpa)	3.5	3.5	4.6
Modulus (Gpa)	73.5	72	86.8
Elongation (%)	4.8	2	5.4
Density (g/cc)	2.57	2.68	2.46
Refractive Index	1.547	1.561	-
Coefficient of Thermal Expansion (107/0c)	50-52.0	75.0	23-27.0

MATERIALS

Cement

Portland Pozzolano (Ultratech) cement available in local market is used in the investigation. The cement used has been tested for various proportions as per IS :4031-1998 and found to be conforming to various specifications of IS :12269-1987.

Coarse aggregate

The crushed aggregates used were minimum size of aggregate 12mm.

Fine aggregate

Locally available Manjara river bed sand was used as fine aggregate.

Glass fibre

The glass fibres used are of Cem-fil-anti-crack AR fibres (high dispersion) with modulus of elasticity 72Gpa, filament diameter – 14 microns, specific gravity 2.68, length 12 mm and having the aspect ratio of 857.1.The number of fibres per 1 kg is 212 million fibres.

Water
Locally available potable water is used.

METHODOLOGY:

1) **Workability**

The workability tests were performed using standard sizes of Slump Moulds as per IS: 1199 - 1999 and Compaction Factor apparatus which was developed in UK and is described in IS: 1199 - 1999.

i.e. value 90mm & 0.90 respectively.

2) **Compressive Strength**

Casted 100 x 100 x 100 mm cubes & allowed for curing in curing tank for 7 days & 28 days & tested in 200 tones compression testing machine**.**

3) **Flexural Strength**

Casting beam 100 x 100 x 500 mm& they were allowed for curing in a curing tank for 28 days and they were tested in flexural testing machine.

4) **Tensile Strength**

Casted 100 x 100 x 100 mm cubes& they were allowed for curing in a curing tank for 7 days & 28 days and they were tested in Compression testing machine.

1. Mix proportion=
2.

Water	Cement	FA	CA
200	500	644	985
0.40	1	1.28	1.97
20	50	64	98

RESULTS AND DISCUSSIONS

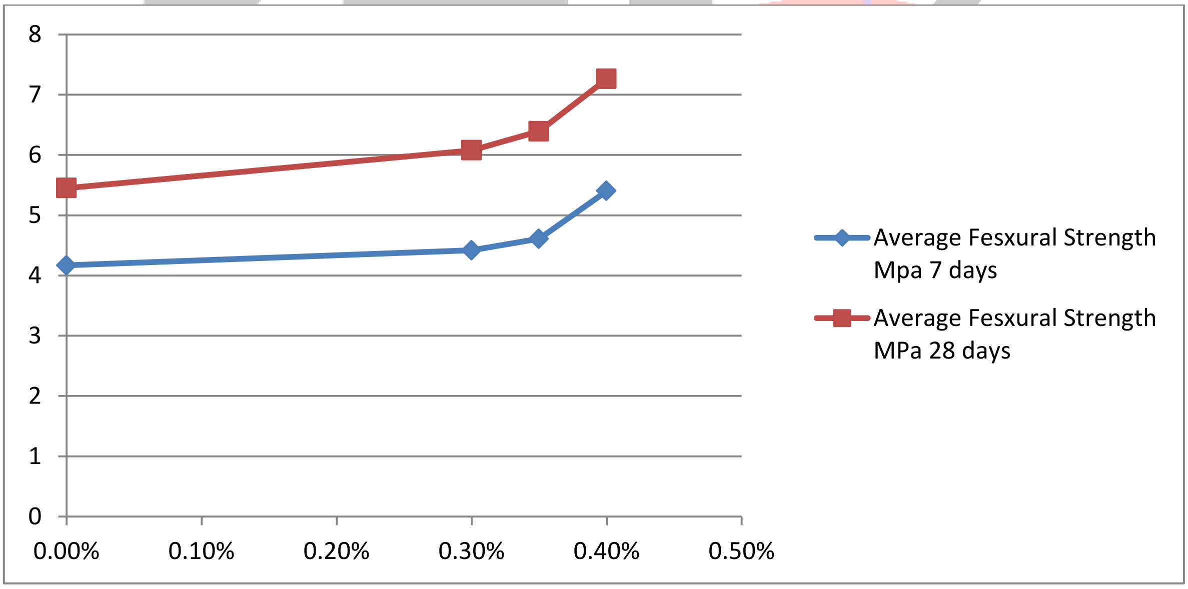
Effect of glass fibre on workability of glass fibre concrete
The workability of concrete of M30 grade of concretes were estimated in terms of compaction factor for addition of percentage of glass fibre. It was observed that the addition of glass fibres, the compaction factor of 0.93 to 0.97 was maintained for M30 grade of concrete.

Effect of glass fibre on bleeding of glass fibre concrete
On the basis of the experimental study it was concluded that addition of glass fibre in concrete gives a reduction in bleeding. A reduction in bleeding improves the surface integrity of concrete, improves its homogeneity and reduces the probability of cracks occurring where there is some restraint to settlement.

Results of test :
Flexural Strength

Sample No.	%of glass fibre	Flexural Strength MPa (N/mm^2) 7 days	Average Flexural Strength MPa 7days
1	0 %	4.5	4.167
2	0 %	3	
3	0 %	5	
4	0.3 %	4.75	4.416
5	0.3 %	3.25	
6	0.3 %	5.25	
7	0.35 %	4.125	4.608
8	0.35 %	4.95	
9	0.35 %	4.75	
10	0.4 %	5	5.403
11	0.4 %	5.37	
12	0.4 %	5.84	

Sample No.	% of glass fibre	Flexural strengthMPa (N/mm^2) 28 days	Average Flexural Strength MPa 28 days
1	0 %	5.51	5.45
2	0 %	5.56	
3	0 %	5.28	
4	0.3 %	5.8	6.076
5	0.3 %	6.25	
6	0.3 %	6.18	
7	0.35 %	6.40	6.393
8	0.35 %	6.25	
9	0.35 %	6.53	
10	0.4 %	6.75	7.26
11	0.4 %	7.25	
12	0.4 %	7.78	

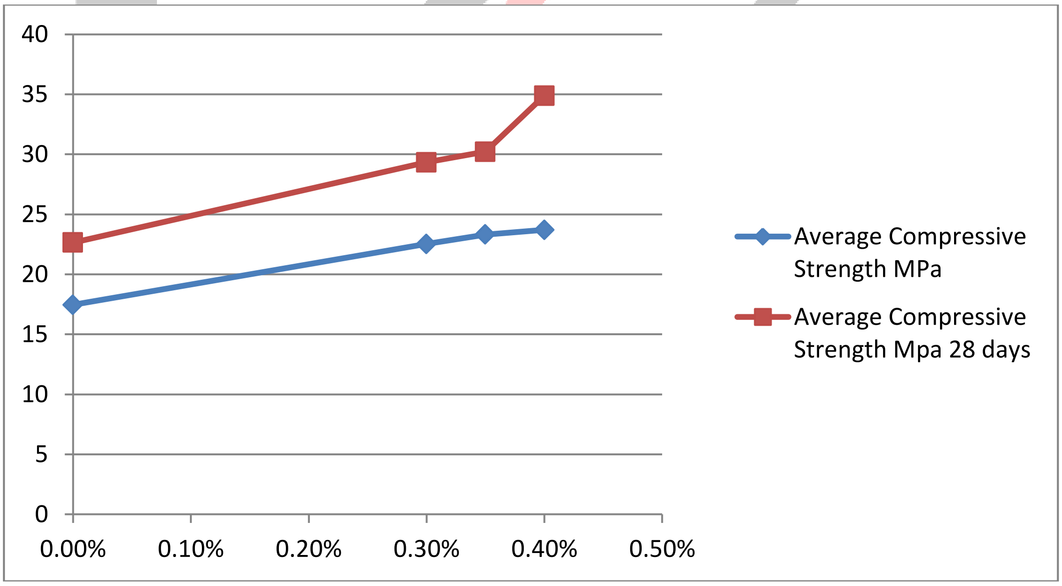


Flexural strength (MPa)

Compressive Strength :

Sample No.	% of glass fibre	Compressive strength MPa (N/mm^2) 7 days	Average Compressive Strength MPa 7 days
1	0 %	22.062	
2	0 %	11.87	17.45
3	0 %	18.43	
4	0.3 %	24.93	22.53
5	0.3 %	20.44	
6	0.3 %	22.22	
7	0.35 %	23.43	
8	0.35 %	22.084	23.31
9	0.35 %	24.432	
10	0.4 %	21.490	
11	0.4 %	23.809	23.696
12	0.4 %	25.789	

Sample No.	% of glass fibre	Compressive strength MPa(N/mm^2) 28 days	Average Compressive Strength MPa 28 days
1	0 %	25.11	
2	0 %	22.38	22.65
3	0 %	20.47	
4	0.3 %	26.23	
5	0.3 %	27.27	29.33
6	0.3 %	33.50	
7	0.35 %	29.68	
8	0.35 %	28.06	30.21
9	0.35 %	33.91	
10	0.4 %	27.12	
11	0.4 %	33.10	34.88
12	0.4 %	44.44	

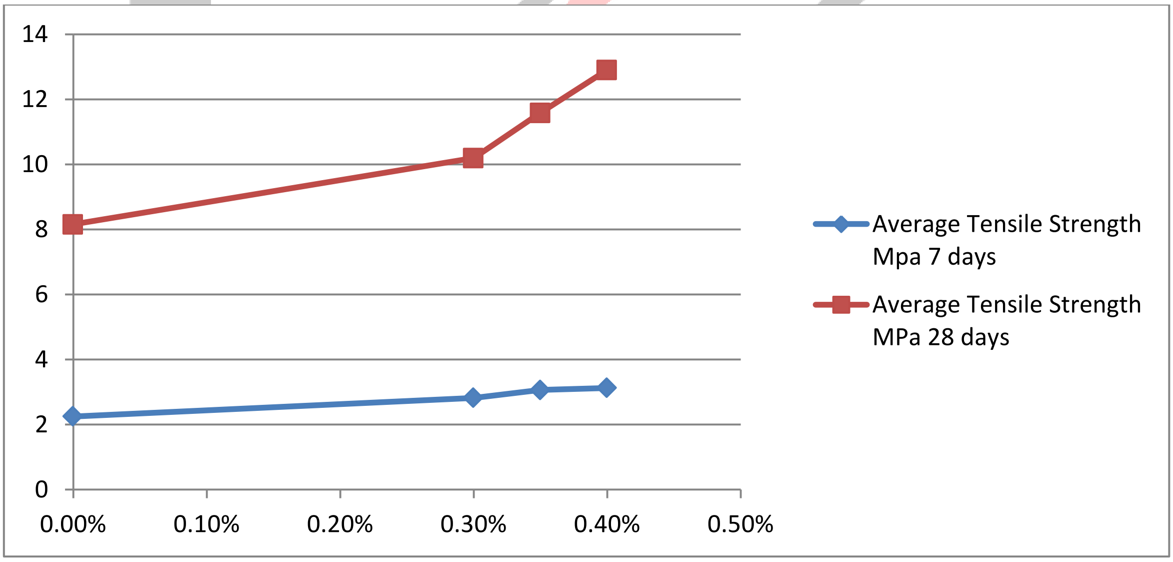


Compressive strength (MPa)

Tensile Strength :

Sample No.	% of glass fibre	Tensile strengthMPa (N/mm^2) 7 days	Average Tensile Strength MPa 7 days
1	0 %	1.95	2.25
2	0 %	2.35	
3	0 %	2.45	
4	0.3 %	2.55	2.82
5	0.3 %	2.86	
6	0.3 %	3.05	
7	0.35 %	2.96	3.063
8	0.35 %	3.05	
9	0.35 %	3.181	
10	0.4 %	2.727	3.127
11	0.4 %	3.5	
12	0.4 %	3.155	

Sample No.	% of glass fibre	Tensile strength MPa (N/mm^2) 28 days	Average Tensile Strength MPa 28 days
1	0 %	7.49	8.152
2	0 %	8.24	
3	0 %	8.727	
4	0.3 %	9.08	10.19
5	0.3 %	10.26	
6	0.3 %	11.24	
7	0.35 %	10.84	11.58
8	0.35 %	11.72	
9	0.35 %	12.18	
10	0.4 %	12.65	12.9
11	0.4 %	12.86	
12	0.4 %	13.19	



Tensile strength (MPa)

CONCLUSION :

Based on the result and observation made in this experimental research study. The following conclusion are drawn.

1. By the addition of 0.4 % Alkali resistant Glass fibre the slump off concrete & compaction factor is increased 90 mm & 0.90 respectively.
2. Early age 7 days compressive strength, tensile strength & flexural strength is reduced 35.75 %, 38.97 % & 29.66 % respectively by addition of 0.4 % alkali resistant glass fibre.
3. However the compressive strength tensile strength & flexural strength increased at 28 days of age in comprasion of controlled concrete is 53 %, 58.24 % and 33 % respectively by addition of 0.4 % Alkali resistant glass fibre by using water cement ratio 0.4 and aggregate cement ratio 3.25
4. It has been observed that, Alkali resistant glass fibre can control shrinkage crack easily & reduction in bleeding, improves its homogeneity & reduces the probability of cracks.

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