Comparative Study of Glass Fiber Reinforced Concrete

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***Abstract:* - The most of the research over the world are carried out to develop high performance concretes by using fibers and other admixtures in concrete up to certain proportions. In the view of the global sustainable developments, it is imperative that fibers like glass, carbon, polypropylene and aramid fibers provide improvements in compressive strength, tensile strength, fatigue characteristics, durability, shrinkage characteristics, impact, cavitations, erosion resistance and serviceability of concrete. Fibers impart energy absorption, toughness and impact resistance properties to fiber reinforced concrete material and these characteristics in turn improve the fracture and fatigue properties of fiber reinforced concrete research in glass fiber reinforced concrete resulted in the development of an alkali resistance fibers high dispersion that improved long term durability. This system is named as alkali resistance glass fiber reinforced concrete. The present study investigates the effect of alkali resistance glass fibers in addition of 0.5% and 0.1% on compressive strength of M20 grades of concrete. Total 27 samples were prepared under this study to determine the compressive strength of different proportions of glass fibers in concrete. The results is found for 0%, 0.5% and 1% glass fibers in concrete about 18.59 MPa, 20.81 MPa and 21.5 MPa after 7 days, 19.6 MPa, 22.22 MPa, 22.7 MPa after 14 days and 20.59 MPa, 24.4 MPa and 25.3 MPa respectively.**

***Keywords*: Glass Fiber, Control Concrete, Compressive strength etc.**

I. INTRODUCTION

Concrete is the most useful building material has several desirable properties such as high compressive strength, stiffness and durability under usual environmental factors and service loads. 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 demerits are generally overcome by reinforcing materials like steel, wire, cable, fibers etc [1]. The materials having tensile properties improve the strength of concrete by mixing with it. The adhesive bonding of concrete with reinforcing is provided by grip or adhesive gel.

Now to overcome and find out a better property of tensile strength in concrete, Fiber Reinforced Concrete (FRC) is a relatively new material is introduced. This is a composite material consisting of a matrix containing a random distribution or dispersion of small fibers, either natural or artificial, having a high tensile strength [1]. Due to the presence of these uniformly dispersed fibers, the cracking strength of concrete is increased and the fibers acting as crack arresters [2]. Fibers suitable of reinforcing concrete having been produced from steel, glass and organic polymers. Many of the current applications of FRC involve the use of fibers ranging around 1% by volume of concrete. Recent attempts made it possible to incorporate relatively large volumes of steel, glass and synthetic fibers in concrete [2]. This may be attributed to the fact fibers suppress the localization of micro-cracks into macro-cracks and consequently the apparent tensile strength of the matrix increases [3]. Glassmakers throughout history have experimented with glass fibers, but mass manufacture of glass fiber was only made possible with the invention of finer machine tooling. Edward, 1893 exhibited a dress at the World's Columbian Exposition incorporating glass fibers with the diameter and texture of silk fibers. Glass fibers can also occur naturally, as Pele's hair. Glass fiber when used as a thermal insulating material is specially manufactured with a bonding agent to trap many small air cells, resulting in the characteristically air-filled low-density "glass wool" family of products [3].

Glass fiber has roughly comparable mechanical properties to other fibers such as polymers and carbon fiber. Although not as strong or as rigid as carbon fiber, it is much cheaper and significantly less brittle when used in composites. Glass fibers are therefore used as a reinforcing agent for many polymer products; to form a very strong and relatively lightweight fiber-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), also popularly known as "fiberglass". This structural material product contains little or no air or gas, is denser, and is a much poorer thermal insulator than is glass wool [3].

II. OBJECTIVE OF STUDY

The aim of the present investigation is:

a) To study different strength properties of Glass Fiber Reinforced Concrete with age in comparison to Control concrete.

b) To study the relative strength development with age of Glass Fiber Reinforced Concrete with Control concrete of same grade.

III. MATERIALS

Glass fiber: Glass fiber is formed when thin strands of silica-based or other formulation glass are extruded into many fibers with small diameters suitable for textile processing. The technique of heating and drawing glass into fine fibers has been known for millennia; Until this time, all glass fiber had been manufactured as staple (that is, clusters of short lengths of fiber).The first commercial production of glass fiber was in 1936. In 1938 Owens-Illinois Glass Company and Corning Glass Works joined to form the Owens-Corning Fiberglas Corporation.

Types of Glass Fibers

The most common types of glass fiber used in fiberglass is E-glass, which is alumino-borosilicate glass with less than 1% w/w alkali oxides, mainly used for glass-reinforced plastics. Other types of glass used are-

- A-glass (Alkali-lime glass with little or no boron oxide)
- E-CR-glass (Electrical/Chemical Resistance; alumino-lime silicate with less than 1% w/w alkali oxides, with high acid resistance)
- C-glass (alkali-lime glass with high boron oxide content, used for glass staple fibers and insulation)
- D-glass (borosilicate glass, named for its low Dielectric constant), R-glass (alumino silicate glass without MgO and CaO with high mechanical requirements as reinforcement)
- S-glass (alumino silicate glass without CaO but with high MgO content with high tensile strength) [23]

Water: Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. In this project clean potable water was used for mixing and curing of concrete.

Basically four types of material are used in this investigation. The characteristics of material are mentioned in table.

Table.1 Characteristic of Materials

Materials	Properties	Values
Cement (53 grade)	Specific gravity (IS: 4031-1988)	3.02
	Fineness (IS: 12269-1987)	3200 cm^2/gm
Coarse Aggregate	Specific gravity	2.71
	flakiness index	4.58
	elongation index	3.96
Fine Aggregate	Specific gravity	2.55
	fineness modulus	2.93
Glass Fiber (10mm×80mm)	Tensile Strength	1700 MPa

Table.2 Mix proportion

Water	Cement	Fine aggregate	Coarse aggregate
0.5	1	1.5	3.0
210kg	420kg	630kg	1260kg

Note: In this experiment we prepared 9 test specimen of control concrete & 9 test specimens of 0.5% and 1% Glass Fiber added in Concrete by volume of each (As per IS: 516-1959) respectively. Three sample of each types have prepared for 7days,14days and 28 days. That's noted total 27 samples were prepared under this study.

The concrete shall be mixed by hand or preferably in a laboratory batch mixer, in such a manner as to avoid loss of water or other materials.

IV. CALCULATION

The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross-sectional area, calculated from the mean dimensions of the section and shall be expressed to the nearest kg per sq cm. Average of three values shall be taken as the representative of the batch provided the individual variation is not more than + 15percent of the average. Otherwise repeat tests shall be made. [22]

Area (mm^2) 22500

Table.3 Compressive Strength after 7 days

Specimens		Weight (kg)	Avg. wt(kg)	Max Load (kN)	Avg. load (kN)	Compressive strength (N/mm^2)
CC1	0%	8.05	8.19	420	418.33	18.59
CC2		8.20		420		
CC3		8.32		415		
GFC1	0.5 %	8.3	8.33	470.6	468.23	20.81
GFC2		8.45		465.8		
GFC3		8.25		468.3		
GFC1	1.0 %	8.42	8.38	485.7	483.75	21.5
GFC2		8.35		479.6		
GFC3		8.37		485.95		

Table.4 Compressive Strength after 14 days

Specimens		Weight (kg)	Avg. wt(kg)	Max Load(kN)	Avg. load (kN)	Compressive strength (N/mm^2)
CC1	0%	8.13	8.21	435	441	19.6
CC2		8.23		446		
CC3		8.27		442		
GFC1	0.5 %	8.41	8.38	496	499.95	22.22
GFC2		8.35		499		
GFC3		8.38		504.85		
GFC1	1.0 %	8.42	8.45	503.5	510.75	22.7
GFC2		8.46		515.7		
GFC3		8.48		513.05		

Table.5 Compressive Strength after 28 days

Specimens		Weight (kg)	Avg. wt(kg)	Max Load (kN)	Avg. load (kN)	Compressive strength (N/mm^2)
CC1	0%	8.12	8.24	475	463.33	20.59
CC2		8.20		470		
CC3		8.39		445		
GFC1	0.5 %	8.32	8.35	556.8	549	24.4
GFC2		8.38		540.6		
GFC3		8.35		549.6		
GFC1	1.0 %	8.33	8.38	575.3	569.25	25.3
GFC2		8.42		565.7		
GFC3		8.39		566.75		

Table.6 Strength of GFRC over control concrete

Glass Fiber % with Days	Increase(+) or decrease(-) in strength%
0.5% GFRC at 7 days	11.94
1.0% GFRC at 7 days	15.65
0.5% GFRC at 14 days	13.36
1.0% GFRC at 14 days	15.81
0.5% GFRC at 28 days	18.5
1.0% GFRC at 28 days	22.87

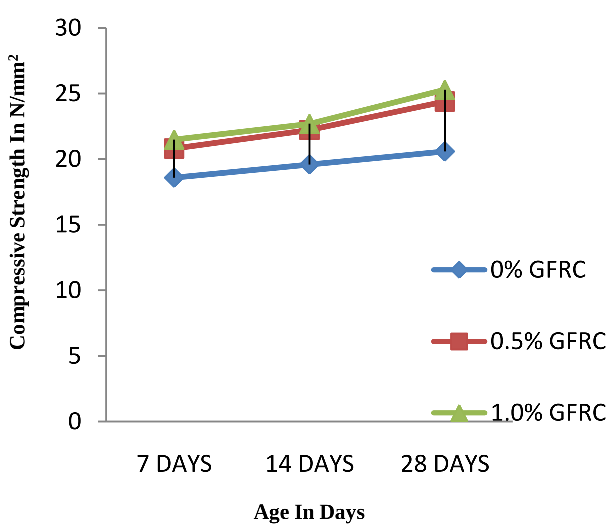

Fig.1 Variation of Compressive strength with age and percentage of GLASS FIBER

V. MIX PROPORTIONING OF CONTROL CONCRETE

According to IS method of mix design, the proportions of control concrete was first obtained. The trial mixes were carried out to determine the strength at 7, 14 and 28 days and the results are obtained as shown in figure. The cube compressive strength at 28 days was obtained higher than the strength of control concrete as shown in figure. The compressive strength at different ages of M20 grade concrete is shown in figure.

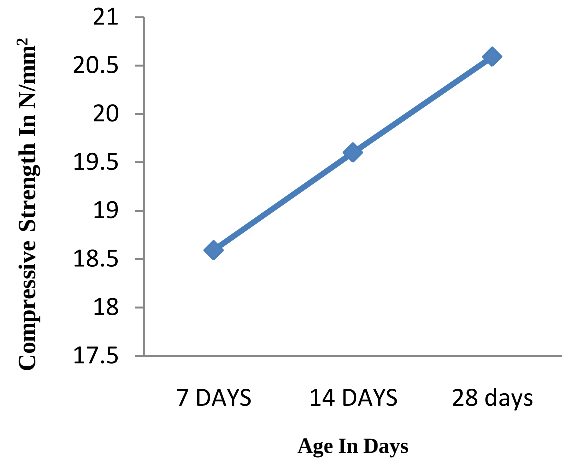

Fig.2 Strength of control concrete on ageing

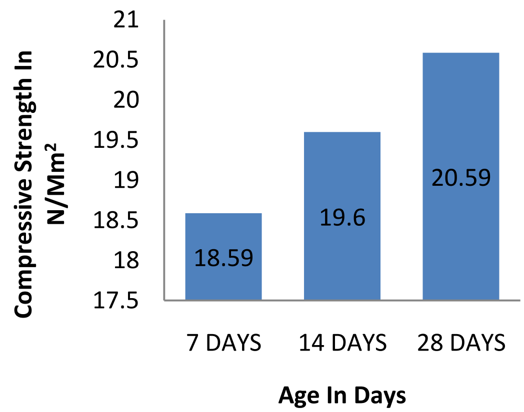

Fig.3 Representation of Strength of M20 Grade Control Concrete at Different Ages

VI. RESULT AND DISCUSSION

This chapter deals with the presentation of test results, and discussions on Compressive strength development of Control concrete and GFRC at different curing periods. The present investigation is based on the IS method for Control concrete. For GFRC, volume % method is considered. Trial mix proportions have been obtained for M20 grade Control concrete from the mix design. By conducting trail mixes, an optimized proportion for the mix is obtained for M20 grade Control concrete. Compressive strength behaviour of GFRC concrete designed by the volume % method are studied, where in the effect of age and percentage of GFRC on Compressive strength is studied in comparison with that of M20 grade Control concrete.

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