EXPERIMENTAL INVESTIGATION ON GLASS FIBRE REINFORCED CONCRETE

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Abstract : In this paper, we have seen that now days Construction industry is always trying to find new, better and economical material to manufacture new product, which is very beneficial to the industry. Today a significant growth is observed in the manufacture of composite material. With this energy conservation, corrosion risk, sustainability is important when a product is changed or new product is manufactures. Glass fibre (GF) is one of the high performance non-metallic fibres made by fusing (co-melting) silica with minerals. Glass fibre reinforced concrete (GFRC) offers more characteristics such as light weight, good fire resistance and strength. In future it is very beneficial for construction industry. Many applications of glass fibre are residential, industrial, highway and bridges etc.

Most of the studies preferred parameters like addition of glass fibres into the concrete with various proportions represented the positive as well as negative improvements in mechanical properties of concrete. However, the researchers could not exhibit the improvement in properties like compressive strength, modulus of elasticity, flexural strength, tensile strength, toughness, early age cracking etc. Even though these properties are important for desired quality of concrete, to overcome this, use of optimum percentage glass fibres in concrete. In present work different percentages of glass fibres were added for M-30 grade of concrete. The experimental study were carried out by casting the cubes in different proportions of glass fibres and glass fibre mesh and the results were obtained to find out optimum percentage of glass fibres. The glass fibres were added into the concrete in proportion of 0, 0.5 %, 1.0 % and 1.5 % by volume at an increment of 0.5 %. A comparative study of various experimental results was carried out.

***IndexTerms* - cement, coarse aggregate, fine aggregate, water, steel bars and glass fibre.**

I. INTRODUCTION

Industry is always trying to find new, better and economical material to manufacture new product, which is very beneficial to the industry. In the recent days, the various fibres develop and used in the construction, industrial and highway engineering. The steel is mainly used in that various application. Also fibre glass polythene fibres, carbon fibres, polyamide fibres are now developed and also used in construction, industrial and infrastructure development. In that list new one fibre is added, called as glass fibres.

Today a significant growth is observed in the manufacture of composite material. With this in mind energy conservation, corrosion risk, the sustainability and environment are important when a product is changed or new product is manufactures. Glass fibre is a high-performance nonmetallic fibre Glass melts are made by fusing (co-melting) silica with minerals, which contain the oxides needed to form a given composition. The molten mass is rapidly cooled to prevent crystallization and formed into glass fibres by a process also known as fibreization. The glass fibres do not contain any other additives in a single producing process, which gives additional advantage in cost. Glass fibres have no toxic reaction with air or water, are non-combustible and explosion proof. When in contact with other chemicals they produce no chemical reaction that may damage health or the environment. Glass fibre has good hardness and thermal properties. Glass fibres have been successfully used for foundation such as slabs on ground concrete.

By industrial production of glass fibres on the basis of new technologies their cost is equal and even less than cost of basalt fibre. The glass fibres and materials on their basis have the most preferable parameter ratio of quality and the price in comparison with glass, carbon fibres, and other types of fibres. It can also be mixed with other materials, when compacted it develops a high degree of mechanical particle interlock which results in high shear strength partly due to its texture.

In this modern age, civil engineering constructions have their own structural and durability requirements, every structure has its own intended purpose and hence to meet this purpose, modification in traditional cement concrete has become mandatory. It has been found that different type of fibres added in specific percentage to concrete improves the mechanical properties, durability and serviceability of the structure. It is now established that one of the important properties of Fibre Reinforced Concrete (FRC) is its superior resistance to cracking and crack propagation and which containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel fibres, basalt fibres, glass fibre, synthetic fibres and natural fibres – each of which lends varying properties to the concrete. In addition, the character of fibre reinforced concrete changes with mixing fibre materials, geometries, distribution, orientation, and densities. The weak matrix in concrete, when reinforced with fibres, uniformly distributed across its entire mass, gets strengthened enormously, thereby rendering the matrix to behave as a composite material with properties significantly different from conventional concrete. Because of the vast improvements achieved by the addition of fibres to concrete, there are several applications where FRC can be intelligently and beneficially used. These fibres have already been used in many large projects involving the construction of industrial floors, pavements, highway overlays, etc. in India. These fibres are also used in the production of continuous fibres and are used as a replacement to reinforcing steel. High percentages of steel fibres are used extensively in pavements and in tunnelling. Fibres are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibres produce greater impact, abrasion, and shatter– resistance in concrete. Glass fibres can be considered environmentally friendly and non-hazardous materials. It is not a new material, but its applications are surely innovative in many industrial fields, from building and construction to energy efficiency, from automotive to aeronautic, thanks to its good mechanical, chemical and thermal performances. Hence, glass fibre has gained increasing attention as a reinforcing material. The production process, even if it is very similar to the glass fibres one, does not require additives and a lower amount of energy is needed with benefits in terms of environmental impact, economics and plants maintenance. The base cost of glass fibres depend on the quality and the chemical composition of the raw material and this leads to have several kind of fibres with different thermal, chemical and mechanical properties.

II. AIM AND OBJECTIVE

The aim of the experimental investigation is to analyse the properties of concrete by adding the most suitable combination of glass fibre percentage into the concrete. This optimum percentage of glass fibre is used for further investigation.

I. To check the behaviour of GFRC under compression.
II. To determine the optimum percentage of glass fibre quantity into the concrete.
III. To increase the toughness of the concrete.

III. LITERATURE REVIEV

A significant amount of research work on various structural aspects of use of structure and their mechanism has been published by many investigators. Review of some of the technical papers are briefed below:

2.1" Glass Fibre Reinforced Concrete to study the Properties of the Concrete"
Md.Abid Alam (2015)

For experiment Cem-Fil Anti-Crack, HD 12mm, Alkali Resistant glass fibre were used for the work. The specific gravity of the fibre is 2.68 mm and the length 12 mm. For the experimentation, M-20 and M-30 Grade concrete is used under the proportioning procedure mentioned under IS 10262-2009. For M20 grade of concrete 0.50 W/C Ratio is used and for M-30 Grade of Concrete 0.42, W/C Ratio is used. Fibre is added in an increment of 0.02% from 0% to 0.06%. (0%, 0.02%, 0.04%, 0.06%). And according to the test result concrete attain higher strength that the target strength. An M-20 grade of concrete attains 41.28 Mpa of Compressive Strength and 5.76Mpa of Tensile Strength when 0.06% of fibre is added in concrete. And M-30 grade of concrete attain 62.29Mpa of Compressive strength and 7.17Mpa of Tensile Strength. Almost concrete attain 1 times of the target strength of the concrete.

2.2 "Conducted Durability Studies On Glass Fibre Reinforced Concrete"
Dr. P. Srinivasa Rao, 2015

The alkali resistant glass fibres were used to find out workability, resistance of concrete due to acids, sulphate and rapid chloride permeability test of M-30, M-40 and M-50 grade of glass fibre reinforced concrete and ordinary concrete. The durability of concrete was increased by adding alkali resistant glass fibres in the concrete. The experimental study showed that addition of glass fibres in concrete gives a reduction in bleeding. The addition of glass fibres had shown improvement in the resistance of concrete to the attack of acids.

2.3 "The Performance Of Glass Fibre Reinforced Concrete"
Yogesh Murthy 2015
The study revealed that the use of glass fibre in concrete not only improves the properties of concrete and a small cost cutting but also provide easy outlet to dispose the glass as environmental waste from the industry. From the study it could be revealed that the flexural strength of the beam with 1.5% glass fibre shows almost 30% increase in the strength. The reduction in slump observed with the increase in glass fibre content.

2.4 " Experimental Study On Behavior Of Steel And Glass Fibre Reinforced Concrete Composites"
Kavita Kene, 2012

The study conducted on Fibre Reinforced concrete with steel fibres of 0% and 0.5% volume fraction and alkali resistant glass fibres containing 0% and 25% by weight of cement of 12 mm cut length, compared the result.

2.5 "The Strength Aspect Of Glass Fibre Reinforced Concrete"
Avinash Gornale, 2012

The study had revealed that the increase in compressive strength, flexural strength, split tensile strength for M-20, M-30 and M-40 grade of concrete at 3, 7 and 28 days were observed to be 20% to 30%, 25% to 30% and 25% to 30% respectively after the addition of glass fibres as compared to the plain concrete.

IV. METHODOLOGY

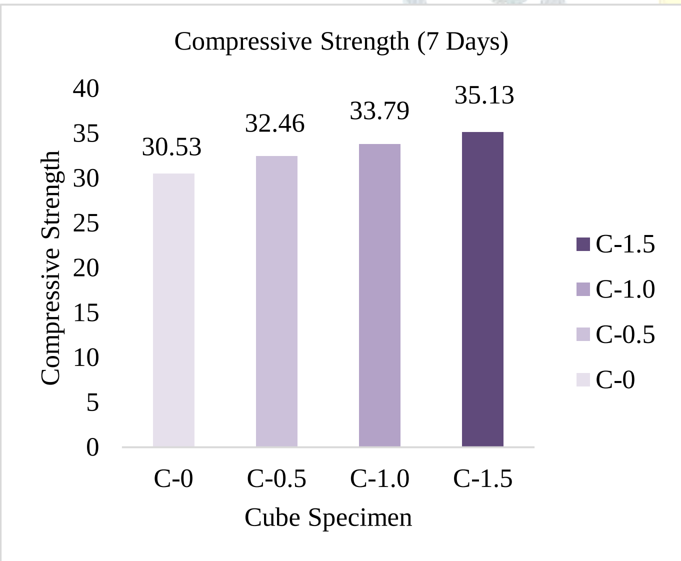
The experimental investigation was carried out in six phases. The first phase is to study of various properties of ingredients of concrete such as cement, sand, aggregate etc. The second phase is to design M-30 mix as per IS code method (IS 10262:2009). Addition of different percentage of glass fibres into the mixture of concrete is scheduled, from which optimum percentage of glass fibres available for experimental investigation was to be found out. The third phase addition of glass fibres in different proportion such as 0 %, 0.5 %, 1.0 % & 1.5 % at an increment of 0.5 %. The fourth phase preparation of 48 cubes for compressive strength of concrete for different proportion. The fifth phase preparation of 48 beams for flexural strength of concrete for different proportion of GF. The sixth phase to analyse the results based on experimental data. Specimens will be computed by conducting compressive and flexural strength tests into the laboratory.

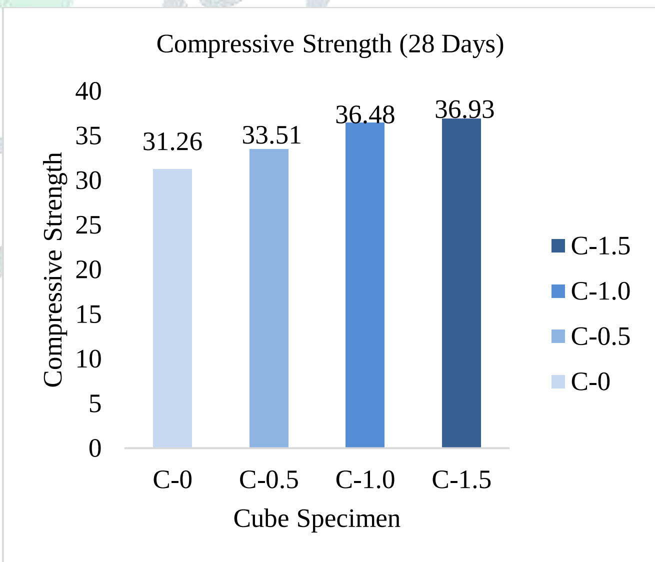
1. A mix design of M-30 grade concrete is adopted. Cubes were casted & cured for a period of 90 days. These cubes were tested for compression strength.
2. A total 48 number of cubes were casted by addition of glass fibres in different percentages into the concrete by volume, such as 0 %, 0.5 %, 1.0 % and 1.5% at an increment of 0.5%.
3. By adding different percentage of glass fibres into the concrete, its optimum percentage quantity will be obtained.
4. Further beam specimens were casted by using optimum percentage glass fibres and steel bars as a Glass Fibre Reinforced Concrete (GFRC). A total number of 48 beams were casted for flexural strength test. After the test, load-deflection data and flexural strength of different beams specimens was compared with normal concrete specimens.
5. A beam using glass fibre mesh is also casted of size 700 X 150 X 150 and tested for flexural strength.

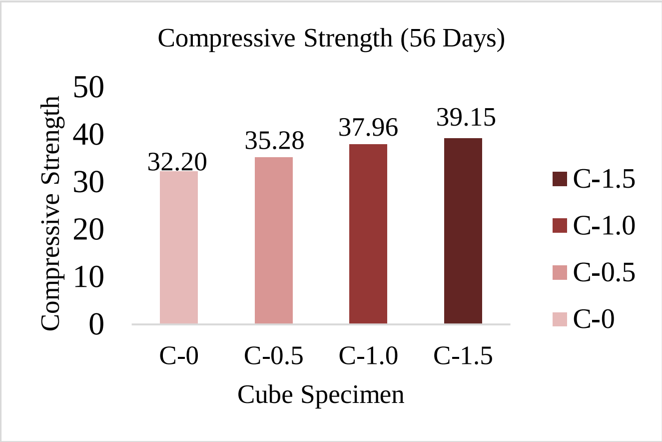
V. RESULT AND CONCLUSION

Table No-1: COMPRESSIVE STRENGTH

S.NO	M-30 + GF	Compressive Strength (N/mm^2)			
		7 days	28 days	56 days	90 days
1	0%	30.53	31.26	32.20	33.21
2	0.5%	32.46	33.51	35.28	37.21
3	1.0%	33.79	36.48	37.96	39.30
4	1.5%	35.13	36.93	39.15	41.36







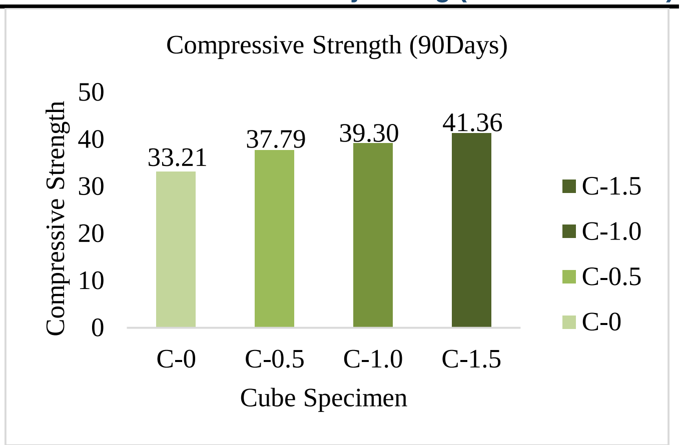
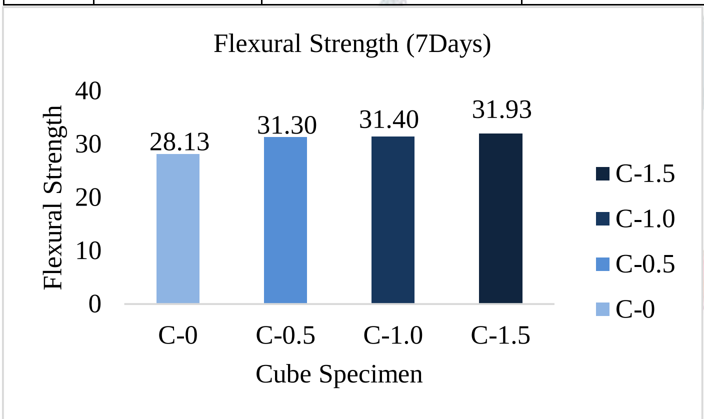
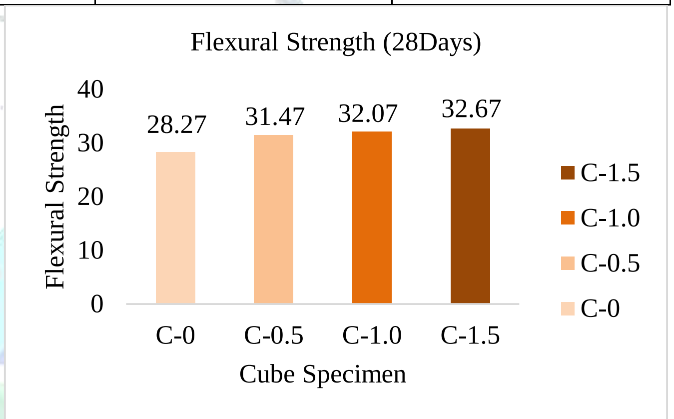
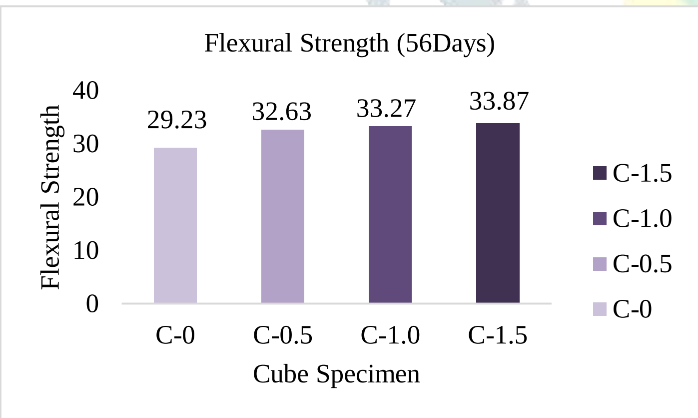


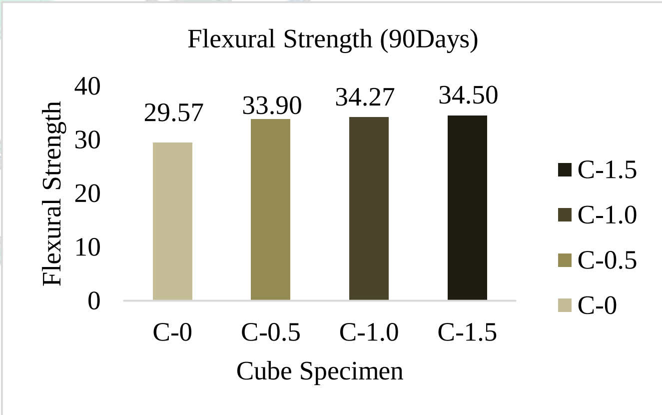
Table No-2: FLEXURAL STRENGTH

S.NO	M-30 + GF	Flexural Strength (N/mm^2)			
		7 days	28 days	56 days	90 days
1	0%	28.13	28.27	29.23	29.57
2	0.5%	31.30	31.47	32.63	33.90
3	1.0%	31.40	32.07	33.27	34.27
4	1.5%	31.93	32.67	33.87	34.50









CONCLUSION

The present experimental investigation was carried out to study behaviour of glass fibre reinforced concrete. In experimental work varying percentage of glass fibre content from 0.5 to 1.5 at an increment of 0.5 % by volume were added into the concrete. The main parameters evaluated in this study were compressive strength and flexural strength of glass fibre reinforced concrete. The following conclusions were drawn.

1. Based on the experimental analysis it has been found that adding glass fibre in concrete in different proportions there was gain in strength in all aspect of concrete like compression.
2. From the compression test, it has been observed that the maximum increase in compressive strength at 1.5% of glass fibre content into the concrete which was increased by 24.54% as compared to the control specimens.
3. The maximum compressive strength was obtained at 1.5 % glass fibre content mixed into the concrete.
4. A reduction in bleeding is observed by addition of glass fibers in the concrete mixes.
5. Addition of glass fibers reduces bleeding and it improves the surface integrity of concrete. Also it increases the homogeneity and reduces the probability of cracks.
6. From the results analysis of flexural strength test it has been observed that there is increase in flexural strength of 1.50 % specimen as compared to controlled specimen.

VI. FUTURE SCOPES

1. The glass fiber concrete is good in road construction, if it is used in road construction the number of joints will be less or reduce.
2. As total output of these properties one of the kay features of GFRC has been its versatility in use. GFRC is widely and reliably used in architecture i.e., cladding, mouldings, and buildings i.e., roofing, walls, windows, renovation, foundations and floors.
3. And permanent i.e., formwork, utilities, acoustics, bridges and tunnels, roads, water and drainage.

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