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A STUDY ON MECHANICAL PROPERTIES AND FLEXURAL BEHAVIOUR OF R.C. BEAMS WITH THE ADDITION OF HYBRID FIBERS

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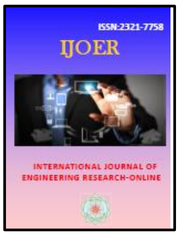

ABSTRACT

In India the concrete is the most widely using material for construction work and also the materials, for the production of the concrete is also available plenty in many areas and several locally available materials also proved as a best one for the production of the concrete. And also in present situations the researchers are also keeping interest on the improvement of concrete properties by adopting the various techniques in curing, compaction, and usage of admixture and fibers. With a connection to above discussed researches it has been carried a study on the flexural properties of the hybrid fibers incorporated concrete. As a part of this, it has been adopted the poly vinyl alcohol (PVA) fibers and glass fibers as the additive to the concrete. The reason behind the PVA fibers usage is that, in recent years it's usage in research is increasing significantly especially in china and Japan countries. And it is found that, in India the research work was limited to some extent because of its high cost of fibers. Generally PVA fibers are found to be alkali resistant and the similar properties were found in the glass fibers with this connection it has been chosen the PVA fibers and glass fibers in this research work.

In this study, the experimental work is done by finding the optimum percentage of the PVA fibers and glass fibers as well, By testing the specimens for compressive, split tensile strength and flexural strength and by considering the various percentages of fibre content viz.0%,1%,2%,3%,4%and 5%. And comparing the mechanical properties with the conventional concrete, here the conventional concrete is designed for M25 grade. After finding the results variation of compressive strength split tensile strength and flexural strength of RC beam were observed and conclusions were made.

1. INTRODUCTION

Concrete is considered a construction material with strong Heterogeneous behaviour, with a good compressive strength and a low tensile strength. Moreover, concrete has a low strain capacity and is brittle in fracture. The use of fibre reinforced concrete is currently of particular interest, especially in structures with high standards of performance and durability. The behaviour of these concretes is mainly conditioned by the binding matrix properties and by its interaction with the reinforcing fibres. The most common fibres capable of improving the properties of plain concrete are made of steel, glass or poly vinyl alcohol. During the middle age history, extensive research was in progress for the use of composite materials for concrete reinforcement. After, the use of asbestos for concrete reinforcement was discrete due to the detection of health risks. New materials like steel, glass, and synthetic fibers were replaced by asbestos for reinforcement. Active research is still in progress on this important technology. Fiber Reinforced Concrete is considered to be one of the greatest advancements in the construction engineering. It is an advantage of increased tensile strength and better fatigue strength.In hardened stage the fibers contribute to reducing the bleeding in fresh concrete & make the concrete more impermeable. Addition of some amount of % of fibers in concrete towards flexural strength is smaller compared to the strength given by the reinforcements. Generally fiber restricts the magnification of crack under load thereby arresting ultimate cracking load. Alkali-resistant glass fibers and synthetic fibers provide resistance against chemicals. Reinforcing capacity of fibers is based on length of fibers, diameter of fibers, the percentage of fibers and condition of mixing, orientation of fibers and aspect ratio are non-metallic materials. Aspect ratio is ratio of length of fibers to its diameter which plays an important role in the process of reinforcement.

2. LITERATUER REVIEW

G. JyothiKumari, et al[2] was studied the behavior of reinforced concrete beams with glass fiber reinforced polymer flats and it was observed that beams with silica coated Glass fiber reinforced polymer (GFRP) flats shear reinforcement have shown higher failure loads.KavitaKene, et al[1],was conducted experimental study on behaviour of steel and glass Fiber Reinforced Concrete. In this study it was conducted on Fiber Reinforced concrete with steel fibers of different percentages like 0% and 0.5% volume fractions of concrete and alkali resistant glass fibers with 0% and 25% by weight of cement of 12 mm cut length, compared the result. Durability studies on glass fiber reinforced concrete. Conducted by Dr. P. SrinivasaRao, et al.[3]S. H. Alsayed, et al[4] studied the performances of glass fiber reinforced plastic bars using as a reinforcing material for concrete structures. The study showed that the flexural load carrying capacity of concrete beams reinforced by GFRP bars can be estimated accurately using Review on the Performance of Glass Fiber Reinforced Concrete the ultimate design theory. The study also showed that as G.F.R.P bars having low modulus of elasticity. Deflection criteria were also controlled the design of intermediate and long beams reinforced with F.D.R.P bars. Yogesh Murthy, et al[5] studied the performance of G.F.R.C. The study showed that the usage of glass fiber in concrete not only improves the properties of concrete and a small cost cutting but also provides easy outlet to dispose the glass as environmental waste from the industry. Romualdi and Batson (1963)[6] published their classical paper on 'Mechanics of crack arrest in concrete'. They concluded that application of linear elastic fracture mechanics to reinforced concrete indicates that the relatively low tensile strength of concrete is not inherent to the material and can be avoided with suitable reinforcement arrangement. Gopalaratnam and shah (1986)[7] discussed the effect of strain rate on the flexure behaviour of unreinforced matrix and three different fibre reinforced concrete mixes. It was concluded that FRC is more sensitive than plain matrix and showing improvement in flexural strengths of 79, 99 and 111 percent over respective static flexural strengths for the 0.5, 1.0 and 1.5 percent (fibre volume content) composites (aspect ratio of 62.5) at identical loading rates. Also they have developed modified charpy instrument to conduct impact tests and results obtained by them were found to vary with conventional impact tests. Antonio Nanni (1988)[8] concluded that the splitting –tension test could be used to determine the tensile strength of fibre reinforced concrete commonly obtained with static flexural test. Also it was concluded that computation of first crack and ultimate crack is more convenient than that of flexural or direct tension test. Balaguru and Ramakrishnan(1988)[9] concluded that initial and final setting times of plain and fibre reinforced concretes were the same. Fibre concrete had lower slump & air- content and the rate of loss of these parameters with time was also higher. It was also observed that shrinkage of fibre concrete was slightly less but it underwent slightly more creep deformations. Bentur (1989)[10] reported that the use of alkali resistant glass fibres with silica fume was effective in improving durability performance of alkali resistant glass fibre reinforced cement composites (GFRC). KavitaKene,[10] et al conducted experimental study on behavior of steel and glass Fiber Reinforced Concrete Composites. The study conducted on Fiber Reinforced concrete with steel fibers of 0% and 0.5% volume fraction and alkali

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resistant glass fibers containing 0% and 25% by weight of cement of 12 mm cut length, compared the result. G. JyothiKumari[11], et al studied behavior of concrete beams reinforced with and observed that beams with silica coated Glass fiber reinforced polymer (GFRP) flats shear reinforcement have shown failure at higher loads.

3. MATERIALS AND METHODS

3.1. Ordinary Portland cement.

Portland cement is the most common type of cement in general use around the world, used as a basic ingredient of concrete, mortar, stucco, and most non-specialty grout. It developed from other types of hydraulic lime in England in the mid-19th century and usually originates from limestone. It is a fine powder produced by heating materials in a kiln to form what is called clinker, grinding the clinker, and adding small amounts of other materials. Several types of Portland cement are available with the most common being called ordinary Portland cement (OPC) which is grey in color, but white Portland cement is also available.

3.2 Sand.

Fine aggregate / natural sand is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by the size of the grains or particles, but is distinct from clays which contain organic materials. Sands that have been sorted out and separated from the organic material by the action of currents of water or by winds across arid lands are generally quite uniform in size of grains. Usually commercial sand is obtained from river beds or from sand dunes originally formed by the action of winds.

3.3. PVA fibers.

Table 1. Properties of PVA fibres

Type	PVA
Density	1.26
Length(mm)	12
Modulus of elasticity	42.8
Reduction in water	<2
Breaking elongation	<7-15
Normal strength	1620

Polyvinyl alcohol, were developed some 20 years ago by Kuraray, a Japanese company. When added to concrete or mortar, the fibers develop a molecular and chemical bond with the cement during hydration and curing. .Generally the fiber used in ECC is PVA, One of the remarkable characteristics of this fiber is capable of strong bonding with cement matrix. The layer of $Ca(OH)_2$ called as Interfacial transition zone is formed round PVA fiber It is known PVA makes complex cluster with the metal hydroxide of cement matrix. It is pursued that Ca^+ and OH^- two different ions in the cement slurry are attracted by PVA fibers and makes layer of $Ca(OH)_2$ around the fibers and hence the $Ca(OH)_2$ layer plays an important role for bonding strength between the fiber and the matrix

3.4. Coarse aggregate.

Coarse aggregate of size less than 10 mm i.e., passed through 10mm sieve and retained on 6.3mm sieve are taken. Because, if we add aggregate of larger size, then the crack width of concrete specimen increases and it cannot heal the cracks in presence of moisture.Two single sized crushed stone aggregates ranging from 12.5mm to 2.36 mm and 20 mm to 4.75 mm (10mm and 20mmsizes) were used in respective proportions in concrete mixes.

3.5. Glass Fibre

The glass fibers with the designation "Cem-Cem-Fil Anti-Crack, HD-12mm, Alkali Resistant glass fibres"were used throughout in this experimental work. The specifications of these fibres are presented in Table.

Table 2. Properties of Glass fibres

Physical Properties	Recommended values by the supplier
Specific gravity	2.68
Elastic Modulus (Gpa)	72
Tensile Strength (Mpa)	1700
Length (mm)	12

The current experimental study was carries by conducting Preliminary tests for mix design of concrete and the for M25 grade concrete. And the mix proportion is shown in table.

Table 3 Mix proportion of M25 grade concrete.

ingredients	quantities	proportion
Water	191.6 lit	0.45
cement	425.78kg	1
fine aggregate	563.71kg	1.323
coarse aggregate	1194.586 kg	2.805

Then cubes of size 150mmx150mmx150mm are castedand tested for compressive strength.Similarly the cylinders of height 30 cm and 15 cm in diameter were casted and tested for the split tensile strength. And then RCbeams of size 700mmx150mmx150mm were casted and tested for flexural strength for different percentages of the PVA and glass fibre content viz. 0%, 1%, 2%, 3%, 4% and 5% after 28 days curing.Observing the effect of PVA fibre in various aspects on the concrete properties and determining the optimum % of PVA fibre content and glass fibre content. Examining the results obtained from compressive strength test split tensile strength test and flexural strength test.

4. RESULTS

The tests were conducted and the results were tabulated and the same are represented in the graphical form

Table 4.variation of compressive strength split tensile strength and flexural strength with % of fibres.

		compressive strength (MPa)		Split tensile strength (MPa)		Flexural strength (MPa)	
S.No	% of fibre	Glass fibre	PVA fibre	Glass fibre	PVA fibre	Glass fibre	PVA fibre
1	0	26.6	26.6	3.1	3.1	11.6	11.6
2	1	27.8	27.7	3.19	3.18	12.08	12
3	2	28.7	28.5	3.26	3.24	12.64	12.6
4	3	29.3	29.2	3.32	3.32	12.88	13
5	4	30.4	29.9	3.46	3.4	13.36	13.2
6	5	29	28.74	3.35	3.36	12.8	12.96

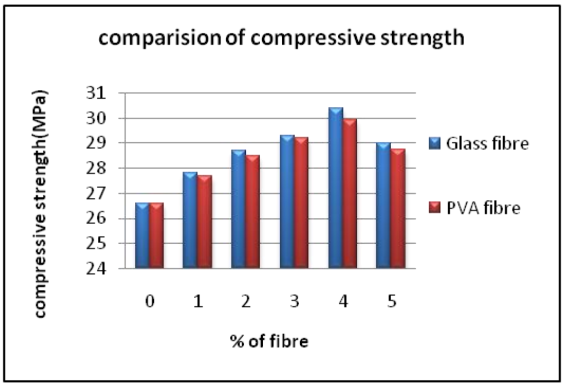

Figure 1.Variation of compressive strength.

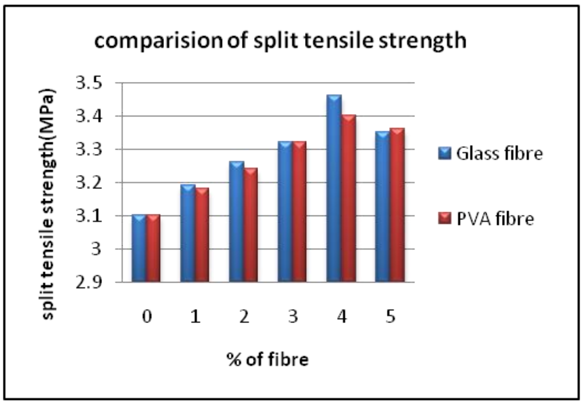

Figure 2.Variation of split tensile strength

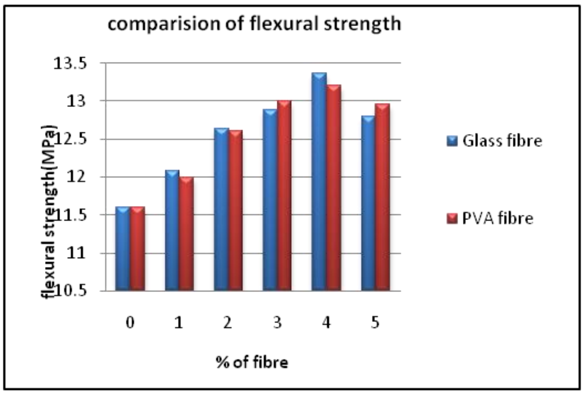

Figure 3.variation of flexural strength

5. DISCUSSIONS

From the above results the fallowing discussions were made

5.1. Percentage variation of compressive strength with percentage of fibres:

The compressive strength of concrete is increased by 4.51% for 1% addition of glass fiber, 7.89% for 2% addition of glass fiber, 10.15% for 3% addition of glass fiber, 14.28% for 4% addition of glass fiber and 9.02% for 5% addition of glass fibers than conventional concrete and The compressive strength of concrete is increased by 4.135%for 1% addition of PVA fiber, 7.14% for 2% addition of PVA fiber, 9.77% for 3% addition of PVA fiber, 12.4% for 4% addition of PVA fiber and 8.04% for 5% addition of PVA fibers than conventional concrete.

5.2. Percentage variation of split tensile strength with percentage of fibres:

The split tensile strength of concrete is increased by 2.9% for 1% addition of glass fiber, 5.16% for 2% addition of glass fiber, 7.09% for 3% addition of glass fiber, 11.6% for 4% addition of glass fiber and 8.06% for 5% addition of glass fibers than conventionalconcrete and the split tensile strength of concrete is increased by 2.58% for 1% addition of

PVA fiber, 4.5% for 2% addition of PVA fiber, 7.09% for 3% addition of PVA fiber, 9.67% for 4% addition of PVA fiber and 8.38% for 5% addition of PVA fibers than conventionalconcrete.

5.3. Percentage variation of flexural strength with percentage of fibres:

The flexural strength of concrete is increased by 4.13% for 1% addition of glass fiber, 8.96% for 2% addition of glass fiber, 11.03% for 3% addition of glass fiber, 15.17% for 4% addition of glass fiber and 13.44% for 5% addition of glass fibers than conventional concrete and The flexural strength of concrete is increased by 3.44 %for 1% addition of PVA fiber, 8.62% for 2% addition of PVA fiber, 12.06% for 3% addition of PVA fiber, 13.79% for 4% addition of PVA fiber and 13.10% for 5% addition of PVA fibers than conventional concrete.

6. CONCLUSIONS

For the addition of glass fibers, the compressive strength of concrete is increased for a maximum of 14.25%, the split tensile strength of concrete is increased for a maximum of 11.6% and the flexural strength of concrete is increased for a maximum of 15.17% when compared with conventional concrete.For the addition of PVA fibers, the compressive strength of concrete is increased for a maximum of 12.4% , the split tensile strength of concrete is increased for a maximum of 9.67% and the flexural strength of concrete is increased for a maximum of 13.79% when compared with conventional concrete. The usage of fiber in the concrete matrix gives the better performance in all aspects due to the bridging action and high tensile properties of fiber.

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