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Fracture Study of Glass and Polypropylene Hybrid Fiber Reinforced Concrete

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Abstract: Concrete is a composite material used for construction worldwide. the presence of cracks and pores inside concrete material is inevitable and it is necessary to investigate if they are stable or not. Reinforcement of concrete with randomly distributed short fibres may improve the toughness of cementitious matrices by preventing or controlling the initiation , propagation of cracks. Hence problems related to fracture are vital in concrete. Fracture study assesses the ductile behaviour of concrete structures under loading using various fracture parameters.

The present study aims to finding out the effect of two non metallic fibre (AR Glass fibre and Polypropylene fibre) in fracture properties of hybrid fibre reinforced concrete by varying the percentage of each fibre content in the mix and compare the results of each mix with control mix. The total dosage of fibres is maintained at 0.5%, primarily from point of view of providing good workability. Three point bending test on notched beams were conducted for determination of fracture parameters. The tests were done as per the guidelines of International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM). Hybrid fibre reinforced concrete can be used in bridge, tunnel linings, building components like column, beams, slabs, sandwich structure like steel concrete structure, industrial flooring, machine foundation.

***Keywords**: AR Glass fibre, Polypropylene fibre, Fracture parameters, Notched beams, Three point bending tests.*

I. INTRODUCTION

Concrete is strong in compression and weak in tension. In order to make concrete capable of carrying tension at strains greater than those at which cracking initiates, it is necessary to increase the tensile strength. To increase the tensile and flexural strength, fibres are added in concrete. The role of fibres are essentially to arrest any advancing cracks by applying punching forces at the rack tips, thus delaying their propagation across the matrix. Reinforcing capacity of fibre is based on length of fibre, diameter of fibre, the percentage of fibre and condition of mixing, orientation of fibres and aspect ratio. Aspect ratio is ratio of length of fibre to its diameter which plays an important role in the process of reinforcement. Hybrid fibre reinforced concrete is use of two or more than two fibres in a single concrete matrix. Fracture is defined as the separation of a component into, at least, two parts. The most common applications of hybrid fibre reinforced concrete are pavements, tunnel linings, slabs, shotcrete, airport pavements, bridge deck slab repairs, and so on.

Here an attempt was made to study the fracture behaviour of normal concrete when its characteristics was modified by adding Alkali Resistant (AR) glass and polypropylene fibres in varying volume fractions. The total dosage of fibres was maintained at 0.5% of volume of concrete, primarily from the point of view of providing good workability.

II. EXPERIMENTAL PROGRAMME

A. Methodology Adopted

The experimental study consist of testing constituent materials and preparing a normal strength concrete of grade M25. Fibres used were ARglass and polypropylene fibre having an aspect ratio of 1200 and 120 respectively.

The fibre were added in volume fractions from 0% to 0.5%. The experimental programme consist of three point bending test on notched beam specimens of size 500x100x100 mm with notch size of 30 mm for all the mixes with an effective span of 400 mm.

The test is conducted as per the guidelines of RILEM(The international union of laboratories and experts in construction material, system and structures).

The details of the specimen for the fracture test are shown in Fig 1. During testing, the deflection was noted using dial gauge.

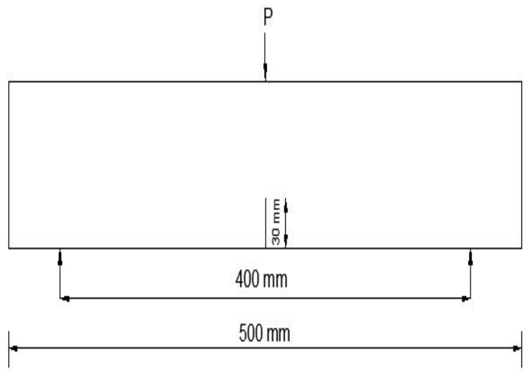

Fig 1 Details of the specimen for the fracture test

Fracture parameters such as fracture energy, fracture toughness and ductility were determined in this paper. The fracture parameters were determined using the formulae given by the technical committee RILEM. Fracture energy (G_F) is determined by the equation (1):

$$G_F = \frac{W_0 + 2mg\delta_0}{t(b-a)} \quad (1)$$

Where, G_F - Fracture energy (N/m)

W_o- Area under the load-deflection curve (Nm)

δ_0 - displacement corresponding to the maximum load (m)

m - weight of the beam between supports (N)

t - width of the beam (m)

b - breadth of the beam (m)

a - initial notch of the beam (m)

According to the RILEM, the fracture toughness K_{IC} is calculated by the equation (2):

$$K_{IC} = \frac{3PS\sqrt{\pi a}}{2bd^2} \quad (2)$$

Where, K_{IC} - fracture toughness (MPa√m)

P_{max} - peak load + self weight of the beam (N)

S, d and b are the span, depth, and width in mm, respectively of the testing beam

f(α) is geometry factor, which depends on the ratio of the initial crack length/notch depth (a) to the depth (d) of the beam. f(α) can be written as shown in equation(3):

$$f(\alpha) = \frac{[1.99 - \alpha(1-\alpha)(2.15 - 3.93\alpha + 2.7\alpha^2)]}{\pi(1+2\alpha)(1+\alpha)^{3/2}} \quad (3)$$

Where, { α = a/d }.

III. MATERIALS USED

The materials used for the study are ordinary Portland cement of grade 53, locally M sand used as fine aggregate, coarse aggregates of 20 mm, 12.5 mm and 6 mm, glass and polypropylene fibres of 12 mm length and 0.01 mm and 0.1 mm diameters respectively were

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used, Master sky Glenium 8233 as super plasticizer and water of drinking quality. The properties of cement and aggregates are shown in Table 1 and 2 respectively. Grading curve for fine aggregate were shown in fig 2. Mix design of M25 grade concrete was carried out as per IS 10262-2009. The mix was confirmed based on a slump of 90 mm and 7thday cube compressive strength of 19MPa.

Table 1 Properties Of Cement

Sl.No.	Properties	Value
1	Specific gravity	3.125
2	Standard consistency	36%
3	Initial setting time (in minutes)	70

Table 2 Properties Of Aggregates

Properties	Fine aggregate	Course aggregate		
		20 mm	12 mm	6 mm
Specific gravity	2.64	2.84	2.85	2.83
Fineness module	3.62	-	-	-
Grading zone	II	-	-	-

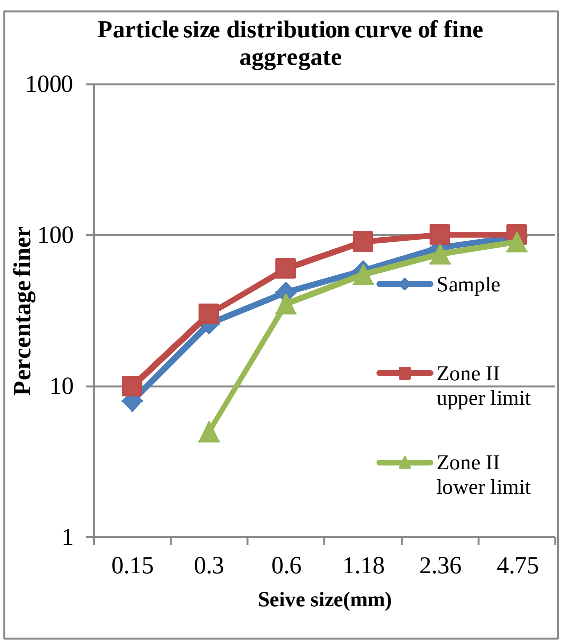

Fig 2 Grading curve for fine aggregate

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The final mix arrived and mix designation is shown in Table 3 and 4 respectively.

Table 3 Concrete Mix

Details of mix proportion	1:1.88:3.55:0.45
Cement content	372.11 kg/m^3
Fine aggregate content	813.37kg/m^3
Coarse aggregate content	1247.16 kg/m^3
Water - cement ratio	0.45

Table 4 Mix Designation

S L.NO.	Mix designation	Volume fraction of fibre	
		AR Glass fibre (%)	Polypropylene fibre (%)
1	C0	0	0
2	CG	0.5	0
3	CP	0	0.5
4	CGP1	0.12	0.38
5	CGP2	0.38	0.12
6	CGP3	0.25	0.25

A. *Casting of specimens*

The moulds for the beam specimen were prepared. Fig 3 shows the notched beam for fracture test. Specimens with and without fibres were cast for conducting fracture test. Three specimens were cast for each mix. The concrete beam specimens were left without disturbance until it attained a hardened state.

The notch apparatus were removed after 2 hours and the specimens were immersed in water for a period of 7 days.

Fig 3 Notched beam

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B. Fracture test

The specimens were subjected to three point bending under simply supported end condition. The deflection was noted using dial gauge. The Fracture test loading arrangement are shown in fig 4.

Fig 4 Fracture test loading arrangement

IV. RESULTS AND DISCUSSION

Three point bending test was carried out on beams having 100x100 mm cross section and an effective span of 400 mm to determine the fracture parameters. The results were obtained are the average of the three test results.The addition of AR Glass and polypropylene fibres affects the fresh properties of concrete and was measured using slump test. The slump values were obtained are presented in table 5.

Table 5 Slump Values

Mix designation	Slump value(mm)
C0	90
CG	87
CP	88
CGP1	85
CGP2	82
CGP3	80

The fracture parameters such as fracture toughness, fracture energy and also the ductility were determined. Table 6 shows the fracture energy, fracture toughness. Table 7 shows Ductility results. Fig 5 and 6 shows fracture energy and fracture toughness for various hybrid fibre concrete.

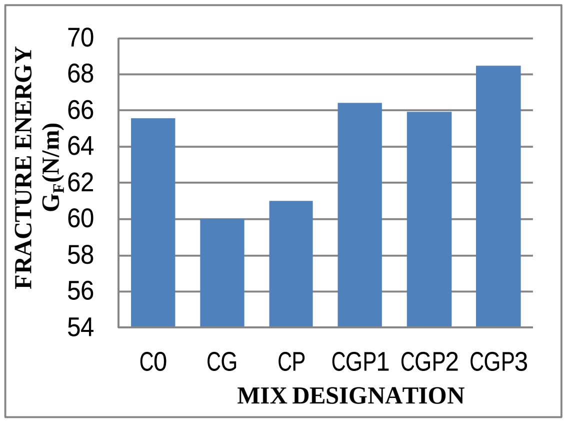


Fig 5 Fracture energy for various hybrid fibre concrete.

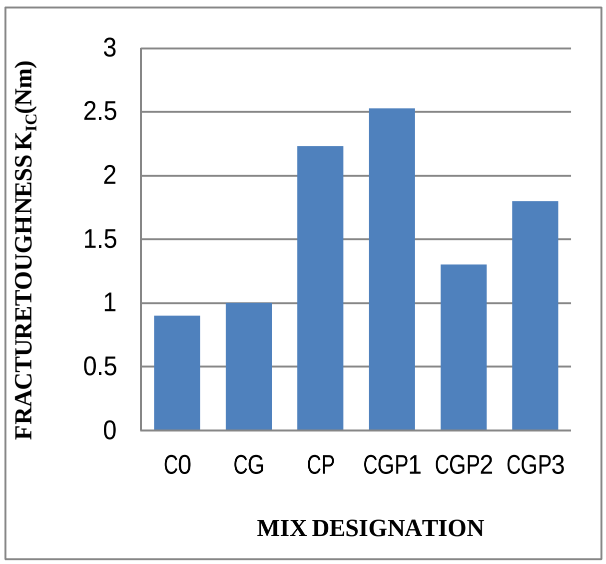


Fig 6 Fracture toughness for various hybrid fibre concrete.

Table 6 Fracture Energy And Fracture Toughness

Mix designation	Fracture energy(N/m)	Fracture toughness(Nm)
C0	65.55	0.90
CG	60.00	1.00
CP	61.02	2.23
CGP1	66.40	2.53
CGP2	65.90	1.30
CGP3	68.50	1.80

Table 7 Ductility Results

Deflection corresponding to ultimate load(δu)(mm)	Deflection corresponding to yield load(δy)(mm)	Ductility(δu/δy)
0.21	0.07	3.00
0.25	0.06	4.10
0.36	0.08	4.50
0.49	0.09	5.44
0.50	0.09	5.55
0.54	0.05	10.8

V. CONCLUSION

A. The concrete mix of M25 grade was designed with a maximum aggregate size of 20 mm. The effect of fibre content on the fresh properties of concrete was studied. The main objective of the study was to explore the influence of AR Glass fibre and polypropylene fibres on fracture behaviour of concrete beams. From the results obtained following conclusions were arrived. As the polypropylene fibre content increases fracture toughness also increases and above 0.38% of polypropylene fibre fracture toughness starts to decrease.

B. The hybrid combination 0.12% AR Glass fibre and 0.38% polypropylene fibre (CGP1) shows 64.42% increase in fracture toughness than C0 and for 0.25% AR Glass fibre and 0.25% polypropylene (CGP3) 50% increase in fracture toughness than C0.

C. Among all mix hybrid combination CGP3 fibre shows high fracture energy.

D. For hybrid combination CGP3 ductility seems to be increased by 72.22% than C0.

E. This increase in ductility and fracture energy is due to ability of non-metallic fibre in bridging smaller micro-cracks .This bridging action increases the load carrying capacity of hybrid fibre reinforced concrete.

F. Among all hybrid combination, CGP3 mix (0.25% AR Glass fibre and 0.25%Polypropylene fibre) performed better in all respects compared to other hybrid combination.

REFERENCES

[1] C.X.Qian and P. Stroeven, Development of hybrid polypropylene,Journal of Cement and Concrete Composites 30 (2000)63–69

[2] Chunxiang Qian and Piet Stroeven, Fracture properties of concrete reinforced with steel-polypropylene hybrid fibers, Journal of Cement and Concrete Composites 22 (2000)343-351

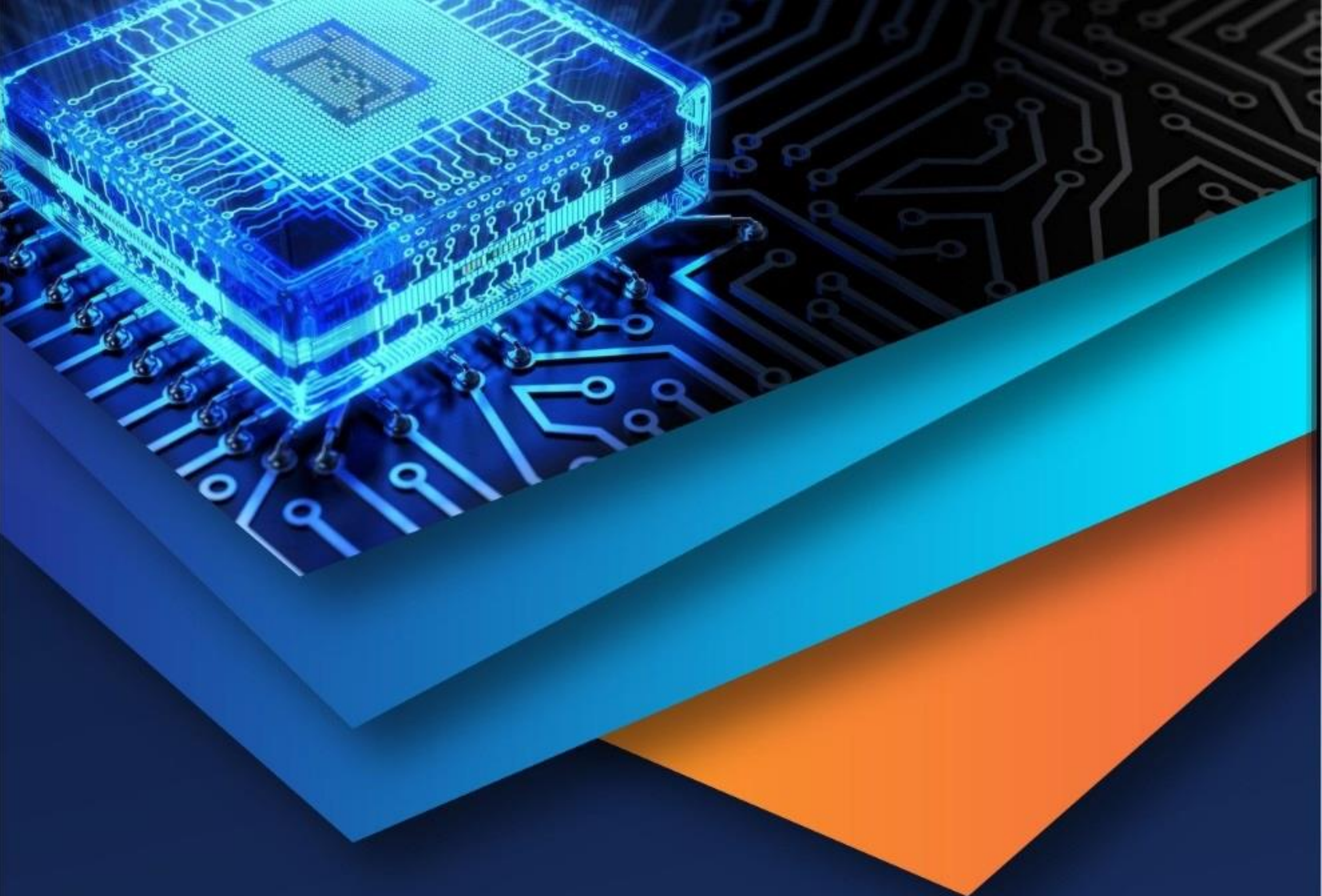
[3] Wu Yao, Jie Lib, Keru Wu, Mechanical properties of hybrid fibre-reinforced concrete at low fibre volume fraction, Journal of Cement and Concrete Research 33 (2003)27–30

[4] Sivakumar, Manu Santhanam, Mechanical properties of high strength concrete reinforced with metallic and non-metallic fibers, Journal of Cement and Concrete Composites 29 (2007)603-608

[5]]F. Bencardino L. Rizzuti , G. Spadea,R.N. Swamy, Experimental evaluation of fibre reinforced concrete fracture properties, Journal of Composites Part B 41(2010)17–24.

[6] Piotr smarzewski and Danutabarnat-Hunek, Fracture properties of plain and steel-polypropylene-fibre-reinforced high-performance concrete, Journal of Cement and Concrete Composites (2015)343-351.

[7] Tarek Almusallam S.M. Ibrahim, Yousef Al-Salloum, ArefAbadel, Husain Abbas, Analytical and experimental investigations on the fracture behavior of hybrid fibre reinforced concrete,Journal of cement and concrete composites 74(2016) 201-217



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