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Impact Response of Partially Replaced Anti- Crack Glass Fiber as Fine Aggregate in Concrete

E. Vinodha[1], K. Saravanan[2], M. Hari Haran[3], J. Augustin Raj[4], K. Vignesh[5], E. Mathiyazhagan[6]
[1, 2]*Assistant Professor, Department of Civil Engineering, Indra Ganesan College of Engineering, Tamil Nadu, India.*
[3, 4, 5, 6]*B.E Final Year Student, Department of Civil Engineering, Indra Ganesan College of Engineering, Tamil Nadu, India.*

***Abstract:** The main objective of this research goal is to investigate the impact response of anti -crack glass fiber as fine aggregate in concrete under drop weight impact test. In this study, Anti crack glass fiber is used in the ratio of 0%, 2%, 4% and 6% in the weight of fine aggregate in concrete matrix. Water Cement ratio was 0.42 for compressive test and drop weight impact test. Four slabs were casted in the dimension of 500mmX500mmX50mm and 6mm diameter steel bars were used with 90mm center to center spacing. The Impact testing machine was self-fabricated. The test results indicate the failure pattern of the slab by visible observation of First crack and final crack occur in the slab. The cracks length, width, depth were observed in every blows.*
***Keywords:** Anti Crack Glass fiber, Drop weight Hammer, First Crack, Final Crack, Impact test.*

I. INTRODUCTION

Now a day, the research on control the crack on concrete are plays a main role in research. Cracks on concrete have a several reasons such as temperature, elongation, durability, bonding etc. [10], [2]. Fibers play a main role in the reduce the cracks compare to other sources [2]. Anti-crack Glass fiber reduces the crack and gives high compressive strength compare to conventional concrete [5]. The cracks are in many types such as micro and macro cracks [2], [1]. Impact gives the sudden shock on the concrete in a short period of time. It is relationship with velocity of the material. The crack resistance of the slab can be calculated by measuring the length, width and depth of the crack. The width of the crack is hair line thickness [1]. According to Kariappa and shete, 2016, Glass fiber reinforced concrete is not a new material; it has been used over past 50 years especially in architectural cladding panels, domes, Planters and statues. The first GFRC pedestrian bridge was constructed in Israel since 1975 and then after it is used in North America, Asia and Europe. According to Jiff Girard (CCI), 2013, Anti-Crack Glass fibers act as the principle tensile load carrying member while the polymer and concrete matrix binds the fibers together and helps transfer loads from one fiber to another.

II. EXPERIMENTAL CAMPAIGN

A. Material Used and Properties of the Material

OPC 53 grade cement, fine aggregate size of below 2.36mm, coarse aggregate were used. Cement had specific gravity 3.56; Fine aggregate had specific gravity 2.6, fineness modulus 2.2 and water absorption 2.2%. Course aggregate had specific gravity 2.59, water absorption 2.1%. Super Plasticizer was Polycarboxylate Ether 0.1% of weight of cement was used which is ordered from TECHNY CHEMY, in Tiruchirapalli, Tamil Nadu. Anti-Crack Glass fiber added in the ratio of 0%, 2%, 4% & 6% by the weight of fine aggregate. Water cement ratio is 0.42.

B. Physical and Mechanical Properties of Anti Crack Glass Fiber

The studies Anti Crack Glass Fiber from Chemzest Enterprises, Chennai,TamilNadu. It's had length of 6mm, diameter of 11micron

Table 1: Physical and mechanical properties of anti-crack glass fiber

Density	2.68g/cm^3
Tensile Strength	3000Mpa
Tensile modulus	73000Mpa

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C. Mix Design and Fabrication of Concrete

For compressive strength 150x150x150mm specimen was used. Impact test for slab specimen size of 0.5x0.5x0.05m with 90mm center to center spacing and provide 6mm diameter of bars in main reinforcement and distribution reinforcement as shown in Figure1. The mix design done as per Indian Standards IS10262:2009.

Fig.1: Reinforcement Details for Slab

Table 2:Mix Design

Materials	Quantity (kg/m^3)
Cement	492
Fine Aggregate	780
Coarse Aggregate	992

D. Impact Test

The drop weight impact machine was self-fabricated with the height of 1m and drop hammer weight (steel ball) was 4.5kg. The slab is placed in the base plate. The slab is subjected to simply supported, the four sides are not clipped. The drop weight hammer was permitted for free fall on the concrete slab at center point on the slab. Number of blow was noted and observes the first crack and final crack in the specimen and also measures the crack length, width and depth for every blow to calculate the crack resistance of the concrete.

Fig.2: Self-Fabricated Impact Instrument

III. RESULT AND DISSCUSSION

A. Compressive Strength of the Concrete

After casting the concrete, the specimens are in rest for 24hrs, and then proceed to 28 days of curing to attain strength. F0 represents 0% Anti Crack Glass Fiber in the concrete matrix, F2 represents 2% Anti Crack Glass Fiber was added by the weight of Fine Aggregate. Similarly, F4 and F6 represent 4% and 6% of Anti Crack Glass Fiber added by the weight of fine aggregate in the concrete matrix. F0, F2, F4 and F6 had the compressive strength of 30.22N/mm^2, 34.8 N/mm^2, 27.37N/mm^2 and 25.68 N/mm^2. Compare to the F2, other mix ratio was lower strength. F2 mix was the higher compressive Strength.

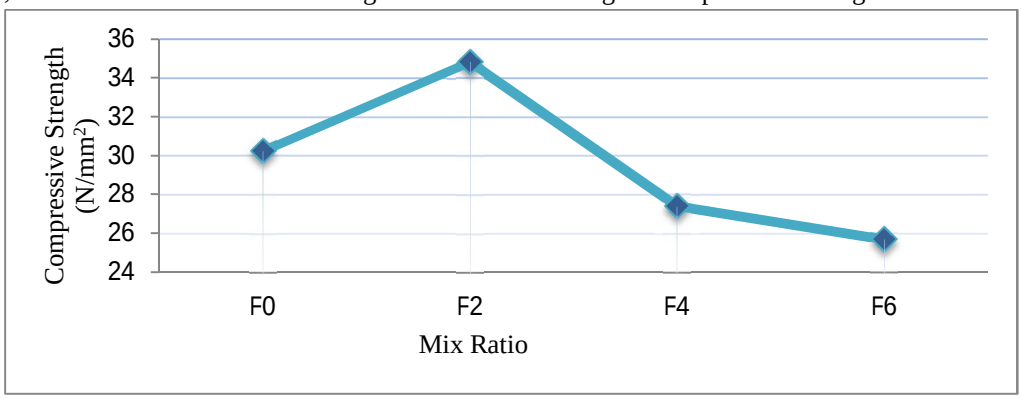

Fig.3: Compressive Strength (N/mm^2) after 28days of curing

B. Impact test on Slab and Crack Resistance

The drop weight hammer is free fall from 1000mm height as shown in figure 2. The slabs are simply supported at the ends. The impact energy is calculated by statically [2], [4]. The first crack and final cracks are observed visually. From the experimental surveillance, F0 concrete gives low impact energy than others; also have minimum crack with minimum blows and length of the crack also long, wider than fiber concrete matrix. F2 concrete matrix have higher impact energy ratio with six number of crack and also resists more blows. F2 has more cracks compare to other concrete matrix but impact resistance is high. F4 resist more cracks but blows are minimum compare to F2 concrete. F6 resist more cracks and minimum number of crack and crack length, width of cracks also minimum compare to other matrix but has minimum blows compared to F2 and F4. Impact energy formula,

Impact Energy U = mxgxHxN -------- (1)

m = Mass of the drop weight hammer (kg),

g = Acceleration due to gravity (m/s^2)

H= height of free fall of steel ball (m)

N= Number of blows for First and Final Crack

The ultimate crack resistance concrete Ru,

Calculation,

Impact Energy U= 4.5x9.81x1x10 = 485.6 N-m

Ultimate crack resistance,

$Ru = \frac{U}{Lc\ x\ dc\ \ x\ wc}$ ------- (2)

U = Impact Energy of First Crack N-mm

Lc = Maximum length of Crack, mm

dc = Depth of the crack, mm

wc = Maximum width of the crack, mm

$Ru = \frac{485600}{315x\ 50\ \ x\ 1}$ = 30.83N/mm^2

The crack resistance of the concrete matrix Cr,

$Cr = \frac{Ru}{fcu}$ ------ (3)

Ru = ultimate crack resistance concrete (N/mm^2)

fcu = Compressive strength of concrete (N/mm^2)

$Cr = \frac{30.83}{30.22}$ = 1.02 (No Unit)

C. Failure Pattern

F0 had low impact resistance and crack resistance ratio. F0 has two crack and failure in minimum blow compare to other anti- crack fiber ratio slab. F2 has many numbers of cracks and give maximum impact Energy.F2 given many crack to indicate the failure. F2 and F4 had only 4 cracks but, failure is quickly happened in F4 compare to F2. F6 had developed only two cracks but failure in 55th blow and has resist minimum blow, failure is happened suddenly with minimum number of crack.

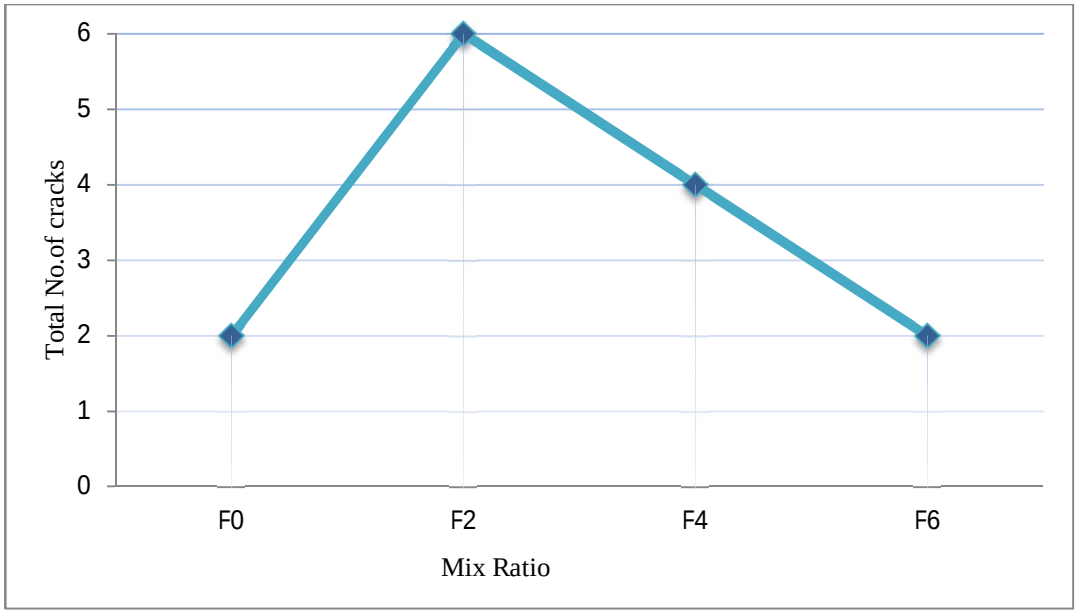

Fig.4: Total no. of cracks in slab up to ultimate failure

D. Maximum Crack Length Details

F0 has only 2 cracks, in that the maximum crack length is 315mm and width is1mm.Compare to other the concrete matrix F0 has max. Crack length and width. F2 has 300mm but it has high impact energy.F4and F6 had only 240and 235 mm lengths but it had sudden failure.F2 indicate the failure but F4and F6 are not indicate the failure before they fail.

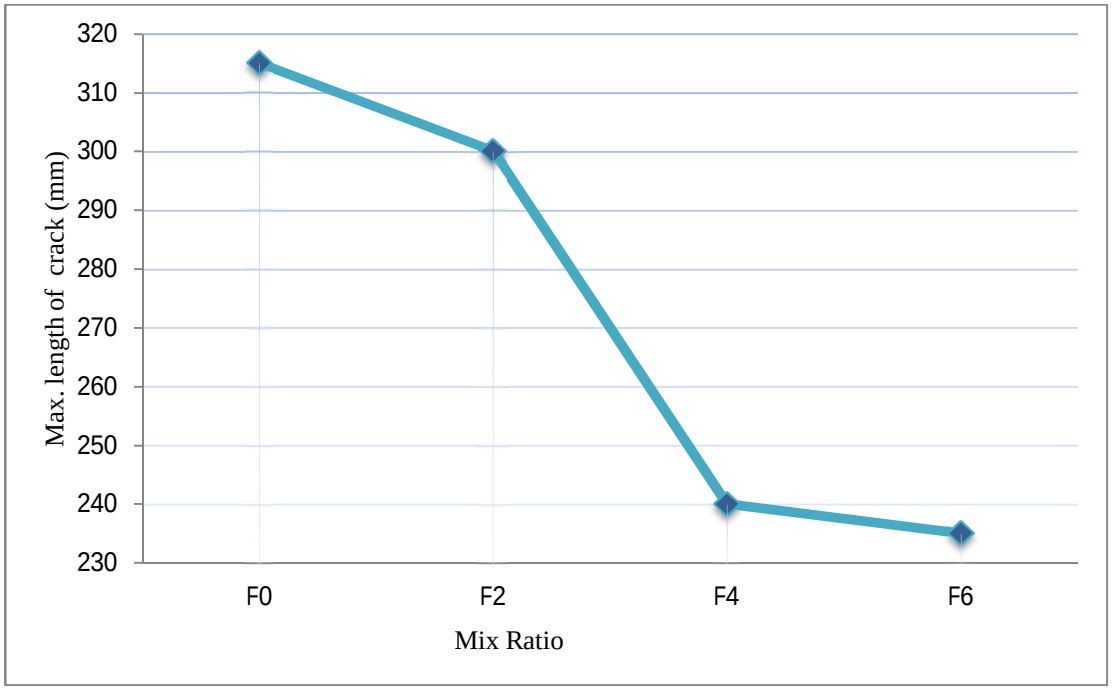

Fig.5: Maximum length of crack on slab up to ultimate failure

Ratio	No. of Blows		EI statics, N-m		No. of cracks up to Final blows	Max. crack depth (dc),mm	Max. crack length (lc),mm	Max. crack width (wc), mm	Ultimate crack Resistance (Ru), N/mm^2	Crack Resistance Ratio (Cr), N/mm^2
	First Crack	Final Crack	First Crack	Final Crack						
F0	10	29	485.6	1408.2	2	50	315	1	30.83	1.02
F2	13	155	631.3	7526.7	6	50	300	0.5	84.17	2.418
F4	9	68	582.7	3002	4	50	240	0.5	97.11	3.548
F6	12	55	437.0	2661.4	2	50	235	0.5	74.38	2.89

Table 3: Impact Energy, Ultimate Crack Resistance, Crack Resistance Ratio Details

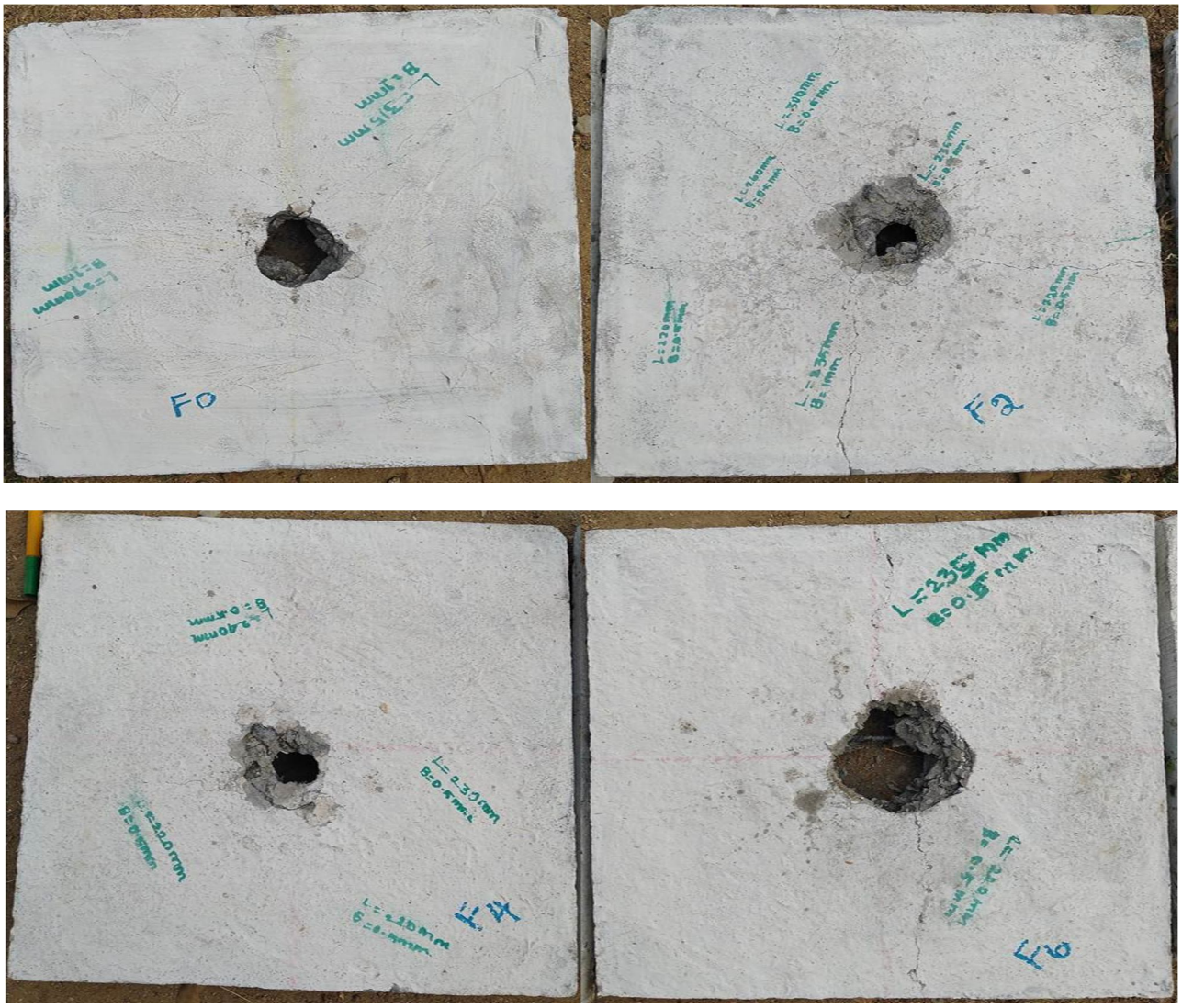

Fig.7: Impact Failure Pattern of Slab with Crack Details

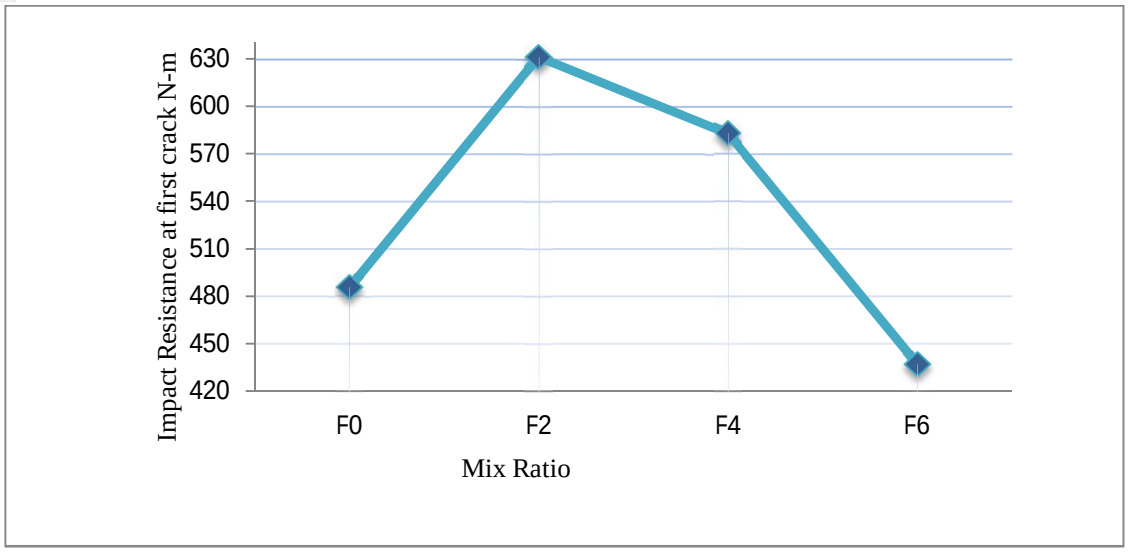

Fig.7: Impact Resistance at first crack in N-m

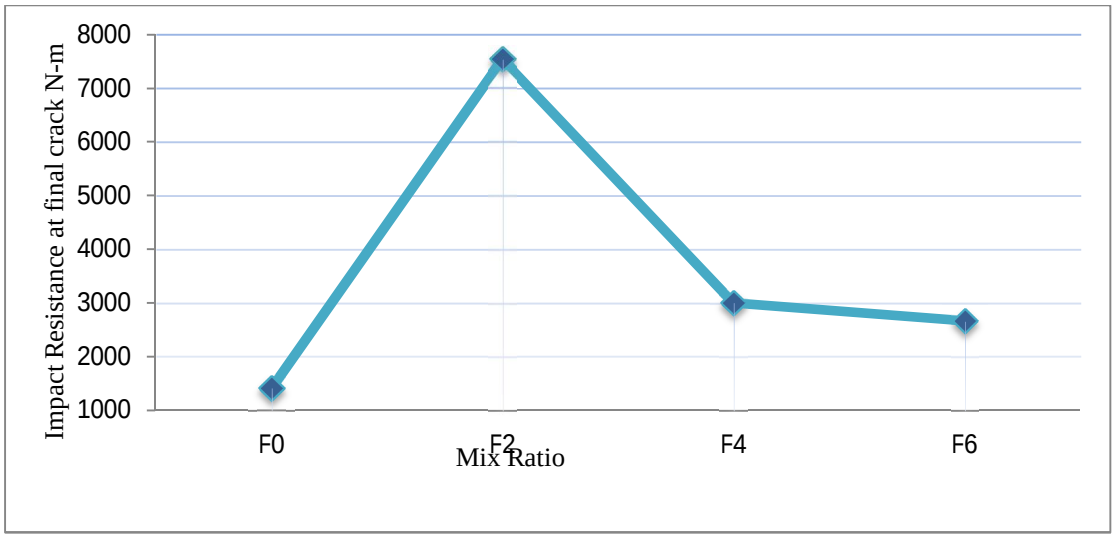

Fig.8: Impact Resistance at final crack in N-m

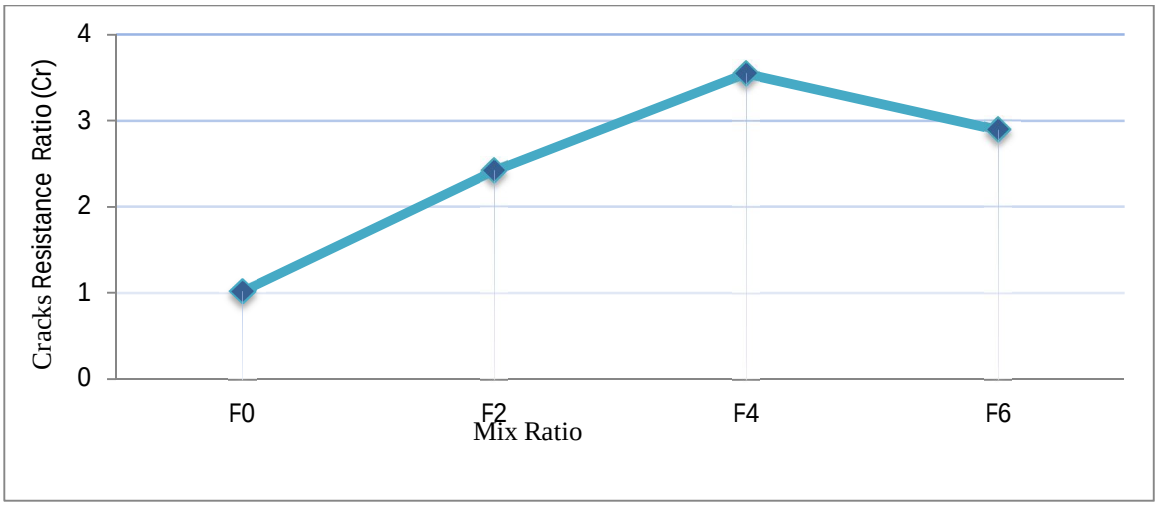

Fig.9: Crack Resistance Ratio (Cr)

IV. CONCLUSION

Based on the experimental test results, conclusions are drawn as follows:

A. As the result suggest,F2 gives maximum crack length compare to other fiber concrete matrix but F2 resist maximum impact energy compare to other concrete matrix.
B. F2 indicate the failure by forming a number of cracks in slab but other only for two or four hair line cracks and failure suddenly.
C. F4 has maximum crack resistance but impact energy is low compare to F2.
D. All the Anti-crack glass fiber plays good compare to conventional concrete. F2 has the maximum impact resistance and indicate the failure before ultimate failure by number of visible cracks.

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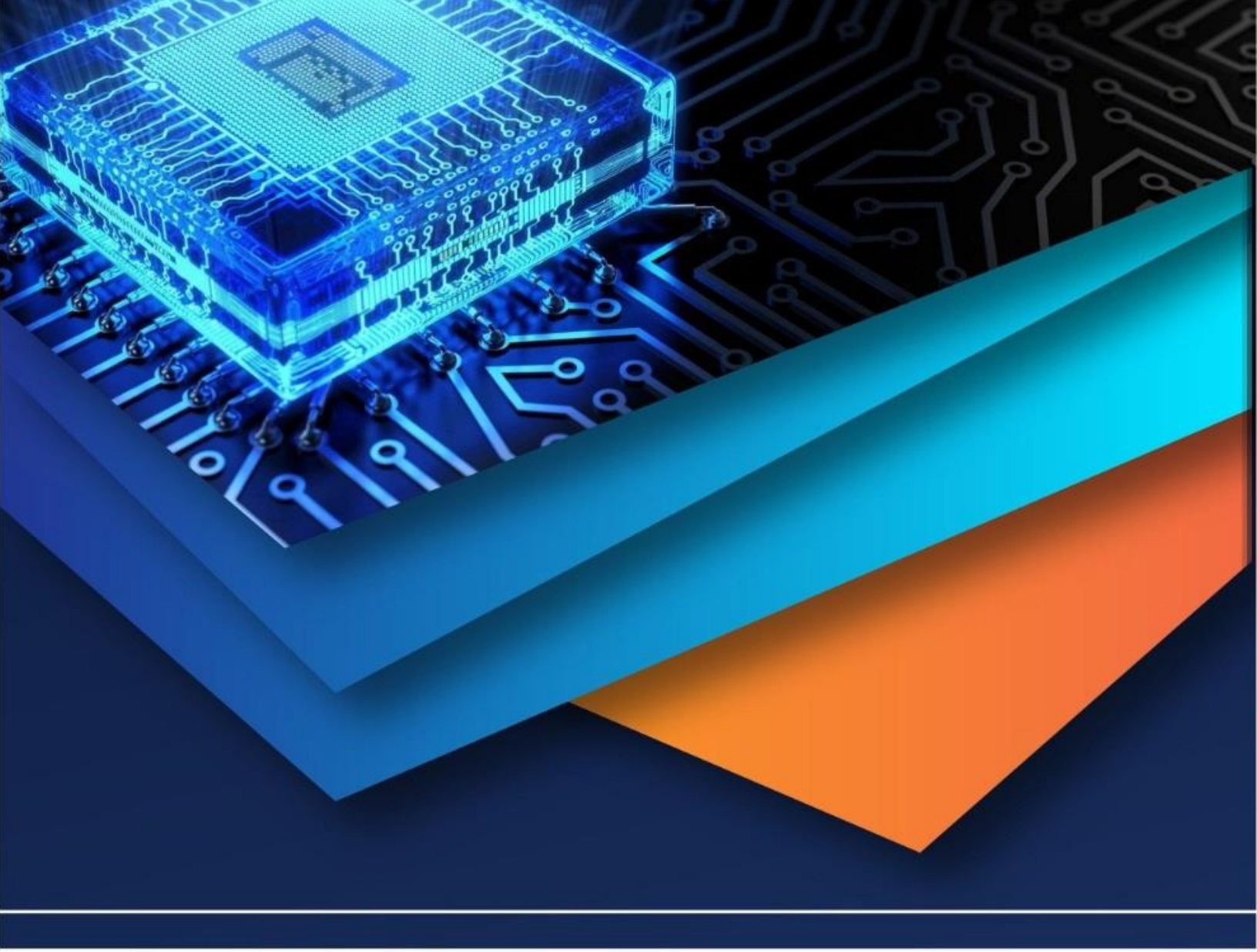

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