International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 5, July-August 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Study Effect of Optimized Hybrid Fiber on the Strength Characteristics and Structural Performance of the Concrete

Sumit Kumar[1], Deeksha Shrotriya[2]

[1]Research Scholar, [2]Assistant Professor,
[1,2]Department of Civil Engineering, LNCT, Bhopal, Madhya Pradesh, India

ABSTRACT

Hybridization is a process by which two or more kinds of fiber are blended appropriately so as to produce hybrid fiber. Hybrid fibers when inducted in concrete add greater value to the concrete. The selection of hybrid fiber is based on fiber response, fiber dimension, and fiber function. A combination of long fiber and short fiber enhances the ductility of concrete to a greater extent by way of reducing the formation of micro cracks and macro cracks in the concrete. Short fibers bridge the micro cracks and thereby increase the tensile strength of concrete. Long fibers block the propagation of macro cracks and thereby increase the tensile strength of concrete. In accordance with fiber constitute response, one type of fiber should be stronger and stiffer to meet the first crack stress and improve the ultimate strength of concrete, whereas the second type of fiber should be more flexible and ductile to improve the toughness and strain capacity in the post-crack zone.

***KEYWORDS:** hybrid fiber, concrete, tensile strength, stiffer, ultimate strength*

How to cite this paper: Sumit Kumar | Deeksha Shrotriya "Study Effect of Optimized Hybrid Fiber on the Strength Characteristics and Structural Performance of the Concrete" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-5, August 2022, pp.1340-1342, URL: www.ijtsrd.com/papers/ijtsrd50635.pdf

IJTSRD50635

INTRODUCTION

Fibers distributed randomly in concrete serve as reinforcement and can resolve problems like concrete becoming brittle and development of cracks in concrete. Development of cracks is an indication of low resistance shown by the concrete. Addition of fibers in concrete is one of the solutions toaddress the problem of crack growth in both plastic stage and hardened stage of concrete. Fibers in concrete enhance the ductility performance, post-crack tensile strength, fatigue strength, and impact strength of concrete structures.

As the fibers are distributed randomly, the strength properties of concrete are improved in all directions. A normal concrete matrix is infirm. When it is reinforced with individual fibers uniformly distributed across the whole concrete mass, it becomes strengthened; the fiber reinforced concrete mass behaves as a composite material with properties significantly different from that of normal concrete. Kinds of fibers that are commonly used in fiber reinforced concrete are polypropylene-, nylon-, polyester-, glass-, carbon-, and steel-fibers. Application of each kind of fiber is wide-ranging. Suitable kind of fiber has to be selected for incorporation in fiber reinforced concrete to get maximum benefits. Using a single type of fiber may improve the properties of fiber reinforced concrete to a limited level only.

Hybridization is a process by which two or more kinds of fiber are blended appropriately so as to produce hybrid fiber. Hybrid fibers wheninducted in concrete add greater value to the concrete. The selection of hybrid fiber is based on fiber response, fiber dimension, and fiber function. A combination of long fiber and short fiber enhances the ductility of concrete to a greater extent by way of reducing the formation of micro cracks and macro cracks in the concrete. Short fibers bridge the micro cracks and therebyincrease the tensile strength of concrete. Long fibers block the propagation of macro cracks and thereby increase the tensile strength of concrete. In accordance with fiber constitute response, one type of fiber should be stronger and stiffer to meet the first crack stress and improve the ultimate strength of concrete, whereas the second type of fiber should be more flexible and ductile to improve the toughness and strain capacity in the post-crack zone. Regarding fiber function, one type of fiber should facilitate the attainment of fresh and early stage properties of concrete in such a manner as to control the plastic shrinkage and the second type of fiber should improve the mechanical properties of concrete.

Literature Review

Annadurai and Ravichandran (2016) studied the flexural performance of high strength hybrid fiber reinforced concrete. Design for M60 grade concrete mix was followed. The constituents of hybrid fibers were steel fibers (80%) and polyolefin fibers (20%). The hybrid fibers were added to the concrete mixes at volume fractions of 1% and 2%. The specimens were tested under third-point loading, and the deflections were measured at mid span using dial gauge. The experimental test results disclosed that hybrid fiber reinforced concrete with hybrid fibers at 2% volume fraction showed noticeable improvements in flexural performance as compared to control specimen, and that steel fibers imparted high strength to the concrete. The specimens were examined after failure. It was found that the hybrid fibers bridged the cracks.

Fathima and Ipe (2016) formulated a kind of hybrid fiber consisting of steel fiber, polypropylene fiber, and glass fiber and employed it in the casting of hybrid fiber reinforced concrete column. Load was applied as axial load and cyclic lateral load. From the experimental test results it was learnt that the peak lateral load capacity and ductility ratio of FRC column specimen were increased by 40% and 33% respectively as compared to control concrete specimen.

METHODOLOGY

Naturally available river sand passing through IS 4.75 mm sieve and retained on IS 600 µm sieve was used and tested following the guidelines contained in IS: 2386 - 1963. Adopting the procedure stipulated in IS: 383 - 1970, sieve analysis test on fine aggregate was conducted, and it was found that the sand conformed to grading Zone III. The physical properties of fineaggregate are presented in Table 1.

Table 1 Properties of Fine Aggregate

Sl. No.	Test for FineAggregate	Relevant IS code	Observed Value
1	Fineness modulus	IS: 383 – 1970	2.56
2	Specific Gravity	IS: 2386 – 1963(Part I)	2.61
3	Sieve Analysis	IS: 383 – 1970	Conforming toZone III

Coarse Aggregate

Broken blue granite coarse aggregates passing through 20 mm sieveand conforming to IS: 383 - 1970 were used in the current research. The coarse aggregates were tested as per the stipulations presented in IS: 2386 - 1963 and the results are given in Table 2.

Table 2 Properties of Coarse Aggregate

Sl. No.	Test for FineAggregate	Relevant IS code	ObservedValue
1	Fineness modulus	IS: 383 – 1970	6.7
2	Specific Gravity	IS: 2386 – 1963(Part I)	2.68
3	Water absorption (%)	IS: 2386 – 1963(Part III)	1
4	Sieve Analysis	IS: 383 – 1970	Conforming to20 mm size

Table 3 Materials Required for One Cubic Meter of Concrete

Sl. No.	Mix Identification	Materials (kg)						
		Cement	Fine Aggregate	Coarse Aggregate	Water	SP	Steel Fiber	PVA fiber
1.	HFRC 0	352	716.64	1274.03	147.9	3.52	0.00	0.00
2.	HFRC 1	352	716.64	1274.03	147.9	3.52	0.00	24.90
3.	HFRC 2	352	716.64	1274.03	147.9	3.52	6.22	18.67
4.	HFRC 3	352	716.64	1274.03	147.9	3.52	12.45	12.45
5.	HFRC 4	352	716.64	1274.03	147.9	3.52	18.67	6.22
6.	HFRC 5	352	716.64	1274.03	147.9	3.52	24.90	0.00

CONCLUSIONS

- From the experimental test results of compressive strength, split tensile strength, and flexural strength of HFRC mixes, it is deduced that the optimum dosage of hybrid fiber to concrete mix is demonstrated by HFRC 4 mix prepared with 1% hybrid fiber made up of 0.75% steel fiber and 0.25% PVA fiber by volume of concrete.

- The relationship between compressive strength and split tensile strength of Hybrid Fiber Reinforced Concrete was found as $f_{th} = 0.45\sqrt{f_{ch}}$. For normal concrete the relationship between compressive strength and split tensile strength is $0.35\sqrt{f_{ck}}$.
- The relationship between compressive strength and flexural strength of Hybrid Fiber Reinforced Concrete was found as $f_{fh} = 0.9\sqrt{f_{ch}}$. For normal concrete the relationship between compressive strength and flexural strength is $0.7\sqrt{f_{ck}}$.

REFERENCES

[1] Ganesan, N.; Indira, P.; Sabeena, M. Behaviour of hybrid fibre reinforced concrete beam–column joints under reverse cyclic loads. Mater. Des. 2014, 54, 686–693. [CrossRef]

[2] Ganesan, N.; Indira, P.; Sabeena, M. Bond stress slip response of bars embedded in hybrid fibre reinforced high performance concrete. Constr. Build. Mater. 2014, 50, 108–115. [CrossRef]

[3] Ganesan, N.; Indira, P.; Santhakumar, A. Engineering properties of steel fibre reinforced geopolymer concrete. Adv. Concr. Constr. 2013, 1, 305–318. [CrossRef]

[4] Ganesan, N.; Indira, P.V.; Ruby, A. Steel fibre reinforced high performance concrete beam column joints subjected to cyclic loading. ISET J. Earthq. Technol. 2007, 44, 445–456.

[5] Ganesan, N.; Indira, P.V.; Sathish Kumar, V. Effect of Alkaline Activator to Binder Ratio on the Compressive Strength of Ternary Blend Geopolymer Concrete. ICI J. 2017, 17, 22–27. 58. IS 383:1970; Specification for Coarse and Fine Aggregates from Natural Sources for Concrete. Bureau of Indian Standards: New Delhi, India, 2002. Polymers 2022, 14, 2239 19 of 19 .

[6] Ganesan, N.; Marakkath, N.; Indira, P.V. HFRHPC interior beam-column-joints with slab under reverse cyclic loading. Indian Concr. J. 2017, 91, 17–25.

[7] He, D.; Wu, M.; Jie, P. Study on Mechanical Properties of Hybrid Fiber Reinforced Concrete. IOP Conf. Ser. Earth Environ. Sci. 2017, 100, 012111. [CrossRef] Polymers 2022, 14, 2239 18 of 19 31. Smarzewski, P. Hybrid Fibres as Shear Reinforcement in High-Performance Concrete Beams with and without Openings. Appl. Sci. 2018, 8, 2070. [CrossRef]

[8] Jaganathan, V.; Sathish Kumar, V.; Thirugnanam, G.S. Experimental investigation on sfrscc exterior beam column joint. Int. J. Appl. Eng. Res. 2015, 10, 32383–32387. 38. Praveen Kumar, S.; Mahakavi, P.A. Suba Priya, Experimental study on structural behaviour of beam column joint using geopolymer concrete. Int. J. Civ. Eng. Technol. 2017, 8, 688–698.

[9] James, J.S.; James, M.M. Effect of Fibres on Beam Column Joint Failure. Appl. Mech. Mater. 2016, 857, 59–64. [CrossRef]

[10] Jenifer, J.V.; Brindha, D. Development of hybrid steel-basalt fiber reinforced concrete–in aspects of flexure, fracture and microstructure. Rev. La Construcción. J. Constr. 2021, 20, 62–90. [CrossRef]

[11] Jiuru, T.; Chaobin, H.; Kaijian, Y.; Yongchen, Y. Seismic behaviour and shear strength of framed joint using steel fiber reinforced concrete. J. Struct. Eng. 1992, 118, 341–357. [CrossRef]

[12] Karthik, S.; Mohan, K.S.R.; Murali, G. Investigations on the Response of Novel Layered Geopolymer Fibrous Concrete to Drop Weight Impact. Buildings 2022, 12, 100. [CrossRef]

[13] Kathirvel, P.; Gunasekaran, M.; Sreekumaran, S.; Krishna, A. Effect of Partial Replacement of Ground Granulated Blast Furnace Slag with Sugarcane Bagasse Ash as Source Material in the Production of Geopolymer Concrete. Mater. Sci. 2020, 26, 477–481. [CrossRef]

[14] Komloš, K.; Babál, B.; Nürnbergerová, T. Hybrid fibre-reinforced concrete under repeated loading. Nucl. Eng. Des. 1995, 156, 195–200. [CrossRef]

[15] Kumar, V.S.; Ganesan, N.; Indira, P. Engineering Properties of Hybrid Fibre Reinforced Ternary Blend Geopolymer Concrete. J. Compos. Sci. 2021, 5, 203. [CrossRef]

[16] Kumar, V.S.; Ganesan, N.; Indira, P.V. Effect of Hybrid Fibres on the Durability Characteristics of Ternary Blend Geopolymer Concrete. J. Compos. Sci. 2021, 5, 279. [CrossRef] 55. IS 3812:2003; Pulvarized Fuel Ash-Specification. Bureau of Indian Standards: New Delhi, India, 2003.

[17] Kumar, V.S.; Ganesan, N.; Indira, P.V. Effect of Molarity of Sodium Hydroxide and Curing Method on the Compressive Strength of Ternary Blend Geopolymer Concrete. IOP Conf. Ser. Earth Environ. Sci. 2017, 80, 012011. [CrossRef]