iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** III **Month of publication:** March 2023

DOI: https://doi.org/10.22214/ijraset.2023.49216

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue III Mar 2023- Available at www.ijraset.com

Structural Behaviour of Hybrid Fibres Concrete Using Regression Analysis

Sanjeev Suman[1], Gourav Tiwari [2], Abhay Kumar Jha[3], Barun Kumar[4]
[1, 2, 3, 4]*Department of Civil Engineering, Lakshmi Narain College of Technology, Bhopal (M.P)*

Abstract: ***The main objective of the current effort is to create hybrid fibre reinforced concrete with improved strength properties, structural behaviour, and structural performance by adding the right dosage amount of hybrid fibre. In this work, it is suggested to employ hybrid fibres of two different types, one of which is Steel fibre, a metallic fibre, and the other is Polyvinyl Alcohol fibre, which has a synthetic foundation. In this way, the concrete gains high tensile strength, flexural strength, and compressive strength due to the inclusion of steel fibre with a high Young's modulus and tensile strength. The steel fibre functions as a crack arrestor, stopping the growth of cracks at the macro level. The microscopic cracks are stopped from spreading by the use of synthetic Polyvinyl Alcohol (PVA) fibre, which is more flexible and ductile, increasing the strength and hardness of the concrete. The objective of the current study is to assess the structural behaviour and strength features of hybrid fibre reinforced concrete. For different mix proportions, such as 0% Steel fibre and 1% PVA fibre, 0.25% Steel fibre and 0.75% PVA fibre, 0.50% Steel fibre and 0.50% PVA fibre, 0.75% Steel fibre and 0.25% PVA fibre, and 1% Steel fibre and 0% PVA fibre by the volume of concrete, the specimens were cast with the addition of hybrid fibres at a total volume fraction of 1%.***
Keywords: Polyvinyl Alcohol fibre, flexural strength, compressive strength, synthetic, Steel fibre, flexible.

I. INTRODUCTION

Constructions involving civil engineering frequently employ the material concrete. It is well knowledge that concrete exhibits strong resistance to compressive stress but weakens when subjected to tensile tension. Even under low loads, when a concrete element is loaded, cracks frequently appear as a sign of the concrete's weak tensile strength. Additionally, during dynamic loads, the fractures enlarge and cause failure, which in turn affects the ductility of the concrete structural part. By adding particular reinforcement, such as the insertion of a single type of fibre in the concrete matrix, this inherent weakness of concrete can be remedied. Fiber Reinforced Concrete is the name given to this type of concrete (FRC).

Single-type fibre secondary reinforcement will add less value to the concrete overall.Hybrid fibres are used to achieve a balanced enhancement in the performance of concrete in order to overcome this restriction.

A hybrid fibre is made up of two or more different types of fibre that have been logically mixed to produce a synergistic reaction and offer significant advantages. The entire amount of potential energy derived from the various types of fibre makes up hybrid fibre synergy. Hybrid Fiber Reinforced Concrete is a term used to describe concrete made by blending two or more different types of fibre as secondary reinforcement (HFRC).

The addition of hybrid fibres to the concrete mix is a type of development for fiber-reinforced concrete. Fibers of two or more distinct kinds are thoroughly mixed into the concrete mixture. Combining two or more types of fibres allows us to take advantage of each type's advantages while strengthening the concrete's resistance to tensile stress.

A better composite concrete is created than one prepared with a single type of fibre when two types of fibre are combined in the right quantities and added to the concrete mix.

A hybrid fibre technology improves the concrete's resistance and inhibits the growth of cracks. By including hybrid fibre made of metallic and non-metallic fibre in the concrete mix, one step further, a better hybrid fibre reinforced concrete is produced.Metallic fibre is important because it offers concrete strength, but it also changes the concrete's ductility, which causes a phenomena known as post-cracking in concrete.

Contrarily, non-metallic fibre has a favourable impact on concrete by preventing the formation of tiny cracks during the concrete's plastic phase and minimising plastic shrinkage. Metallic fibres have a higher degree of stiffness and improve the structural qualities of concrete, such as its high energy absorption capacity and tensile, impact, and flexural toughness. To achieve superior mechanical characteristics and considerable structural performance of the concrete, it is important to have a suitable combination of low modulus fibre and high modulus fibre contained in the concrete mix.

©IJRASET: All Rights are Reserved

II. LITERATURE REVIEW

Peijiang and Chung Wu (2007) employed the short polyvinyl alcohol fibers to improve the mechanical properties of brittle fly ash samples. The mechanical properties of the polyvinyl alcohol fiber reinforced fly ash composites are evaluated by splitting tensile test. Addition of fibers is known to restrict the growth of shrinkage cracks. Fiber has added up to 0.5% by the volume of concrete. Individual steel fibers as well as hybrid combinations of steel and non-metallic (polyester, polypropylene and glass) fibers were evaluated for their influence on plastic shrinkage cracking. Results showed that hybrid fiber has most effective in reducing shrinkage cracks. Among the hybrid fiber combinations, the steel and polyester amalgamation has established to decrease plastic contraction cracks by more than 99% associated with the plain concrete. Since the fibers will decompose at high temperature the composite processed at that temperature shows the high strength but brittle behavior again.

Joshua and Ostertag (2009) analyzed the deflection hardening behaviour and workability of hybrid fiber concrete composites prepared with polyvinyl alcohol fiber and two different lengths of hooked end steel fiber. The combined effect of the constituents of hybrid fiber enhanced the material flowability and cohesiveness of the fiber reinforced concrete.

Sivaraja et al. (2010) emphasized the usefulness of the emerging genre of natural fibers as reinforcing material and pointed out that application of natural fibers has more traditional than technical. Furthermore, it has ascertained that natural fiber reinforced concrete possessed certain distinct properties like improved tensile and bending strength, greater ductility, and strong resistance to cracking.

Machine et al. (2011) investigated the abrasion resistance shown by hybrid fiber reinforced concrete prepared with steel fiber and polypropylene fiber using statistical experimental design. Hooked end and crimped steel fibers were used in this research. It has discerned from the ANOVA results the performance of polypropylene fiber has better than that of steel fiber. Hybrid fibers increased the abrasion resistance to a great extent.

Chandrasekhar et al. (2011) studied the behaviour of self- compacting concrete prepared with adequate hybrid fiber reinforcement. The inclusion of hybrid fibers in the concrete mix improved the ductile properties and increased the resistance to tensile stress. The hybrid fiber consisted of steel fiber and glass fiber. Design of M30 grade concrete was adopted in the preparation of hybrid fiber-reinforced self compacting concrete

Wenzhong et al. (2012) used hybrid fiber produced from a combination of steel fiber and polypropylene fiber in concrete mix and examined the compressive strength and microstructure of reactive powder concrete. From the experimental test results, an equation was developed to show the relationship between compressive strength and heating temperatures. The hybrid fiber-reinforced reactive powder concrete exhibited strong resistance to high temperature as compared to normal strength concrete high strength concrete.

Sharma (2013) investigated the effects of hybrid fibers made up of polypropylene fibers and steel fibers on the behaviour of fibrous concrete. The amount of polypropylene fibers was varied from 0.1% to 0.4% whereas the quantum of steel fibers was kept at 0.8%. The mechanical properties of the concrete were studied. The experimental test results revealed that the addition of polypropylene fibers produced a limited effect on the compressive strength but a remarkable increase in the tensile strength with increase in fiber volume. There was an increase of 47% in the split tensile strength whereas the increase in flexural strength was 50%. The results also indicated that the ultimate load depended mainly on the volume fraction of fiber.

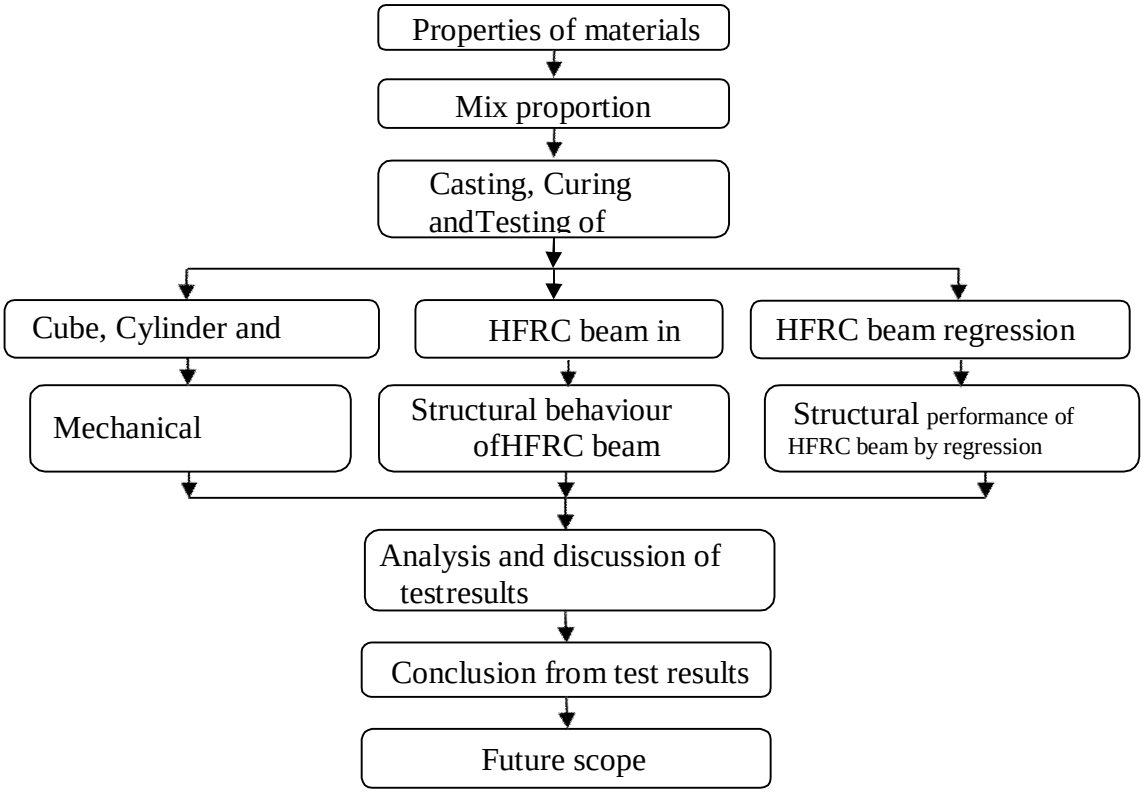
Alberti et al. (2014) developed four types of fiber-reinforced self compacting concrete with the incorporation of hybrid fibers made by a combination of steel-hooked fibers and polyolefin fibers. The research brought to light the synergic effect of the constituents of hybrid fiber. Also there was an improvement in the orientation and distribution of the fibers on the fracture planes.

Pantea et al. (2014) investigated the flexural strength and impact resistance of hybrid fiber-reinforced concrete. Optimum proportions of steel fiber and polypropylene fiber were adopted. It was found that the toughness index, modulus of rupture, and impact resistance were higher in respect of hybrid fiber-reinforced concrete having the optimum proportion of 0.75% steel fiber and 0.25% polypropylene fiber. Furthermore, the addition of metakaolin and pumice improved the strength to a greater extent.

Ilker et al. (2015) presented a numerical method to estimate the curvature, deflection, and moment capacity of hybrid fiber (polymer fiber + steel fiber)-reinforced concrete beams. Experimental test results and theoretical results were compared. The proposed numerical technique produced accurate results in the prediction of the said parameters. From the numerical results, it was gathered that the ductility and stiffness were enhanced when steel reinforcement was additionally provided to the fiber- reinforced polymer (FRP) reinforced concrete beams. Kaushal et al. (2016) examined the behaviour of polyvinyl alcohol fiber reinforced concrete. A small fraction of polyvinyl alcohol fiber was used along with different fibers such as banana fiber, sisal fiber, etc. Polyvinyl alcohol in solution was added to the concrete mix at 0.5% volumetric fraction. In all kinds of concrete mixes taken up for research, cement was partially replaced by fly ash. The experimental test results showed that the incorporation of polyvinyl alcohol fiber in fiber reinforced concrete increased the compressive strength and flexural strength substantially.

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |

III. FLOW CHART OF THE PRESENT WORK

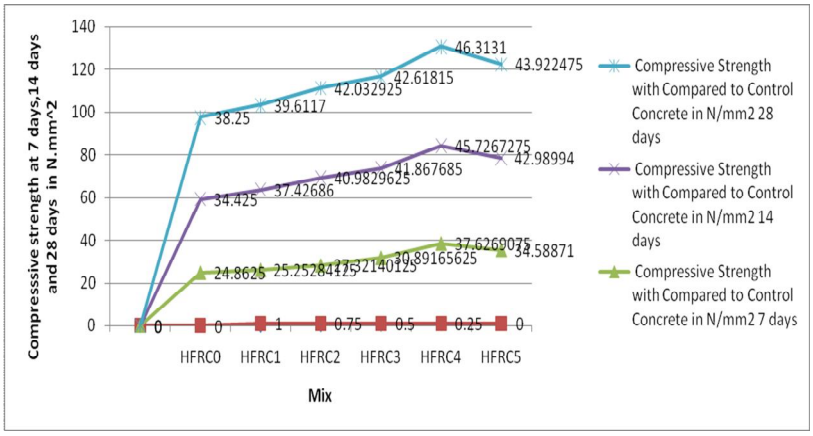


IV. CUBE COMPRESSIVE STRENGTH

The compressive strength test results has been analyzed. The results from the analysis are discussed as follows. The compressive strength test results in respect of cube specimens of control concrete mix and hybrid fiber reinforced concrete mixes at different ages such as 7, 14, and 28 days are presented graphically in Table 1 and Graph 1

Table no.1 Cube Compressive Strength of Control Concrete and Hybrid Fiber Reinforced Concrete at the Age of 7, 14, and 28 Days

Sr. No.	Mix Identification	Volume of Fiber (%)		Compressive Strength with Compared to Control Concrete in N/mm2		
		Steel Fiber	PVA Fiber	7 days	14 days	28 days
1	HFRC0	0	0	24.8625	34.425	38.25
2	HFRC1	0	1	25.25284125	37.42686	39.6117
3	HFRC2	0.25	0.75	27.32140125	40.9829625	42.032925
4	HFRC3	0.5	0.5	30.89165625	41.867685	42.61815
5	HFRC4	0.75	0.25	37.6269075	45.7267275	46.3131
6	HFRC5	1	0	34.58871	42.98994	43.922475



Graph 1 Development of Cube Compressive Strength of Control Concrete and Hybrid Fiber Reinforced Concrete at the Age of 7, 14, and 28 Days

Table no.1 % increase in Cube Compressive Strength of Control Concrete and Hybrid Fiber Reinforced Concrete at the Age of 7, 14, and 28 Days

Sr. No.	Mix Identification	Volume of Fiber (%)		Compressive Strength with Compared to Control Concrete in N/mm^2			Increase in Compressive Strength with Compared to Control Concrete (%)		
		Steel Fiber	PVAFiber	7 days	14 days	28 days	7DAYS	14 DAYS	28 DAYS
1	$HFRC_0$	0	0	24.86	34.43	38.25	0	0	0
2	$HFRC_1$	0	1	25.25	37.43	39.61	1.57	8.72	3.56
3	$HFRC_2$	0.25	0.75	27.32	40.98	42.03	9.89	19.05	9.89
4	$HFRC_3$	0.5	0.5	30.89	41.87	42.62	24.25	21.62	11.42
5	$HFRC_4$	0.75	0.25	37.63	45.73	46.31	51.34	32.83	21.08
6	$HFRC_5$	1	0	34.59	42.99	43.92	39.12	24.88	14.83

V. CONCLUSION

Based on the above study following conclusions can be made

1) HFRC mixes show improvement in the flexural strength. The flexural strength of HFRC 4 mix (0.75% steel fiber and 0.25% PVA fiber) at the age of 28 days is 1.31 times higher than that of the control concrete mix (HFRC 0).

2) 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.

3) The relationship between compressive strength and split tensile strength of Hybrid Fiber Reinforced Concrete was found as fcr = 0.414√fccs. For normal concrete the relationship between compressive strength and split tensile strength is 0.35√fck.

4) The relationship between compressive strength and flexural strength of Hybrid Fiber Reinforced Concrete was found as ffch = 0.88√fccs. For normal concrete the relationship between compressive strength and flexural strength is 0.7√fck.

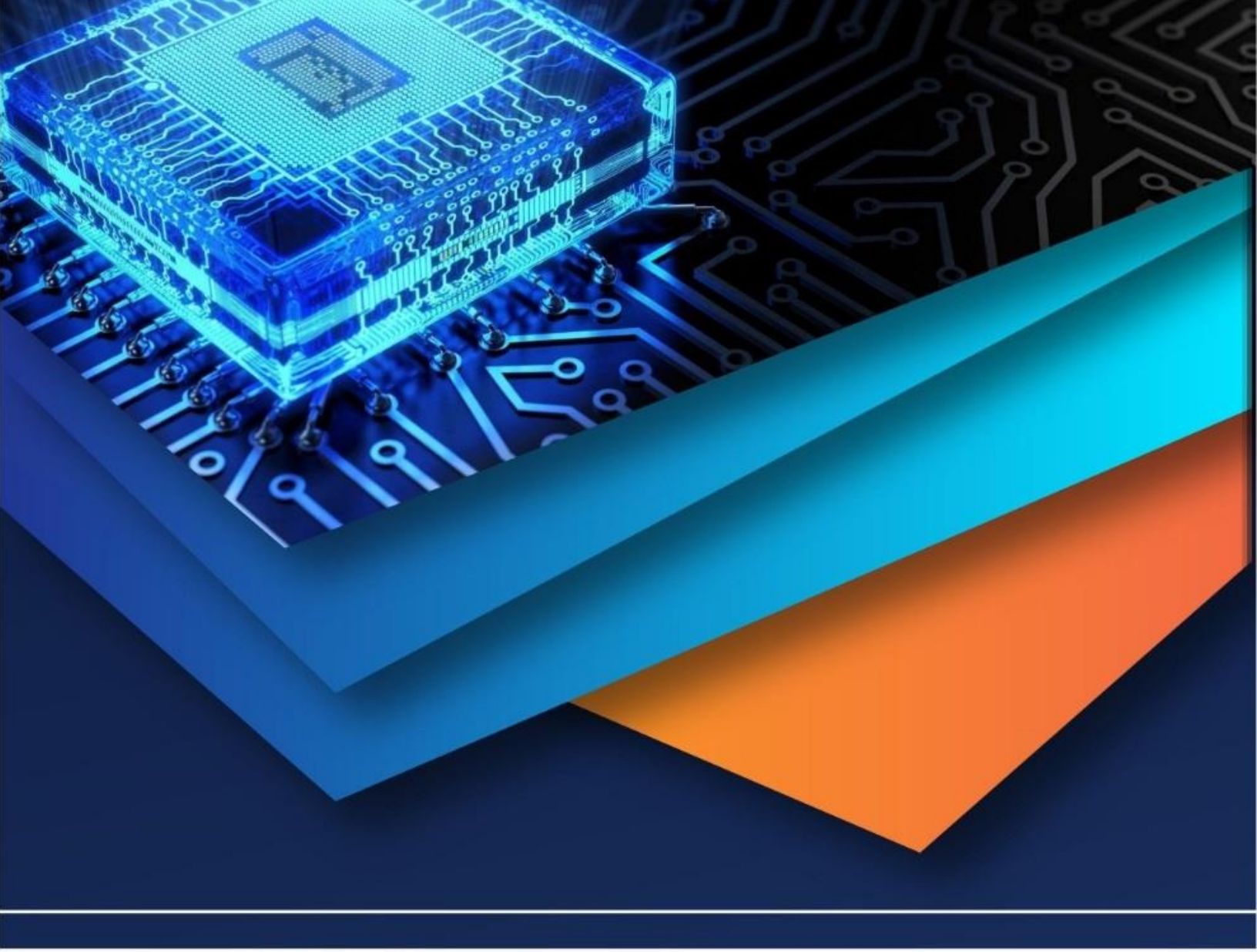
VI. ACKNOWLEDGMENT

This work was completed with the grants and facilities of Lakshmi Narain College of Technology, Bhopal (M.P.). Authors are thankful to this institute and faculties for extending this cooperation.

REFERENCES

[1] Geethu Asok & Sunilaa George 2016, 'Investigation on Hybrid Concrete Using Steel and Polypropylene Fiber', International Journal of New Technology and Research, vol. 2, no. 5, pp. 61-64.
[2] Harini, B R & Elangovan, P 2015, ' Experimental Study on Flexural behaviour of Hybrid Fibre Reinforced Concrete with Elastomeric Pads', Bonfring International Journal of Industrial Engineering and Management Science, vol. 5, no. 2, pp. 67-72.
[3] Ilker Fatih Karaa, Ashraf F Ashour, Mehmet al.paslan Köroğlu 2015, 'Flexural behavior of hybrid FRP/steel reinforced concrete beams', Composite Structures, vol. 129, pp. 111-121.
[4] Indumathi, B & Gnanadevi, V 2015, 'An Experimental Investigation on Properties of Hybrid Fiber Reinforced Concrete with GGBS and Fly ash', International Journal of Emerging Technology in Computer Science and Electronics, vol. 13, pp. 120-123.
[5] IS: 12269, 1987, 'Specification for 53 grade Ordinary Portland cement', BIS, New Delhi, India.
[6] IS: 2386, Part 3, 1963, 'Methods of test for aggregates for concrete: specific gravity, density, voids, absorption and organic impurities', BIS, New Delhi, India.
[7] IS: 2386, Part 4, 1963, 'Methods of test for aggregates for concrete: Mechanical properties', BIS, New Delhi, India.
[8] IS: 383, 1970. 'Specification for coarse and fine aggregates from natural sources for concrete' (second revision), BIS, New Delhi, India.
[9] IS: 4031, 1988, 'Method of physical test for hydraulic cement', BIS, New Delhi, India.
[10] IS: 4032, 1985, 'Method of chemical analysis of hydraulic cement', BIS, New Delhi, India.
[11] IS: 456, 2000, 'Plain and Reinforced Concrete Code of Practice', (4th revision), BIS, New Delhi, India.
[12] IS: 516, 1959, 'Methods of tests for strength of concrete', Bureau of Indian Standards, New Delhi, India.
[13] IS: 5816, 1999, 'Method of test for splitting tensile strength of concrete', BIS, New Delhi, India.
[14] Jadhav, H S & Koli, M D 2013, 'Flexural Behavior of Hybrid Fiber Reinforced Concrete Beams', International Journal of Structural and Civil Engineering Research, vol. 2, no. 3, pp. 210-218.
[15] Job Thomas & Ananth Ramaswamy 2007, 'Mechanical Properties of Steel Fiber-Reinforced Concrete', Journal of Materials in Civil Engineering, pp. 385-392.
[16] Joshua D Blunt & Claudia P Ostertag 2009, 'Deflection Hardening and Workability of Hybrid Fiber Composites', ACI Materials Journal, pp. 265-272.
[17] Jyothis Jose Oommen, 2015 'Bond Strength Behaviour of Mono Fibre and Hybrid Fibre Reinforced Concrete using Steel and Nylon', International Journal of Core Engineering & Management, vol. 2, no. 6, pp. 83-98.
[18] Kartheek Babu, K, RushiKesava Reddy, K & Annadurai, A 2015, 'Experimental Investigation on Hybrid Fibre Reinforced Concrete Beams', International Journal of Scientific Research Engineering Technology, vol. 1, no. 6, pp. 121-125.
[19] Kaushal Jatti, Preeti Vaishnav & Abhyuday Titiksh 2016, 'Evaluating the Performance of Hybrid Fiber Reinforced Concrete Dosed with Polyvinyl Alcohol', International Journal of Trend in Research and Development, vol. 3, no. 2, pp. 354-357.
[20] Konapure, C G & Kangiri, S D 2014, 'Evaluation of Performance of Hybrid Fibre Reinforced Concrete (HFRC) for M25 Grade', International Journal of Current Engineering and Technology, vol. 4, no. 3, pp. 1831-1835.
[21] Kumar, V.S.; Ganesan, N.; Indira, P.V.; Murali, G.; Vatin, N.I. Flexural Behaviour of Hybrid Fibre-Reinforced Ternary Blend Geopolymer Concrete Beams. Sustainability 2022, 14, 5954. [CrossRef]

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)