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Experimental Study on the Influence of Steel Fiber Reinforcement on the Properties of Self Compacting Concrete

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Abstract: Self compacting concrete (SCC) is becoming a popular choice in concrete industry due to ease of placement in congested reinforcements, reduced labor and equipment, no segregation character and smooth surface. Fly ash has been used in producing SCC which increases filling and passing ability of concrete. The present study was carried out to check the optimum dosage of super plasticizer which influence on fresh properties of self compacting concrete, the super plasticizers are varied from 0.5% to 1.75%. And also to check the fresh and hardened properties of Steel fiber reinforced SCC with different percentage of fiber addition. The materials were mixed with 0.5%, 1.0% and 1.5% addition of fiber in M30 mix design and casted in cubes, beams and cylinders. The obtained specimens were subjected to test the compressive, flexure and split tensile strength. Compressive, flexure and split tensile strengths of the specimens were analyzed for 7 and 28 days of curing.
Keywords: Self compacting concrete, Steel fiber, Fresh state properties, Compressive Strength, Split Tensile Strength, Flexural Strength.

I. INTRODUCTION

A. General

Self compacting concrete (SCC) is a high-performance concrete which is highly flow or self-leveling cohesive concrete that can be effectively put in the congested reinforcement. It otherwise called as super workable concrete. SCC is a type of concrete, which is not a product of blending substances having various properties however a combination of several blends having a similar flow characteristics. Utilization of SCC has increased enormously in the previous couple of years. SCC not only guarantees a structure with robust characteristics but also helps in timely completion of structures. Current Indian situation in construction indicates expanded development of enormous and complex structures, which regularly leads to troublesome concreting conditions, SCC us the main solution for all such issue.

B. Development of SCC

For several years beginning in 1983, the problem of the durability of concrete structures was a major topic of interest in Japan. The creation of durable concrete structures requires adequate compaction by skilled workers. The designs of modern reinforced concrete structures become more advanced, the designed shapes of structures are becoming increasingly complicated and heavy reinforcing is no longer unusual. Furthermore, the gradual reduction in the number of skilled workers in Japan’s construction industry has led to a similar reduction in the quality of construction work. One solution for the achievement of durable concrete structure independent of the quality of construction work is the employment of self – compacting concrete, which can be compacted into every corner of a form work, purely by means of its own weight and without the need for vibrating compaction. Okamura proposed the necessity of this type of concrete in 1986. Studies to develop self compacting concrete, including a fundamental study on the workability of concrete, have been carried out by “Ozawa and Maekawa” at the university of Tokyo. The prototype of SCC was first completed in 1988 using materials already on the market. The proto type performed satisfactorily with regard to drying and hardening shrinkage, heat of hydration, denseness after hardening, and other properties. This concrete was named “High Performance Concrete” and was defined as follows at the three stages of concrete:

1) *Fresh:* Self Compactable.
2) *Early Age:* Avoidance of initial defects
3) *After Hardening:* Protection against external factors.

C. Steel Fibers
Steel fibers are proved to be very effective in conventional and SCC concrete mixes for enhancing their both fresh and hardened properties. Steel fibers of different diameters, aspect ratios and shapes have been successfully used. Steel fiber reinforced concrete is used as a supplementary material to prevent craking, to improve resistance to impact or dynamic loading and to prevent material disintegration.

D. Need for the Use of Steel Fiber
Fiber reinforced Self-Compacting Concrete(FRSCC) in the construction of structural elements is seen as an alternative solution to the complication in placing the reinforcement and compaction of normally vibrated concrete. The main advantages of FRSCC is the ability to be properly poured in place, filling the form work corners and small voids between reinforcement bars by means of it's own weight. The incorporation of fibers in the mix has been found to enhance the hardened properties of self compacting concrete in terms of tensile strength, ductility, toughness. The knowledge could be used as a guide in expanding the application of FRSCC as the main material in the construction of different structures.

E. Objectives of the Study
To arrive at mix proportion for self compacting concrete of grade M_{30} by suitable mix design procedure and experimental trials and to study the influence of steel fiber reinforcements at different proportions on the fresh and hardened properties of SCC.

F. Methodology
1) Collection of required materials.
2) Investigation of physical properties for Cement, Fly ash, Fine aggregate and Coarse aggregate.
3) Arriving mix proportions by checking the flow properties of SCC.
a) Slump flow test
b) V- funnel test
c) J- ring test
d) L box test
e) T500 test
4) Casting of specimens.
a) For compressive strength test a cube of size 150X150X150mm is used.
b) For flexural strength test for beam of size 100X100X500mm is used.
c) For split tensile strength for cylinder of size 150X300mm is used.
5) Curing of specimens.
6) Testing of specimen at 7 and 28 days of age.
7) Discussion of the results.

II. MATERIALS

A. Cement
Grade 53 ordinary Portland cement (OPC) confirming to IS: has been used. The physical properties of the cement such as consistency, initial and final setting time and specific gravity were tested in accordance with IS: 4031- 1988 and given in table 1.

Table 1: Physical Properties of Cement

Sl. No	Property	Value
1	Standard consistency	33%
2	Initial setting time	75 min
3	Final setting time	145 min
4	Specific gravity	3.15

B. Coarse Aggregate

The coarse aggregate used in the concrete mixtures was crushed stone of 12mm down size. It has specific gravity of 2.64 and was determined according to IS: 2386 (part-III) of 1963. The physical properties were also determined and given in Table 2.

Table 2: Physical Properties of Coarse Aggregate

Sl. No	Property	Value
1	Specific gravity	2.64
2	Fineness modulus	3.71
3	Bulk density	1450kg/m^3
4	Water absorption	0.5%

C. Fine Aggregate

Manufactured sand was used as fine aggregate with a maximum size of 4.75mm. The specific gravity of the fine aggregate is 2.61 and was determined according to IS: 2386 (part-III) of 1963. Sieve analysis was performed on the fine aggregate according to IS: 383-1970. The physical properties are given in table 3.

Table 3: Physical Properties of Fine Aggregate

Sl. No	Property	Value
1	Specific gravity	2.61
2	Fineness modulus	2.4
3	Bulk density	1463kg/m^3
4	Water absorption	7%

D. Fly Ash

Fly ash of class C type having a specific gravity of 2.0 has been used in the present study.

E. Steel Fibers

Steel fiber used in this investigation. These fibers are available into pieces to a length of 35mm & 0.5mm diameter. The extent of fiber content that can be used in fiber reinforced self compacting concrete can be fixed either on the basis of volume of concrete or by weight of the cement. In this experimental work also volume of cement is considered for determining the fiber content. The fiber content adopted for the study is 0.5%, 1.0% and 1.5%volume of cementitious material and fiber length 35mm were considered.

F. Water

Ordinary potable water was used for the entire experimental investigation both for casting and curing of specimens.

G. Admixtures

Super plasticizer by trade name MasterGlenium 123 was used. MasterGlenium is an innovative versatile admixture based on third generation polycarboxylic ether (PCE) polymers. MasterGlanium is a high range water reducing admixtures. It may be used in combination with MasterMATRIX admixtures for producing Rheodynamic^{TM} concrete, capable of self-compaction, even in the presence of dense reinforcement. Viscosity modifying agent (VMA) by trade name MasterMatrix 110 is an innovative product. It is aqueous solution of a high-molecular weight synthetic copolymer. It imparts a level of viscosity within a mix enabling the right balance between fluidity, passing ability and resistance to segregation.

III.RESULTS AND DISCUSSION

A. Fresh Properties of Self compacting Concrete

First a reference mix using OPC, FA, CA , Fly Ash and Super plasticizer proportioned for M30 concrete using Nan Su, et al., method of mix design for SCC. The Slump flow test results thus obtained was given in table 4.

Table 4: Trial mix slump flow result of SCC for M30 grade of Concrete

CASTING DATE	SUPERPLASTICIZER In (%)	D1 In (mm)	D2 In (mm)	D(avg.)	T500 In (second)
14/2/19	0.5	No flow occurred			
16/2/19	0.75	No flow occurred			
28/2/19	1.0	520	500	510	6
12/3/19	1.25	540	585	563	5
13/3/19	1.5	670	690	685	2
15/3/19	1.75	Segregation observed – not satisfactory			

B. Fresh Properties Of Self Compacting Concrete Reinforced With Steel Fiber

1) Slump Flow Properties of Steel fiber reinforced SCC

The slump flow for the SCC and steel fibre reinforced SCC are given in the table 4.3. The variation of slump flow with respect to the fiber content is shown in fig 4.1. From the results following are the observations.

a) The slump flow decreases with increase in fibre content from 0.5% to 1.5%.

b) The maximum decrease in the slump flow is 13.33% at 1.5% fibre content with respect to SCC without fibre.

c) The slump flow decreases at the fibre content of 1.5% is due to resistance of the fibre to the flow of the cement matrix. Visually it shows that, the matrix especially finer portions (i.e., Sand+ Cement+ Fly Ash) are separated from the fiber content. Hence there is a revision of mix proportions is required to get a good flow matrix.

Table 5: Slump flow values of steel fiber reinforced SCC.

Sl. No	% of steel fibers	Slump flow (mm)	T500 sec
1	0	715	2
2	0.5	680	3
3	1.0	560	5
4	1.5	520	6

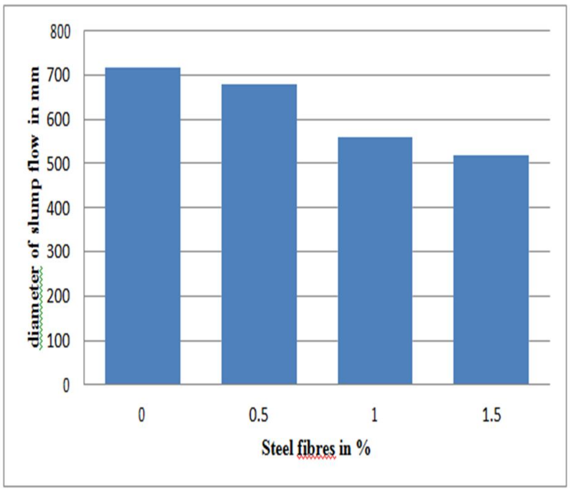

Fig 1: Slump flow test results

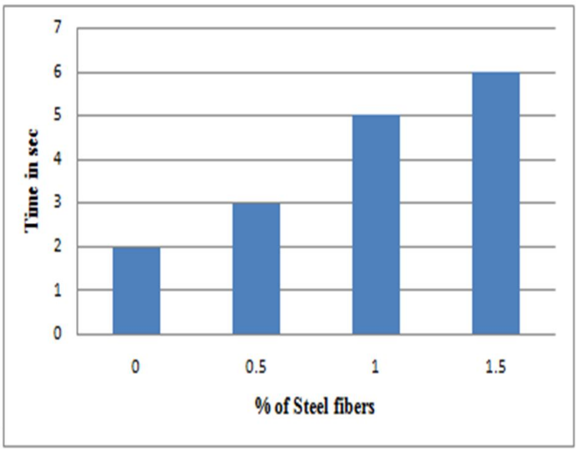

Fig 2: T500 time test results

2) *V funnel properties of Steel fiber reinforced SCC:* The V funnel values of SCC and steel fiber reinforced SCC is given in table 6 and its variation is shown in Fig 7.6. From the results following are the observations.
   a) The V funnel flow decreases & time increases with increases in the fiber content from 0.5% to 1.5%.
   b) The maximum decrease in the flow is 85% at 1.5% fiber content with respect to SCC without fibre.

Table 6: V Funnel Values of steel fiber reinforced SCC

Sl. No	% of steel fiber	V funnel values sec
1	0	8
2	0.5	8.4
3	1.0	9.1
4	1.5	10.2

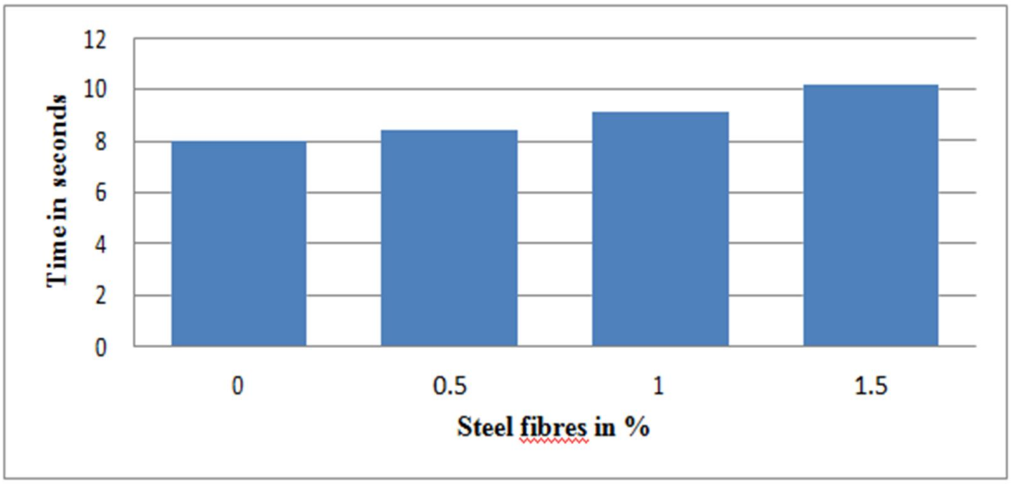

Fig 2: V funnel flow test results

3) *J-ring Properties of Steel fiber Reinforced SCC:* The J ring flow of the SCC and steel fiber reinforced SCC are given in table 7. The variation of flow and blockage with respect to the fiber content is shown in Fig 3. From the results following are the observations.
   a) The J ring height increases with increase in the steel fiber content from 0.5% to 1.5%.
   b) The maximum decrease in the flow occur at the use of 1.5%steel fiber content with respect to the SCC without fiber and blockage increased with increasing the fiber content.

Sl. No	% of steel fibers	J-ring values mm
1	0	5
2	0.5	6
3	1.0	8
4	1.5	9

Table 7: J -ring values of steel fiber reinforced SCC

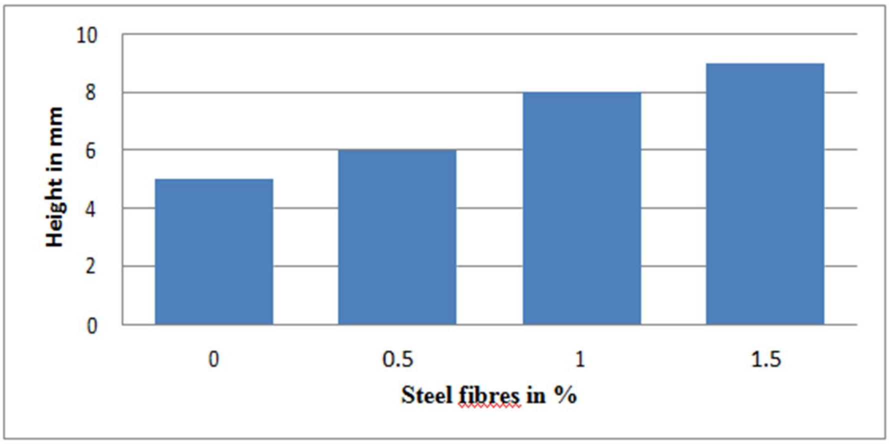

Fig 3: J-ring Height of steel fiber reinforced SCC

4) *L-box properties of steel fiber reinforced SCC* : The L box flow of the SCC and steel fiber reinforced SCC are given in table 8 and its variations are shown in Fig 4.From the results following are the observations.

a) The L box flow decreases with increase in the steel fiber content from 0.5% to 1.5%.

b) The maximum decrease in the flow is 29.87% at 1.5% steel fiber content with respect to the SCC without fiber and the blockage increased with the increasing fiber content.

Table 8: L-box values of steel fiber reinforced SCC

Sl. No	% of steel fibers	L-box values h_2/h_1
1	0	0.94
2	0.5	0.88
3	1.0	0.82
4	1.5	0.81

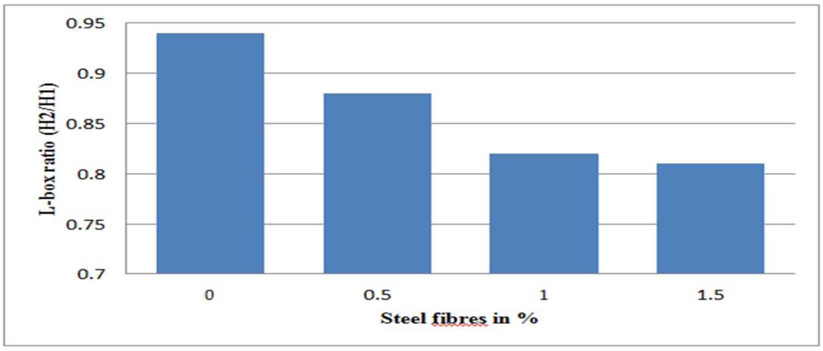

Fig 4: L-box flow of Steell fiber reinforced SCC

C. Tests on Hardened Concrete

1) *Compressive strength of steel fiber reinforced SCC :* The concrete specimens were tested for compressive strength after 7 and 28 days of curing. The results are given in table 9. The variation of compressive strength with respect to % of fibre content is shown in fig 5. From the results following are the observations.

a) The compressive strength of the specimen increase gradually up to 1.5% of steel fibre content.

b) Across the age of curing i.e., from 7 days to 28 days, the compressive strength was increased in the range of 2 % to 6%, which corresponds to the respective fibre content.

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Table 9: Compressive strength values of steel fiber reinforced SCC

Sl. No	% of steel fibers	Compressive strength in N/mm^2	
		@7 days	@28 days
1	0	24.16	35.14
2	0.5	26.48	41.96
3	1.0	28.57	44.94
4	1.5	31.86	49.96

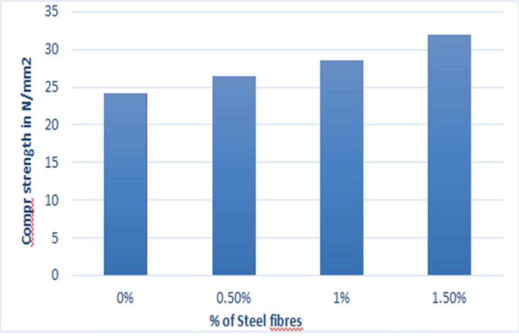


Fig 5: At 7 days compressive strength

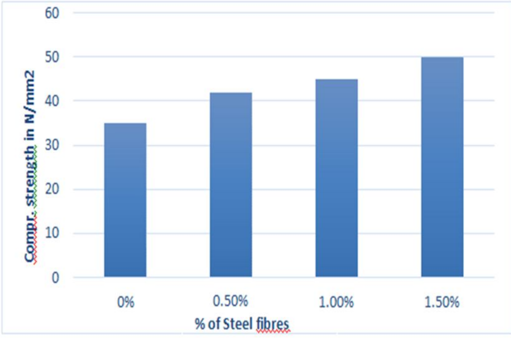


Fig 6: At 28 days compressive strength

Fig 5 & Fig 6 : Compressive strength of steel fiber reinforced SCC at various fiber content.

2) *Split Tensile Strength Of Steel Fiber Reinforced SCC*: The concrete specimens were tested for split tensile strength after 7 and 28 days of curing. The results are given in table 10. The variation of split tensile strength with respect to % of fiber content is shown in fig 6. From the results following are the observations.
a) The split tensile strength of the specimen increase gradually up to 1.5% of steel fiber content.
b) Split tensile strength of SCC with steel fiber in comparison to plain SCC is found 24.47% more.

Table 10: Split tensile strength values of steel fiber reinforced SCC

Sl. No	% of steel fibers	Split tensile strength in N/mm^2	
		@7 days	@28 days
1	0	1.83	2.23
2	0.5	1.89	2.85
3	1.0	2.17	2.87
4	1.5	2.31	3.61

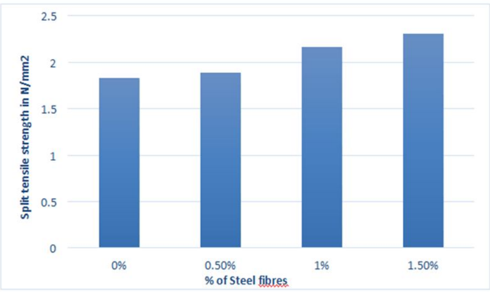


Fig 6: At 7 days split tensile strength

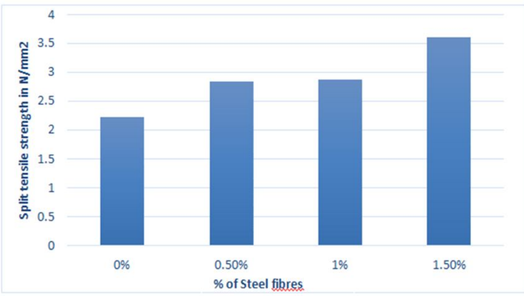


Fig 7: At 28 days split tensile strength

Fig 6 & Fig 7: Split tensile strength of steel fiber reinforced SCC at various fiber content

3) *Flexural Strength of Steel Fiber Reinforced SCC:* The concrete specimens were tested for flexural strength after 7 and 28 days of curing. The results are given in table 11. The variation of split tensile strength with respect to % of fiber content is shown in fig 7. From the results following are the observations.

a) The flexural strength of the specimen increase gradually up to 1.5% of steel fiber content.

b) The percentage increase in flexural strength is 19.47% with respect to the plain SCC.

Table 11: Flexural Strength Values of steel Fiber Reinforced SCC

Sl. No	% of steel fibers	Flexural strength in N/mm^2	
		@7 days	@28 days
1	0	4.08	5.04
2	0.5	4.40	5.48
3	1.0	4.57	5.83
4	1.5	5.02	6.15

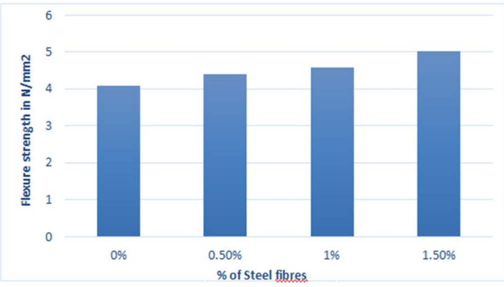


Fig 8: At 7 days flexural strength

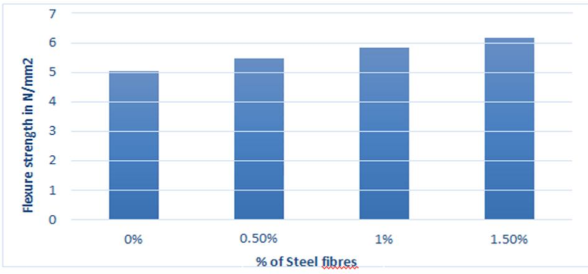


Fig 9: At 28 days flexural strength

Fig 8 & Fig 9 : Flexural Strength of steel Fiber Reinforced SCC at Various Fiber content

IV.CONCLUSIONS

The general conclusions drawn based on the experimental investigations carried out inthis study are as follows:

A. Methods described in IS 10262:2009 for conventional concrete and the method given by Nan Su et al (one of the methods suggested by Eurocode) are accurate and convenient methods to arrive at initial mix design for conventional concrete and SCC respectively. However, practical trials are required to arrive at the final design mix with desired performance.

B. From the experimental study has shown that acceptable flow characteristics were achieved for SCC with a dosage of SP between 1 and 1.5. Lesser dosages resulted in no flow while higher dosage resulted in segregation and quick set.

C. In this study Slump flow test, T500 test, L-box test, J-ring test & V-funnel tests are carried out. Based on test results it was observed that Increases the percentage of steel fiber slump flow decreases and T500 time increases, and also decreases in the passing ability & filling ability of Self-Compacting Concrete.

D. We found that the compressive, split tensile and flexural strength of the specimen increase gradually up to 1.5% steel fiber.

E. Compressive strength, Flexural strength and split tensile increased by 15.38%, 19.47% and 24.47% respectively after addition of 1.5% steel fiber for M30 mix design.

REFERENCES

[1] Athulya Sugathan, “Self Compacting Concrete Reinforced with Sisal Fibre”,IJLTEMAS Volume VI, Issue VII, July 2017

[2] Bhoopathi Vivek Reddy, Madadi Rajender Reddy, “Design and Analysis of Self Compacting Concrete Using Nan–Su Method”, IJPRES, Volume VI, Issue 4, AUG 2016.

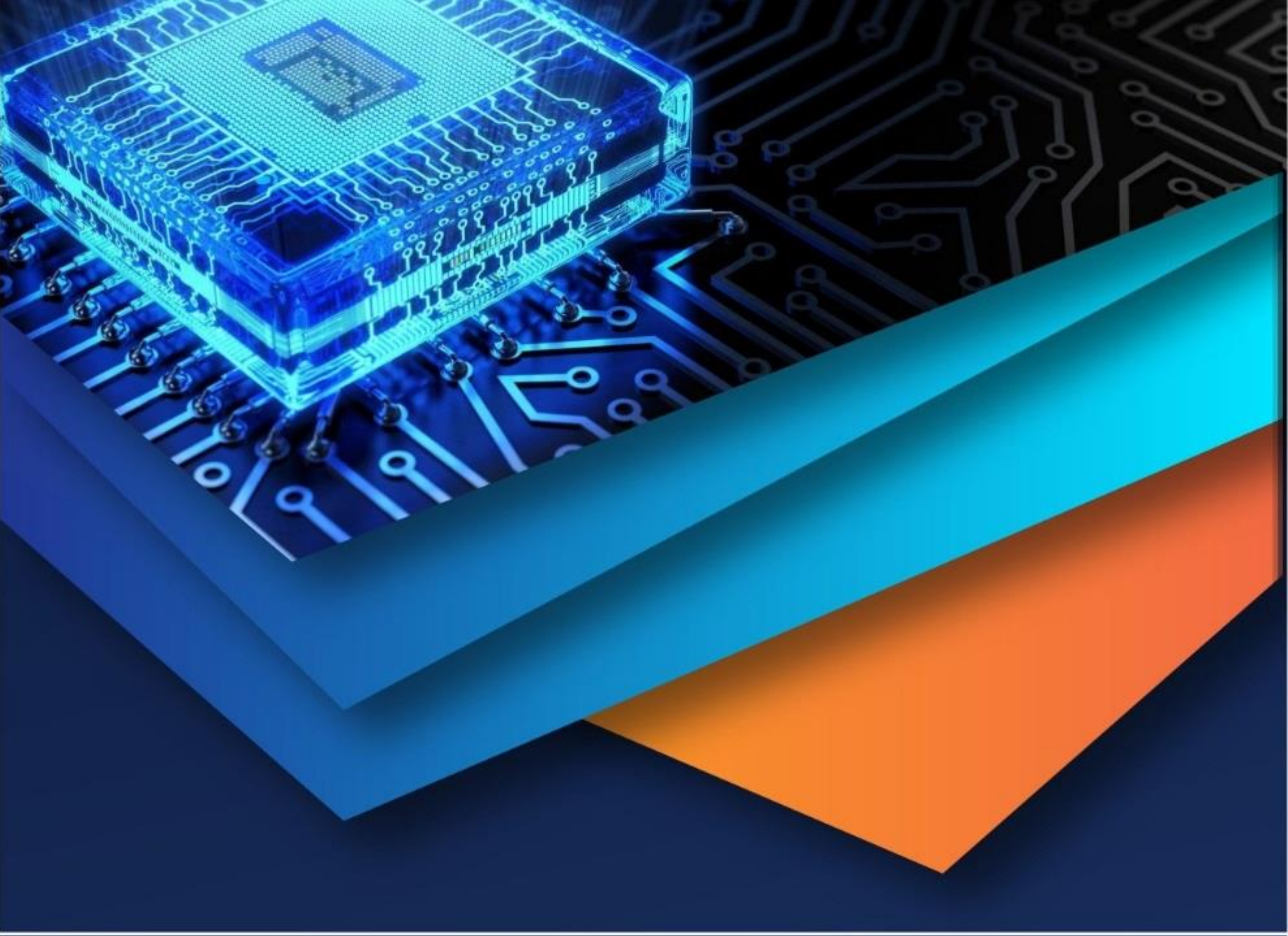
[3] Maágorzata Pająka, Tomasz Ponikiewski, “Experimental investigation on hybrid steel fibers reinforced self-compacting concrete under flexure”, Published by Elsevier Ltd 1877-7058 © 2017 .

[4] Mustafa Sahmaran, Alperen Yurtseven, I. Ozgur Yaman, “Workability of hybrid fiber reinforced self compacting concrete”, Building and Environment 40 (2005) 1672-1677.

[5] Nan Su al “Mix Design Method for Self-Compacting concrete” journal of cementand concrete research 31, 2001.

[6] Paratibha Aggarwal 1, Rafat Siddique 2,*, Yogesh Aggarwal 1, Surinder M Gupta 1 Leonardo Electronic Journal of Practices and Technologies ISSN 1583-1078Issue12, January-June 2008 p. 15-24.

[7] Pratyush Kumar, Rahul Roy, “Study and experimental investigation of flow and flexural properties of natural fiber reinforced self compacting concrete”, Procedia Computer Science 125 (2018) 598–608.



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