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Experimental Studies on SCC by Partial Replacement of Fine Aggregate with Foundry Sand

Shweta Raghunath Jadhav[1], Dr. Prashant O. Modani[2]
[1]*P.G. Student,* [2]*Assistant Professor, Department of Civil Engineering, Pankaj Laddhad Institute of Technology and Management Studies, Buldhana, Maharashtra, India*

Abstract: ***The paper demonstrates the possibilities of using waste foundry sand as partial replacement of sand in self-compacting concrete. Self-compacting concrete, as the name indicates, is a type of concrete that does not require external or internal compaction, because it becomes levelled and consolidated under its self-weight. Foundry sand is high quality silica sand used as a moulding material by ferrous and non-ferrous metal casting industries. It can be reused several times in foundries but, after a certain period, cannot be used further and becomes waste material, referred to as waste, used or spent foundry sand. Natural sand was replaced with four percentage (0%, 10%, 20%, 30%,40%) of WFS by weight. Fresh properties of self-compacting concrete were studied. Compression test, flexural test and splitting tensile strength test were carried out to evaluate the strength properties of concrete at the age of 7, 14, and 28 days.***
Keywords: Compressive strength, concrete and shrinkage

I. INTRODUCTION

Increasing rate of urbanization and industrialization has lead to over exploitation of natural resources such as river sand and gravels, which is giving rise to sustainability issues. It has now become imperative to look for alternatives of constituent materials of concrete. Waste foundry sand, a by-product of ferrous and non-ferrous metal casting industries is one such promising material, which can be used as an alternative to natural sand in concrete Foundry sand is high quality silica sand that is a by-product from the production of both ferrous and non-ferrous metal casting industries. It is used for the centuries as a moulding casting material because of its high thermal conductivity. For various foundry operations, raw sand is used and several binders and additives are added into it to enhance its properties.

II. REVIEW OF LITERATURE

Dr.G. Prince Bavita Bhardwaj and Pardeep Kumar (2017) found that the need of use of waste foundry sand (WFS) in concrete. Material properties of WFS. WFS shows enhanced mechanical performance of concrete. Durability of concrete enhanced with incorporation of WFS up to an optimum level.

Gurpreet Singh and Rafat Siddique (2011) added that the partial replacement of sand with WFS (up to 15%) increases the strength properties (compressive strength, splitting tensile strength and modulus of elasticity) of concrete. Maximum increase in compressive strength, splitting tensile strength and modulus of elasticity of concrete was observed with 15% WFS, both at 28 and 91 days. Inclusion of WFS increases the USPV values.

G. Ganesh Prabhu, Jung Hwan Hyun, Yun Yong Kim (2014) stated that the Foundry sand (FS) reused as a substitute material for fine aggregate in concrete. The physical and chemical characterization of the FS was studied. FS substituted in five different substitution rates (10%, 20%, 30%, 40% and 50%). Destructive and non-destructive tests were performed on all concrete mixtures. 20% Substitution is established as an optimum proportion of FS in concrete making.

III. METHODOLOGY

Ordinary Portland cement (J.K. Cement, Grade 43) was used conforming as per Indian standard specification BIS-8112:1989. The sand used for the experimental programme was locally procured and conformed to Indian Standard Specifications IS: 383-1970 and belonged to zone II.

Locally available coarse aggregate having the maximum size of 10 -12 mm was used in the work. Waste Foundry Sand was obtained from a local foundry unit, having specific gravity 2.43.

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The physical properties of foundry sand is as follows:

Table 1: Physical Properties of Foundry Sand

Properties	Observed values
Colour	Grey (Blackish)
Fineness Modulus	1.29
Specific Gravity	2.55
Water Absorption (%)	1.27

The chemical composition of foundry sand is as follows:

Table 2: Chemical composition of foundry sand

Constituents	Composition
SiO2	87.91
Al2O3	4.7
Fe2O3	0.94
CaO	0.14
MgO	0.3
SO3	0.09
TiO2	0.15
K2O	0.25
Na2O	0.19
LOI	5.15

The mix proportions of SCC for M30 are given below in Table

Table 3: Mix proportion of SCC

Mix	cement	WFS	Sand	CA	water		Superplasticizer	Superplasticizer
%	kg/m3	kg/m3	kg/m3	kg/m3	kg/m3	w/c	kg/m3	%
0%	472.5	0	1058.4	731.85	221.2035	0.4935	3.78	0.84
10%	472.5	105.84	952.56	731.85	221.2035	0.4935	3.78	0.84
20%	472.5	158.76	846.72	731.85	221.2035	0.4935	3.78	0.84
30%	472.5	211.68	740.88	731.85	221.2035	0.4935	3.78	0.84
40%	472.5	258.93	635.04	731.85	221.2035	0.4935	3.78	0.84

IV. RESULTS

From the experiment carried out following results are obtained:

Table 4: Slump values for SCC

Mix	Slump Flow	V-Funnel	L-Box	U-Box
%	mm	sec		mm
0%	635.25	7.35	1	5.25
10%	656.25	6.93	0.945	11.55
20%	656.25	6.594	1	17.85
30%	619.5	9.8385	0.84	24.15
40%	603.75	9.9225	0.798	29.4

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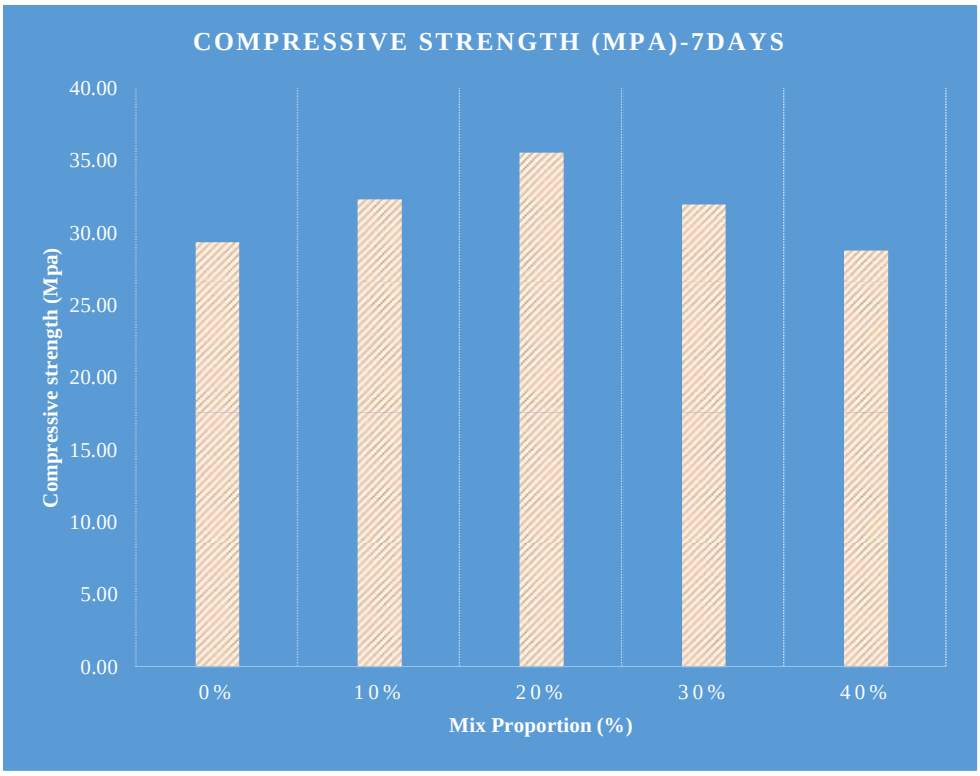

Figure 1: Compressive strength (7 days) of SCC with foundry sand

From the above figure it is observed that the compressive strength (7 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 35 MPa and then it goes on decreasing.

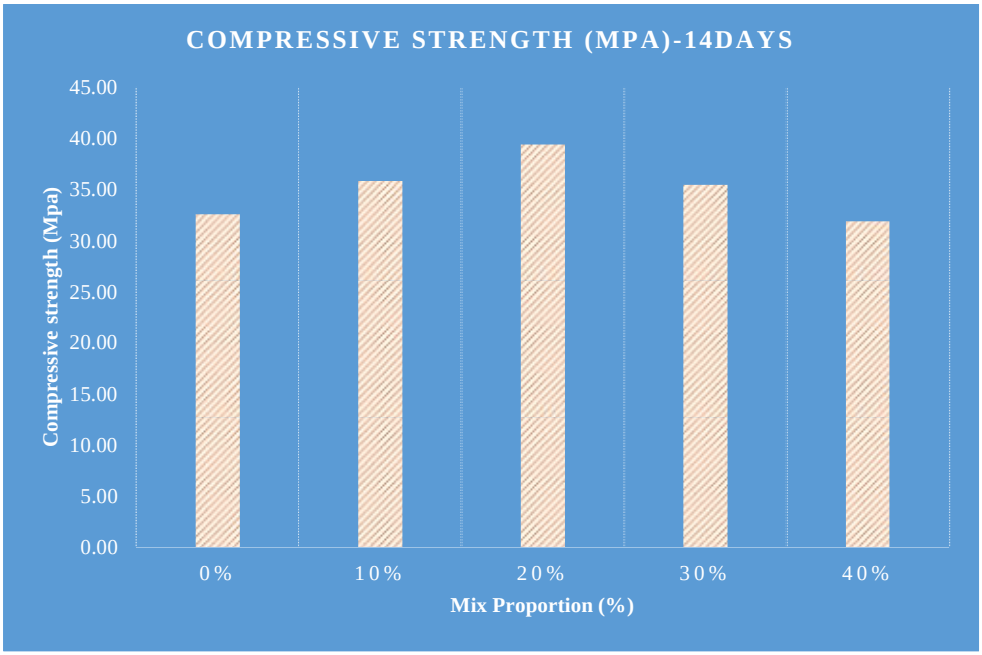

Figure 2: Compressive strength (14 days) of SCC with foundry sand

From the above figure it is observed that the compressive strength (14 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 40 MPa and then it goes on decreasing.

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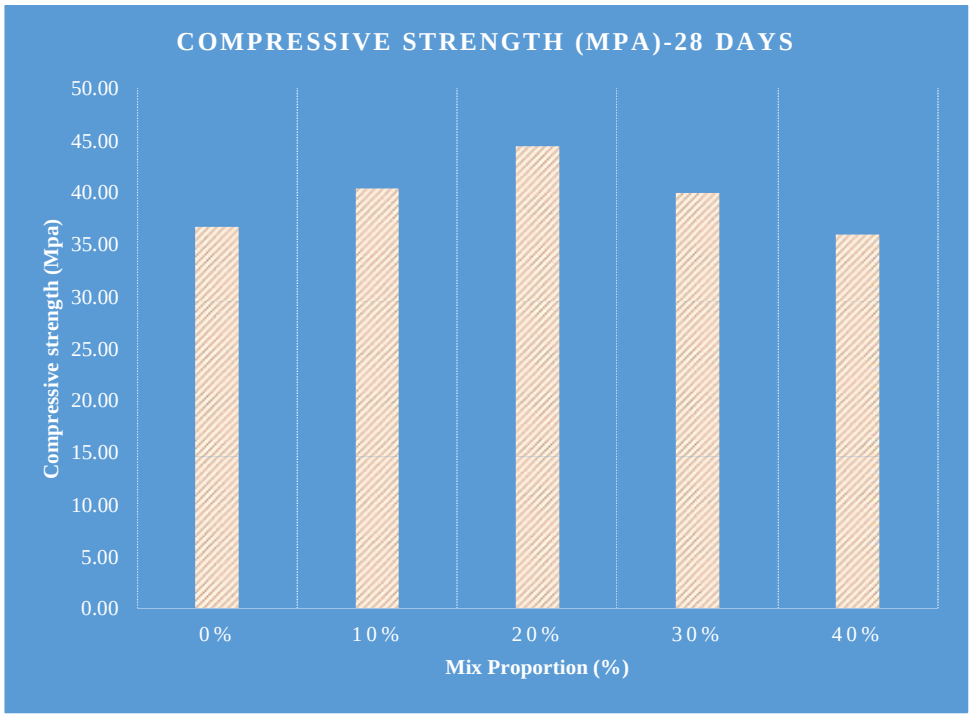

Figure 3: Compressive strength (28 days) of SCC with foundry sand

From the above figure it is observed that the compressive strength (28 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 45 MPa and then it goes on decreasing.

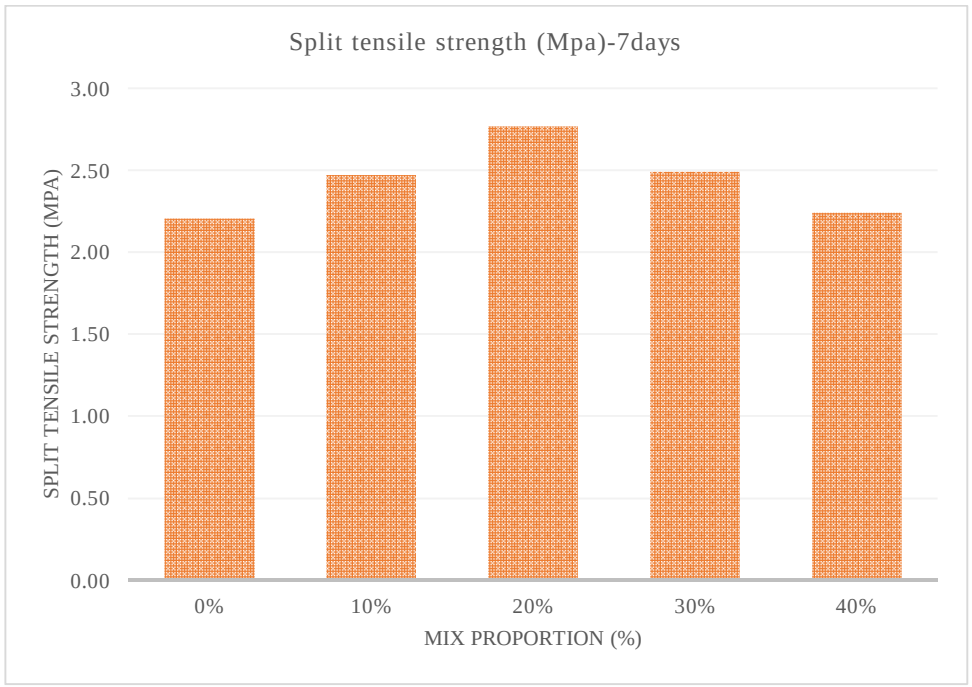

Figure 4: Split Tensile strength (7 days) of SCC with foundry sand

From the above figure it is observed that the Split tensile strength (7 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 2.75 MPa and then it goes on decreasing.

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Figure 5: Split Tensile strength (14 days) of SCC with foundry sand

From the above figure it is observed that the Split tensile strength (14 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 2.95 MPa and then it goes on decreasing.

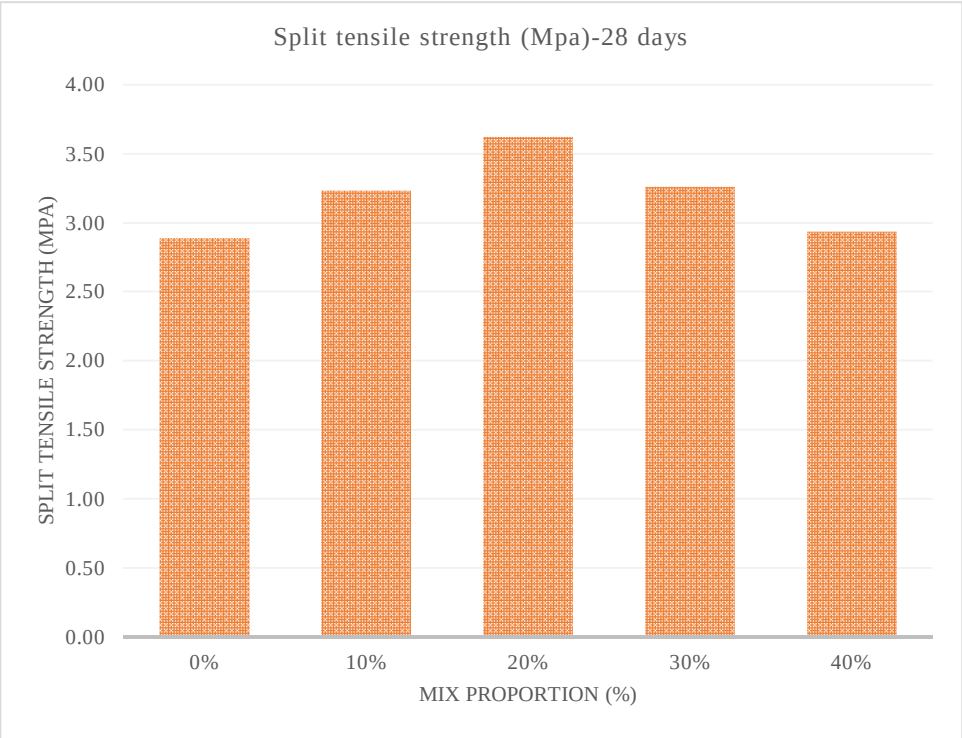

Figure 6: Split Tensile strength (28 days) of SCC with foundry sand

From the above figure it is observed that the Split tensile strength (28 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 3.52 MPa and then it goes on decreasing.

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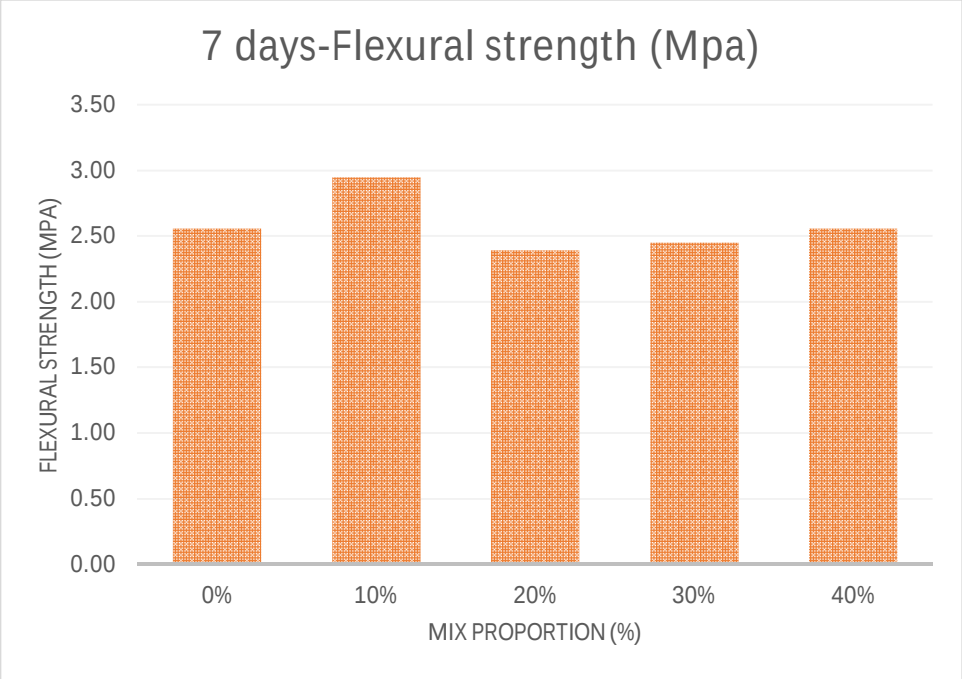

Figure 7: Flexural strength (7 days) of SCC with foundry sand

From the above figure it is observed that the Split tensile strength (7 days) of SCC with foundry sand observed to be highest in the 10% mix proportion having the value of 2.95 MPa and then it goes on decreasing.

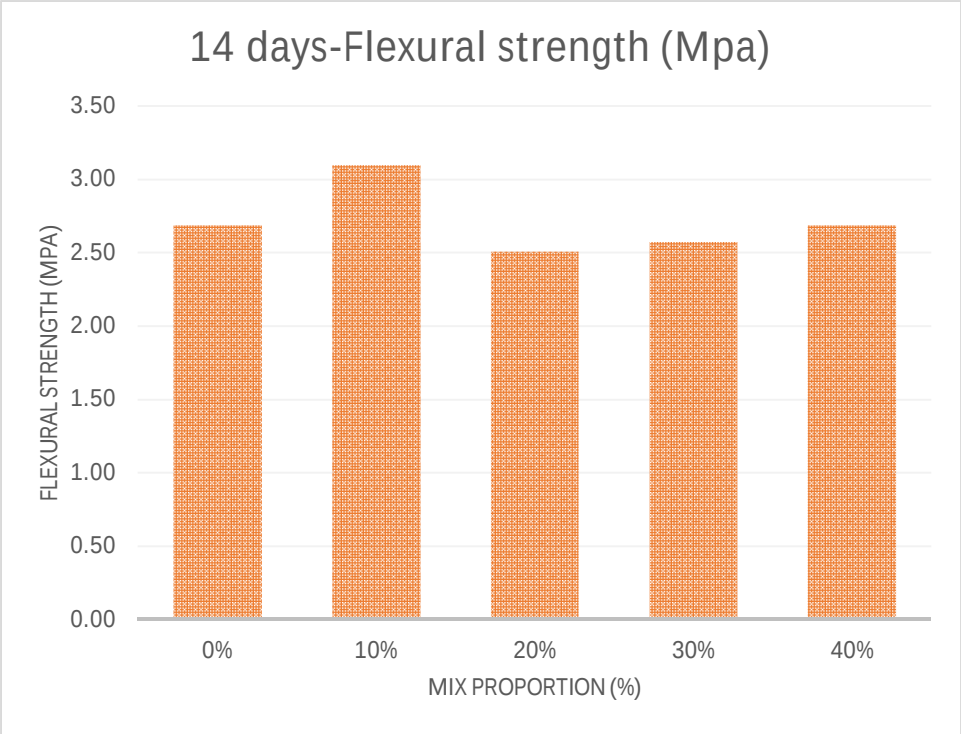

Figure 8: Flexural strength (14 days) of SCC with foundry sand

From the above figure it is observed that the Split tensile strength (14 days) of SCC with foundry sand observed to be highest in the 10% mix proportion having the value of 3.15 MPa and then it goes on decreasing.

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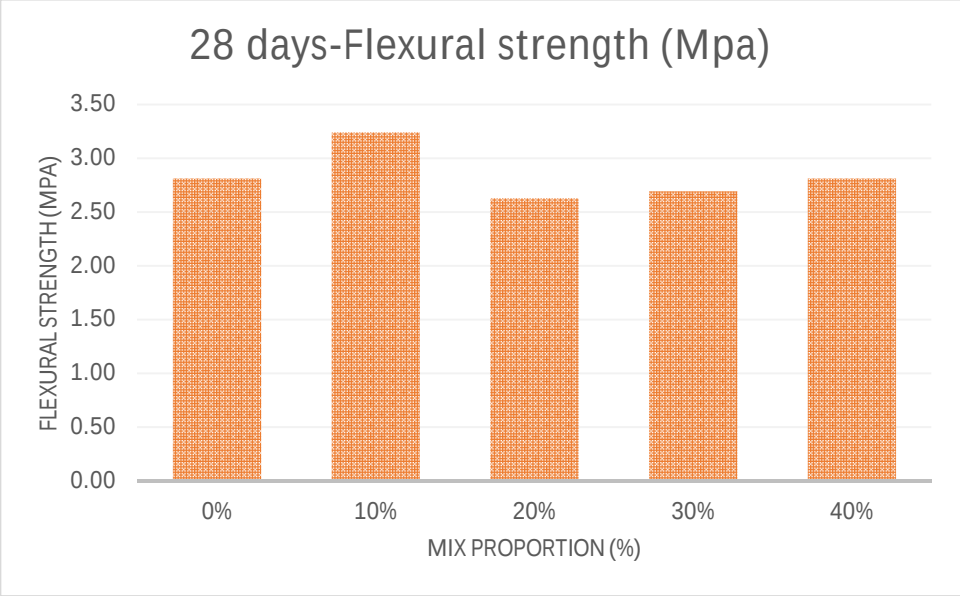

Figure 8: Flexural strength (28 days) of SCC with foundry sand

From the above figure it is observed that the flexural strength (28 days) of SCC with foundry sand observed to be highest in the 10% mix proportion having the value of 3.25 MPa and then it goes on decreasing.

V. CONCLUSION

The conclusions from the above study are as follows:

A. The From the above results it is observed that the compressive strength (7 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 35 MPa and then it goes on decreasing. Also it is observed that the compressive strength (14 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 40 MPa and then it goes on decreasing.

B. From the above results it is observed that the compressive strength (28 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 45 MPa and then it goes on decreasing. Also it is observed that the Split tensile strength (7 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 2.75 MPa and then it goes on decreasing.

C. From the above results it is observed that the Split tensile strength (14 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 2.95 MPa and then it goes on decreasing. Also it is observed that the Split tensile strength (28 days) of SCC with foundry sand observed to be highest in the 20% mix proportion having the value of 3.52 MPa and then it goes on decreasing.

D. From the above results it is observed that the Flexural strength (28 days) of SCC with foundry sand observed to be highest in the 10% mix proportion having the value of 3.25 MPa and then it goes on decreasing.

E. It is observed that the maximum replacement of fine sand in the self compacted concrete is possible up to 20% with the foundry sand.

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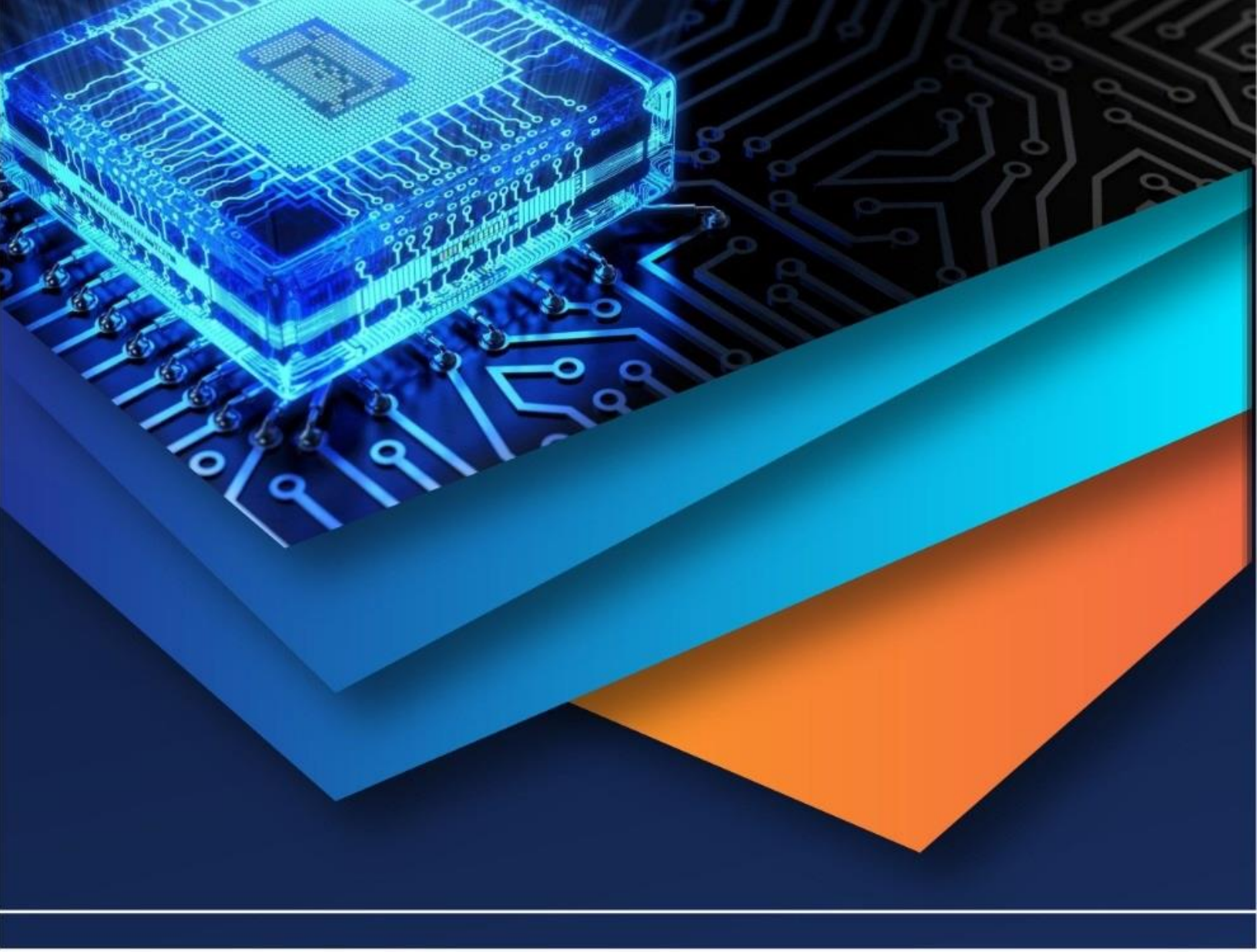

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