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An Experimental Study on Partial Replacement of River Sand by Manufactured Sand in Self-Compacting Concrete

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***Abstract:** SCC was first developed in Japan to achieve durable concrete structures in 1980's. Self-compacting concrete (SCC) is an innovative concrete which can be placed and compacted under its own weight with little or no vibration effect and at the same time cohesive enough to be handled without segregation or bleeding. Adoption of SCC offers substantial benefits in enhancing construction productivity, reducing overall cost, and improving work environment. Cost reduction in the building is the primary objective in developing countries like India. This paper puts forward the applications of manufactured sand as an attempt towards sustainable development in India. It will help to find valuable solution to the declining availability of natural sand to make eco-balance. Manufactured sand is one among such materials to replace river sand, which can be used as an alternative fine aggregate in mortars and concretes. The use of manufactured sand in concrete is gaining momentum these days. The present experimental investigations have been made on concrete using manufactured sand as fine aggregate and observed the effects of crushed manufactured sand on strength properties of concrete. The application of concrete meeting the specification is of paramount importance, to ensure construction of durable R.C.C. structure. A well processed manufactured sand as full replacement to river sand is the need of the hour as a long-term solution in Indian concrete industry until other suitable alternative fine aggregate are developed.*
***Keywords:** Cement, Fine Aggregate, Coarse Aggregate, Water, Chemical Admixtures, High Range Water Reducing Admixture, Viscosity Modifying Admixture, Slump Flow test, L-Box, J-Ring, V-Funnel test.*

I. INTRODUCTION

Concrete Concrete technology has made tremendous strides in the past decade. The development of specifying a concrete according to its performance requirements, rather than the constituents and ingredients has opened innumerable opportunities for producers of concrete and users to design concrete to suit their specific requirements. One of the most outstanding advances in the concrete technology over the last decade is "Self-Compacting Concrete" (SCC). Self-compacting concrete (SCC) was first developed in Japan in 1988. Self-Compacting Concrete is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The improved construction practice and performance, combined with the health and safety benefits, make self-compacting concrete a very attractive solution for civil engineering construction. The use of SCC is increasing.

Concrete is a widely used construction material around the world, and its properties have been undergoing changes through technological advancement. Numerous types of concrete have been developed to enhance the different properties of concrete. So far, this development can be divided into four stages. The earliest is the traditional normal strength concrete which is composed of only four constituent materials, which are cement, water, fine and coarse aggregates. At the way to achieve the high compressive beginning, reducing the water cement ratio was the easiest way to achieve the high compressive strength. Thereafter the fifth ingredient a water reducing agent or super plasticizer was indispensable. But now a day the cost of sand has been increasing beyond imagination which is resulting in the increase in concrete cost. This is because demand for sand is more than its supply to overcome this problem the experiment on concrete by partial replacement of river sand by manufactured sand in self-compacting concrete. We can reduce the cost of concrete and enhance the strength of concrete also M-sand can reduce ecological imbalance in nature. To study the mechanical properties of both SCC and manufactured sand as a replacement material in various percentages to the mix. A study has been done on the compressive, flexural and split tensile strength with these various mix Self-compacting mixes are designed to have fresh properties that have a higher degree of workability than convectional concrete. Workability is a way of describing the performance of concrete in the plastic state.

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II. ADMIXTURES USED

A. Chemical Admixtues

Chemical admixtures reduce the cost of construction, modify properties of hardened concrete, ensure quality of concrete mixing/transporting/placing/curing, and overcome certain emergencies during concrete operations. Chemical admixtures are used to improve the quality of concrete during mixing, transporting, placement and curing. Superplasticizers are well known chemical admixtures for concrete used in the reduction of water to cement ratio without affecting workability, and to avoid particle aggregation in the concrete mixture. These are also known as high range water reducers (HRWR), fluidifiers, and dispersants as these are capable of reducing water to cement ratio by 40.0%. These chemical admixtures are added in the concrete just before the concrete is placed. These admixtures help to improve strength and flow characteristics of the concrete. Flow characteristics and slump of concrete varies with type, dosage, and time of addition of concrete superplasticizer. Superplasticizers can be classified into four types such as,

1) High Range Water Reducing Admixture (HRWA),
2) Viscosity Modifying Admixture (VMA),

B. High Range Water Reducing Admixture (HRWA)

Concrete in different situations require different degree of workability. A high degree of workability is required in situations like deep beams, thin walls of water retaining structures with high percentage of steel reinforcement. The conventional method used for obtaining high workability is by improving the gradation or by the use of relatively higher percentage of fine aggregate or by increasing cement content.

There are difficulties and limitations to obtain high workability in the field for a given set of conditions. The addition of excess water will only improve the fluidity or the consistency but not the workability of the concrete. The excess water will not improve the fluidity or the consistency but not the workability of the concrete. High range water reducing admixture helps to solve the problem by giving required workability at lower water content. It has become to use high range water reducing admixture for all reinforced concrete and mass concreting to reduce the water requirement for making concrete of higher workability. The use of HRWA permits the reduction of water to an extent up to 30% without reducing workability. The water/cement ratio can be low as 0.35 or even lower and flowing concrete can have strength of the order of 120 MPa.

C. Viscosity Modifying Admixture (VMA)

A Self-compacting concrete should have high workability and viscosity. The fluidity of the mix increases as there is no internal friction between the particles and the concrete flows freely. Segregation occurs when the components of the concrete separates out into the mortar ad large aggregates. Reaching a right balance between fluidity and resistance to segregation is essential for Self-compacting concrete. This balance is lacking when the fluidity of the concrete is obtained by adding water. Even through HRWA gives high fluidity, the required property of the Self-compacting concrete is not ensured. Therefore, there is a need for Viscosity Modifying Admixture to attain required property.

High-Range Water Reducing Admixture

Viscosity Modifying Admixture

III. MIX DESIGN

A MIX FOR M30 GRADE OF CONCRETE WAS DESIGNED AS PER IS 10262-2019.

A. Design Parameter

1) Grade of concrete = M30
2) Exposure type = Severe
3) Standard deviation = 5
4) Maximum size of aggregate = 10
5) Maximum water/cement ratio = 0.45
6) Minimum cement content = 360 kg/m3
7) Cement type = PPC
8) Mineral admixture type = Fly-ash
9) Percentage of fine aggregate = 55%
10) Specific gravity of cement = 3.10
11) Specific gravity of coarse aggregate = 2.75
12) Specific gravity of fine aggregate = 2.59

B. Target Mean Strength

Target mean strength = fck + (t * s)
= 30 + (5 * 1.65)
= 38.25 MPa

C. Water Cement Ratio

The water cement ratio required for the target meant strength of 38.25 MPa is 0.45 (as per IS: 10262)
Adopt water-cement ratio as 0.45

D. Water Content

Maximum water content = 208 kg (for 10mm aggregate)
Water content = 208+ ((208*6)/100)
= 208+12.48
= 220.48 litre

E. Cement Content

Water cement ratio = 0.45
Water = 220.48 litre
Cement Content = 220.48/0.45
= 489.95 kg/m^3

From table 5 of IS 456, minimum cement content for 'severe' exposure condition = 320 kg/m^3.
489.95 kg/m^3>320 kg/m^3, Hence O.K.

F. Volume of Coarse Aggregate and Fine Aggregate Content

Proportion of volume of coarse aggregate for the water-cement ratio of 0.45 = 0.62 + 0.028 = 0.648.
Volume of coarse aggregate = 0.648 kg/m^3
Volume of fine aggregate = 1 – 0.648 = 0.352kg/m^3

G. Selection of Dosage of HRWA and VMA

Percentage of HRWA = 1% of solution = 4.9 kg
Percentage of HRWA = 2% of solution = 9.8 kg
Percentage of VMA = 0.2% of solution = 0.98 kg

H. Mix Proportion

Mix ratio for concrete depends on the properties of materials used in making of concrete. Admixture is added 1% of the weight of the cement in wet mix.

Materials	Cement	Coarse Aggregate	Fine Aggregate	Water/Cement Ratio	Super-Plasticizer (1%)	Super-Plasticizer (2%)	VMA (02%)
Proportion	1	2.21	1.16	0.44	0.01	0.02	0.002
Quantity kg/m^3	489.95	1084	570	220.48	4.9	9.8	0.98

IV. CASTING OF SPECIMEN

As per derived mix design ratio, Specimen to be casted are listed below as follows as

1) Cube mould (150 x 150x 150 mm)
2) Cylinder mould (150 x 300 mm)
3) Beam mould (500 x 100 x 150 mm)

Cube Specimen

Cylindrical Specimen

Beam Specimen

V. TESTING OF SPECIMEN

A. Fresh Concrete Test

Self-compacting concrete (SCC) can be defined as fresh concrete that flows under its own weight and does not require external vibration to undergo compaction. It is used in the construction where it is hard to use vibrators for consolidation of concrete. Filling and passing ability, segregation resistance are the properties of self-compacting concrete. SCC possess superior flow ability in its fresh state that performs self-compaction and material consolidation without segregation issues. The materials, tests and properties of self-compacting concrete are explained in the below sections.

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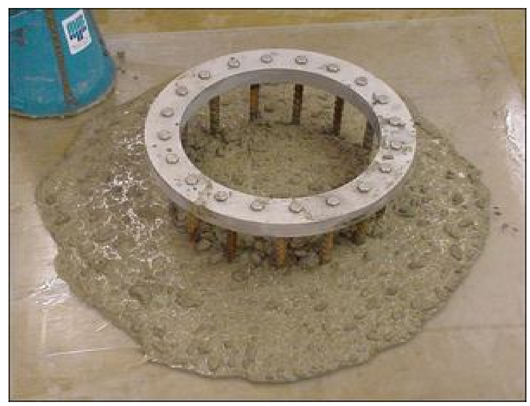
The following test should be conduct for determine the fresh properties of concrete.

1) Slump flow test
2) V funnel test
3) L Box test
4) J Ring test

Slump Flow Test

V-Funnel Test

L-Box Test



J-Ring Test

B. Hardened Concrete Test

Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works. One of the main purposes of testing hardened concrete is to confirm that the concrete used at site has developed the required strength. Following are the static tests to be carried out on the fresh concrete in order to study the properties and behaviour of a fresh concrete that determines the mechanical behaviour of the concrete. Hardened concrete is a type of concrete that is strong and have the capacity to bear the structural as well as service loads that are applied to it. Hardened concrete is one of the strongest and durable construction materials. Hardened concrete is concrete that is completely set and able to take the loads.

Compression Test on Cube

Split Tensile Strength Test on Cylinder

Flexural Strength Test on Beam

VI. TEST RESULTS

Acceptance Criteria for SCC

Name of the Test	Property	Unit	Minimum	Maximum
Slump flow	Filling ability	spread (mm)	650	800
T-50cm slump flow	Filling ability	Time (sec)	2	5
V-funnel	Filling ability	Time (sec)	6	12
V-funnel (5 min)	Segregation resistance	Time (sec)	0	15
L-box	Passing ability	H2/H1	0.8	1

Fresh Concrete Test Results of Different Mixes

Particulars	Slump flow (mm)	V-funnel (secs)	V-funnel @ T5 mins (secs)	L-box	Remarks
TM-01	455	17	25	0.5	Not Satisfied
TM-02	615	14	18	0.76	Not Satisfied
TM-03	515	16	22	0.63	Not Satisfied
TM-04	720	8	10	0.96	Satisfied
TM-05	675	9	12	0.83	Satisfied
TM-06	710	7	9	0.81	Satisfied
TM-07	520	17	-	0.52	Not Satisfied
TM-08	665	11	13	0.82	Satisfied
TM-09	690	9	11	0.84	Satisfied
TM-10	725	8	10	0.89	Satisfied
TM-11	635	15	18	0.56	Not Satisfied
TM-12	680	11	13	0.86	Satisfied

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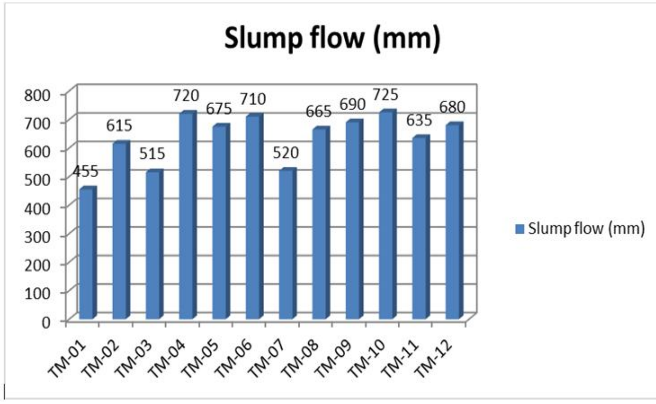
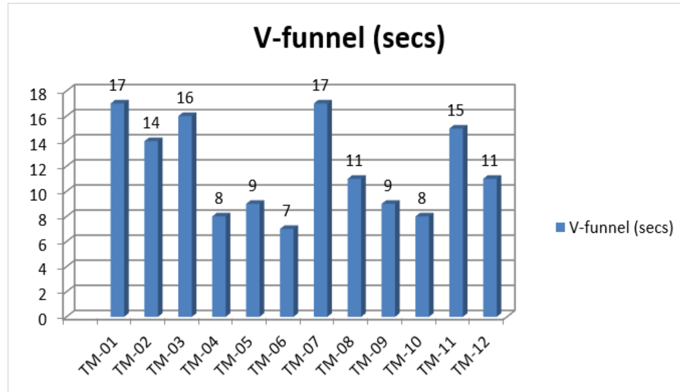
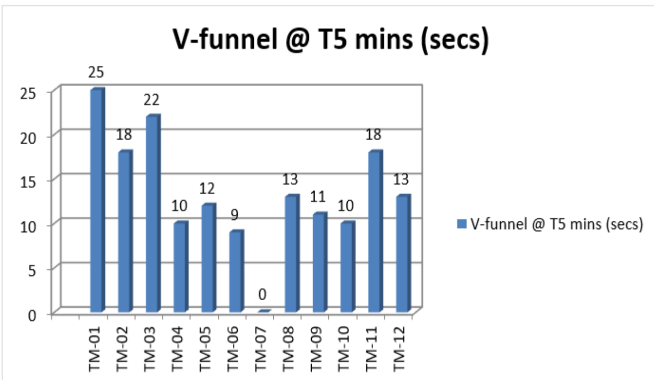
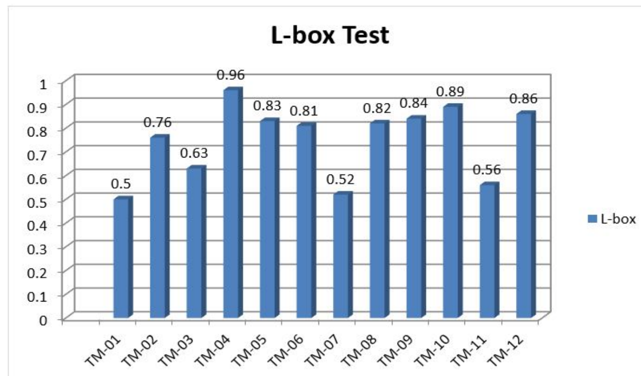


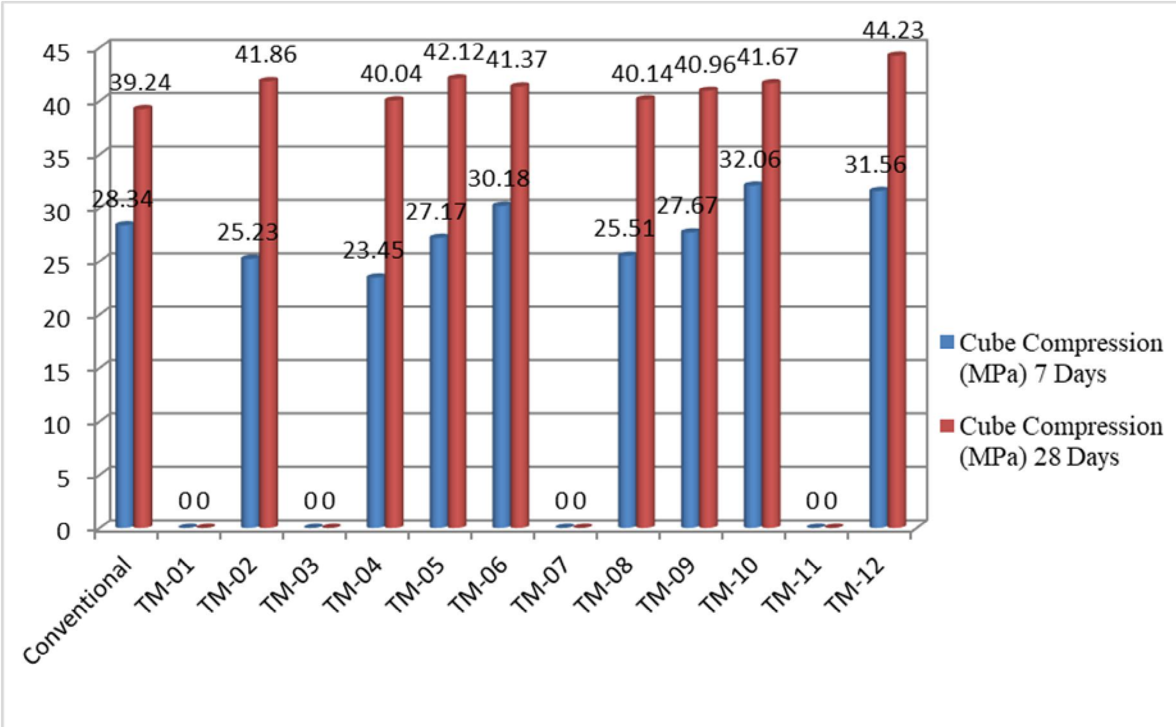




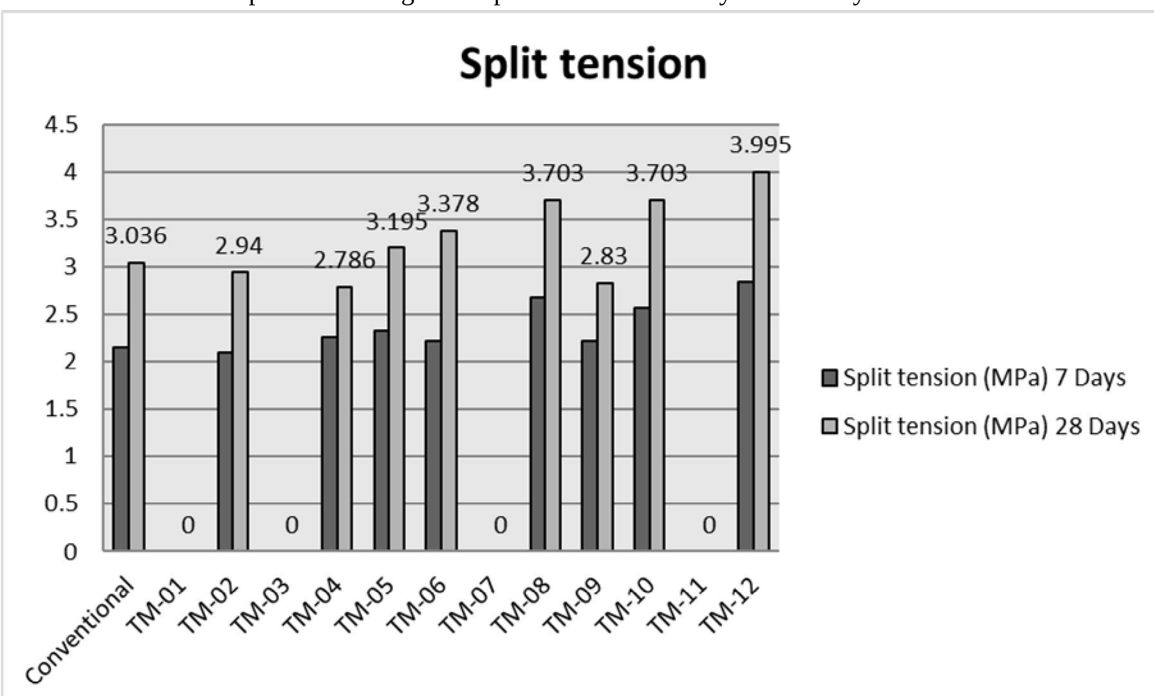


Hardened Concrete Test Result for Conventional and SCC

Particulars	Cube Compression (MPa)		Split tension (MPa)		Flexural Strength (MPa)
	7 Days	28 Days	7 Days	28 Days	28 Days
Conventional	28.34	39.24	2.153	3.036	5.490
TM-01	-	-	-	-	5.651
TM-02	25.23	41.86	2.100	2.940	5.729
TM-03	-	-		-	5.863
TM-04	23.45	40.04	2.261	2.786	5.615
TM-05	27.17	42.12	2.320	3.195	5.686
TM-06	30.18	41.37	2.217	3.378	5.772
TM-07	-	-	-	-	-
TM-08	25.51	40.14	2.674	3.703	5.526
TM-09	27.67	40.96	2.213	2.830	5.412
TM-10	32.06	41.67	2.561	3.703	5.739
TM-11	-	-	-	-	-
TM-12	31.56	44.23	2.843	3.995	5.415



Compression Strength Comparison Chart of 7 days and 28 days result



Split Tension Comparison Chart of 7 days and 28 days result

VII. CONCLUSION

Today, the engineering industry in India is growing very fast. The infrastructure growth is phenomenal which demands new innovative methodologies in execution of the projects. Effective handling and quicker completion of the projects are very important to achieve the proposed growth of the country. The civil engineering fraternity all over the world in general and in India is working to find new innovative materials which would help in achieving the targets. Such innovation has to be with materials which are easily available, ecofriendly, economical and satisfies the technical requirements.

Self-compacting concrete (SCC) is one such innovations of type of concrete that has excellent fluidity in the fresh state with high resistance to segregation and can be placed in intricate geometry and gets compacted under its own self weight without applying vibration. The requirement of concrete in India is increasing day by day but at the same time, the resources like river sand is depleting. More use of river sand also would affect the water table in the river beds which in turn will have a detrimental effect on the environment. At this juncture, it is all the more important to find a suitable alternative to river sand which can perform equally. In this context, this study was aimed at developing and investigating SCC with the use of manufactured sand replacing natural river sand. Design and development of SCC were done using European Federation for Specialist Construction Chemicals and Concrete Systems (EFNARC) Norms. Following criteria was followed in the study.

The SCC mix proportion that was obtained using EFNARC 2005 guidelines is capable of achieving the SCC characteristics. Cement and coarse aggregate is kept as constant throughout this study. Fine aggregate is partly replaced as Manufacture sand in the percentage of 25%, 50% and 75%. The recommended dosage of super plasticizer admixture (Glenium B233) is kept as 1percent and 2 percent by weight of powder content for the various mixes of concrete and the Viscosity modifying agent (Glenium stream 2) is fixed as 0.2 percent of weight of powder content. The test results of the workability investigations are summarized in table. Based on the test results we can conclude that the table values satisfied the requirement criteria mentioned in table. The hardened concrete test results are summarized in table. It is observed that with the increase in percentage of Fly ash and Rice husk ash there is reduction in strength parameters. And also compared to the 7 days strength of concrete, the 28 days compressive strength and split tensile strength of concrete are increased by 41% and 55%.

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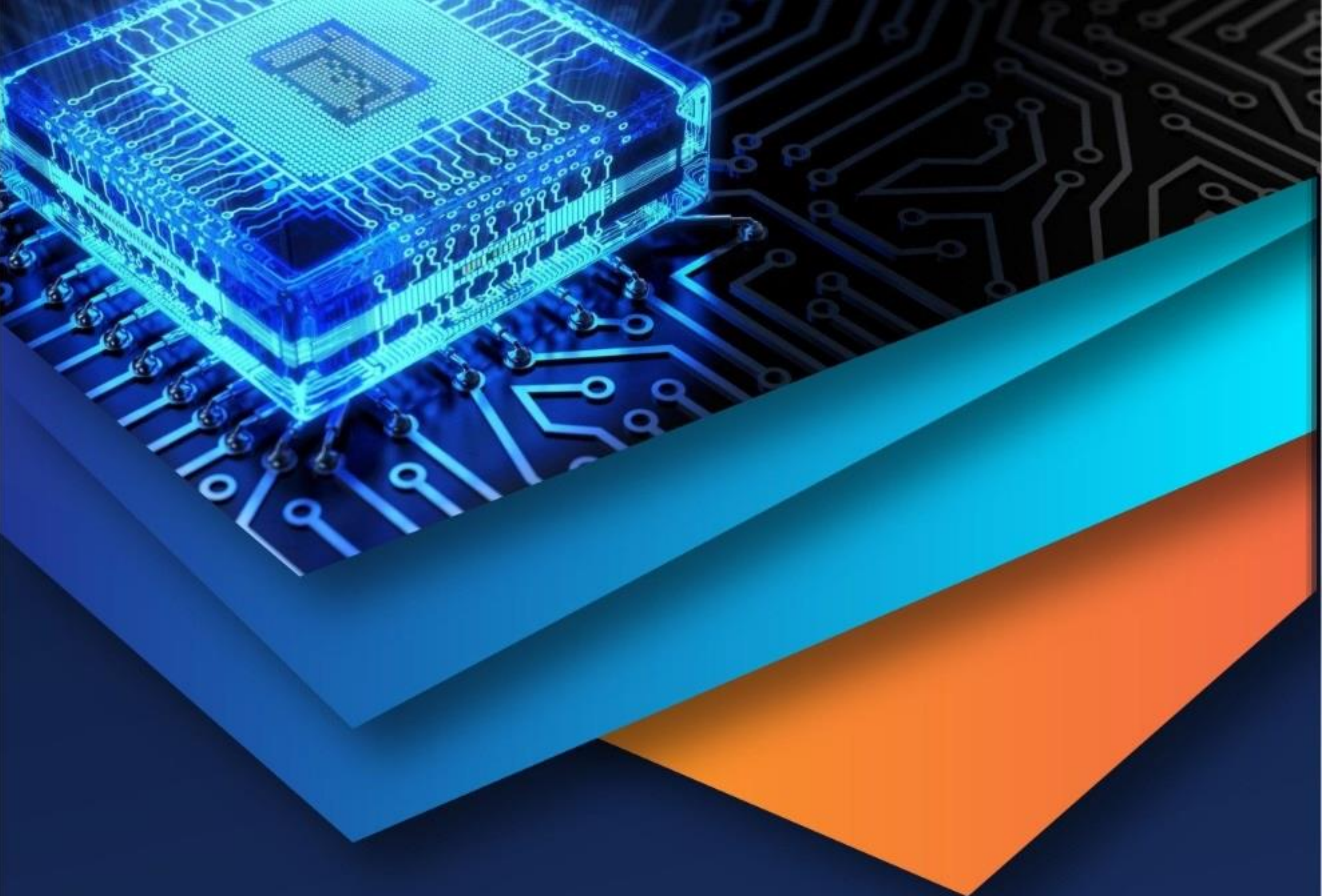
REFERENCES

[1] Manufactured Sand, a Solution and an Alternative to River Sand and In Concrete Manufacturing by Dr.S.Elavenil, et.al, DR. M.G.R. University, Chennai,2013.
[2] Effect of replacement of natural sand by manufactured sand on the Properties of cement mortar by Priyanka A. et.al, IIT, Bombay, 2013.
[3] Experimental Investigation of Concrete with Combined High alumina cement, Silica fume and M-Sand byDona Maria Joseph, et.al. Karunya University, 2013.
[4] An experimental investigation on the properties of concrete containing manufactured sand by Priyanka A, et.al, IIT, Bombay, 2012.
[5] Investigations on flexural behavior of high strength manufactured sand concrete, By C.V. Raghu Pathi, et.al Osmania University, Hyderabad, 2010
[6] Study on fly ash concrete using SEM analysis by B.Vidivelli, et.al. Annamalai University, 2009.
[7] Strength development of cement mortar and Concrete incorporating GGBFS, by Shariq, et.al, IIT Roorkee, 2008.
[8] Effects of curing procedures on the strength and permeability of cementitious composites incorporating GGBFS by Seung-Tae Lee, et.al, Kunsan National University, Korea, 2008.
[9] The use of manufactured sand in concrete production by Dinku Belay, et.al, Addis Ababa University, 2006.
[10] Influence of silica fume on the tensile strength of concrete by S. Bhanja, et.al, Bengal Engineering College, 2004.
[11] EFNARC, "Specification and Guidelines for Self-Compacting Concrete", February, 2002.
[12] Sven-Henrik Norman (2008), "Sand solutions: Replacing natural sand in concrete -special report", page no. 24-26, QUARRY, December, 2008.
[13] Salvador Villalobos and Lange D.A. (2005), "Evaluation, testing and comparision between crushed manufactured sand and natural sand", Technical Note No. 15, CEAT, University of Illinois.
[14] B. V. Kavyateja, J. Guru Jawahar, and C. Sashidhar, "Effectiveness of alccofine and fly ash on mechanical properties of ternary blended self-compacting concrete," Mater. Today Proc., vol. 33, pp. 73–79, 2020.
[15] B. V. Kavyateja, J. Guru Jawahar, and C. Sashidhar, "Effect of alccofine and fly ash on analytical methods of self-compacting concrete," Innov. Infrastruct. Solut., vol. 5, pp. 1–11, 2020.
[16] G. Kaur, R. Siddique, and A. Rajor, "Properties of concrete containing fungal treated waste foundry sand," Constr. Build. Mater., vol. 29, pp. 82–87, 2012.
[17] B. V. Kavyateja, J. Guru Jawahar, C. Sashidhar, and N. Reddy Panga, "Moment carrying capacity of RSCC beams incorporating alccofine and fly ash," Pollack Period., vol. 16, no. 1, pp. 19–24, 2021.
[18] P. N. Reddy, B. Bhushan Jindal, B. V. Kavyateja, and A. Narender Reddy, "Strength enhancement of concrete incorporating alccofine and SNF based admixture," Adv. Concr. Constr., vol. 9, no. 4, pp. 345–354, 2020.
[19] P. N. Reddy and J. Ahmed Naqash, "Effectiveness of polycarboxylate ether on early strength development of alccofine concrete," Pollack Period., vol. 15, no. 1, pp. 79–90, 2020
[20] BIS: 12269-1987, B.: Specification for 53 Grade Ordinary Portland Cement, Bur. Indian Stand. New Delhi, India, 1987.
[21] BIS-3812 (Part-1):2003, Pulverized fuel ashspecification for use as pozzolana in cement, cement mortar and concrete, New Delhi, India, Bureau of Indian Standards.
[22] BIS 383, Specification for Coarse and Fine Aggregate from natural Sources for Concrete (Second Revision), New Delhi, India, Bureau of Indian Standards, 1970.



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