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Experimental Study of Replacement of Cement by Silica Fume for M-25 Concrete

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Abstract: In this research paper for described the replacement by the cement by silica fume for various percentage. For present scenario concrete are the most adjustable structure materials for the reason that it can be designed to survive the harshest environments while taking on the most encouraging forms. In the present scenario most concrete mixture contains additional cementitious material which forms element of the cementitious element. The major benefit of supplementary cementitious material is their ability to return certain amount of cement and still capable to present cementitious property, for result reduced cost of using portland cement. For waste materials which can be used as additional cementitious material like silica fume. For this purpose silica fume is replaced by 0%, 5%, 7.5%, 12.5%, 15%, 20% & 25% by the weight of cement. Tests were conducted in the research which showed the results of the same percentage at the different of 0% 5%, 7.5%, 12.5%, 15%, 20% & 25% for the time period of 7, 14, and 28 days curing as a substitution of cement by micro silica on compressive strength test. The results show the maximum increase in strength of concrete occurred when 15% cement replacement was done with silica fume.
Keywords: Cement, Compressive strength, Silica fume, Workability

I. INTRODUCTION

Concrete is a most commonly used building material .It is a mixture of cement, sand, coarse aggregate and water. They are used as a multi-storey Buildings, dams, Road pavement, tanks, offshore structures, canal lining. The method of selecting appropriate ingredients of concrete and determining their relative amount with the intention of producing a concrete of the necessary strength durability and workability as efficiently as possible is termed the concrete mix design. The CS (Compressive Strength) of harden concrete is commonly considered as a index of its extra properties depends upon a lot of factors e.g. worth and amount of cement water and aggregates batching and mixing placing compaction and curing. The cost of concrete prepared by the cost of materials plant and labour the variation in the cost of material begin from the information that the cement is numerous times costly than the aggregates thus the intent is to produce a mix as feasible from the practical point of view the rich mixes may lead to high shrinkage and crack in the structural concrete and to development of high heat of hydration in mass concrete which may cause cracking. The genuine cost of concrete is related to cost of materials essential for produce a minimum mean strength called characteristic strength that is specific by designer of the structures.

II. REVIEW OF LITERATURE

The study on the performance of HPC trial mixes having different replacement levels of cement with SF were done by them. Compressive strengths of 60 MPa, 70 MPa and 110 MPa at 28days were obtained by using 10 percent substitute of cement by Silica Fume. Its results also show the SF concretes possess superior durability properties. Cement replacement level of 10 percent with SF in M60, M70 and M110 grades of HPC mixes is found to be the optimum level to achieve high values of CS (Compressive strength), ST(Split tensile strength) ,FS(flexural strength) and the EM(Elastic Modulus) and lower values SWA, porosity and sorptivity at the age of 28 days. It can be concluded that substitute of cement with MS up to 10 % would provide the concrete more strong and durable. This observation is in par with the maximum limit of 10 % for mineral admixture in concrete mixes as recommended by IS:456-2000 (K. Perumal et.al [2004])

The current research work is to determine the optimum replacement percentages which be able to be properly used under the Indian conditions. It has been seen that when cement is replaced with silica fume compressive strength increases up to definite percentage 10% substitute of cement by a SF. However higher substitute of cement with SF gives lesser strength. For the result of SF on various other properties of Concrete have also is evaluated. This paper be an extremely superior tool used for the basic to understand the effect and have an forget of Silica Fume on Concrete. Since the results it is conclude with the aim of the silica fume is a superior replacement of cement. The rate of strength increase in silica fume concrete is high. They concluded that increase in w/cm ratio strength of concrete decreases (Prof. Vishal S. Ghutke, et.al [2011])

Investigation on the properties of materials crystalline and non-crystalline was done by them. Micro silica are especially fine non crystalline material. In Present investigation we are using silica fume as a non-natural pozzolana. On adding 0%, 5%, 10%, 15% by wt of cement in concrete. SF improve concrete throughout two mechanisms: PE and: MFE. Silica fume increases the strength of concrete more 25%. Silica fume is a material which can be a explanation of Air Pollution this is a by-product of some Industries use of micro silica with concrete decrease the air pollution. Silica fume also reduce the voids in concrete. Addition of silica fume reduce the (capillary Absorption & porosity) as a finer particles of SF react through lime here into cement (Verma Ajay et.al [2012]).

Reviewed study for M35 grade of a concrete with a partial substitute of a cement by micro silica by 0, 5, 10, 15 and by 20% were done by them. It gives a detailed experimental study on CS(Compressive strength), ST(split tensile strength),FS(flexural strength) For 7 and 28 Days. Durability study on acid assault was also study and percentage of weight loss is compared by normal concrete. Test results shows that use of MS(micro silica) within concrete have enhanced performance for concrete in strength as well as in durability feature The optimum micro silica replacement percentage for obtaining highest 28- days strength of concrete range from 10 to 20 %. Cement substitute up to 10% with silica fume leads to enhance in compressive strength, designed for M30 grade of concrete. Consistency of cement depends upon its fine quality. Micro silica is having better fine quality than cement and better surface area so the consistency increases very much, when micro silica percentage increases. The normal consistency increases about 40% once micro silica percentage increases from 0% to 20% (N. K. Amudhavalli, Jeena Mathew [2012]).

They worked on the strength parameters of concrete made with replacement of a cement by Silica Fume. Compressive strength, Flexural strength, Splitting Tensile strength have been determined for different mix up combinations of materials and these values are compared with the related values of conventional concrete Investigation have been designed at to bring awareness along with the practicing civil engineers regarding advantages of these new concrete mixes. From the study it has been observed that maximum compressive strength (both cube and cylinder) is noted for 10% substitute of cement with micro silica and the values are higher (by 19.6% and 16.82% respectively) than those of the normal concrete (for cube and cylinder) whereas ST(split tensile strength) & FS(flexural strength) of a silica fume concrete are increased by about 38.58% and 21.13% respectively over those (2.6 N/mm2 and 4.07 N/mm2respectively) of the normal concrete when 10% of cement is replaced by SF (Dilip Kumar Singha Roy et.al [2012]).

They explained the use of micro silica will not significantly vary the unit mass of concrete. Silica fume will produce a much fewer permeable also high strength concrete, however it will not manufacture a concrete with a high mass for each unit volume. The addition of silica fume reduces workability. However, in some cases improved workability were also reported. Silica fume inclusion increases compressive strength significantly (6-57%) and increase in compressive strength depends upon replacement level. TS(Tensile strength) and FS(Flexure Strength) of a SF concrete is similar that of conventional concrete. Addition of SF improve bond strength of a concrete. ME(Modulus of elasticity) of a SF concrete is similar that conventional concrete (Vikas Srivastava et.al [2012]).

They made an attempt to explore the possibility of utilizing a wide range of materials as partial substitute materials used for cement during the manufacture of concrete. Reviewed on the strength property of silica fume concrete. The specific gravity and chemical composition of micro silica and cement were replaced with micro silica from 0 to 25%in steps of 5% by weight; mix proportioning was based on 1:2:4mix ratio. Cube Size 150 x 150 x 150 mm be formed as well as cured in a curing tank for 3, 7, 14 and 28 days. Volume replacement methods are suggested to investigate the possibility of producing high strength concrete with silica fume (Faseyemi Victor Ajileye [2012]).

They carried out of silica fume into the normal concrete is a routine one in the present days to produce the high strength and high performance concrete. The design parameters are increasing by integration of a SF is a usual concrete and the mix proportioning is becoming complex. The Main aim of a paper have been prepared and Evaluate a unusual mechanical properties like compressive strength, compacting factor, slump of concrete incorporate micro silica. In this five mix of concrete incorporating silica fume are cast to perform experiments. These experiments be carried out by replacing cement with different percentages of silica fume at only constant water-binder materials ratio keep other mix design variables constant. Silica fume is replaced by 0%, 5%, 10%, 15% and 20% for water-binder materials (w/cm) ratio for 0.40 (Debabrata Pradhan et.al [2013]).

They investigated the study the effect of rheological and engineering properties of with partial replacement of OPC by silica fume. However as a result helps in protecting RS (Reinforced Steel) for a corrosion. It concluded that Compaction factor decreases when the percentage of cellulose fibre increases with silica fume. The values of compacting factor are within range of 0.86 to 0.95 which meets the requirement of BIS-456. 7% replacement of silica fume and 0.5% of cellulose fibre gives an optimum compressive strength. Beyond 7% silica fume and 0.5% cellulose fibre compressive strength decreases (Pratik Patel et.al [2013]).

In this study Industrial by-product like (SF) be able to utilize and enhance strength & water permeability characteristics for a High Performance Concrete (HPC). This paper investigates the individual effects of micro silica as replacement of a Cement on water permeability, CS(compressive strength), ST(split tensile strength) &FS(flexural tensile strength) of a High Performance Concrete (HPC).The OPC Replaced by a SF were 0%, 2.5%, 5%, 7.5%, 10%, 15% and 20%. 1% super-plasticizer is used in all the test specimens for better performance and to recognize the quick special effects of SF on the property of concrete. Water-cement ratio was kept 0.42 for every cases and the specimens be tested at ages of 7, 14 and 28 days. 7.5% (B. Muhit et.al [2013]).

In this experimental data are presented and analysed to better understand this behaviour. Crumb-rubber-modified concrete exhibits the reducing slump as maintain a HCF in a plastic state. Structural rubber-modified concrete fcu . 17 MPa, rd 5.2000 kg/m3 be able to designed among crumb-rubber replacement up to a 20% Weight fine aggregate replacement or else approximately 15%weight coarse aggregate or coarse + fine aggregate replacement. The dynamic modulus of elasticity can be predicted reliably using the empirical equation Ed 5 0?524 fcu + 15?5 which allows the ultrasonic pulse velocity test to be used as an indicative assessment of mix quality. 'Good' quality rubber-modified mixes can be produced using 10%wt fine aggregate and coarse + fine aggregate replacement mixes, and 20%wt coarse + fine aggregate replacement, and 30%wt fine aggregate replacement, is achievable depending upon the original mix workability (Khalid Battal Najim et.al [2013]).

They carried out to determine the optimum percentage of silica fume to replace cement in order to improve the properties of high-strength concrete. To complete the aim, some properties of concrete contain micro silica be valuate after 7, 28 and 60 days of curing. Also, comparison between regular concrete and micro silica concrete containing various levels of silica fume content (5%, 10% and 15%) was conducted. It is mentionable that silica fume incorporation in the concrete mix significantly improved the properties of concrete such as, compressive and flexural strengths. Based on this research work, 10% and 15% silica fume content as replacement of cement were found to be the optimum amount for significantly enhancement of compressive strength and flexural strength respectively. silica fume can significantly reduce concrete permeability and enhances its durability (Nasratullah Amarkhails [2015]).

III.RESULTS

A. *Compressive Strength Analysis*

A minimum of three cubes are casted in each batch mix for determining compressive strength. Tests are performed at the age of 28 days of the specimens. Specimens are placed in the test machine as per IS: 516-1959 clause no 5.5.1 page no 11,

Fig. 1: Compressive Testing Analysis of Cube

Table 1: Compressive Strength Result for 7 days

S. NO.	COMBINATION	CUBES	MAX. LOAD (KN)	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE COMPRESSIVE STRENGTH (N/mm^2)
Mix-01	C+S+NCA	Cube-1	395.30	17.57	18.17
		Cube-2	423.60	18.83	
		Cube-3	407.50	18.11	
Mix-02	C(75%)+S+NCA + SF(25%)	Cube-1	442.06	22.36	21.24
		Cube-2	460.32	20.45	
		Cube-3	470.84	20.92	
Mix-03	C(80%)+S+NCA+ SF(20%)+	Cube-1	441.00	19.61	21.08
		Cube-2	494.50	21.98	
		Cube-3	487.40	21.66	
Mix-04	C(85%)+S+NCA+ SF (15%)	Cube-1	437.20	21.03	21.77
		Cube-2	507.76	22.56	
		Cube-3	488.80	21.72	
Mix-05	C(87.5%)+S+NCA+ SF (12.5%)	Cube-1	447.30	19.88	18.91
		Cube-2	413.90	18.40	
		Cube-3	415.00	18.44	
Mix-06	C(92.5%)+S+NCA+ SF (7.5%)	Cube-1	372.50	16.56	17.23
		Cube-2	390.80	17.37	
		Cube-3	399.80	17.77	
Mix-07	C(95%)+S+NCA+ SF (5%)	Cube-1	340.40	15.13	15.37
		Cube-2	349.11	15.51	
		Cube-3	347.90	15.46	

Table 2: Compressive Strength Result for 14 days

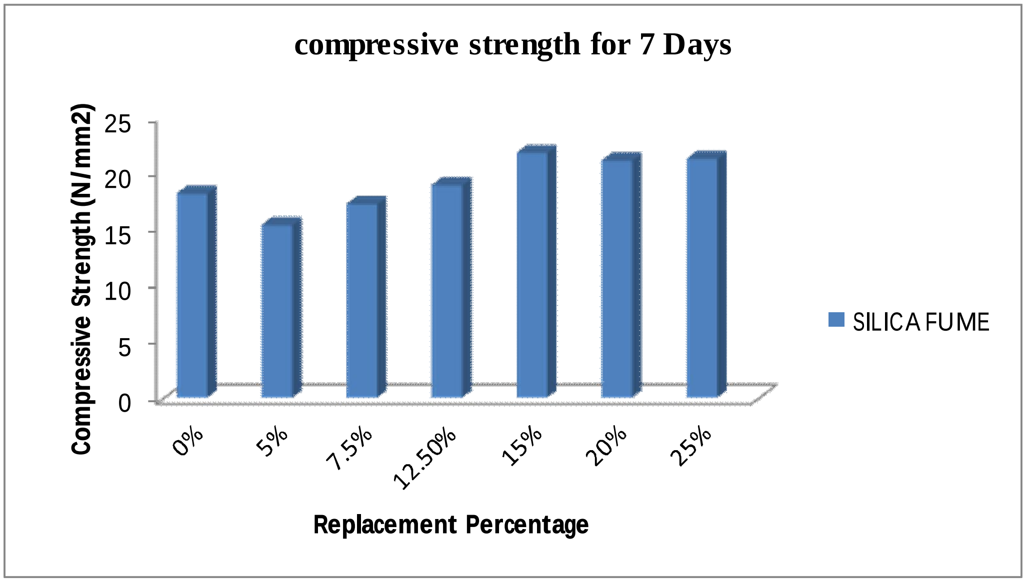
S.NO.	COMBINATION	CUBES	MAX. LOAD (KN)	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE COMPRESSIVE STRENGTH (N/mm^2)
Mix-01	C+S+NCA	Cube-1	450.60	20.03	20.63
		Cube-2	478.00	21.24	
		Cube-3	463.70	20.61	
Mix-02	C(75%)+S+NCA+ SF(25%)	Cube-1	479.84	21.32	23.02
		Cube-2	525.50	23.35	
		Cube-3	550.00	24.44	
Mix-03	C(80%)+S+NCA+ SF(20%)+	Cube-1	509.80	22.66	24.03
		Cube-2	558.20	24.81	
		Cube-3	553.70	24.61	
Mix-04	C(85%)+S+NCA+ SF (15%)	Cube-1	537.60	23.89	24.85
		Cube-2	577.89	25.68	
		Cube-3	562.10	24.98	
Mix-05	C(87.5%)+S+NCA+ SF (12.5%)	Cube-1	510.23	22.67	21.77
		Cube-2	480.10	21.34	
		Cube-3	479.30	21.30	
Mix-06	C(92.5%)+S+NCA+ SF (7.5%)	Cube-1	432.10	19.20	19.86
		Cube-2	452.90	20.13	
		Cube-3	455.66	20.25	
Mix-07	C(95%)+S+NCA+ SF (5%)	Cube-1	394.40	17.53	17.71
		Cube-2	402.30	17.88	
		Cube-3	399.32	17.74	

Table 3: Compressive Strength Result for 28 days

S.NO.	COMBINATION	CUBES	MAX. LOAD (KN)	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE COMPRESSIVE STRENGTH (N/mm^2)
Mix-01	C+S+NCA	Cube-1	517.45	22.99	24.14
		Cube-2	561.65	24.97	
		Cube-3	550.24	24.45	
Mix-02	C(75%)+S+NCA+ SF(25%)	Cube-1	595.00	26.44	28.28
		Cube-2	640.23	28.45	
		Cube-3	674.20	29.96	
Mix-03	C(80%)+S+NCA+ SF(20%)+	Cube-1	576.87	25.63	27.37
		Cube-2	635.40	28.24	
		Cube-3	636.00	28.26	
Mix-04	C(85%)+S+NCA+ SF (15%)	Cube-1	625.56	27.80	28.84
		Cube-2	670.98	29.82	
		Cube-3	650.55	28.91	
Mix-05	C(87.5%)+S+NCA+ SF (12.5%)	Cube-1	592.70	26.34	25.03
		Cube-2	551.90	24.52	
		Cube-3	545.25	24.23	
Mix-06	C(92.5%)+S+NCA+ SF (7.5%)	Cube-1	491.00	21.82	22.80
		Cube-2	515.22	22.89	
		Cube-3	533.30	23.70	
Mix-07	C(95%)+S+NCA+ SF (5%)	Cube-1	447.00	19.87	20.39
		Cube-2	468.10	20.80	
		Cube-3	461.88	20.52	

B. Compressive Strength Graph

In the Compressive strength test is performed on 3 cubes of each batch mix for 7 days, 14 days & 28 days. There are 7 batch mixes and each one having 9 cubes of these 9 cubes, 3 cubes are tested for 7, 14 and 28 days each. An average of 3 values as tabulated in subhead results, are considered for discussions.



Graph 1: Compressive strength of silica fume for 7 days

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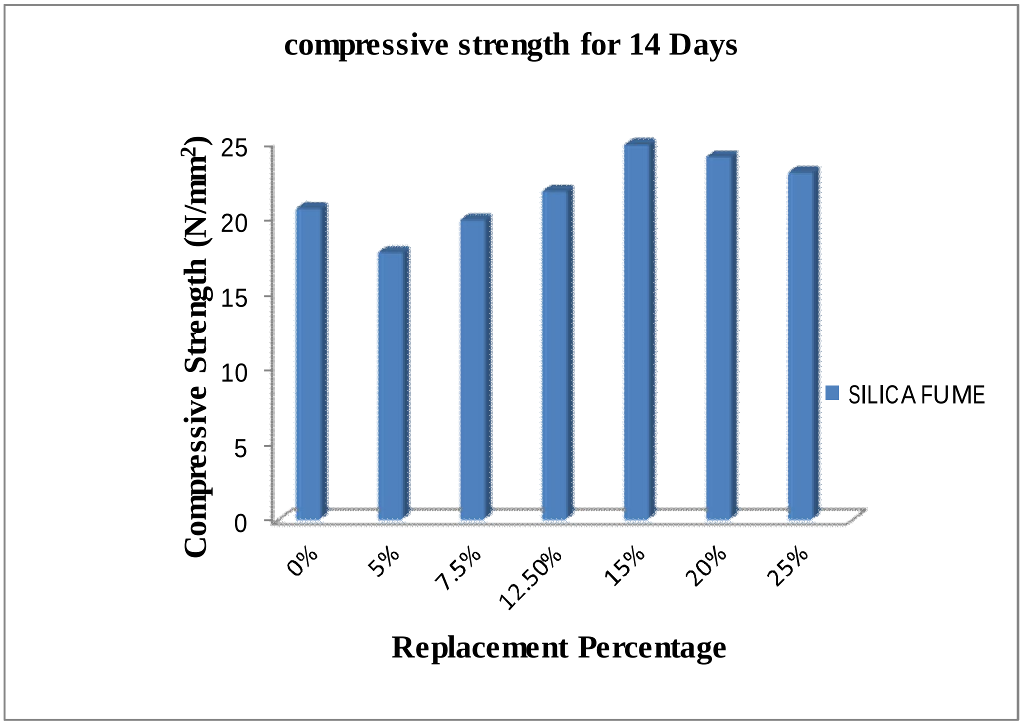
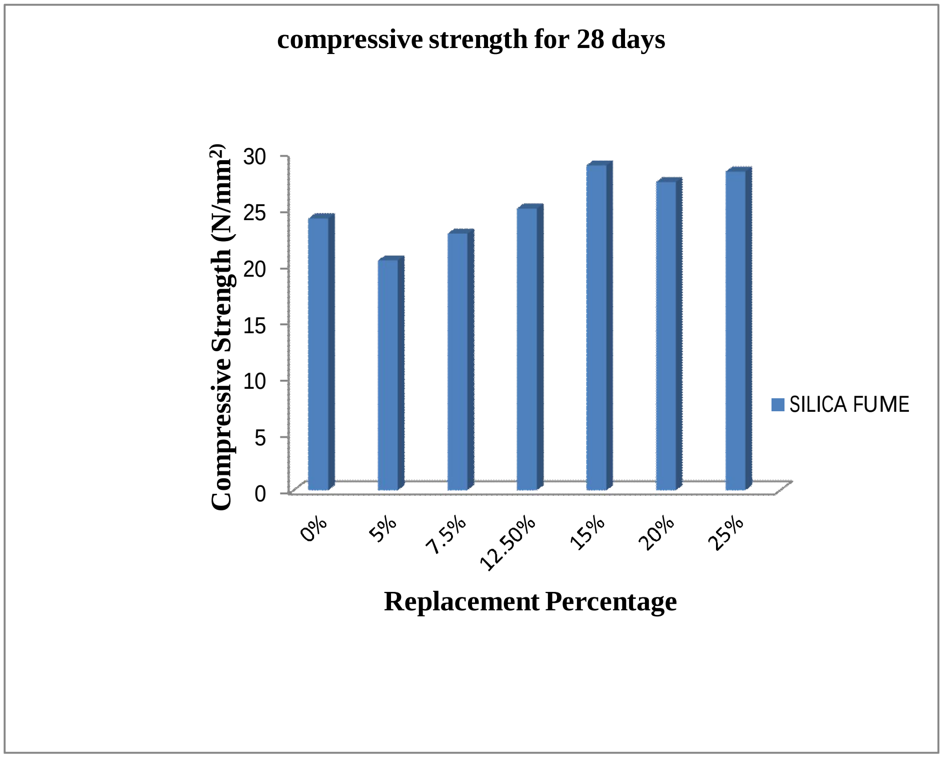


Graph 2: Compressive strength of silica fume for 14 days



Graph 3: Compressive strength of silica fume for 28 days

IV. CONCLUSION

CS (Compressive Strength) of a concrete mix with & without SF has been determined at 7, 14 and 28 Curing Days. The strength gained has been determined of silica fume added concrete with addition of 5%, 7.5%, 12.5% 15%, 20% & 25% for M25 grade replacement of cement for a conventional concrete. From the results it is conclude that the silica fume is a superior replacement of cement. The rate of strength increase in silica fume concrete is high. After performing all the tests and analysing their result, the following conclusions have been derived:

A. The results achieved from the existing study shows that silica fume is great potential for the utilization in concrete as replacement of cement.
B. Workability of concrete decreases as proportion of silica fumes increases.
C. Maximum compressive strength was observed when silica fume replacement is about 15%.

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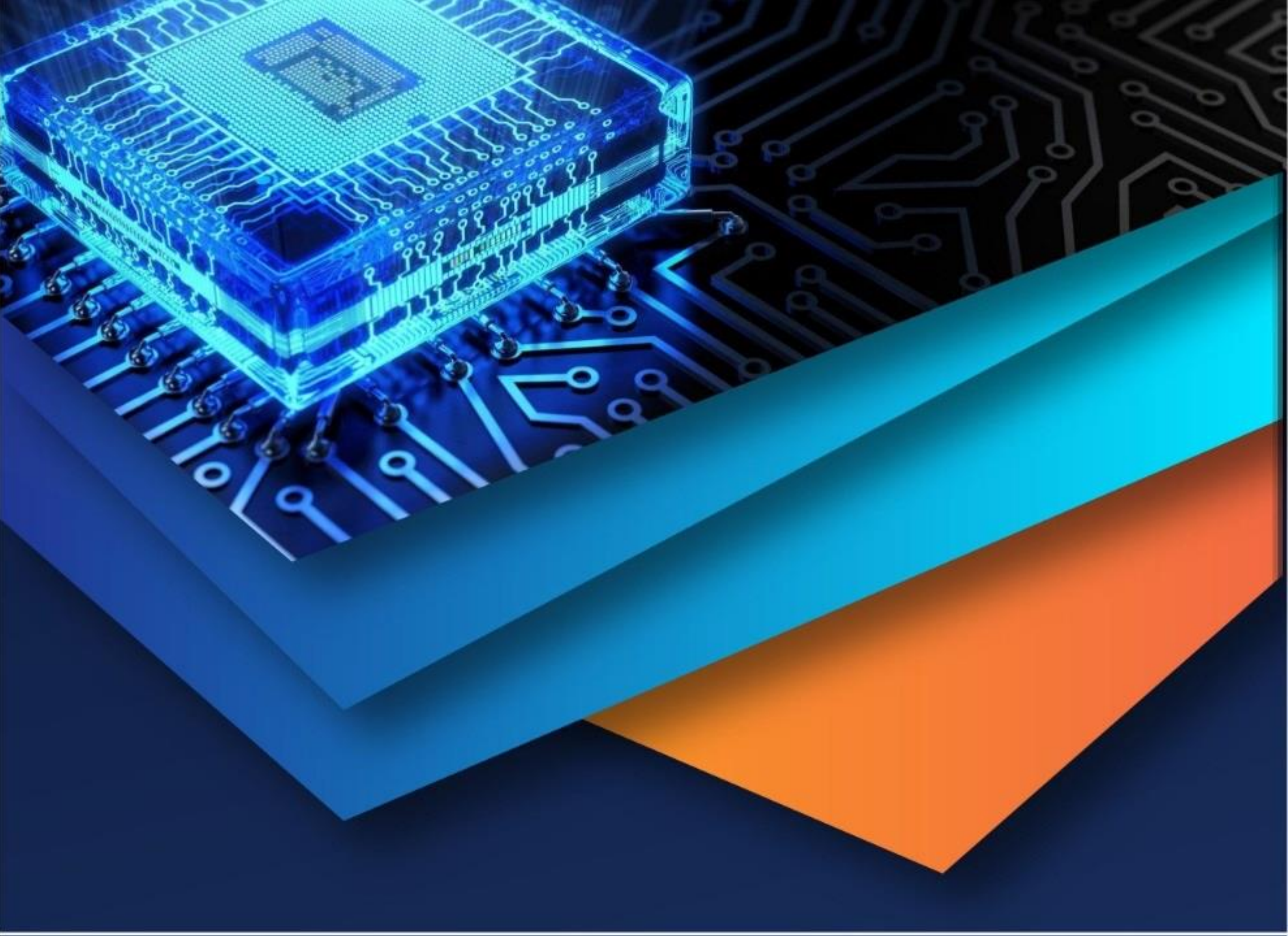

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