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Review on Comparative Study by Using Nano $CaCo_3$ and Nano Fe_2O_3 in Fly Ash Containing Concrete

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***Abstract**: The application of nano material in concrete has added a new dimension to the efforts to improve its properties. Nano materials by virtue of their very small particles size can effect the concrete properties by altering the microstructure. In these study i completed a work of literature review. In the literature review I study a various nano materials used in the concrete and its effects on the properties of concrete. there are a various nano materials used in the concrete such as nano SiO_2,nano Fe_3O_4, nano $CaCo_3$, nano ZrO_2,nano CuO, nano Fe_2O_3,nano TiO_2 , nano ZnO_2, nano Al_2O_3 etc. By reffered a various research paper I decided that a in these study i note down that a nano $CaCo_3$ are improved a concrete compressive strength and durability properties and nano Fe_2O_3 are improve in such case flexural strength and in such a case improve the compressive strength and the durability properties.*

***Keywords**: Concrete, nano material, compressive strength, durability properties, flexural strength*

I. INTRODUCTION

Concrete is the most common material used in the construction. It is second most consumed material on the earth. It is a highly homogeneous material produced by mixture of finely powdered cement , aggregates of various size and water with inherent physical, chemical and mechanical properties. A reaction between the cement and water yields calcium silicate hydrate(C-S-H).which gives concrete strength and other mechanical properties of concrete as well as some by product including calcium hydroxide (C-H)gel pores.

A Concrete structure are usually exposed environmental conditions. Such as that involving chlorides, which may impact the mechanical and durability properties of the reinforced concrete structure through rebar corrosion. A strong and durable concrete can be produced by improving the behaviour of cement mortar. Various mineral additives such as fly ash and silica fume have been traditionally utilise composites not only for their environmental and economic advantages, but also for their technical benefits such as the ability to fill in micro and macro voids and displaying partial binder effect. The fly ash is used in concrete industries to reduce the amount of cement and to enhance durability and mechanical properties of concrete. Many of the available studies have focused on the uses of different types of nano materials such as nano SiO_2,nano Fe_3O_4, nano $CaCo_3$, nano ZrO_2,nano CuO, nano Fe_2O_3,nano TiO_2 , nano ZnO_2, nano Al_2O_3 etc Are effect on the properties of hardened cement paste, cement mortar and/ or concrete. Results of this study showed that nano particles can be very effective in improvement of both mechanical properties and durability of concrete.

Nano materials are very small sized materials with particle size in nanometres. These materials are very effective in changing the properties of concrete at the ultrafine level by the virtue of their very small size. The small size of the particles also means a greater surface area . Since the rate of a pozzolanic reaction is proportional to the surface area available, a faster reaction can be achieved.Only a small percentage of cement can be replaced to achieve the desired results. These nanomaterials improve the strength and permeability of concrete by filling up the minute voids and pores in the microstructure.

By using a nano materials in concrete the surface area of the nano material are high so improve the mechanical properties of the concrete. The different nano materials are different durability properties so to improve the durability properties of the concrete. Different Nano materials use in concrete are Nano-SiO_2,Nano-Fe_2O_3,Nano-ZrO_2,Nano-TiO_2,NanoAl_2O_3,Nano carbon tube, Nano ZnO_2,Nano cuo, Nano Fe_3O_4,Nano $CaCo_3$ etc….

The use of fly ash as partial replacement of cement in concrete is a common practice for many decades. During 2010–2012, the utilization of fly ash for construction application has achieved approximately 55% and become a commercial product which is the utilization of high volume fly ash in concrete addresses the challenges of sustainable construction. Chemically, fly ash has pozzolainic activity which is attributed to the presence of SiO_2 and Al_2O_3. It reacts with calcium hydroxide (C-H) during cement hydration, to form additional calcium silicate hydrate(C-S-H) and calcium alluminate hydrate (C-A-H) which are effective in forming denser matrix leading to higher strength and better durability.

II. LITERATURE REVIEW

A. *Ali Nazari, Shadi Riahi, Shirin Riahi, Seyedeh Fatemeh Shamekhi and A. Khademno ,2010 investigated the "Benefits of Fe_2O_3 nanoparticles in concrete mixing matrix".* It was found that the cement could be advantageously replaced with nano- Fe_2O_3 particles up to maximum limit of 2.0% with average particle sizes of 15 nm. Although, the optimal level of nano- Fe_2O_3 particles content was achieved with 1.0% replacement. Partial replacement of cement by nano- Fe_2O_3 particles decreased workability. The optimum result was found at the 1 % replacement of cement by nano- Fe_2O_3.

B. *[2] Xiaoyan Liu, Lei Chen , Aihua Liu, Xinrui Wang, 2012 investigated "Effect of Nano- $CaCo_3$ on Properties of Cement Paste".* In These Paper they study the effect of nano- $CaCo_3$ (NC) on properties of cement paste. Experimental results showed that Nano $CaCo_3$ had no effect on water requirement of normal consistency of cement. However, with the increase of Nano $CaCo_3$ content, the flowability decreased and the setting time of fresh cement paste was shortened. The flexural and compressive strength of hardened cement paste with Nano $CaCo_3$ increased at the age of 7 days and 28 days, and the optimal content of Nano $CaCo_3$ was 1%.

C. [*3] Meral Oltulu , Remzi S ahin,2013 investigated''Effect of nano- SiO_2, nano- Al_2O_3 and nano- Fe_2O_3 powders on compressive strengths and capillary water absorption of cement mortar containing fly ash: A comparative study''.* In this study, addition of both nano- SiO_2 (NS), nano- Al_2O_3 (NA) and nano- Fe_2O_3 (NF) powders and their binary and ternary combinations on the compressive strength and capillary water absorption of cement mortars containing fly ash (FA) were investigated. The use of 1.25% Nano SiO_2 + Nano Al_2O_3 powders improved the compressive strength by the most compared to the control specimen. The best results were obtained from the mortars added with Nano SiO_2 + Nano Al_2O_3 + Nano Fe_2O_3 powders at 1.25%.

D. *[4] Faiz U.A. Shaikh , Steve W.M. Supit, 2014 investigated''Mechanical and durability properties of high volume fly ash (HVFA) concrete containing calcium carbonate ($CaCo_3$) nano particles''.* The effects of $CaCo_3$ nanoparticles on compressive strength and durability properties of high volume fly ash (HVFA) concretes containing 40% and 60% fly ash as partial replacement of cement are evaluated in this study. The concrete containing 1 % by wt $CaCo_3$ nano particles yielded the highest compressive strength at all ages. The early age compressive strength of concrete containing 1% nano- $CaCo_3$ is about146–148% higher than the ordinary concrete. The early age compressive strength of HVFA concretes is also improved due to addition of 1% nano- $CaCo_3$. Most significant improvement of about 46–48% is observed in HVFA concrete containing 39%fly ash and 1% nano- $CaCo_3$. The addition of 1% nano $CaCo_3$, also improved the long term(90 days) compressive strength of ordinary concrete by about40% and that of HVFA concrete containing 39% and 59% fly ash by about 57% and 8%, respectively. 1% $CaCo_3$nano particles improved the microstructure of HVFA concretes and thus affected the concrete performance including the improved strength and reduced volume of permeable voids.

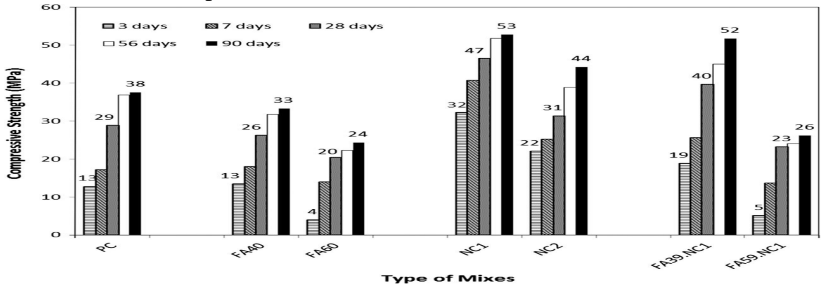

Fig.1 Compressive strength development of concrete containing nano-CaCO3 (NC) and HVFA concretes containing NC at 3, 7, 28, 56 and 90 days.

E. [5] Hamid Soltanian, Reza Khalokakaie, Mohammad Ataei, Ezatallah Kazemzadeh, 2015 investigated''Fe_2O_3 nanoparticles improve the physical properties of heavy weight wellbore cements: A laboratory study''. In these study the evaluate the effect of Fe_2O_3 nanoparticles as a weighting agent on the physical properties of a heavy-weight wellbore cement. Fe_2O_3 nanoparticles improved the properties of the cement slurry and stone. Furthermore, Fe_2O_3 nanoparticles in the slurry increased the viscosity and improved the suspending ability of the slurry. Free water and fluid loss also decreased by increasing the concentration of Fe_2O_3 nanoparticles. It was also observed that the thickening time decreases with increasing the concentration of Fe_2O_3 nanoparticles. Compressive strength, Young's modulus and Poisson's ratio of the cement stone samples increased.. The excellent improvements in cement physical properties caused by Fe_2O_3 nanoparticles.

F. [6] Huiwen Yuan, Yu Shi, Zhongzi Xu , Chunhua Lu , Yaru Ni, Xianghui Lan, 2015 investigated ''Influence of nano-ZrO_2 on the mechanical and thermal properties of high temperature cementitious thermal energy storage materials''. The mechanical and thermal properties of high temperature aluminate cementitious thermal energy storage materials modified with nano-ZrO_2 are investigated. The results indicate that compressive strength comes to an optimum value at nano- ZrO_2 amount of 1 % by wt.
Residual thermal conductivity and volume heat capacity are enhanced with nano- ZrO_2 introduction after heating at 350 and 900 ºC for 6 h, which is favorable forhigh temperature thermal energy storage materials.

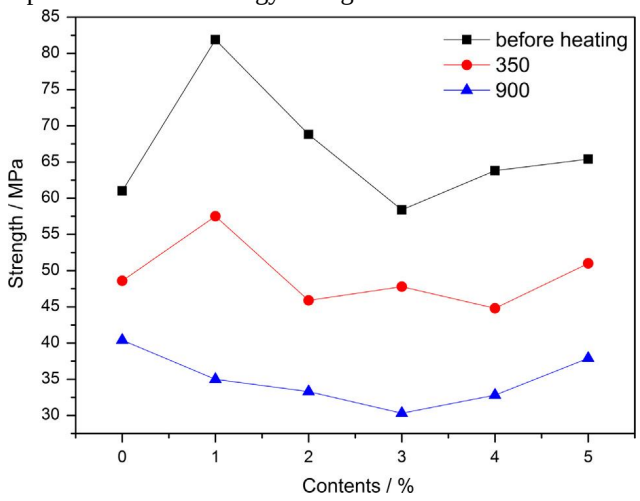

Fig.2Compressive Strength Versus Different % of ZrO_2

G. [7] E. Gerasimova, 2015 investigated ''The Effect of Fe_2O_3 on the Mechanical Properties of the Polymer Modified Cement Containing Fly Ash''. The comparison of mechanical properties of a polymer modified Portland cement stone with fly ash and micro-sized Fe_2O_3 is considered. On the basis of the analysis of the research results it is shown that it is more preferable to use the polymer powder for modifying of Portland cement with 15 % of the fly ash replacement and the optimal quantity of Fe_2O_3 is 0,01 % by weight of cement.

H. [8] Mariana O.G.P. Bragança , Kleber F. Portella, Marcelle M. Bonato , Emerson Alberti , Cláudia E. B. Marino, 2016 investigated ''Performance of Portland cement concretes with 1% nano-Fe_3O_4 addition: Electrochemical stability under chloride and sulfate environments''. Concretes with 1% nano- Fe_3O_4 addition aged for 300 days in chloride and sulfur dioxide chambers were analyzed by multiple techniques and the performance results were evaluated by impedance spectroscopy and cyclic voltammetry. Concretes were prepared with 1% nano- Fe_3O_4 additions as partial replacements of cement, resulting in a material with a similar axial compressive resistance and elasticity modulus after wet curing that was less susceptible to corrosion relative to the reference material, even after exposure to environments with aggressive ions for almost 300 days. This mechanism resulted in a more homogeneous and, therefore, more durable cement matrix, even when used in highly aggressive environments.

I. [9] Tao Meng,Yejia Qiang, Anfeng Hu, Chuntai Xu , Lei Lin,2017 investigated ''Effect of compound nano- $CaCo_3$ addition on strength development and microstructure of cement-stabilized soil in the marine environment''. Effect of compound nano- $CaCo_3$ addition on strength development and microstructure of cement stabilized soil in marine environment was studied in this paper by unaxial compressive test and micro-structure analysis methods including X-ray Diffraction Analysis (XRD), Scanning Electron

Microscopy (SEM) and Mercury Intrusion Porosimetry (MIP). Test results indicated that the compound Nano $CaCo_3$ addition could significantly improve the early compressive strength of cement stabilized soil both in the marine environment and the standard curing condition. The 30 days compressive strength of specimens with 15% and 22% content of cement increased by 14.2% and 7.8% respectively in the marine environment, while the data of specimens maintained in the standard curing condition were 5.8% and 17.8%. Results indicated that the compound Nano $CaCo_3$ addition could effectively enhance the corrosion resistance of cement-stabilized soil in the marine environment. The 180 days compressive strength of specimens with 15% and 22% content of cement increased by 22.8% and 14.8% respectively in the marine environments.

*J. 10] Rahmat Madandoust, Ehsan Mohseni , S. Yasin Mousavi, Maryam Namnevis, 2017 investigated "An experimental investigation on the durability of self-*compacting *mortar containing nano-SiO_2, nano-Fe_2O_3 and nano-CuO".* In this study, the durability properties of self-compacting mortar (SCM) incorporating nano-SiO_2, nano-Fe_2O_3 and nano-CuO were experimentally compared with that of plain mortar. The compressive strength of the specimens is increased by using up to 4 wt% Nano SiO_2, 2 wt% Nano Fe_2O_3 and 3 wt% Nano CuO and then it is decreased. The water absorption of the specimens is decreased by increasing the nanoparticles content. Electrical resistivity results showed significant enhancement by addition of nanoparticles. The chloride permeability values decreased 60%, 44% and 44% by addition of Nano SiO_2, Nano Fe_2O_3 and Nano CuO respectively.

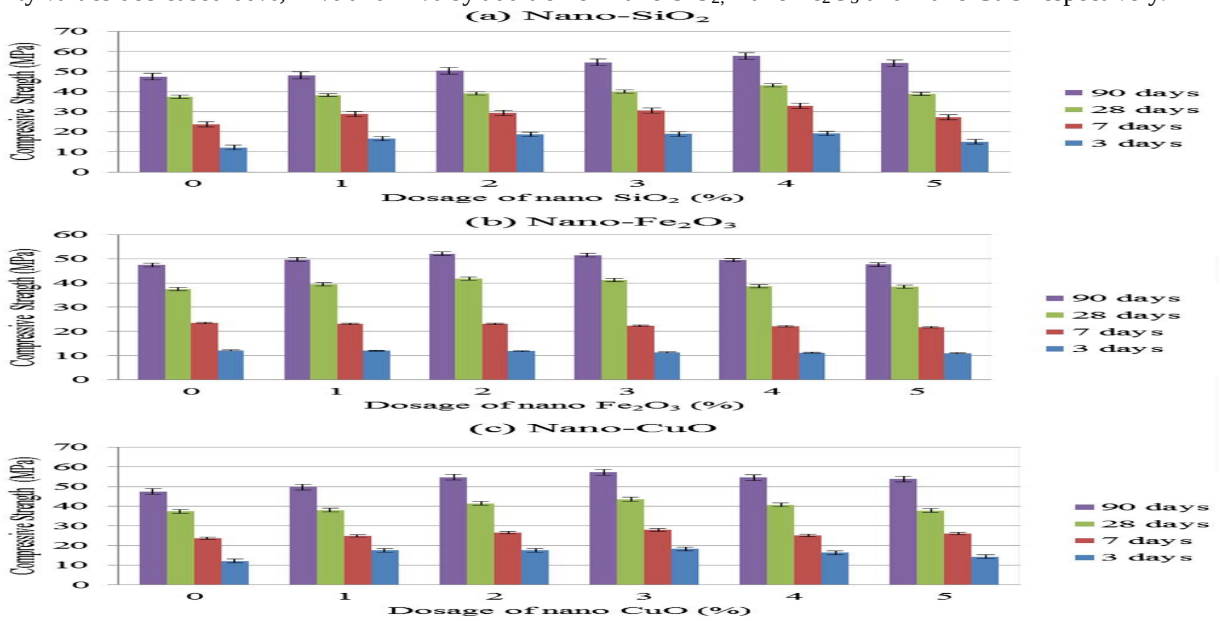

Fig.3 Compressive strength of specimens containing different nanoparticles.

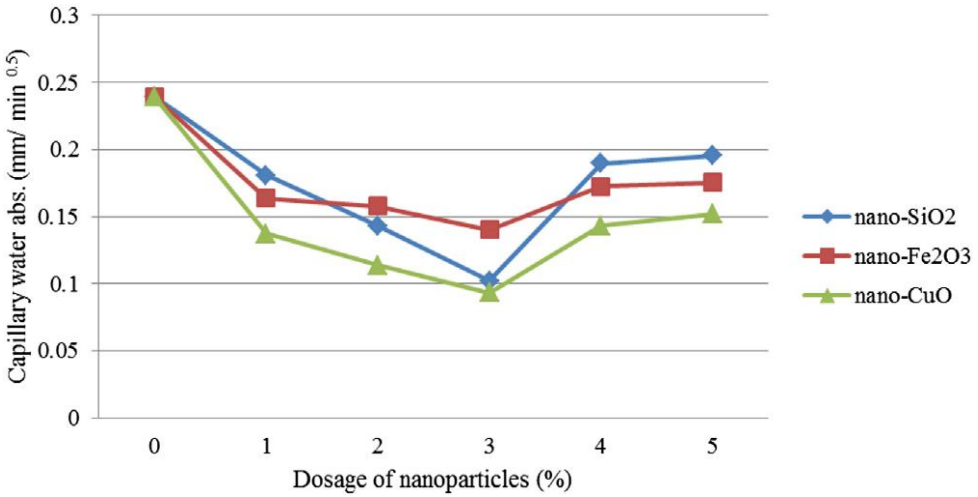

Fig.4 Capillary water absorption of specimens containing different nanoparticle

K. [11] Kalpana Kumaria, R.Preethaa, D. Ramachandranb, Vinita Vishwakarmab, Rani.P.Georgec, C.Sundaramurthya,U.Kamachi Mudalic, C.Sivathanu Pillaia, 2016 investigated ''Nanoparticles for enhancing mechanical properties of fly ash concrete''. This study is attempted to understand the effect of nano TiO_2 (NT), nano $CaCo_3$ (NC) particles and a combination of Nano TiO_2 and Nano $CaCo_3$ particles (NTC) on various properties like compressive strength, workability and durability of fly ash concrete by partial replacement of cement. It was observed that a 0.5 % substitution of nanoparticles gave an appreciably higher strength and also an increase in percentage of Nano TiO_2 particles showed an increase in strength (with maximum at 3%). The NTC particles showed a maximum strength at 2% substitution. The 2% substitution of Nano TiO_2 and Nano $CaCo_3$ particles yielded slightly lower strength when compared to the maximum strength attained but the RCPT values were very low at this percentage indicating a good impermeable concrete. Though the workability of fresh concrete showed a decline in slump value as the percentage of nanoparticles increased, these slump values as such gave a workable concrete. When seen from durability point of view a 2 % substitution of nanoparticles showed a very good resistance to chloride ion penetration and also a high pH value.

L. Specifications Of Cement, Silica Fume And Nano Material

Table : 1 Properties of cement and fly ash(Meral Oltulu , Remzi S, ahin, 2013)

Composition (%)	Cement	Fly Ash
Chemical compositions		
SiO_2	10.33	48.30
Al_2O_3	5.11	12.70
Fe_2O_3	3.28	23.30
CaO	61.31	3
MgO	2.38	-
SO_3	3.02	-
Na_2O	0.28	-
K_2O	0.78	-
Loss Ignition	2.49	-
Physical properties		
Specific Gravity	3.16	2.39
Blaine	3500	13.47
Initial Setting Time	110	-
Final Setting Time	175	-
Expansion in le chatelier apparatus	2.00	-
Compressive Strength (MPa) 3 days	28	-
7 days	45.10	-
28 days	55.40	-

III. CONCLUSION

A. In Various Research they shows that a number of nano materials like Fe_2O_3, $CaCo_3$, SiO_2, TiO_2, Al_2O_3,Fe_3O_4, colloidal nano silica and Fly Ash and others can be incorporated to improve the properties of concrete.

B. The water absorption of the specimen is decreased by increasing the nanoparticles content.

C. The durability properties are improved when the nano particles are used.

D. The mechanical and thermal properties of cementitious material are improve when the nano ZrO_2 are used.

E. In the above research paper shown they used a nano $CaCo_3$ then the compressive strength, flexural strength and durability properties are good. the optimum % of nano $CaCo_3$ are 1 %.

F. When the uses of nano Fe_2O_3 the compressive as well as the flexural strength of the concrete are improved.

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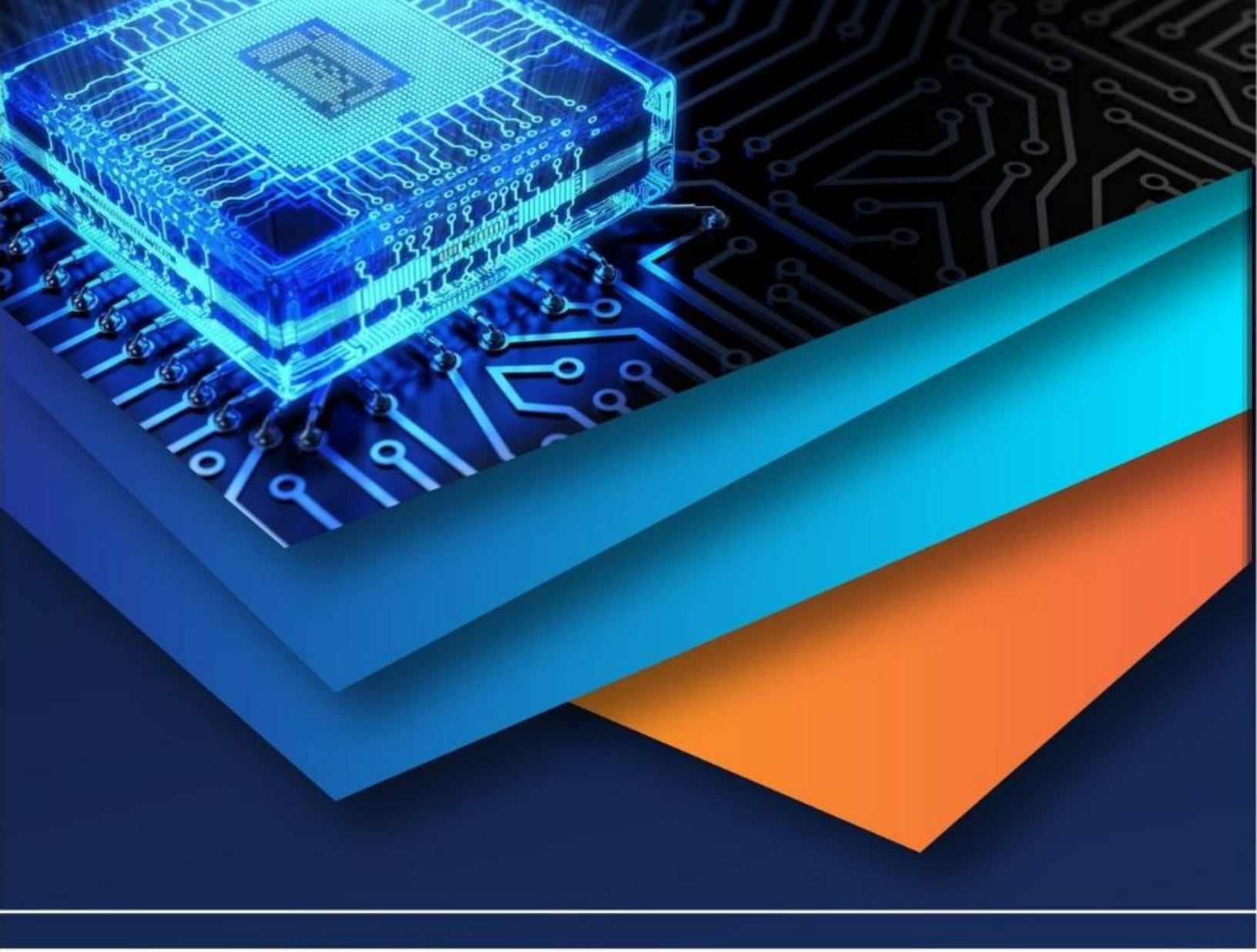

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