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# Strength Assessment of Concrete using Rice Husk Ash, Polyvinyl Alcohol Fiber and Recycled Concrete Aggregate: A Critical Review

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***Abstract:*** ***In this review study, the effect of three different materials such as rice husk ash, recycled concrete aggregate and Polyvinyl Alcohol fibre was reviewed in detail. Several past studies related to these material usage in strength enhancement of concrete was studied in detail. Rice husk ash is the ash which is mainly derived after burning the waste derived from the rice industry after the processing of rice. Recycled concrete aggregate is mainly the aggregate derived from the constructional waste. Polyvinyl Alcohol fibre is a special type of high strength fibre that is mainly used to improve the flexural strength and internal bonding of the concrete. Numerous studies were discussed in detail and depending upon the studies certain conclusion are drawn which are discussed further. Several studies related to the usage of rice husk ash conclude that the most optimum usage percentage of rice husk ash as partial replacement of ordinary Portland cement was at 10 percent usage. After 10 percent usage strength tends to decline. Results related o usage as partial replacement of natural fine aggregate that is sand showed that it can be used as partial replacement of natural coarse aggregate up to 20 percent and beyond that usage the strength was declining. The studies related to the usage of recycled concrete aggregate conclude that the most optimum percentage of usage of recycled concrete aggregate as partial replacement of natural coarse aggregate was 50 percent replacement and beyond this percentage the strength starts declining so therefore should not be used beyond that limit. Studies related to the usage of Polyvinyl Alcohol fibre revealed that the most optimum percentage of Polyvinyl Alcohol fibre was 1.5 percent and beyond this percentage both the compressive strength of concrete and flexural strength of concrete was declining. Test results concluded that Polyvinyl Alcohol fibre should be used up to 1.5 percent only.***

***Keywords: Rice Husk Ash, Recycled Concrete Aggregate, Polyvinyl Alcohol Fiber, Green Concrete, Waste Generated Concrete***

## I. INTRODUCTION

### *A. General*

Concrete is the one of the most usable product of the construction sector and without concrete the sustainable construction work cannot be possible, but day by day the demand of concrete is rising and the main reason behind this demand is the growing population. World's population is increasing very rapidly and with respect to it parallel the demand of concrete is also rising. But day by day the scarcity of constructional material is increasing, so therefore an alternative to these construction materials should be determined to fulfill the scarcity of these materials. This scarcity can be fulfilled either by production of new construction materials or by utilization of various waste materials as construction materials in concrete. Day by day the waste from the several outlets is increasing so therefore it can be predicted that this rise in waste can fulfill the need of the scarcity of constructional materials. In this research work some waste materials were discussed in a detailed manner so therefore their usage can be beneficial for the society and fulfill the need of the scarcity faced by the constructional industry.

### *B. Rice Husk Ash*

Rice husk is generally the waste generated from the rice mills during the processing of rice. Past studies revealed that the out of 100 percent of the total rice product from the field when supplied to rice mills, 80 percent is derived in the form of rice grains and 20 percent is derived in the form of waste. This 20 percent waste generated from the rice preprocessing mills is known as rice husk. This rice husk in general aspects is not have much beneficial but after proper burning it ca be easily used to replace either ordinary Portland cement and natural fine aggregate during the production of concrete.

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Figure. Rice Husk Ash
https://gharpedia.com/blog/rice-husk-ash-in-concrete-pros-cons/

*C. Recycled Concrete Aggregate*

Recycled concrete aggregate is basically the aggregate derived after the demolition of a building or a structure. With time, the life span of every building is decreasing so after the completion of its life span, It should be demolished foe the safety and prosperity of the adjacent areas. After this demolition after or before the completion of life span huge amount of waste is generated depending upon the type of building. This waste can be utilized in concrete in the form of coarse aggregate after proper processing. The aggregated generated after the proper processing of waste generated after the demolition of a building or structure is termed as recycled concrete aggregate.

Recycled Concrete Aggregate
https://www.indiamart.com/proddetail/recycled-concrete-aggregate-18310988530.html

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*D. Polyvinyl Alcohol fibre*

Polyvinyl Alcohol fibre are the high strength and high intermolecular bonding fibre s which can be used to improve the strength and durability parameters of concrete and other cement composites. Polyvinyl Alcohol fibre can also be used for its other superior properties such as high modulus of elasticity, high split tensile strength, higher compressive strength and higher resistance to chemicals, fatigue and abrasion.

Polyvinyl Alcohol fibre
https://www.indiamart.com/proddetail/pva-fibre-for-concrete-19546384673.html

## II. LITERATURE REVIEW

*A. Rice Husk Ash (Noaman, Karim, & Islam, 2019)*

I this research work rice husk ash was used to improve and enhance the strength aspects of brick aggregate concrete. Basically brick aggregate concrete was made with cement, sand and brick coarse aggregate, so therefore rice husk ash was used as replacement of ordinary Portland cement so as to predict the effect of usage of rice husk ash over its engineering and strength properties. Rice husk ash was used as partial replacement of ordinary Portland cement from 0 percent to 25 percent at an increment of 5 percent in each case respectively. It means that the rice husk ash was used at 0 percent, 5 percent, 10 percent, 15 percent, and 20 percent and at 25 percent respectively. After this brick aggregate was used as replacement of natural coarse aggregate at 100 percent. Then several samples were prepared depending upon the combination and then after curing of 7 days and 28 days were tested for its flexural strength and split tensile strength. The test results revealed that the maximum strength of rice husk ash cum brick aggregate concrete was observed at 10 percent usage of rice husk ash.

*B. (Patel & Shah, 2018)*

In this research work two different kinds of materials were used for enhancing the strength parameters of concrete. Basically rice husk ash and ground granulated blast furnace slag was used in combine form so as to predict the strength aspects of the concrete samples. Mainly rice husk ash was used as partial replacement of ground granulated blast furnace slag for the preparation of ground granulated blast furnace slag based self-compacting geo-polymer concrete. Rice husk ash was used from 5 percent to 25 percent at an increment of 10 percent in each case respectively or in other words rice husk ash was used as partial replacement of ground granulated blast furnace slag at 5 percent, 15 percent and at 25 percent. After this several specimen were prepared depending upon the combinations and then all the specimen were cured for seven days and twenty eight days. After proper curing all the samples were tested for compressive strength test a, flexural strength test and split tensile strength test. The test results showed that the maximum percentage of rice husk ash as replacement of ground granulated blast furnace slag can be 15 percent and after this percentage the strength starts declining.

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*C. (Ahsan & Hossain, 2018)*

In this experimental work two similar kinds of materials such as fly ash and rice husk ash was used for predicting several strength and engineering properties of the concrete. Both fly ash and rice husk ash were used as partial replacement of cement so as to utilize this waste as supplementary cementitious material in concrete. Fly ash was used at a fixed percentage of 10 percent and the rice husk ash was used at 2 different percentages that is at 10 percent and at 20 percent. Rice husk ash was used at 3 different sizes also depending upon the particle size of the rice husk ash. After these various combinations were formed and then several cubes, beams and cylinders were casted depending upon these combinations. After proper casting all these cubes, beams, and cylinders were tested cured for three days, seven days, fourteen days, twenty eight days and fifty six days. After proper curing all the samples were tested for their compressive strength and flexural strength and the test results showed that the maximum strength was obtained at 10 percent usage of fly ash and 10 percent usage of rice husk ash when both used in combined form.

*D. (Gill & Siddique, 2017)*

In this investigational study 2 completely different kinds of materials were used for enhancing and improving the strength aspects of the conventional concrete. Meta-kaolin was used as partial replacement of the ordinary Portland cement and rice husk ash was used as partial replacement of natural fine aggregate that is sand. Meta-kaolin was used at 3 different percentages that is at 5 percent, 10 percent and at 15 percent that is it was mainly used from 5 percent to 15 percent at an increment of 5 percent in each case respectively. Rice husk ash was used from 10 percent to 30 percent at an increment of 10 percent in each case that is rice husk ash was used at 10 percent, 20 percent and 30 percent. Both meta-kaolin and rice husk ash was used in combination with each other and after forming numerous combination were tested for compressive strength and split tensile strength. The test results concluded that maximum strength was obtained at 15 percent usage of meta-kaolin as partial replacement t of ordinary Portland cement and at 20 percent usage of rice husk ash as partial replacement natural fine aggregate replacement when used in combination with each other.

*E. (Huang, Gao, Wang, & Ye, 2017)*

In this research work silica fume and rice husk ash was mainly used to enhance the strength aspects of the conventional concrete. Both these materials were supplementary cementitious material so therefore used in combined form as partial replacement of ordinary Portland cement for improving the strength aspects of the conventional or normal concrete. Both silica fume and rice husk ash were firstly tested for their physical and chemical properties and then used at 1/6, 1/3, 1/2, 2/3 and 5/6 ratio as partial replacement of ordinary Portland cement. After forming the combinations and mixes, several cube, beams and cylinders were casted so as to implement compressive strength test, flexural strength test and split tensile strength test respectively. From the test results it was seen that the maximum strength was observed at 1/6 ratio usage for both rice husk ash and silica fume.

*F. Recycled Concrete Aggregate (Adessina, Ben Fraj, Barthélémy, Chateau, & Garnier, 2019)*

In this experimental work recycled concrete aggregate was used as partial replacement of natural coarse aggregate so as to improve and enhance the strength aspects of the conventional concrete. Generally two different sizes of recycled concrete aggregate were used to carry out the whole research work and as per that recycled concrete aggregate was used at 10mm size and 20 mm size. It was also observed that recycled concrete aggregate was used at several different percentage to determine the optimum usage percentage of the recycled concrete aggregate. It was used from 0 percent to 100 percent at an increment of 20 percent in each case. It was used at 0 percent, 20 percent, 40 percent, 60 percent, 80 percent and 100 percent as partial and fully replacement of natural coarse aggregate, after this numerous samples were prepared and then cured for 7 days and 28 days. Then all the samples were tested for compressive strength test, flexural strength test and split tensile strength test. The test results showed that the maximum strength was obtained at 60 percent usage of 10 mm sized recycled concrete aggregate.

*G. (Kox, Vanroelen, Van Herck, de Krem, & Vandoren, 2019)*

In this research work recycled concrete aggregate was used for determining the improvement in the strength aspects of the conventional concrete. Recycled concrete aggregate was mainly used as partial replacement of natural coarse aggregate so as to predict the behavior after the usage of Recycled concrete aggregate in place of normal natural scores aggregate. Recycled concrete aggregate was used from 10 percent to 10 percent at an increment of 10 percent in each case, so therefore it was seen that it was used at 10 percent, 20 percent, 30 percent, 40 percent and 50 percent as partial replacement of natural coarse aggregate. After this several concrete samples were prepared depending upon the percent of Recycled concrete aggregate and then all the samples were tested after a curing period of seven days, fourteen days, twenty eight days and fifty six days. Mainly compressive strength test was

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performed to predict the strength aspects. From the test results it was conclude that at 40 percent usage of Recycled concrete aggregate, maximum strength was observed.

*H. (Dimitriou, Savva, & Petrou, 2018)*

In this experimental work 3 different materials were used for improving the strength aspects of the conventional concrete. Basically fly ash, silica fume and Recycled concrete aggregate was used in combination with each other so as to improve certain engineering and strength properties of soil. Fly ash and silica fume were used as partial replacement of ordinary Portland cement and Recycled concrete aggregate was used as partial replacement of natural coarse aggregate. Fly ash was used at fixed percentage of 25 percent, silica fume was used at fixed percentage of 5 percent and both these were used as partial replacement of ordinary Portland cement. Recycled concrete aggregate was used at 2 different percentages that is at 50 percent sand at 100 percent. After this several cubes, beams and cylinders were formed so as to implement compressive strength test, flexural strength test and split tensile strength respectively. From all the test results it was conclude at that last that maximum strength was obtained at 25 percent usage of fly ash, 5 percent usage of silica fume and 50 percent usage of Recycled concrete aggregate.

*I. (Zheng et al., 2018)*

In his experimental work Recycled concrete aggregate and recycled brick aggregate was in combined form so as to predict the behavior of the conventional concrete with the incorporation of these materials. Recycled concrete aggregate was collected from the local demolition of the buildings whereas Brick aggregate was collected as waste from the brick kiln. Both the materials were used as partial replacement of natural coarse aggregate. Both theses material were used from 0 percent to 100 percent at an increment of 25 percent in each case respectively, in other words both Recycled concrete aggregate and recycled brick aggregate were used at percent, 25 percent, 50 percent, 75 percent and 100 percent. After preparing samples depending upon the percentage and combinations formed, all these samples were cured for 7 days and 28 days. After proper curing all these poles were tested for flexural strength and split tensile strength test. The results of these tests revealed that the maximum strength was obtained at 50 percent usage of Recycled concrete aggregate and 25 percent usage of recycled brick aggregate when used in combination with each other.

*J. (Bravo, de Brito, Evangelista, & Pacheco, 2017)*

In this research work a combination of superplasticizer and recycled concrete aggregate was mainly used to enhance the strength aspects of the conventional concrete. Lingo-sulfate based and poly-carboxylic-based superplasticizer was mainly used so as to carry out the research work in a detailed manner. Both the superplasticizer and recycled concrete aggregate were used in combined form and separately to predict the effect of superplasticizer over the strength aspects of the concrete. Recycled aggregate was used as partial replacement of natural coarse aggregate from 0 percent to 100 percent at an increment of 254 percent in each case that means it was used at 0 percent, 25 percent, 50 percent, 75 percent and 100 percent. Superplasticizer was used at 1 percent only and generally two different superplasticizers were used that includes Lingo-sulfate based and poly-carboxylic-based. After this several samples were prepared depending upon the percentage of recycled concrete aggregate and the Lingo-sulfate based and poly-carboxylic-based superplasticizer. All this all the samples were cured and then tested for compressive strength test. The results of compressive strength test were quite impressive and improved strength was observed in case of super plasticizer based concrete at 50 percent usage of recycled concrete aggregate.

*K. Polyvinyl Alcohol fibre (Xu et al., 2020)*

In this research work 3 different kinds of material were mainly used to carry out the research work. Basically cellulose fiber, Polyvinyl Alcohol fibre and vase spray was used to enhance the strength and durability aspects of the conventional concrete. All these materials were used in combination with each other so as to carry out the research work and to improve the strength aspects of the conventional concrete. Cellulose fibre was used at 1 percent, 1.2 percent, 1.5 percent and 1.8 percent. Polyvinyl Alcohol fibre was used at 1 percent, 1.5 percent and 2 percent. Spray was used at 2 percent, 3 percent and 4 percent. All these materials were used both separately and in combined form for improving the strength aspects of the concrete. Depending upon the percentages several specimens were prepared and then cured for 7 days, 14 days, 28 days and 56 days. After proper curing all the samples were tested for compressive strength test and flexural strength test. From the test results it was conclude that the most optimum percentage of cellulose fibre was 1.5 percent, for Polyvinyl Alcohol fibre was 1.5 percent and for spray 3 percent. The results of flexural strength test were quite similar and it was conclude that the combination of these materials has improved the strength up to a great extent.

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*L. (Said, Mustafa, Shanour, & Khalil, 2020)*

In this research work related to the usage of Polyvinyl Alcohol fibre for improving the strength aspects of the concrete, basically 2 different types of material were used in combined form and separately for improving the strength and durability aspects of the concrete. Hybrid reinforcement and Polyvinyl Alcohol fibre were used at different percentages, in combined form and in separate form to predict the effect of these material over the strength aspects of the concrete. Hybrid reinforcement was used at 0.85 percent, 1.26 percent and 1.7 percent and this percentages were assumed by the researcher, similar inn other case Polyvinyl Alcohol fibre was used at 0 percent, 0.75 percent and 1.5 percent. After this several samples were prepared depending upon the percentages of the materials and then cured for seven days and twenty eight days. From the test results it was found that the maximum strength was obtained at 1.5 percentage of Polyvinyl Alcohol fibre and 1.7 percent of hybrid reinforcement when used separately and the maximum strength was obtained at 1.5 percent of Polyvinyl Alcohol fibre and 1.26 percent hybrid reinforcement when used in combined form

## III. CONCLUSIONS

*A. General*

In this review study, the effect of three different materials such as rice husk ash, recycled concrete aggregate and Polyvinyl Alcohol fibre was reviewed in detail. Several past studies related to these material usage in strength enhancement of concrete was studied in detail. Rice husk ash is the ash which is mainly derived after burning the waste derived from the rice industry after the processing of rice. Recycled concrete aggregate is mainly the aggregate derived from the constructional waste. Polyvinyl Alcohol fibre is a special type of high strength fibre that is mainly used to improve the flexural strength and internal bonding of the concrete. Numerous studies were discussed in detail and depending upon the studies certain conclusion are drawn which are discussed further.

*B. Rice Husk Ash*

Several studies related to the usage of rice husk ash conclude that the most optimum usage percentage of rice husk ash as partial replacement of ordinary Portland cement was at 10 percent usage. After 10 percent usage strength tends to decline. Results related o usage as partial replacement of natural fine aggregate that is sand showed that it can be used as partial replacement of natural coarse aggregate up to 20 percent and beyond that usage the strength was declining.

*C. Recycled Concrete Aggregate*

The studies related to the usage of recycled concrete aggregate conclude that the most optimum percentage of usage of recycled concrete aggregate as partial replacement of natural coarse aggregate was 50 percent replacement and beyond this percentage the strength starts declining so therefore should not be used beyond that limit.

*D. Polyvinyl Alcohol fibre*

Studies related to the usage of Polyvinyl Alcohol fibre revealed that the most optimum percentage of Polyvinyl Alcohol fibre was 1.5 percent and beyond this percentage both the compressive strength of concrete and flexural strength of concrete was declining. Test results concluded that Polyvinyl Alcohol fibre should be used up to 1.5 percent only.

## IV. FURTHER CREDITS

(Adessina et al., 2019; Ahmad & Umar, 2018; Ahsan & Hossain, 2018; Al-Majidi, Lampropoulos, Cundy, Tsioulou, & Al-Rekabi, 2018; Alex, Dhanalakshmi, & Ambedkar, 2016; Bravo et al., 2017; Chen, Chen, Xu, Lui, & Wu, 2019; Das, Dey, Dandapat, Mukharjee, & Kumar, 2018; Dimitriou et al., 2018; Gholampour & Ozbakkaloglu, 2018; Gill & Siddique, 2017; He, Li, & Du, 2017; Ho, Huang, Lin, & Cheng, 2018; Hossain, Lachemi, Sammour, & Sonebi, 2013; Huang et al., 2017; Kannan, 2018; Kox et al., 2019; Lertwattanaruk, Sua-iam, & Makul, 2018; Li, Hai, & Jinping, 2012; Makul & Sua-iam, 2018; Nematzadeh, Dashti, & Ganjavi, 2018; Noaman et al., 2019; Noushini, Samali, & Vessalas, 2013; Pacheco, de Brito, Chastre, & Evangelista, 2019; Patel & Shah, 2018; Said et al., 2020; Saraswathy & Song, 2007; Sargın, Saltan, Morova, Serin, & Terzi, 2013; Tanyildizi & Yonar, 2016; J. Wang, Dai, Si, & Guo, 2018; Y. Wang, Hughes, Niu, & Fan, 2019; Z. Wang, Yu, Li, Zhang, & Leung, 2019; Xie et al., 2019; Xu et al., 2020; Zerbino, Giaccio, & Marfil, 2014; Zheng et al., 2018)

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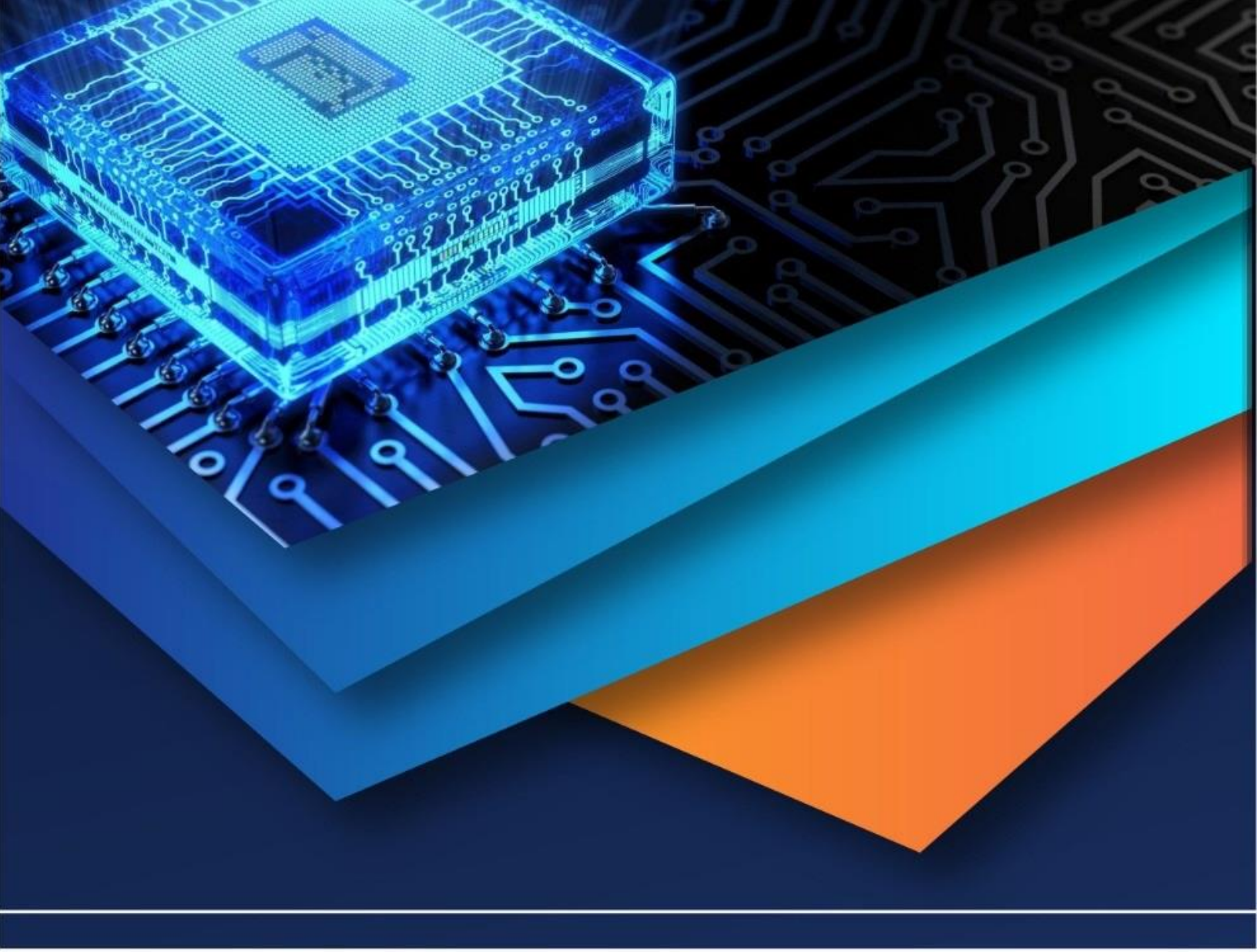

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