iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VI **Month of publication:** June 2021

DOI: https://doi.org/10.22214/ijraset.2021.35097

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VI Jun 2021- Available at www.ijraset.com

Strength Assesment of Asphaltic Concrete using Bitumen, Natural Fibre and Stone Dust: A Critical Review

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Abstract: ***In this review article, the usage of bitumen, sisal fiber and the sisal fiber for improving the strength parameters of concrete is discussed in detail. Numerous research studies related to the usage of bitumen, sisal fiber and stone dust are studied in detail to determine the results and outcome out of it. Previous research works showed that all, these materials were enhancing the strength and durability aspects of the concrete and depending upon the research studies certain outcomes has been drawn which are as follows.***
The studies related to the usage of the bitumen or asphalt in concrete so as to produce bituminous concrete or asphaltic concrete, the previous research works conclude that the maximum strength was attained at 5 percent usage of the bitumen and after further usage the general compressive strength of the concrete starts declining.
The previous studies related to the usage of the sisal fiber showed that with the usage of the sisal fiber in the concrete, the strength aspects of concrete were improving and the maximum strength was obtained at 1.5 percent usage of the sisal fiber and after his the strength starts declining.
Further the studies related to the usage of the stone dust showed that with the usage of stone dust as partial replacement of the natural fine aggregate the compressive strength of the concrete was improving and it was conclude that with the increase in the percentage of the stone dust, the compressive strength of the concrete was increasing.
Keywords: bitumen, natural fiber, sisal fiber, stone dust, fiber reinforced concrete, recycled waste concrete, green concrete.

I. INTRODUCTION

A. General

Concrete is the most widely used constructional material in the world. In every constructional activity the usage of concrete is there. Concrete is used for the constructions of buildings, roads, dams, retaining walls, beams, columns, slabs, water tanks and many more constructions.

The demand of the concrete is increasing day by day with respect to that the demands of the constructional material is also increasing. But with time these basic constructional material of concrete are decreasing, so therefore some alternative materials are proposed ion this review work and it mainly deals with the usage of the sisal fiber, bitumen or asphalt and stone dust in concrete.

B. Bitumen

In various countries bitumen is also known as asphalt so therefore the construction done with the help of bitumen is also known as bituminous construction and asphaltic construction. Bitumen is mainly produced during the distillation process of the crude oil in the form of a residue or a left over product.

The distillation process of this crude oil is also called its water proofing. Bitumen is basically a complex form of several or numerous hydrocarbons and also contains elements such as oxygen, calcium, Sulphur and iron depending upon the quality of the bitumen and depending upon the distillation process of the crude oil.

This materials is mainly used in the construction of road pavement but it can also be used in concrete so as to produce bituminous concrete or the asphaltic concrete. The production of this asphaltic concrete with the help of other supplementary cementitious materials are discussed further.

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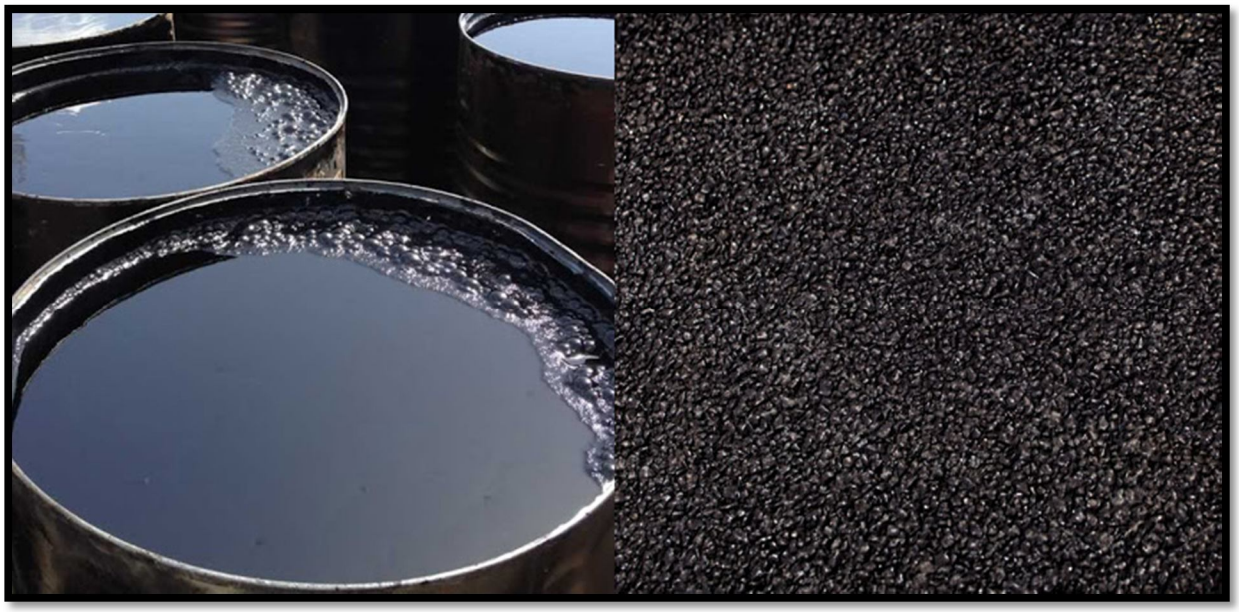


Figure. Usage of Bitumen
https://www.asphalt.com.au/why-asphalt/bitumen-vs-asphalt/

C. Sisal Fiber

Sisal is basically a flowering species that is grown in mostly every country in the world. It is basically grown to produce a fabric like fiber so as to fulfill several clothing and storage purposes. It is mainly a very stiff fiber that is majorly used for making ropes and other strong synthetic fiber products. The other products which can be mad from this fiber include dartboard, geotextile, carpets, bags, hats, footwear, cloth, paper etc. this fiber was earlier used to fulfill all these above discussed purposes but in this article the usage of the this sisal fiber in the construction industry is discussed in detail. This fiber id used in concrete strength enhancement process as this fiber is good in compressive forces resistance and is very much stiff in nature so therefore can easily be used to enhance the stiffness parameters of the conventional concrete samples.



Figure. Sisal Fiber
https://www.exportersindia.com/agro-bond/sisal-fiber-3303868.htm

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Volume 9 Issue VI Jun 2021- Available at www.ijraset.com

D. Stone Dust

Stone dust is mainly produced during the crushing process of the stone. During the crushing process of the hard stone so as to convert them in a uniform sized aggregate, a huge amount of waste is produced in the form of dust and this dust in general terms is termed as the stone dust. The physical properties of this stone dust completely depends upon the stones to be crushed and the method of crushing. This process of generation of this stone dust is similar to the production of sandstone powder and the limestone powder. This stone dust is also known as the quarry dust and stone residue. This stone dust can be used as partial replacement the natural fine aggregate for improving the strength aspects of the normal concrete.



Figure. Stone Dust
https://ebyland.com/product/stone-dust/

II. LITERATURE REVIEW

A. Bitumen Concrete

1) *(Caputo et al., 2020):* In this research work several nanomaterials were used to enhance the strength aspects of the asphaltic or bituminous concrete sample. Several Nano materials includes Nano silica and Nano ceramic. Bothe these materials were used to enhance the engineering properties of the concrete sample. Firstly Nano silica was collected from a local source and then tested for its physical properties and its chemical composition. Then this Nano silica was used as an additive in the asphaltic concrete at 2 percent, 3 percent, 4 percent, 5 percent, 6 percent and 7 percent. In simple words Nano silica was used from 2 percent to 7 percent at an increment of 1 percent in each case. After this several samples were prepared and after proper testing over these samples it was concluded that the most optimum percentage of usage of Nano silica in asphaltic concrete was found to be 5 percent usage. Then Nano ceramic was used at similar percentages that is from 2 percent to 7 percent at an increment of 1 percent in each case. The test results concluded that in case of usage of Nano ceramic the most optimum results were found at 7 percent usage of the Nano ceramic.
2) *(Vila-Cortavitarte, Lastra-González, Calzada-Pérez, & Indacoechea-Vega, 2018):* In this research work related to the usage bituminous concrete or asphaltic concrete, limestone aggregate, ophitic aggregate and polystyrene were used to improve the strength aspects of the normal or conventional concrete. Limestone aggregate and ophitic was used as partial replacement of the natural aggregate whereas polystyrene was used as partial substitution of the bitumen in the preparation of the asphaltic concrete. Limestone aggregate was used at 10 percent, 20 percent, 20 percent, 40 percent and at 50 percent as partial substitution of natural aggregate, ophitic aggregate was also used at 10 %, 20% 30%,40% and 50 percent and the polystyrene was used at 10 percent , 20 percent and 30 percent. After this several concrete samples were prepared and cured for seven days, fourteen days, twenty eight days and fifty six days. After curing all the samples were taken for testing so as to test them for, wheel tracking test, particle loss test, compressibility test, stiffness test, resistance to fatigue and flexural strength test. The test results showed that the combination with limestone aggregate at 40 percent usage and polystyrene at 20 percent usage was showing the most optimum results as well as the she maximum strength so therefore it was concluded that for obtaining maximum strength limestone aggregate and polystyrene can be used in case of asphaltic concrete.

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3) *(Dehestani et al., 2017):* In this research work bitumen and styrene were used to modify and improve the strength aspects of the normal Sulphur concrete. Sulphur concrete was first prepared with the assertion of Sulphur in a controlled form. Bitumen and styrene both were used as an additive for enhancing and predicting the strength aspects of the concrete sample. Bitumen was collected from the local road manufacturing industry and styrene was purchased from the local source for carrying out the research work. Bitumen was used at 1 percent, 2 percent, 2.5 percent and 3 percent whereas styrene was used at 2 percent, 4 percent, 10 percent, 15 percent, 20 percent and 25 percent. Both the materials were first tested for its physical properties and their chemical composition and then used for enhancing the strength aspects of the controlled concrete. Using the following materials, several samples were casted and then cured for 7 days and twenty eight days. After proper curing all the samples were tested for its compressive strength test and durability test. After proper testing it was concluded that the most optimum results for the usage of bitumen were found at 3 percent usage of the bitumen and in case of usage of the styrene the most optimum results were found at 10 percent usage.

B. Sisal Fiber

1) *(Sabarish, Paul, Bhuvaneshwari, & Jones, 2020):* In this research work sisal fiber was used to improve the strength and durability properties of the concrete sample. Sisal fiber in general aspects is mainly used for several other purposes such as for preparing ropes or bags from it, but I this research work sisal fiber was used as an additive in concrete so as to prepare fiber reinforced concrete and to improve the strength aspects of the normal conventional concrete. Sisal fiber was used from 0 percent to 5 percent at an increment of 1 percent in each case. In other words sisal fiber was used to 0 percent, 1 percent, 2 percent, 3 percent, 4 percent and 5 percent as an additive in the conventional concrete. After this several concrete samples were prepared and then tested for the compressive strength test, flexural strength test and the split tensile strength test. The test results of all the tests concluded that the maximum strength with the usage of sisal fiber can be achieved at 2 percent usage of the sisal fiber and further this percentage the strength of the concrete was declining.
2) *(Castoldi, Souza, & de Andrade Silva, 2019):* In this study related to the concrete, three different kinds of materials were used to improve the strength aspects of the conventional concrete. Metakaoline and fly ash was used as partial replacement of the cement at different proportions in combined form and the separate form. Sisal fiber was used as an additive in the concrete to improve its numerous structural properties. All the three materials that is metakaoline, fly ash and the sisal fiber were used in combination with each other and in separate form. Metakaoline and fly ash were used at 10 percent, 20 percent and 30 percent, while the sisal fiber was used at 0.5 percent, 1 percent, 1.5 percent and 2 percent. Test results of compressive strength test showed that the maximum strength was obtained at 109 percent usage of fly ash, 10 percent usage of metakaoline and 1.5 percent usage of the sisal fiber. So it was conclude that when used combined form fly ash should be used at 10 percent, metakaoline should be used at 10 percent and sisal fiber should be used at 1.5 percent so as to obtain the most optimum results.
3) *(Naraganti, Pannem, & Putta, 2019):* In this research work three different kinds of fibers were used to check the strength aspects of the concrete. Steel fiber, polypropylene fiber and sisal fiber were used separately so as to compare the results of usage of different kind of the fibers over the strength aspects of the conventional concrete. All the three fibers such as the sisal fiber, steel fiber and the polypropylene fiber was used as an additive in the concrete at 0 percent, 0.5 percent, 1 percent, 1.25 percent and 1.50 percent. After this several cubes, beams and cylinders of the concrete were casted depending upon the percentage of all the fibers in the separate form. After casting compressive strength test, flexural strength test and split tensile strength test was performed over the samples after proper curing. The test results revealed that the most optimum results of all the threes fibers were found at 1.25 percent usage of all the three fibers such as sisal fiber, steel fiber and the polypropylene fiber. Comparison showed that the most suitable fiber out of all the fibers was found out to be polypropylene fiber.

C. Stone Dust

1) *(Fares, Hamad Albaroud, & Iqbal Khan, 2020):* In this experimental work related to the usage of the limestone dust, steel fibers and polyvinyl alcohol fiber, the strength and durability parameters of the conventional concrete were analyzed properly. All the three materials such as the polyvinyl alcohol fiber, steel fiber and the limestone dust was used in combined form so as to improve the engineering properties of the normal concrete. Steel fiber and the polyvinyl alcohol fiber were used as an additive at 0 percent, 0.5 percent, 1 percent and 1.5 percent , while the limestone dust was used as partial substitution of the natural fine aggregate at 0 percent, 10 percent, 20 percent, 30 percent, 40 percent and 50 percent, several specimens were prepared depending upon the percentage of materials and then cured for seven days and twenty eight days, the test results showed that

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the maximum strength was obtained at 1 percent usage of steel fiber, 1 percent usage of the polyvinyl alcohol fiber and 50 percent usage off the limestone dust.

2) *(Rajput, 2018):* In this investigational work stone dust was used as partial replacement of the natural fine aggregate or sand to as to enhance and predict the strength parameters of the normal concrete prepared with cement, natural sand and natural coarse aggregate. Stone was collected from the local stone crushing site free of cost and then tested for its physical and chemical properties. After this this stone dust was used as partial replacement of the natural fine aggregate at 0 percent, 20 percent, 40 percent 60 percent, 800 percent and 100 percent. After this several specimens were prepared and then cures for seven days, fourteen days, twenty eight days and fifty six days. Then after curing all the specimen were tested for compressive strength test and the test results showed that with increase in the percentage of the stone dust the strength of the concrete was increasing so stone dust can be used at 100 percent as partial replacement of the natural fine aggregate.

III. CONCLUSIONS

A. General

In this review article, the usage of bitumen, sisal fiber and the sisal fiber for improving the strength parameters of concrete is discussed in detail. Numerous research studies related to the usage of bitumen, sisal fiber and stone dust are studied in detail to determine the results and outcome out of it. Previous research works showed that all, these materials were enhancing the strength and durability aspects of the concrete and depending upon the research studies certain outcomes has been drawn which are as follows.

B. Bitumen Usage

The studies related to the usage of the bitumen or asphalt in concrete so as to produce bituminous concrete or asphaltic concrete, the previous research works conclude that the maximum strength was attained at 5 percent usage of the bitumen and after further usage the general compressive strength of the concrete starts declining.

C. Sisal Fiber

The previous studies related to the usage of the sisal fiber showed that with the usage of the sisal fiber in the concrete, the strength aspects of concrete were improving and the maximum strength was obtained at 1.5 percent usage of the sisal fiber and after his the strength starts declining.

D. Stone Dust

Further the studies related to the usage of the stone dust showed that with the usage of stone dust as partial replacement of the natural fine aggregate the compressive strength of the concrete was improving and it was conclude that with the increase in the percentage of the stone dust, the compressive strength of the concrete was increasing.

IV. FURTHER CREDITS

(Bołtryk, Falkowski, & Pawluczuk, 2017; Caputo et al., 2020; Castoldi et al., 2019; Çelik & Marar, 1996; Chomicz-Kowalska, Gardziejczyk, & Iwański, 2016, 2017; da Gloria & Toledo Filho, 2021; Dehestani et al., 2017; Fares et al., 2020; Frazão, Barros, Toledo Filho, Ferreira, & Gonçalves, 2018; Gorkem & Sengoz, 2009; A. Gupta, Gupta, Saxena, & Goyal, 2021; T. Gupta, Kothari, Siddique, Sharma, & Chaudhary, 2019; Iwański, Mrugała, & Chomicz-Kowalska, 2017; Kishchynskyi, Nagaychuk, & Bezuglyi, 2016; Kumar Verma, Sheikhar Singla, Nadda, & Kumar, 2020; Lima, Barros, Roque, Fontes, & Lima, 2018; Lopes Lima, Roque, Ariani Fontes, Feitosa Lima, & Barros, 2017; Marta, Pedro, Miguel Ángel, & Indacoechea-Vega, 2019; Mrugała & Iwański, 2015; Naraganti et al., 2019; Padanattil, Karingamanna, & K.M, 2017; Pasandín, Pérez, Oliveira, Silva, & Pereira, 2015; Patil & Patil, 2021; Prokopski, Marchuk, & Huts, 2020; Rajput, 2018; Sabarish et al., 2020; Sen & Paul, 2015; Singh, 2021; Soto Izquierdo, Soto Izquierdo, Ramalho, & Taliercio, 2017; Venkata Sairam Kumar, 2021; Venkata Siva Rama Prasad & Vara Lakshmi, 2020; Vila-Cortavitarte et al., 2018; Wei & Meyer, 2014)

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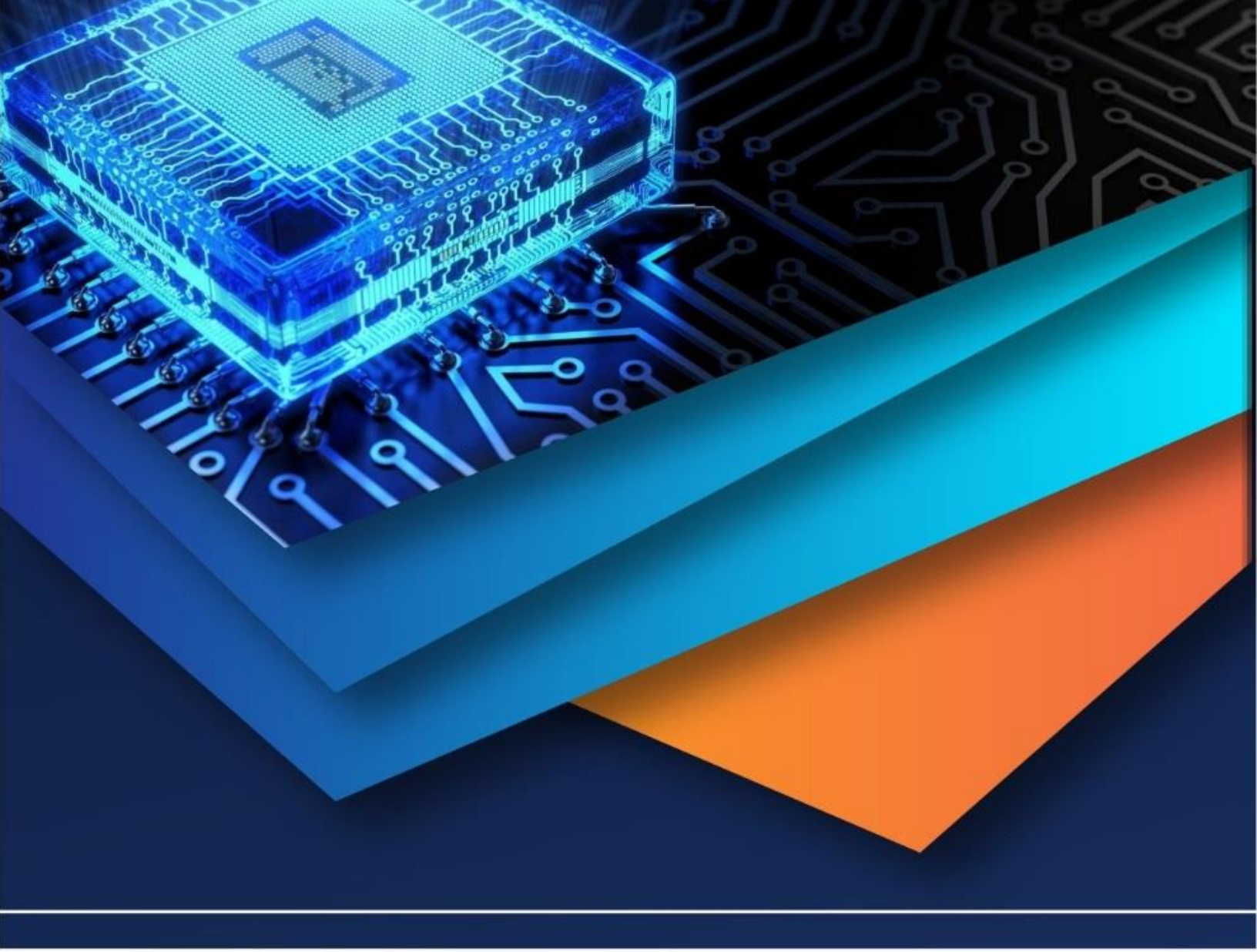
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