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Effect on Mechanical Properties of Paver Block Consist Crusher Stone Dust as Fine Aggregate with Inclusion of Steel Fiber

Akash Gupta[1], Prof. Archana Tiwari[2]
[1]*M.E. Student (Construction Technology and Management), Civil Engineering Department MITS Gwalior*
[2]*Head of Civil Engineering Department, MITS Gwalior*

Abstract: ***Application of concrete paver block in road pavement is more common nowadays .concrete paver block is better option in road construction where conventional road construction is not suitable or uneconomical. This paper describes experimental study of interlocking concrete paver block with stone crusher dust in addition of crimped steel fiber. To overcome the problems due to excessive sand mining, stone crusher dust is used as fine aggregate. In the present investigation, paver blocks were prepared of M40 design mix. The dimension of paver block is 250 X 125 X80 mm. The fine aggregate completely replaced by stone crusher dust and incorporated with crimped steel fibers of aspect ratio 50 is used in different proportion of 0.5%, 1%, 1.5%, 2%, and 2.5% by weight of cement in design mix .The experimental investigation is carried out by conducting compressive strength test, water absorption test and flexural strength test at 28 day age.***

Keywords – Fiber reinforced concrete, Stone crusher dust, Crimped steel fiber, Aspect ratio, Compressive strength, Flexural strength, Paver block

I. INTRODUCTION

Interlocking concrete block pavement (ICBP) has been widely used in many countries as a specialized problem solving method for providing pavement in areas where conventional method of pavement construction are less durable or feasible due to working and environmental restriction . ICBP consists of a surface layer of small-element, solid un-reinforced pre-cast concrete paver blocks lay on a thin, compacted bedding material which is constructed over a properly profiled base course and is enclosed by edge restraints/kerb stones. The block joints are filled using proper fine material. Where conventional systems have lower service life due to a number of geological, traffic, environmental and working constraints, ICBP can be used effectively. Many number of such applications for light, medium, heavy and very heavy traffic conditions are currently in practice around the world.

Concrete plays a major role in the construction industry and a huge quantum of concrete is being utilized. River sand, which is one of the constituent used in the production of conventional concrete, has become expensive and also a scarce material. River sand becoming a scare commodity and hence exploring alternatives to it has become imminent. Depletion of the virgin natural river sand is the main issue pertaining to the construction industry. For the above reason crusher stone dust is used in place of river sand as fine aggregate. Recently in concrete paver block fibers are introduced to increases strength, durability and reduction in crakes. By using fibers in concrete paver block it improves properties of paver block.

In the previous investigation, researchers used fiber like polypropylene ,nylon polyester, coconut coir, glass fiber, steel fiber etc. for the enhancement of mechanical properties and partial or full replacement of ingredient of concrete by fly ash, stone dust, unconventional coarse aggregate in paver block .Sachin B. Kandekar et al [1] investigated the properties of paver block using steel fiber in the range in different percentage by weight of cement and concluded that compressive strength is is increases from 68.70 MPa to 86.80 MPa and flexural strength increases 15.69 to 25.49 MPa with increase in steel fiber 0.5 to 2.5%.S.Revthi et al [2] studied the effect of groundnut husk as fine aggregate in varying percentage 0 to 60 in M40 grade by using 10 mm aggregate and found that with increase in percentage of ground nut husk compressive strength decreases .Shivang D Jaswal et al [3] in their experimental investigation used manufacturing sand as fine aggregate and include crimped steel fiber in different percentage from 0 to 2 %.the mix design study is for M25 and M30 concrete design mix and observed that optimum results are made for flexural and compressive strength at 1.5% steel fiber. G. Navya, J. Venkateswara Rao [4] in their experimental investigation determined the compressive strength, water absorption and flexural strength of paver blocks by adding Polyester fibers in the top 20mm thickness from 0.1-0.5%. Test results indicate that addition of polyester fiber by 0.4% paver block attains maximum compressive, flexural strengths and minimum water absorption at 7 and 28 days. G. Navya, J. Venkateswara Rao [5] in their experimental investigation

determined the compressive strength, water absorption and flexural strength of paver block by adding Coconut fibers in the top 20mm thickness from 0.1-0.5%. Test results indicate that addition of coconut fiber by 0.3% in paver block attains maximum compressive strength Thakur, Saxena and Arora T.R. [6] investigated on Effect of Partial replacement of cement by fly ash with using nylon fiber in concrete paver block. Initially nylon fiber was used in the range of 0.1-0.4% by weight of cement and later fly ash along with optimum nylon fiber content in the range of 10-40%.It was concluded that 20% of partial replacement of cement with fly ash and 0.3% nylon fiber improved the mechanical properties of paver block.

From previous investigation it was evident that few researcher have concentrated on combined use of fiber and replacement of fine aggregate material in paver block .The reason of present study is to examine the suitability of stone crusher dust as fine aggregate in concrete paving block and an attempt is made to evaluate the effect of steel fibers on strength parameter of concrete paving block and also to find in M40 mix of concrete by the use of steel fibers how much higher strength we are able to achieve, so that cost of high grade concrete will be reduced. This experimental investigation is a continuation to study the combined effect of these materials on paver block.

II. MATERIAL USED IN RESEARCH

A. *Cement*

Ordinary Portland cement (OPC) of 43 grade confirming to IS: 8112 (1989) was used for casting the paver blocks. Physical properties of OPC were given in table 1.

Table 1 Physical properties of OPC

Property	Value
Specific gravity	3.12
Consistency limit	30.25%
Initial setting time	42 minutes
Final setting time	385 minutes

B. *Coarse aggregate*

Locally available crushed coarse aggregate of nominal size 10 mm were used in this work physical properties of aggregate are given in table 2

Table2 Physical properties of Coarse aggregate

Property	Water absorption	Specific gravity	Aggregate impact value	Aggregate crushing value
Value	0.13%	2.69	26%	24.61%

C. *Fine aggregate*

The river sand was used in control design mix confirming to IS: 383.the physical test results made on fine aggregate are given in table 3.

Table 3 Physical properties of Fine aggregate

Property	Water absorption	Specific gravity	Fineness modulus
Value	1.3%	2.605	2.98

D. *Crusher Stone Dust*

Stone Dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm.The fineness modulus of crusher stone dust is 3.621.

E. *Steel Fiber*

Carbon steel fiber is a cold drawn steel wire fibers with corrugated/crimped/corrugated for optimal anchorage for reinforcing concrete to prevent cracking ,provide ductility and high load bearing capacity .the length and dia of fiber 50 mm and 1 mm respectively the properties of steel fiber in table given in table 4.

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Table 4 Physical properties of Carbon Steel Fiber

Property	Grade	Aspect ratio	Tensile strength
Value	Low carbon	50	1198.36 MPa

Table 5 chemical composition of steel fiber

Chemical composition	C	Si	Mn	P	S	Cr	Ni	Cu	Mo	N
(%)	0.05	0.14	0.44	0.026	0.02	0.12	0.17	0.28	0.038	0.007

Source: KOMATKO PUNE

F. Admixture

Water reducing admixture Rockplast –KR (A) (Polycarboxylate) in liquid form used in concrete. The doze of admixture is 400 ml per bag of cement i.e. 8ml per kg of cement.

III. DESIGN MIX METHODOLOGY

In the study there were control mix S design as per 10262:2009 for M40 grade with conventional material cement, fine aggregate (sand) and coarse aggregate. After that sand is completely replaced by stone crusher dust, the design mix now designated S1. Different proportions of steel fiber were added from0.5 to 2.5%. Hence total 7 different batches of design prepared .The detail of the mix proportion are given in the table 6.

Table 5 Mix Proportion Detail of M40 grade concrete for 1 m^3 quantity

Material / Mix id	Cement (Kg)	Fine aggregate (sand) (kg)	Fine aggregate (stone crusher dust) (kg)	Coarse aggregate (kg)	Water (lt)	Admixture (lt)	Steel fiber (% by wt of cement)
S	410.52	988.52		885.35	156	3.284	0.00
S1	410.52	-	988.52	885.35	156	3.284	0.00
$SISF_{0.5\%}$	410.52	-	988.52	885.35	156	3.284	0.50
$S1SF_{1\%}$	410.52	-	988.52	885.35	156	3.284	1.00
$S1SF_{1.5\%}$	410.52	-	988.52	885.35	156	3.284	1.50
$S1SF_{2\%}$	410.52	-	988.52	885.35	156	3.284	2.00
$S1SF_{2.5\%}$	410.52	-	988.52	885.35	156	3.284	2.50

S1SF- STEEL FIBER INCORPORATED WITH S1 MIX DESIGN

IV. EXPERIMENTAL METHODOLOGY

Paver blocks were casted confirming to the mix proportion and followed the recommendations laid down in is 15658:2006 .the size of paver block 250x125x80 .Total 105 paver block were casted. The samples were cured in water for 28 days. Compressive strength ,water absorption test and flexural strength test is done after 28 days as per codal recommendation .The test specimen required for the particular test as per IS: 15658 are 4 for compressive strength and flexural strength test each and 3 test specimen required for water absorption test. These tests are conducted as per IS: 15658:2006 given in ANNEXURE C, D and F for Water Absorption, Compressive Strength and Flexural Strength test respectively.

V. TEST RESULTS & DISCUSSION

A. Compressive Strength

The compressive strength values of the standard paver block & paver block with crusher stone dust and inclusion of steel fiber is

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presented in figure 1.

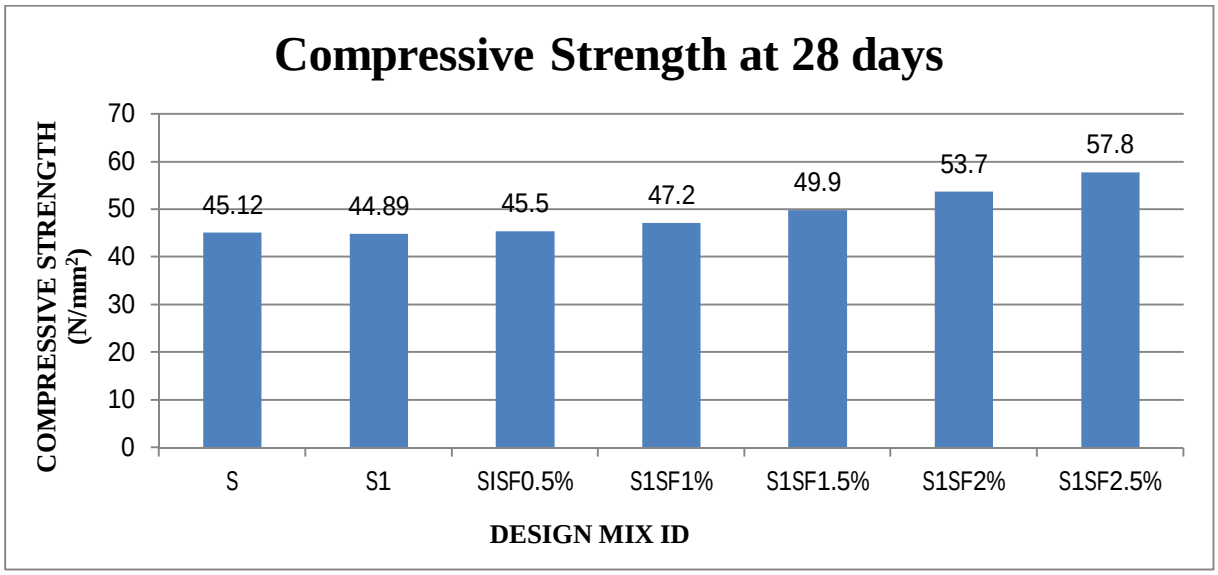

Figure 1

From figure it was observed that the compressive strength of paver block for control design mix S and design mix with crusher stone dust as fine aggregate S1 was approximately same. The graph shows that inclusion of steel fiber in design mix proportion S1 by weight of cement, the compressive strength is increases with increase in steel fiber percentage and maximum at inclusion of 2.5% of steel fiber.

B. Water Absorption

The water absorption values of the standard paver block & paver block with crusher stone dust and inclusion of steel fiber is presented in figure 2.

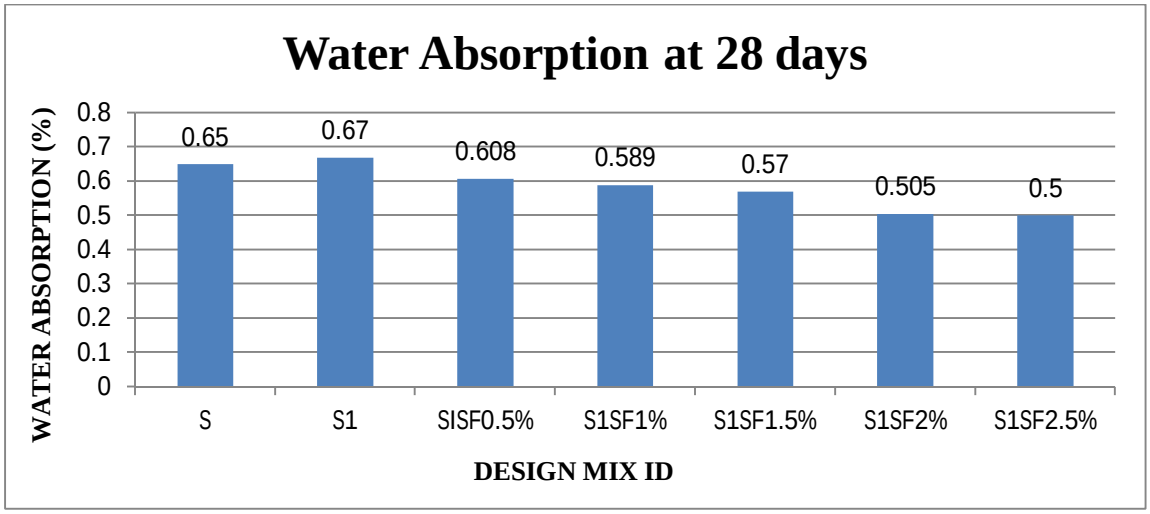

Figure 2

The graph illustrates that water absorption at 28 days decreases with increase in steel fiber content. As per IS15658 :2006 water absorption of individual concrete paving block should be less than 7% or maximum 6% by mass (i.e. average of 3 units). But maximum water absorption among all groups was found to be much less than permissible.

C. Flexural Strength

The flexural strength values of the standard paver block & paver block with crusher stone dust and inclusion of steel fiber is presented in figure 3.

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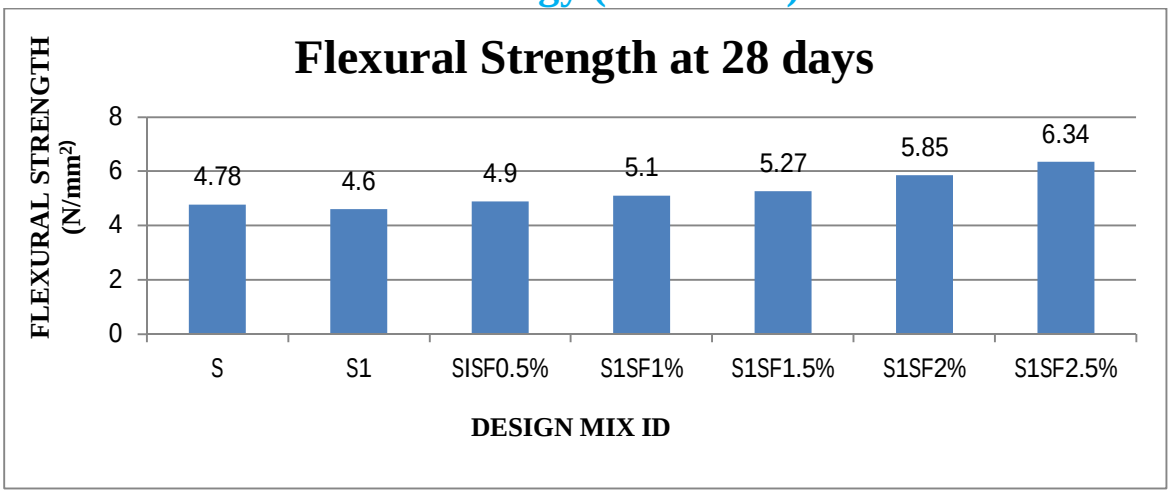

Figure 3

From fig it was observed that the flexural strength of concrete paver block was increasing with inclusion steel fiber. However without steel fiber only replacement of fine aggregate by crusher stone dust (S1) ,it is slightly lower than control mix (S) .the maximum flexural strength is found at inclusion of 2.5% steel fiber in S1 design mix

VII. CONCLUSION

A. Compressive and flexural strength gives slightly less value when fine aggregate replaced by crusher stone dust completely.

B. Paver block consist crusher stone dust as fine aggregate with inclusion of steel fiber showing increasing behaviour of strength as steel fiber percentage increases. It was maximum at 2.5 inclusion of steel fiber.

C. Water absorption is found increase with replacement of fine aggregate by crusher stone dust and decreases after incorporated with steel fiber. The maximum water absorbed by design mix S1 and minimum by S1SF2.5% However both values are much less than permissible value.

D. From the above test result it can be concluded that natural sand can effectively replaced by crusher stone dust without much affecting the properties of paver block and also for enhance the strength by fiber, steel fiber effectively use.

VIII. SCOPE OF FUTURE WORK

The present work has good scope for future research. Some of the research areas are as follows:

A. Investigation of reduction in cement content for different percentage addition of fibres in mix when permissible strength results are achieved.

B. Investigation by use different aspect ratio of steel fiber of different shape.

C. Behaviour under creep and shrinkage.

D. Behaviour of mechanical and physical property by suitable other alternatives of sand and aggregate.

E. Replacement of cement by other binding material such as glass powder, silica fumes, fly ash, stone dust etc incorporated with different type of fiber .

Curing of paver block

Paver blocks in oven

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Compressive strength of paver block


Flexural strength of paver block


Steel fiber used in paver block

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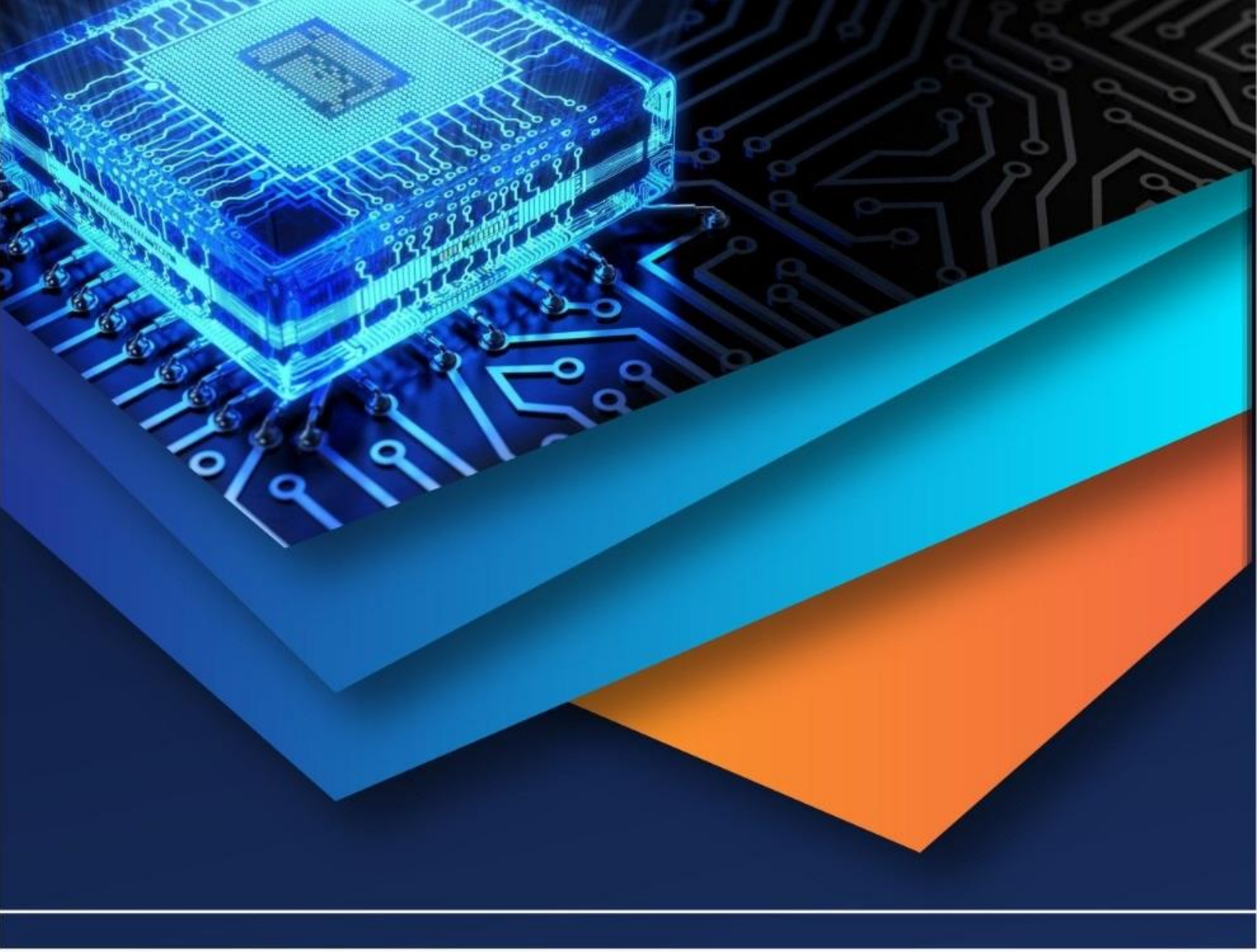

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