iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** XI **Month of publication:** November 2021

DOI: https://doi.org/10.22214/ijraset.2021.39119

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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 XI Nov 2021- Available at www.ijraset.com

Replacement of Conventional Concrete by Light Weight Concrete

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Abstract: Lightweight concrete (LWC) allows for larger spans, fewer piers, and longer bridge designs due to its lower weight and improved durability. Because superstructures with broader shoulders or additional lanes may be improved without requiring extensive work on the substructure, LWC is a particularly desirable construction material at the moment. The goal of this research was to determine the density (unit weight), splitting tensile strength, and elastic modulus of LWC mixtures under various curing circumstances in order to gain a better knowledge of LWC qualities that are critical for long-lasting and cost-effective buildings. The researchers also looked at the relationship between the results of the fast chloride permeability test and the outcomes of other tests and the Werner probe surface resistance test to see if the latter may be used to forecast the permeability of LWC mixtures because it is faster and more convenient.
Keywords: Light weight aggregate, pumice, compressive strength, density,

I. INTRODUCTION

The relevance of lightweight concrete in the construction industry cannot be overstated. The majority of modern concrete research is focused on high-performance concrete, which is defined as a low-cost material that meets strict performance requirements, such as durability.

The term "lightweight concrete" refers to a form of concrete that contains an expansion agent to enhance the volume. while adding extra features such as reduced dead weight to the mixture It is less dense than traditional concrete. Lightweight concrete is commonly used in countries such as the United States, the United Kingdom, and Sweden.

The low density and heat conductivity of lightweight concrete are two of its key advantages. As a result, there is a reduction in dead load, faster construction rates, and lower transportation and handling expenses.

When lightweight concrete is applied to a wall, it retains its big spaces and does not develop laitance layers or cement films. Light weight concrete varies from heavy concrete in that it uses naturally light weight elements (aggregates) like pumice (volcanic stone) instead of sand and gravel in structural concrete mixtures. Ultra-lightweight concrete, we believe, will be one of the most important bulk building materials in the future.

In comparison to conventional weight concrete, LWC has a lower modulus of elasticity, a more continuous contact zone between the aggregate and the paste, and a greater compatibility between the elastic module of the aggregate. More moisture in the pores of aggregates for sustained internal moist curing; a better compatibility between the elastic module of the aggregate and the paste; and a better compatibility between the elastic module of the aggregate and the paste. These enhancements result in lower permeability and less cracking in concrete, which is ideal for bridge deck. When compared to normal weight reference concrete at identical compressive strength, the splitting tensile strength of LWC ranges from 70 to 100 percent.

A. Lightweight Concrete

Lightweight cement can be characterized as a kind of substantial which remembers an extending specialist for that it expands the volume of the combination while giving extra characteristics, for example, nail-capacity and diminished the extra weight. It is lighter than the ordinary cement with a dry thickness of 300 kg/m3 up to 1840 kg/m3; 87 to 23% lighter- For underlying applications the substantial strength ought to be more prominent than 2500 psi (17.0MPa). The substantial combination is made with a lightweight course total. At times allot or the whole fine total might be a lightweight item. Lightweight totals utilized in underlying lightweight cement are ordinarily extended shale, earth or record materials that have been fire Dina revolving oven to foster a permeable design. Different items, for example, air-cooled impact heater slag are likewise utilized. There are different classes of non-primary lightweight cements with lower thickness made with other total materials and higher air voids in the concrete glue framework, for example, in cell concrete.

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B. Types Of Light Weight Concrete

It is helpful to group the different kinds of lightweight cement by their strategy for creation. These are:

1) By utilizing permeable lightweight total of low clear explicit gravity, for example lower than 2.6. This sort of cement is known as lightweight total cement.

2) By presenting huge voids inside the substantial or mortar mass; these voids ought to be unmistakably recognized from the amazingly fine voids delivered via air entrainment.This sorts of cement is differently knows as circulated air through, cell, frothed or gas concrete.

3) By excluding the fine total from the blend with the goal that countless interstitial voids is available; ordinary weight coarse total is by and large utilized. This substantial as no-fines concrete.

C. Lightweight Aggregate Concrete

Primary lightweight total has been effectively utilized for above and beyond two centuries. It has had inescapable need for as long as ninety years. This history of demonstrated execution has shown how primary lightweight total adds to the supportable improvement by saving energy, bringing down transportation necessities, expanding plan and development proficiency and expanding the assistance life of the item it is utilized in. There are three normal sorts of lightweight material: total from volcanic sources, results from coal ignition, and produced totals. This article covers extended shale, mud and record (ESCS), the produced lightweight total that is predominately utilized in the business sectors examined.

D. Aerated Concrete

Cement of this sort has the most minimal thickness, warm conductivity and strength. For works in situ the standard techniques for air circulation are by blending in balanced out froth or by whipping air in with the guide of an air entraining specialist. The precast items are typically made by the expansion of about 0.2 percent aluminums powder to the blend which responds with basic substances in the fastener shaping hydrogen bubbles. Air-relieved circulated air through concrete is utilized where little strength is required for example rooftop tirades and line slacking. Original capacity improvement relies on the response of lime with the siliceous totals, and for the equivalent densities the strength of high pressing factor steam relieved cement is about double that of air-restored cement, and shrinkage is just a single third or less.

E. No-Fines Concrete

The term no-fines concrete by and large means concrete made out of concrete and a coarse (9-19mm) total just (somewhere around 95% should pass the 20mm BS strainer, not in excess of 10% should pass the 10mm BS sifter and nothing should pass the 5mm BS strainer), and the item so framed has numerous consistently disseminated voids all through its mass. No-fines concrete is chiefly utilized for load bearing, cast in situ outside and inside divider, non burden bearing divider and under floor filling for strong ground floors (CP III: 1970, BSI).

No-fines concrete was brought into the UK in 1923, when 50 houses were underlying Edinburgh, followed a couple of years after the fact by 800 in Liverpool, Manchester and London. This portrayal is applied to substantial which contain just a solitary size 10mm to 20mm coarse total (either a thick total or a light weight total, for example, sintered PFA). The thickness is around two-third or 3/4 that of thick cement made with similar totals. No-fines concrete is quite often given in situ essentially a role as burden bearing and non burden bearing dividers remembering for filling dividers, in outlined construction ns, yet at times as filling beneath solids ground floors and for rooftop tirades.

F. Objectives

1) Able to deliver truly stable cell light weight substantial blends during the frothing or air circulation measure.

2) Able to deliver light shading cell light weight substantial blends that can be handily colored by adding appropriate shades.

3) Able to give applications which can utilize reasonable reused materials.

4) Reduction in dead loads making investment funds in establishments and support.

5) Improved warm properties.

6) Improved imperviousness to fire

7) Saving in transportation cost.

8) Reduction in formwork and setting.

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II. LITERATURE REVIEW

A. *Introduction*

In this part a basic survey of writing on property of light weight concrete, light weight totals, strength and toughness of fly debris total cement and blend proportioning of light weight concrete are introduced.

B. *Literature Review*

Serkan et al. (2009) researched the impact of utilizing fly debris in high strength light weight total cement delivered with extended earth total on physical and mechanical properties of the substantial. The concrete substance with 450 Kg/m3 among substantial combinations created high strength esteem and the mechanical properties could be upgraded by utilizing 10% fly debris. A saving in concrete substance and cost could be accomplished.

Nusret et al. (2010) to research the impact of expansion of pozzolanic materials and restoring locales on the mechanical properties and the slender water ingestion (Sorptivity) attributes of light weight concrete. The outcomes showed a decent connection between's the strength advancement of cement and its sorptivity. As the compressive and rigidity expanded because of the hydration, the sorptivity coefficients diminished fundamentally.

Pramana et al. (2010) have detailed that light weight cement can be used as a typical substantial substitution structure safeguard. Circulated air through concrete and light weight total cement can be utilized as energy permeable. Great energy assimilation is expected to the homogenized microstructure of circulated air through substantial part and air void capture in concrete depending upon the materials utilized light weight total cement works on its solidarity to forestall neighborhood harm brought about by ballistic stacking. Lower modulus of versatility and higher elastic strain limit gives better effect protection from light weight concrete than ordinary weight concrete.

Ismail et al (1999) have contemplated the conduct of light weight cement and execution of circulated air through light weight cement, for example, Compressive strength tests, water retention and thickness and correlations made with different kinds of light weight concrete.

Ozyildirim et al. (2009) has contemplated the strength of underlying light weight substantial which incorporates the physical and compound parts of sturdiness, the impact of breaking and obstruction of light weight totals to freezing and defrosting.

Sancak et al (2008) have researched primary light weight concrete created by Pumice and cement with ordinary light weight total. Compressive strength and weight reduction of the substantial were resolved in the wake of being presented to high temperatures. They supplanted the Portland concrete by silica rage in various proportion and added super plasticizer. They noticed the pace of disintegration was higher in ordinary weight substantial when compared to light weight concrete.

III. MATERIAL AND METHODS

A. *Cube Test*

Shape test is utilized to decide the compressive strength of a light weight concrete. Compressive strength will be resolved at 7 years old and 28 days.

- 3 tests for each age will be ready.
- Average result will be taken.

1) *Apparatus Required*

Standard solid shape size100mm3
Steel pole estimated 25×25mm2

2) *Procedure*

- Prepare the shape; apply grease oil in a slight layer to the internal surface of the form to forestall and holding response between the form and the sample (A.M Neville, 1994).
- Overfill each shape with test in three layers (standard Method; BS 1881; Part 3;1970).
- Fill 1/3 of the shape with test. This would be the main layer.
- Compact test with something like 35 stirs up utilizing steel rod. Compaction ought to be done contineously.
- Fill 2/3 of the shape; Second layer, Repeat stage 4
- Continue with the third layer and regard a similar compaction step.
- After compaction has been finished, smooth off by drawing the level side of the scoop (with the main edge marginally raised) once across the highest point of the each 3D shape.

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- Cut the engine off flush with the highest point of the shape by drawing the edge of the scoop (held opposite to the form) with a sawing movement over the form.
- Tag the example, giving gathering number, and example distinguishing proof.
- Store solid shape in clammy storeroom (temperature; 18 ºC - 24 ºC) for 24 hours.
- Open form and saved 3D square in water (temperature; 19 ºC - 21 ºC) – BS 1881;Part 3 ;1970.
- Test 3D shape for 7 days and 28 days in like manner.
- Placed 3D shape on the testing machine; block position ought to be opposite with its pouring position (A. M. Neville, 1994).
- Without utilizing any covering material, apply an underlying burden (at any helpful rate) dependent upon one-portion of the normal most extreme burden (G. E. Troxell, 1956)
- Loading ought to be expanding at a uniform addition; 15 MPa/min (2200 Psi/min)- BS 1881;part 4; 1970. Since that specific example are relied upon to have lower compressive strength, some change will be made; stacking will be expanded with the addition of 5% of the normal most extreme compressive strength.
- When it comes closer to the normal most extreme strength, stacking augmentation will be exercise gradually (A. M. Neville, 1994).

B. Consistency Test

The standard consistency of a concrete glue is characterized as that consistency which will allow the vicat unclogger to infiltrate to a guide 5 toward 7mm from the lower part of the vicat shape.

1) Apparatus

- Vicat Apparatus Conforming to IS: 5513-1976.
- Balance of limit 1Kg and affectability to 1gram.
- Gauging scoop adjusting to IS: 10086-1982

2) Procedure

- Unless in any case indicated this test will be directed at a temperature 27 + 20C and the overall moistness of lab ought to be 65 + 5%.
- Prepare a glue of gauged amount of concrete (300gms) with gauged amount of consumable or refined water, taking consideration that the hour of checking isn't under 3minutes nor more than 5minutes and the measuring is finished before any indication of setting happens.
- The checking is tallied from the hour of adding water to the dry concrete until initiating to fill the form.
- Fill the vicat shape with this glue settling upon a non-permeable plate.
- Smoothen the outside of the glue, making it level with the highest point of the form.
- Slightly shake the form to oust the air.
- In filling the form administrators hands and the sharp edge of the measuring scoop will just be utilized.
- Testing consistency of concrete.
- Immediately place the test block with the non-permeable resting plate, under the pole bearing the unclogger.
- Lower the unclogger tenderly to contact the outside of the test block and rapidly discharge, permitting it sink into the glue.
- Record the profundity of entrance.
- Prepare preliminary glues with changing rates of water and test as depicted a load of added.
- Standard consistency (%) = 25% - 30%.

C. Specific Gravity Of Cement

To decide the particular gravity of concrete utilizing Le Chatelier Flask or explicit gravity bottle.

1) Apparatus

- Le Chatelier Flask or Specific Gravity Bottle – 100ml limit.
- Balance equipped for weighing precisely upto 0.1gm.

2) Procedure: Gauge a spotless and dry Le Chatelier Flask or Specific Gravity Bottle with its plug (W1). Spot an example of concrete up to half of the carafe (about 50gm) and weight with its plug (W2).Add lamp fuel (Polar fluid) to solidify in cup till it is about half full. Blend completely with glass pole to eliminate ensnared air. Keep string and add more lamp oil till it is flush with the graduated imprint. Dry the outside and weight (W3). Captured air might be taken out by vacuum siphon, if accessible. Void the carafe, clean it tops off with clean lamp fuel flush with the graduated imprint wipe dry the outside and Weight (W4).

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D. Initial and Final Setting Time Of Cement

To decide the underlying and last setting seasons of concrete.

1) Appartus

- Vicat mechanical assembly adjusting to IS: 5513-1976.
- Balance of limit 1kg and affectability 1 gram.
- Gauging scoop adjusting to IS: 10086-1982

2) Procedure

- Unless in any case determined this test will be led at a temperature of 27 + 20C and 65 + 5% of relative stickiness of the Laboratory.
- Prepare a glue of 300 grams of concrete with 0.85 occasions the water needed to a give a glue of standard consistency IS: 4031 (Part 4) 1988.
- The season of measuring regardless will not be under 3 minutes not more than 5minutes and the checking will be finished before any indication of setting happens.
- Count the hour of measuring from the hour of adding water to the dry concrete until initiating to fill the form.
- Fill the vicat form with this glue making it level with the highest point of the shape.
- Slightly shake the form to remove the air.
- In filling the form the administrator hands and the edge the measuring scoop will just be utilized.

3) Beginning Setting Time

- Immediately place the test block with the non-permeable resting plate, under the pole bearing the underlying setting needle.
- Lower the needle and rapidly discharge permitting it to infiltrate in to the form.
- In the starting the needle will totally puncture the form.
- Repeat this strategy until the needle neglects to puncture the shape for 5 + 0.5mm.
- Record the period slipped by between the hour of adding water to the concrete to when needle neglects to puncture the shape by 5 + 0.5mm as the underlying setting time.

E. Last Setting Time

1) Replace the needle of the vicat contraption by the needle with an annular ring.

2) Lower the needle and rapidly discharge.

3) Repeat the interaction until the annular ring establishes a connection with the form.

4) Record the period passed between the hour of adding water to the concrete to when the annular ring neglects to establish the connection with the form as the last setting time

IV. RESULTS AND DISSCUSSION

A. General

The tests completed are 3D shape test , consistency test , sway test, starting and last setting time test and explicit gravity test. The outcomes got from these tests are arranged and examined in this part.

B. Cube Test

Table 4.1. Compressive Strength for Different Percentage of Foam.

Days	Compressive strength (KN / m^2)			
	25% foam	50 % foam	75 % foam	100 % foam
7	13.20	9.46	8.13	1.44
14	14.69	8.89	11.02	2.44
21	16.41	14.42	11.96	2.23
28	17.27	11.87	13.12	2.52
32	19.53	14.14	12.89	2.62

From table 4.1 compressive strength goes on decreasing.14 days compressive strength of shapes by supplanting concrete by froth.

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Table 4.1.2 Compressive Strength at Different Foam Agent and Water Ratio.

Days	Compressive strength (KN / m^2)		
	1:25	1:30	1:40
7	4.09	8.12	11.15
14	4.86	11.02	11.95
21	5.45	11.96	13.72
28	5.5	13.12	13.21
Density(kg/m^2)	1720	1810	1840

Table 4.1.2, shows compressive strength diminishes with expansion in the rate froth. It additionally gives thickness following 28 days.

Table 4.1.3 Compressive Strength at Different Cement and Sand Ratio.

Days	Compressive strength (KN / m^2)		
	1:2	1:3	1:4
7	19.44	8.12	7.57
14	17.58	11.02	7.16
21	21.28	11.96	7.44
28	22.99	13.12	10.34
Density(kg/m^2)	2060	1810	1770

C. Specific Gravity

There are three techniques for testing for assurance of explicit gravity of totals, as indicated by the size of totals bigger than 10mm, 40mm and more modest than 10mm. for tests bigger than 10mm,40mm the underneath test result strategies are utilized:

1) Computations

$$\text{SPECIFIC GRAVITY} = \frac{(W2-W1)}{(W2 - W1) - (W3 - W4) \times 0.79}$$

Where,
W1 = Weight of void cup.
W2 = Weight of cup + Cement.
W3 = Weight of cup + Cement + lamp fuel.
W4 = Weight of cup + lamp fuel.
0.79 = Specific gravity of lamp oil.

2) Result

Specific gravity of concrete = 3.15 g/cc

D. Initial and Final Setting Time of Cement

The time at which concrete totally loses its pliancy and become hard is a last setting season of concrete. The time taken by concrete to acquire its whole strength is the last setting season of cement.For conventional Portland concrete the last setting season of concrete is 600 minutes.(10hrs).

The chance to which concrete beginnings hardnes and totally loses its versatility ios called starting setting season of concrete. The underlying setting time is 30 minutes.

1) Result

Beginning setting time =29 minute
Last setting time = 9hr 30 moment

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V. CONCLUSION

In the upcoming years light weight concrete has gained popularity due to its economic characteristics. Moreover since light weight aggregate can be used in cast in place, load bearing and non-load bearing structures, it is an exceptional alternative for the heavy weight aggregate which is being used in Indian markets.

A. The preliminary findings indicate that lightweight concrete has sufficient strength to be used as an alternative construction material in an industrialised building system.

B. For lower density mixtures, the strength of aerated lightweight concrete is poor. As a result, the foam created an increase in voids throughout the sample. As a result, the concrete's compressive strength has decreased.

C. The compressive strength of foamed lightweight concrete is 27 percent lower than recommended, making it unsuitable for use as a non-load bearingwall. Nonetheless, it is believed that the compressive strength is produced as a non-load bearing structure.

D. With increasing curing age, compressive strength improved.

E. Concretes with low PA concentration can meet structural requirements, while concretes with high PA content can be employed in a variety of building applications, such as producing lightweight concrete blocks and bricks with low thermal conductivity.

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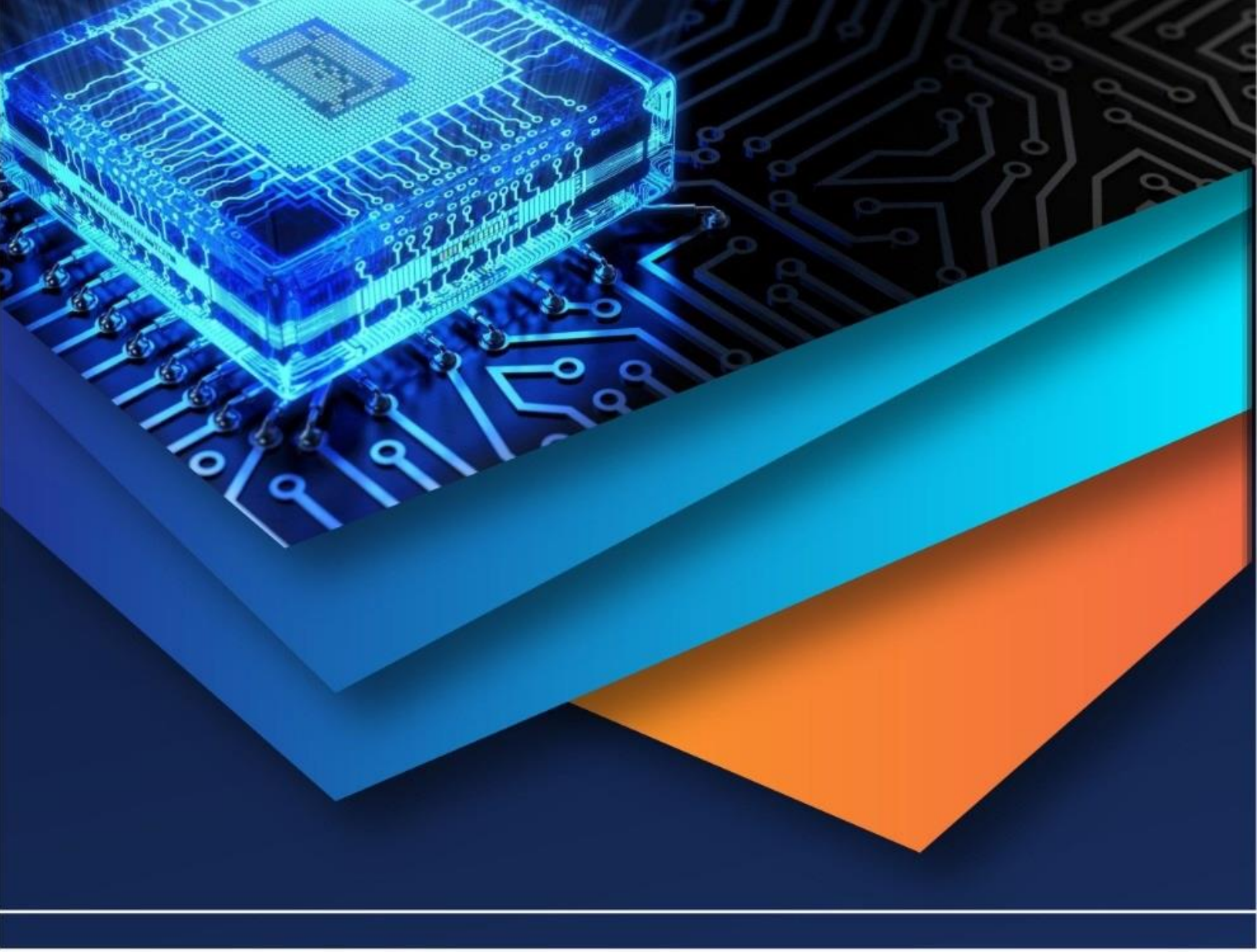

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