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# Study on Behaviour of Coconut Shell Aggregate using Super Absorbent Polymer

G. Vinoth Kanna[1], S.Karthickeyan[2], P.Anitha[3]
[1] *Assistant Professor, Department of Civil Engineering, S.A Engineering college, TN, India*
[2,] *Assistant Professor Department of Civil Engineering, Sriram Engineering college TN, India*
[3,] *PG scholar, Department of Civil Engg, Vel Tech High Tech Dr. Rangarajan Dr. Sakunthala Engg College, TN, India*

***Abstract:*** ***The use of waste materials is one of the options for sustainable Construction. In this project the coconut shell waste is considered as coarse aggregate (After the same has been crushed) for preparing light weight concrete. The various material tests such as sieve analysis, specific gravity, water absorption, soundness, dry density, bulking of fine aggregate, impact test has been carried out. The other tests of Compressive strength, Flexural strength, Deflection, Stress, Strain, and Modulus of elasticity and Crack width of the concrete specimens are to be determined after curing of 28 days in the Phase II. The optimum quantity of super absorbent polymer on the compressive strength of concrete will be determined through experiments and reported in this project. In this study coconut shell is used as light weight aggregate in concrete. The properties of coconut shell and super absorbent polymer is studied. This study has partially replaced coconut shell waste for coarse aggregate in concrete of various percentage 0%, 25%, and 50%.concrete curing plays a vital roles in developing hydration process. Self- curing agents like super absorbent polymer (SAP) will increase water retention capacity as compared to the conventional concrete. Proper self-curing (or) internal curing increases the strength, durability and performances of concrete. In this study 0.5%, 1%, 1.5% and 2% of super absorbent polymer (SAP) is used for casting of various percentage of coconut shell. The coconut shell with 25% replacement with addition of 0.5% SAP is more efficient than the other percentage. It not only saved the cost of construction but it effectively increases the mechanical properties.***

***Keywords:*** ***Portland Cement, coconut shell, Super Absorbent Polymer***

## I. INTRODUCTION

Concrete is the widely used material in the world today. The demand to make this material lighter has been the subject of study that has challenged scientists and engineers alike. The challenge in making a lightweight concrete is decreasing the density while maintaining strength and without adversely affecting cost. Introducing new aggregates into the mix design is a common way to lower a concrete's density. Normal concrete contains four components, cement, crushed stone, river sand and water. The crushed stone and sand are the components that are usually replaced with lightweight aggregates. Lightweight concrete is typically made by incorporating natural or synthetic lightweight aggregates or by entraining air into a concrete mixture. Coconut is grown in more than 93 countries. South East Asia is regarded as the origin of coconut. India is the third largest, having cultivation on an area of about 1.78million hectare. Annual production is about 7562 million nuts with an average of 5295 nuts per hectare. the coconut industry in India accounts for over a quarter of the world's total coconut oil output and is set to grow further with the global increase in demand. However, it is also the main contributor to the nation's pollution problem as a solid waste in the form of shells, which involves an annual production of approximately 3.18 million tones. Coconut shell represents more than 60% of the domestic waste volume. Coconut shell, which presents serious disposal problems for local environment, is an abundantly available as an agricultural waste from local coconut industries. In developing countries where abundant agricultural and industrial wastes are discharged, these wastes can be used as potential material or replacement material in the construction industry. This will have the double advantage of reduction in the cost of construction material and also as a means of disposal of wastes. Self-curing agent like super absorbent polymer can retain moisture for a very long time. SAP can absorb water many times its volume 10,000% in short Period by osmosis. It is biodegradable. It's a polymer were long chain are cross linked to another. Self-curing concrete is one of the special concrete in mitigating insufficient curing due to human negligence, scarcity of water in arid areas, inaccessibility of structures in different terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete. The use of self-curing agent is very important from the point of view that water resources are getting valuable every day. Self-curing agents like super absorbent polymer (SAP) are mainly used. This reduces the development of shrinkage cracks in concrete and also to improve the performance of concrete. This distributes the water required for curing uniformly throughout the entire concrete section. It solves the problem of insufficient curing in case of water scarcity area.

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## II. MATERIALS USED

The materials required to complete the experimental investigation are to be the materials required are

### *A. Cement*

Cement is the binding material used in the preparation of concrete. The cement used for this study is ordinary Portland cement and is conforming to Indian standard is: 8112 of grade 53. Grades are made depending upon the strength of cement at 28 days. Cement in concrete acts as a binding material that harden after the addition of water. It plays an important role in construction sector. In this study the Ordinary Portland Cement (OPC) of 53 grade is used according to IS: 1489-1991.

### *B. Fine Aggregate (Sand)*

The sand is collected from polar river bed. The Sand has been sieved in 4.75 mm sieve before it is used. The sieve analysis, specific gravity and water absorption test were conducted and the results. details of sieve analysis for fine aggregate are shown in table.3.2.the actual grading curve for fine aggregate belonging to zoneii of IS 383-1970 together with upper limit and lower limits for sieve analysis are shown in figure.3.3.

### *C. Coarse Aggregate (Crushed stone)*

Crushed granite stone aggregate of maximum size is 20 mm is chosen as coarse aggregate as per IS: 2386 (Part I) 1963, surface texture characteristics of the aggregate as classified in IS: 383-1970. The material which is retained on BIS test sieve number 4 (4.75mm) is termed as coarse aggregate. The broken stone is generally used as a stone aggregate. Coarse aggregate used is locally available crushed angular aggregate of size 20mm and 10mm are used for this experimental work.

### *D. Water*

Available potable water in university premises which was free from all impurities is used for the entire work whenever it is required. Ph. value of water was found to be 6.8. And the water was conforming to is 3035- 1987(part 1). Portable water is generally considered fit for making concrete. Water should be free from acids, oils, alkalies or other organic impurities. Water reacts chemically with the cement to form a cement paste in which inert aggregate are held in suspension until cement paste are hardened and it will also serve as a lubricant in the mixture of fine aggregates and cement.

### *E. Steel*

Steel for reinforcement Fe 415was used. The steel was used 10 mm diameter of high strength deformed steel bars Conforming to be 1786-1985.the properties of steel were found and reported. The tensile strength of steel was found to be equal to 415 N/mm2.

### *F. Coconut Shell Aggregate*

The freshly discarded coconut shell collected from a local oil mill was used in this study. Since the different species of coconut shell are processed together, the shells are found to have varying thicknesses of 2–8 mm. After crushing, the shells are flaky and irregularly shaped. For preparing coconut shell aggregates, a hammer was used. Since coconut shell is a flaky material, the sizes of coconut shell lengthwise are restricted to a maximum of 12 mm. To get enough workability with the concrete, the surface texture of the shell was fairly smooth on concave and rough on convex faces. The crushed edges were rough and spiky. Coconut shell aggregates have a relatively high-water absorption value nearly 24% compared to the conventional aggregate (0.5%) hence, to prevent water absorption by the concrete mix, it is necessary to mix at saturated surface dry condition (SSD) based on 24 h submersion in potable water. The Figure 3.2 shows coconut shell aggregate before crushed Figure. 3.3 shows coconut shell aggregate after SSD condition.

### *G. Super Absorbent Polymer*

Generally self-curing agents like super absorbent polymer absorb water many times its volume and forms a stiff gel. It can retain moisture for very long time. Self-curing is a technique that can provide additional moisture in concrete for more effective hydration of cement.

## III. RESULTS AND DISCUSSIONS

The following table contain the specific gravity for fine aggregate, coarse aggregate and coconut shell which is used in this experiment.

Table 1 Details of specific gravity

| Materials | Property | Results |
|---|---|---|
| Fine Aggregate | Fineness modulus test | 2.9 |
| | Specific gravity Test | 2.6 |
| | Water absorption | 1.2% |
| Coarse Aggregate (Crushed Stone) | Specific gravity | 2.7 |
| | Water absorption | 0.6% |
| Coconut Shell Aggregate | Specific gravity | 1.53 |
| | Water absorption | 1.2% |

Table 2 Average Compressive Strength at 7 and 28 Days for 50% CS

| M20 | Average Compressive Strength at 7 Days | Average Compressive Strength at 28 Days |
|---|---|---|
| Nominal | 14.162 | 28.12 |
| 0.5% SAP + 50% CS | 16.325 | 31.397 |
| 1% SAP + 50% CS | 12.44 | 26.073 |
| 1.5% SAP + 50% CS | 12.071 | 24.66 |
| 2% SAP + 50% CS | 11.886 | 21.895 |

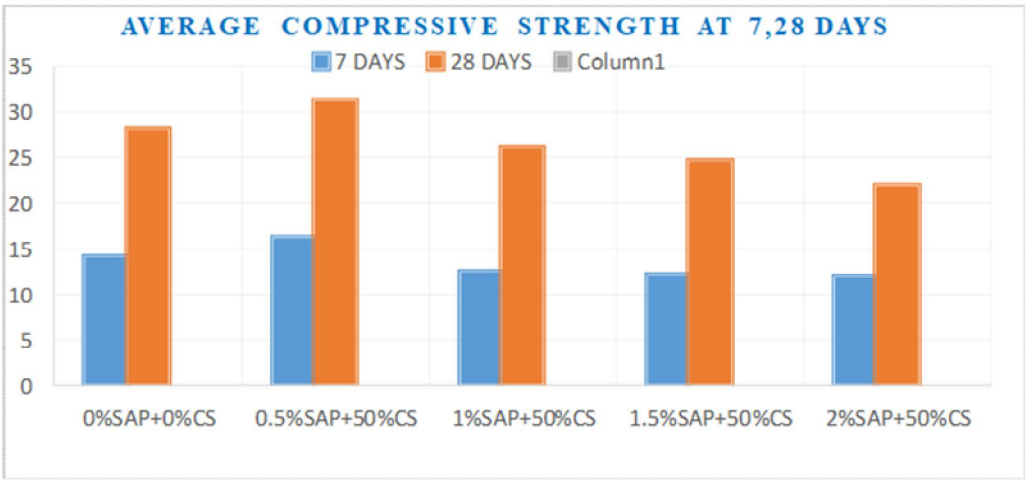


Fig 2 Compressive Strength Result

Table 3 Average compressive strength at 7 and 28 Days for 25% CS

| M20 | Average Compressive Strength at 7 Days | Average Compressive Strength at 28 Days |
|---|---|---|
| Nominal | 14.162 | 28.12 |
| 0.5% SAP + 25% CS | 17.14 | 32.59 |
| 1% SAP + 25% CS | 13.93 | 27.63 |
| 1.5% SAP + 25% CS | 12.07 | 25.47 |
| 2% SAP + 25% CS | 11.36 | 23.70 |

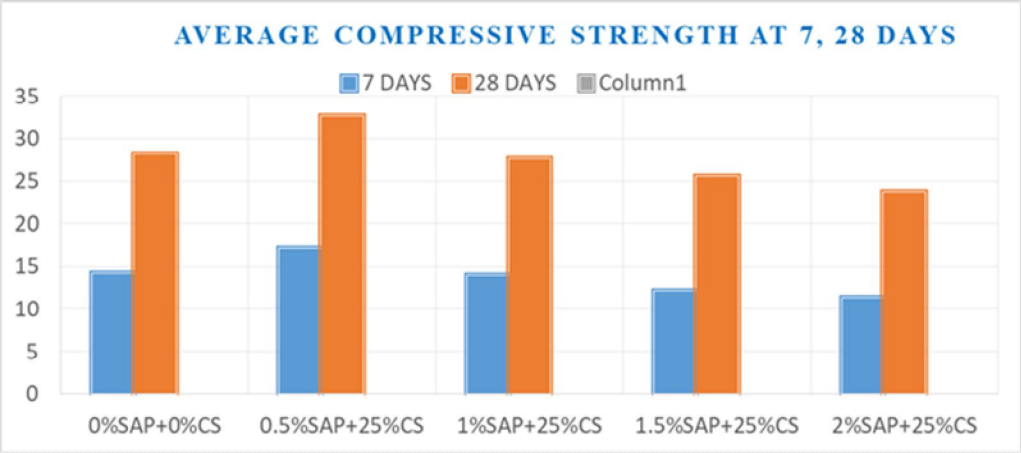


Fig 3. Average compressive strength at 7, 28 Days

Table 4. Average Split Tensile strength at 7 And 28 Days

| M20 | Average Split Tensile Strength at 7 Days | Average Split Tensile Strength at 28 Days |
|---|---|---|
| Nominal | 1.05 | 2.17 |
| 0.5% SAP + 25% CS | 1.14 | 2.38 |
| 1% SAP + 25% CS | 0.92 | 1.95 |
| 1.5% SAP + 25% CS | 0.84 | 1.62 |
| 2% SAP + 25% CS | 0.66 | 1.49 |

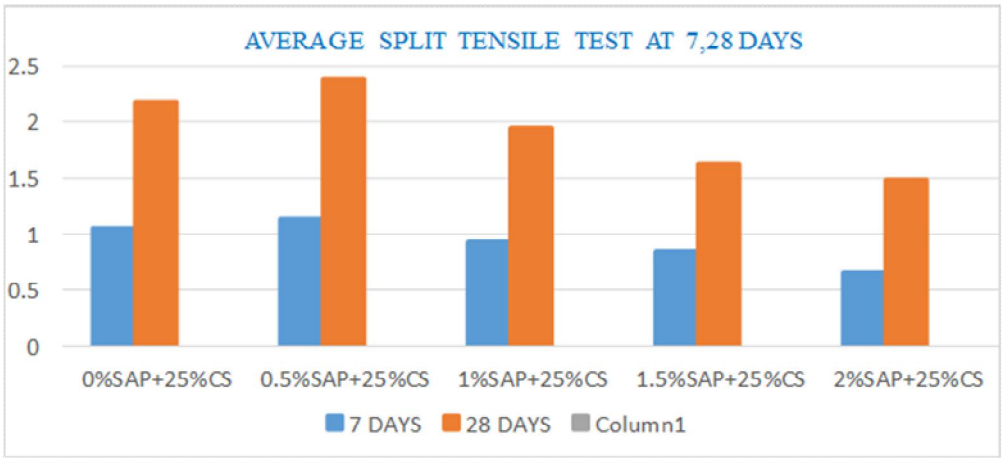


Fig 4. Spilt Tensile Strength at 7 and 28 Days for 50% CS

Table 5. Average Spilt Tensile Strength at 7 And 28 Days For 50% CS

| M20 | Average Split Tensile Strength at 7 Days | Average Split Tensile Strength at 28 Days |
|---|---|---|
| Nominal | 1.05 | 2.17 |
| 0.5% SAP + 50 % CS | 1.08 | 2.30 |
| 1% SAP + 50% CS | 0.87 | 1.69 |
| 1.5% SAP + 50% CS | 0.76 | 1.56 |
| 2% SAP + 50% CS | 0.60 | 1.30 |

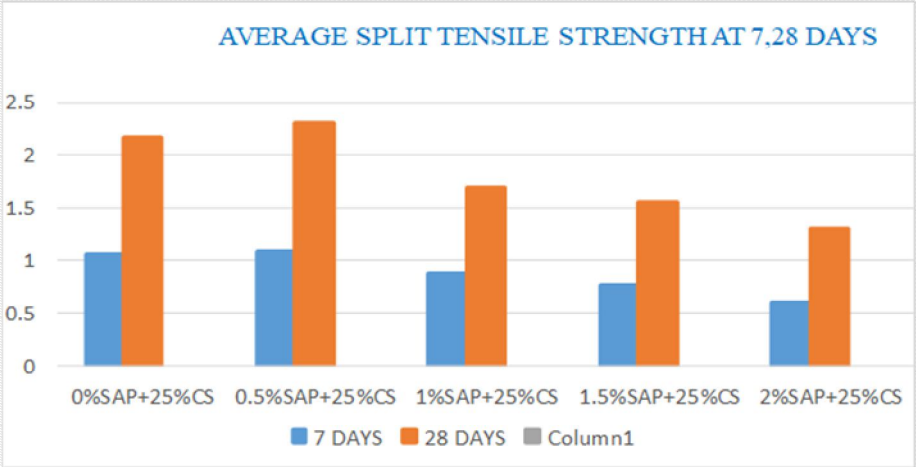


Fig 5. Split tensile strength at 7 and 28 days for 25 % CS

Table 6. Average Spilt Tensile Strength at 7 And 28 Days For 25% Cs

| M20 | Average Flexural Strength at 7 Days | Average Flexural Strength at 28 Days |
|---|---|---|
| Nominal | 2.7 | 3.80 |
| 0.5% SAP + 25% CS | 1.86 | 3.90 |
| 1% SAP + 25% CS | 1.58 | 3.42 |
| 1.5% SAP + 25% CS | 1.64 | 3.24 |
| 2%SAP + 25% CS | 1.51 | 3.08 |

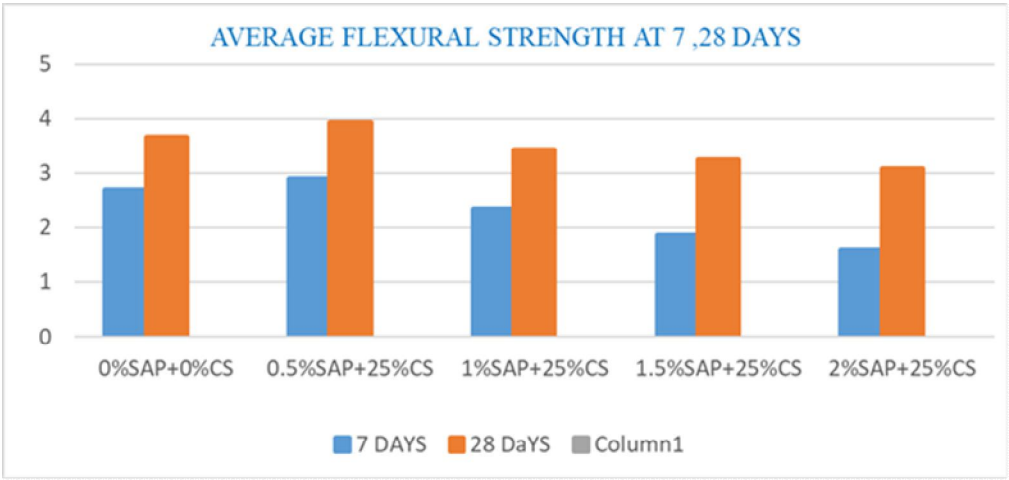


Fig 6. Average flexural strength at 7 and 28 days for 25 % CS

Table 7. Average flexural strength at 7, 28 days for 25% CS

| M20 | Average Flexural Strength at 7 Days | Average Flexural Strength at 28 Days |
|---|---|---|
| Nominal | 2.7 | 3.66 |
| 0.5% SAP + 25% CS | 2.87 | 3.85 |
| 1% SAP + 25% CS | 2.08 | 3.34 |
| 1.5% SAP + 25% CS | 1.76 | 3.16 |
| 2% SAP + 25% CS | 1.64 | 2.98 |

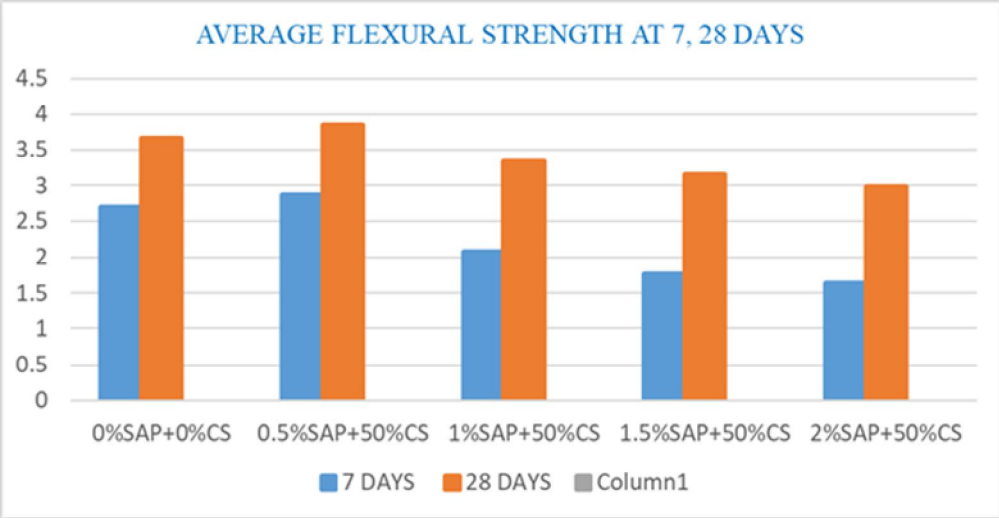


Fig 7. Average Flexural Strength at 7 And 28 Days for 50%CS

## IV. CONCLUSIONS

*A.* The study on coconut shell aggregate by using super absorbent polymer was found to be effective in both strength and cost efficient.

*B.* The efficiency of the conventional concrete and coconut shell by super absorbent polymer concrete was compared.

*C.* M20 grade of concrete was used in both conventional concrete and polymer concrete.

*D.* Experimental result analysis for compressive strength, split tensile strength, flexural strength readings are the basis for conclusions enclosed.

*E.* Type h 25% coconut shell with 0.5% of super absorbent polymer gives more strength comparing to other concrete.

*F.* For the specimen with 0.5 % of self-curing agent the mix showed highest strength when compared to other mixes with the self-curing agents like super absorbent polymer.

*G.* The mix with 0.5 % of sap showed compressive strength marginally equal to the compressive strength of conventional concrete.

*H.* Thus the test indicates the sample containing 0.5% of sap is the ideal mix which does not affect the workability, compressive strength.

*I.* On comparing the values of conventional concrete and self-curing concrete the self-curing concrete shows higher compressive strength than the conventional concrete.

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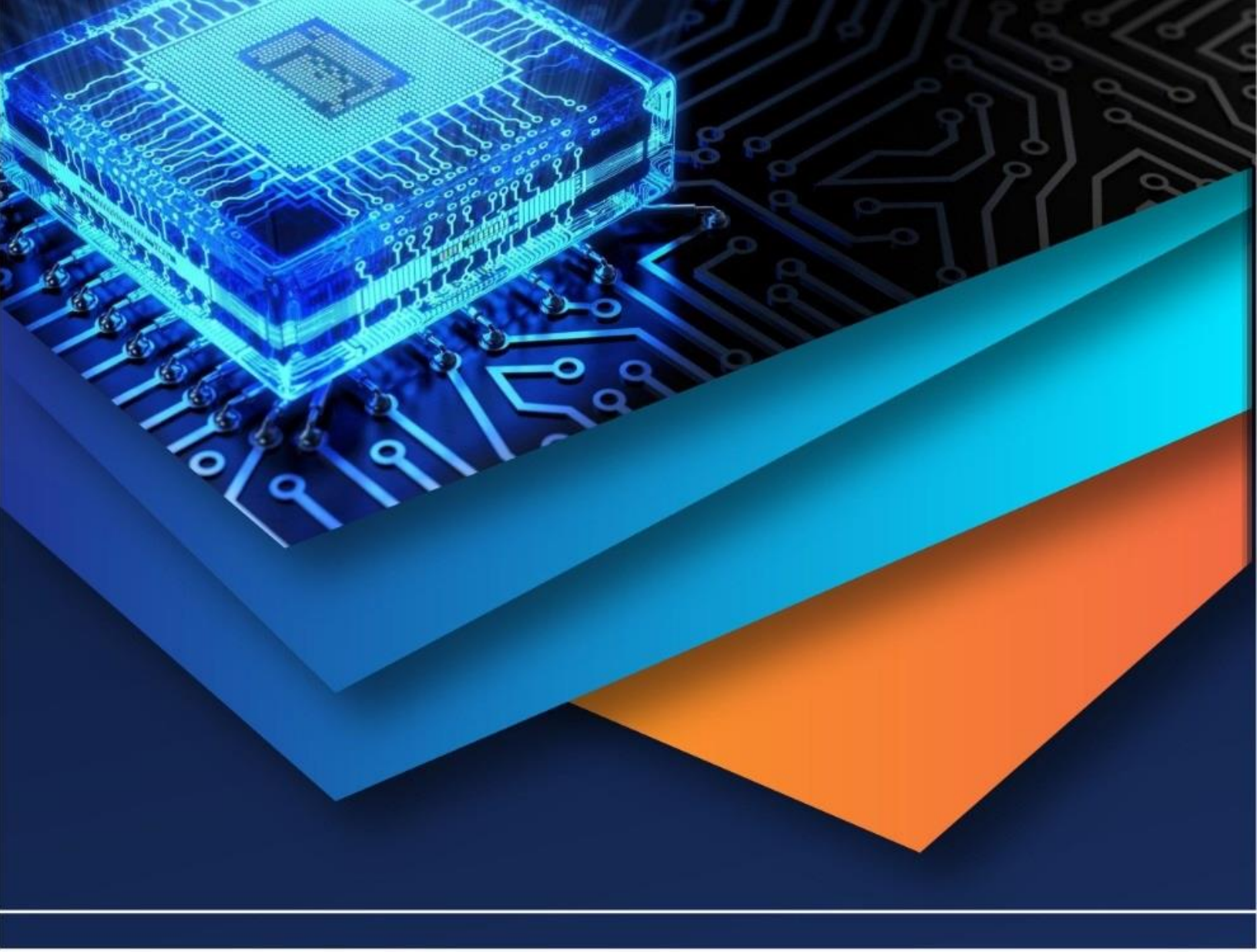

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