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Prefabricated Fibre Reinforced Sandwich Panels over AAC Block and Conventional Brick

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Abstract: ***The construction industry is evolving rapidly, and new materials and technologies are being introduced on a regular basis. Execution of construction projects and their timely delivery has become a prime concern for developers in view of the buyer's agitation on delay in construction. The masonry brick wall is heavy and its construction is time consuming. Other products like plywood, Gypsum Board, Cement bonded particle board, Resin bonded particle Boards etc., have one or more deficiencies such as not being resistant to water, fire, or termites, or being non-load bearing etc. Process of manufacturing bricks is conventional and there is no scope to reduce the time required for completing the work. Bricks are not standardized, uneven in shape and having variation in properties. Manufacturing of bricks creates pollution, Many defects often occurs like cracking or rough and uneven surfaces because bricklaying and cement rendering are not standardized. Due to this there is increased consumption in cement and sand for the plastering work. Furthermore, it is difficult to control the loss of materials during construction. The purpose of this paper is to understand the Prefabricated Fibre Reinforced Sandwich panels and how it is a better alternative to conventional brick and AAC block.***

Keywords: Prefabricated Fibre Reinforced Sandwich Panels, AAC block , Conventional brickwork, Non load bearing walls, Benefit analysis

I. INTRODUCTION

The basic function of the envelope or enclosure of a building or structure is to protect the covered or otherwise conditioned interior spaces from the surrounding environment. This fundamental need for *shelter* is a concept that is as old as the recorded history of mankind. However, as our needs have evolved and technologies have advanced, the demand placed on designers to both understand, *and integrate*, a wide range of increasingly complex materials, components, and systems into the building enclosure has grown in equal proportion.[1] Walls play an integral role in a building. Without a wall the structure is incomplete. The type of wall one selects is also important with respect to usage of space. For partition purposes, a gypsum dry wall is adequate as a divider for two cubicles within the same space. AAC block and red brick are used as permanent partition walls between two flats or independent offices. The question therefore is what happens when two different entities are functioning adjacent to one another in the same premises but with their own allocated temporary space. For two different offices next to each other the most common partition solution seems to be brickwork or AAC block work. However, in commercial establishments where the module could change based on the user requirement, the brickwork will have to be broken down.

Nowadays many builders in the industry are open to renting out spaces in modules. It is rather evident in all malls and multiplexes. For example if A and B have rented a 300 sq.ft space for a period of 3 years. After 3 years A decides not to renew the agreement and move out of the space. However B wants to renew the agreement but now requires 600 sq.ft. of space to expand the business. In this case it would only make sense to have walls which avoid the nuisance of demolition and wastage of wall material. In this fast evolving construction industry, a quick installing material with properties which match with or are even better than conventional brickwork is needed. A material which can also be used as permanent partition as well as temporary partition walls which can be removed and re-used. Prefabricated fibre reinforced sandwich panels is one such material which is gaining popularity and a solution to the problem.

II. SYSTEM IN BRIEF

A. Prefabricated Fibre reinforced Sandwich Panels (Commercial name : Aerocon / Everest Rapicon walls) :

Prefab fibre reinforced sandwich panels, made of two fibre reinforced cement facing sheets, on either sides of a lightweight concrete core. The core is made from a mix of portland cement, binders and silicaceous & micaceous material aggregate. These panels have a unique tongue and groove jointing system that facilitates rapid construction and are fully cured at the factory itself.These panels are of manufactured by using Flexo Board (FOB)/ Fibre Cement Board (NT). Details of these panels are shown in Figs.1, 2 & 3. The panels are available in size of 2400mm.2700mm,3000m (H) x 600mm(W) x 75mm thk. [2]

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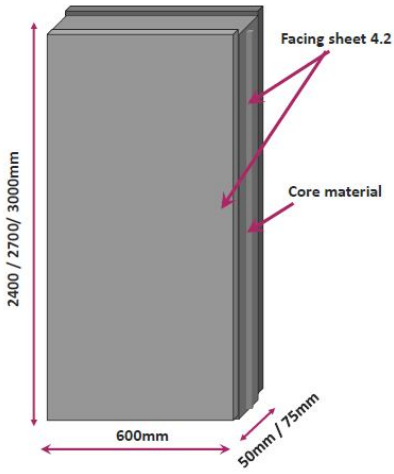
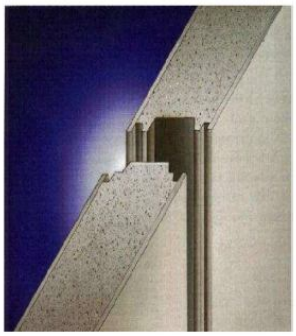


Fig. 1 Dimension of Panel



Tongue and groove joint

Fig. 2 Tongue and groove joint of Panel

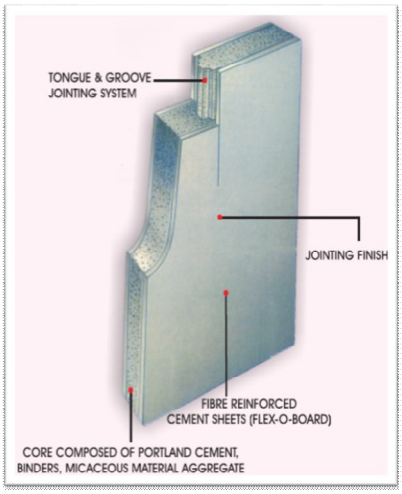


Fig. 3 Cross section of Panel

B. Manufacturing Process Of Panels

Prefabricated fibre reinforced sandwich panels shall be made up of two fibre reinforced cement sheets with a core separating sheets. The core of the panels shall have binders like portland cement and reinforcing bars such as cellulose and synthetic binders. The core shall contain materials such as pulverized fly ash, light weight aggregates as fillers and foaming agents. These materials shall be mixed thoroughly with water in conventional manner and sandwiched between a pair of fibre cement facing sheets which shall be separated and supported by using conventional jigs and fixtures. The adhesion between the core material and fibre cement sheets is achieved by inorganic bonding by aeration while manufacturing the panel in-situ. The panels so prepared shall be allowed to harden for a predetermined period and thereafter jigs/fixtures shall be separated. The panels shall be cured by retaining the humidity of the composite by wrapping the composite with polymeric films. No water is required for curing. [2]

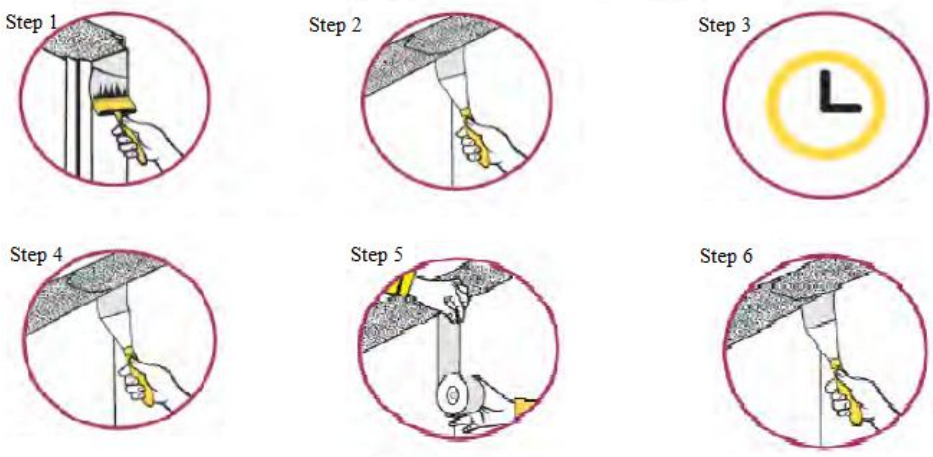


Fig. 4 Six step process for installing of panels

1) *Step 1:* Take SmartGlu powder + Liquid in 1:1 ratio and brush on edges before sliding tongue and groove panels.
2) *Step 2:* After 2 hour interval, take SmartGlu powder + Liquid in 2:1 ratio, apply into the grooves and fill to the surface level.
3) *Step 3:* Setting time : 1hr for external walls , 2 hrs for interiors.
4) *Step 4:* Apply Smartflex paste along the joint.
5) *Step 5:* Immediately paste Smartpoly tape on it. Allow 6 hr shrinkage time.
6) *Step 6:* Apply one coat if Smartflex upto 0.10mm thick on the Smartpoly tape.

Let dry for 6hrs, apply wall putty after 6 hrs. Apply primer and paint or install wallpaper. [2]

III. PROPERTIES OF MATERIALS

Comparing the material properties with one another on the same parameters is necessary to establish the merits pertaining to the above considered materials. Since brick has been widely used for internal as well as external wall construction, it makes for a base material to include as a part of the comparative analysis.

The following table (TABLE I) shows the wall properties of conventional brick, AAC blocks and Prefab fibre reinforced sandwich panels.

Table I
Wall Properties Of Conventional Brick, Aac Block And Prefabricated Fibre Reinforced Sandwich Panels

No.	Parameter	Red Brick	AAC Block	Prefabricated Fibre Reinforced Sandwich Panels
1.	Material composition	Clay(alumina), sand, Lime, iron oxide and Magnesia. Natural soil is used for Production of Bricks.	Fly ash, cement, lime, gypsum and an aeration agent.	Fibre Reinforced Aerated Concrete Core & Fibre Cement Board Both Side (Portland Cement, Silica, Cellulose Fibre, Fly Ash & Additives)
2.	Size / Thickness	230mm / 150mm	200 x 250 x 625 mm, 150 x 250 x 625 mm	Width: 600mm, Length : 3000mm, 2700mm, 2400mm, Thickness: 75mm
3.	Precision in Size	Difficult to ensure precision in kiln burnt brick.	Precision is much better, since the blocks are machine made	As per IS 14862 : 2000
4.	Compressive Strength	35-70kg /cm^2	20 Kg/cm2	75 Kg/cm2
5.	Dry Density (Kg/m^3)	1800 kg/ m^3	800 Kg/Cum	Apparent minimum density is 700kg/m3
6.	Fire Rating	Upto 2 hrs for 100 mm wall (Disintegrates at 1000C)	2 - 6 hrs	134 Minutes
7.	Thermal Conductivity	0.6- 1.0 W/mk	0.21 W/mK	K Value - 0.135 W/mk
8.	Sound Insulation	45 db for 150mm wall , 50 db for 230mm wall	44db	40 db
9.	Moisture Resistance	Average (Depends on Moisture resistance will depend on water absorption of brick and proportion of cement mortar.)	As per IS 2185 - AAC block consists of unconnected micropores which prevent the capillary transport of moisture over a long distance	As per IS 14862 : 2000
10.	Water absorption % by weight	Should not be more than 20% of its weight	Between 35 % to 40 %	32 to 35%

IV. ADVANTAGES OF THE MATERIAL

A. Advantages of Prefabricated Fibre Reinforced Sandwich Panels

1) Prefabricated fibre reinforced sandwich construction 4 times faster than conventional construction
2) Slim wall panels provides extra usable floor area.
3) Light Weight – one fourth times lighter than brick wall
4) Strength and Robustness (BS 5234 (2) 1992) – Based on performance criteria, it falls under “SEVERE DUTY” Panels.
5) Moisture Resistance – Made out of Fibre Cement Board therefore can be used in variable climatic conditions.
6) Re-locatable – Panels are re-locatable, changes required at any time during the construction can be done with ease.
7) Environment Friendly – Panels are made out of the recycled material and is Asbestos free and environmental friendly.
8) Sleeker Walls for great height – Without additional support wall can reach great height upto 4.8m without additional support.
9) Faster completion of Projects- It eliminates the curing times at site and assist in faster completion of projects with ease.
10) High Performance wall – Solid wall panel can be designed for the high performance walls (like 230mm wall) as per the customers need.
11) Clean and non Messy Work – It does not requires plastering keeps the work site neat and clean and is hassle free construction.
12) Structural Design – It saves the cost of the structure, due to light weight.
13) Remote Location – It can be installed in remote location where there is no availability of Sand, water, manpower etc.

14) Finishing Options – It can take up different finishes like POP, wall paper, paints. Etc.
15) Single contract – The order can be placed as a single contract, no need to chase for different agencies for supply of sand, cement, water, labour etc.
16) Minimum Wastage – Easy and economical material and wastage handling
17) Saves Water – As it is factory cured ready to use panel, it does not require water.[3]

B. Limitations of Prefabricated Fibre Reinforced Sandwich Panels

1) Non Load Bearing Walls: These are non-load bearing walls.
2) Chiseling Required: Walls requires chiseling as the conventional brick walls.
3) Finishing: For Zero level finishing, leveling has to be done with putty.

V. MODULE BASED COMPARISON

For the purpose of understanding the cost associated with each wall option, a module based comparison for the total expected **cost** of each option against their total expected **benefits** shall be studied. Figure 11 shows the 3d image of the framed structure.

The structure considered is a G+4 commercial building having a floor plate of 15000 sq.ft. Table II, III and IV show the estimate of constructing the cold shell structure (only RCC framework and walls). The module focuses only on the internal and external walls of the superstructure. The rates mentioned for each item corresponding to each material are inclusive of labour and transportation.

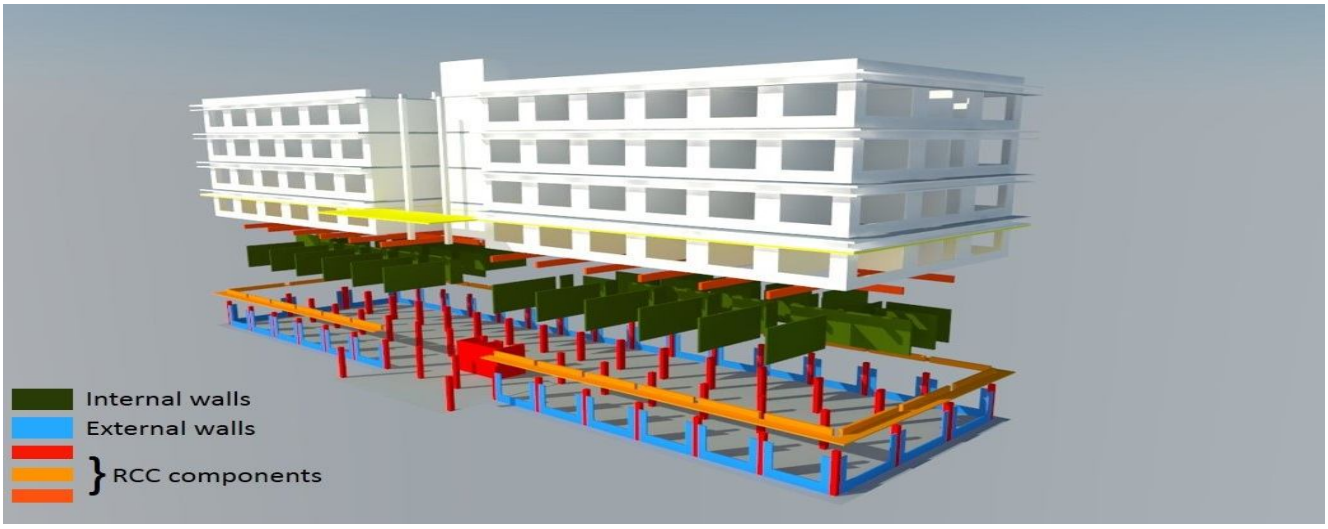


Fig. 11 G + 4 building showing components for estimation purpose.

Total area of the commercial building : 6,000 sq.m , Total area of Walls (Internal and External walls) : 4900 sq.m

VI. COMPARATIVE ANALYSIS

TABLE III
Estimate for G+4 commercial Building using conventional brick

No.	Particular	Qty	Unit	Rate(Rs.)	Amount (Rs.)
1.	Cement	1855	m^3	10000	18550000
2.	Steel	231	ton	72000	16632000
3.	150 thk Brick in superstructure	4900	m^2	1600	7840000
4.	Internal Plaster	3800	m^2	460	1748000
5.	External Plaster	1100	m^2	650	715000
6.	Internal Paint (Satin Enamel)	3800	m^2	300	1140000
7.	External Paint (Exterior Emulsion)	1100	m^2	200	220000
8.	Cleaning post wall construction.	1	LS	50000	50000
				TOTAL	46895000

TABLE IIIII

ESTIMATE FOR G+4 COMMERCIAL BUILDING USING AAC BLOCK

No.	Particular	Qty	Unit	Rate(Rs.)	Amount (Rs.)
1.	Cement	1855	m^3	10000	18550000
2.	Steel	195	ton	72000	14040000
3.	AAC Block in superstructure	4900	m^2	1800	8820000
4.	Internal Plaster	3800	m^2	460	1748000
5.	External Plaster	1100	m^2	650	715000
6.	Internal Paint (Satin Enamel)	3800	m^2	300	1140000
7.	External Paint (Exterior Emulsion)	1100	m^2	200	220000
8.	Cleaning post wall construction.	1	LS	50000	50000
				TOTAL	45283000
Savings in overall cost compared to red bricks : Rs. 16,12000/-					

TABLE IVV

ESTIMATE FOR G+4 COMMERCIAL BUILDING USING PREFABRICATED FIBRE REINFORCED SANDWICH PANELS

No.	Particular	Qty	Unit	Rate(Rs.)	Amount (Rs.)
1.	Cement	1855	m^3	10000	18550000
2.	Steel	171	ton	72000	12312000
3.	Sandwich Panels in superstructure	4900	m^2	1500	7350000
4.	Internal Plaster	0	m^2	460	0
5.	External Plaster	0	m^2	650	0
6.	Internal Paint (Satin Enamel)	3800	m^2	300	1140000
7.	External Paint (Exterior Emulsion)	1100	m^2	200	220000
8.	Cleaning post wall construction.	0	LS	50000	0
				TOTAL	39572000
Savings in overall cost compared to red bricks : Rs. 73,23000/-					

In the above tables it can be observed that Steel requirement incase of brickwork is the highest at 231 tons.
In case of AAC blocks we would require 195 tons of steel and for Prefab sandwich panels we need 171 tons. Therefore we can observe that there is 36 tons of steel which is saved in case of AAC and 60 tons of steel saved in case of prefab sandwich panels. This translates to monetary savings of Rs. 25,92000/- for AAC work and for Prefab sandwich panels the savings are Rs. 43,20000/-. A comparative of all three walls is shown in Table V.

TABLE V

COMPARATIVE STATEMENT FOR G+4 COMMERCIAL BUILDING

No.	Particular	Red Brick	AAC block	Prefab Sandwich Panel
1.	Cement	18550000	18550000	18550000
2.	Steel	16632000	14040000	12312000
3.	Walls in superstructure	7840000	8820000	7350000
4.	Internal Plaster	1748000	1748000	0
5.	External Plaster	715000	715000	0
6.	Internal Paint (Satin Enamel)	1140000	1140000	1140000
7.	External Paint (Exterior Emulsion)	220000	220000	220000
8.	Cleaning post wall construction.	50000	50000	0
	TOTAL	46895000	45283000	39572000

From the above tables II to V it is evident that Prefabricated Fibre Reinforced Sandwich Panels seems to be the best option for walls since the entire cold shell structure can be done in approx. Rs.3.95 Crore. However, cost should not be the only parameter while selecting a material. Carpet area also plays a crucial role for builders. The thickness of a Prefabricated Fibre Reinforced Sandwich panel is 75mm, therefore 20% carpet area is gained over and above 150mm thk conventional brick. In the case of AAC walls which have a thickness of 200mm, the cost of material is around Rs. 180/sq.ft which is slightly more than brickwork(Rs. 160/sq.ft). however there is savings in overall cost but no carpet area increase as compared to 150mm thk brickwork.

A team of 1 mason, 1 male coolie and 1 female coolie can complete 7sq.m of brick wall in a day. In case of Prefabricated Fibre reinforced Sandwich Panels 6 person team can execute 75 sq.m area wall in a day. Hence the entire wall work can be completed in just 20 days (subject to ready availability of the material) whereas brickwork will require around 120 days to complete. AAC block work requires around 92 days to execute (@ 9 sq.m per day with a team of 1 mason, 1 male coolie, 1 female coolie).

Prefabricated fibre reinforced sandwich panels do not require any plastering works, hence cost and time savings in plaster is achieved.

VII. CONCLUSIONS

Prefabricated fibre reinforced sandwich panels are less expensive than brickwork (Rs. 140 / Sq.ft) and also provide for 20 % more carpet area. The dry density of the material is in the same range as that of AAC block work. Since the density is lesser than bricks, there will be cost saving in the construction of the superstructure. It would be safe to assume that in comparison to brickwork, AAC block work will result in 55.6% reduction in weight whereas in case of prefabricated fibre reinforced sandwich panels is would result in a reduction of a massive 80% weight of the walls.

The use of fly ash in the sandwich panels and substituting them for wood and metal makes them an eco-friendly product. The panels have high thermal and acoustic insulation properties and are resistant to fire, water and termites. They have wide applications in construction of Pre-Fab houses, high rise buildings, shelters etc.

Compared to conventional building products, they take much less construction time, they are reusable and can be easily relocated. In difficult terrains where other materials are not suitable this product becomes the favoured option for construction. The design of the product makes it suitable for application in seismic and cyclone prone zones.[3]

From this it is rather clear that not only in terms of money and overall costs but also in terms of time there is a considerable reduction in the amount of time required to install the entire system when we use prefabricated fibre reinforced sandwich panels.

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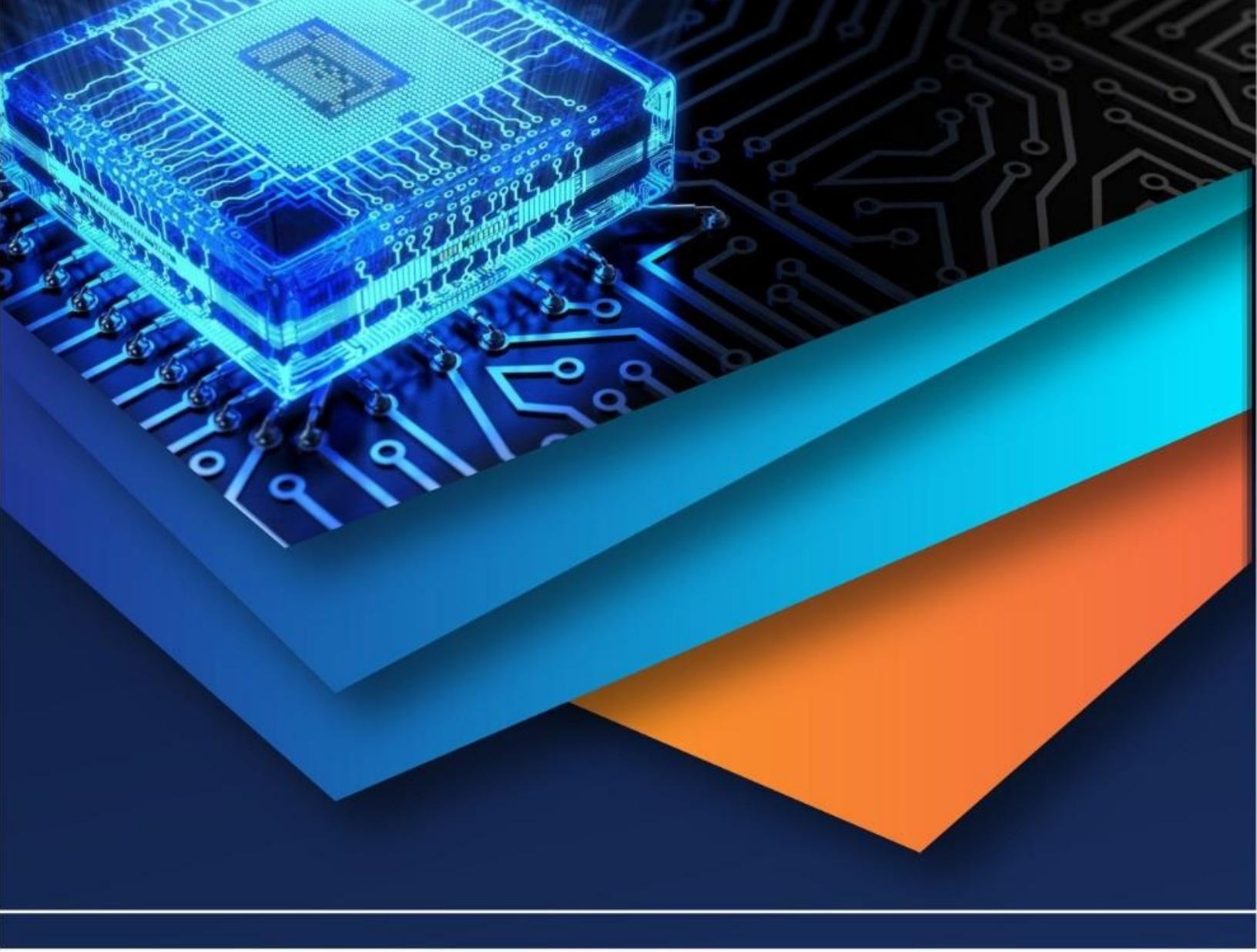

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