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Relative Study on Clash Detection and its Effects on BIM Modelling

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Abstract: ***Designers and builders can simulate a physical environment using BIM, a type of digital technology, before starting actual construction. When developing and building things, various disciplines must work closely together. Each discipline is responsible for providing a unique contribution to the overall design. The objects from other disciplines may, however, occupy the same position in space or the same orientation when the incomplete designs are merged known as 'clash'. A collision of this nature is frequently discovered during construction, necessitating a significant amount of extra time and price. To avoid clashes in the final design, early collaboration is essential. BIM automation techniques can do this and perhaps reduce clashes by coordination of 3D Models. A case study that comprised clash detection between architectural, structural, and MEP BIM models was used to conduct the inquiry. The current study used Autodesk Navisworks Manage and Autodesk Revit as BIM tools to design capabilities to streamline and automatically discover clashes. The analysis of the case study data showed that BIM is a useful tool for identifying conflicts between building components. And an investigative study was done to know the reason why these clashes are created during modeling based on the questioners answered by BIM Modelers. The findings emphasize the need for greater transparency in partnerships where designers from varied backgrounds can work on projects simultaneously. This open and inclusive approach may have an impact on how architects, engineers, and construction professionals are trained in the future.***

Keywords: Building Information Modelling (BIM), Mechanical Electrical Plumbing (MEP), Clash Detection, Revit, Navisworks.

Abbreviations

1) BIM – Building Information Modelling
2) MEP – Mechanical Electrical Plumbing
3) AEC – Architecture, Engineering and Construction.

I. INTRODUCTION

Building information modelling, or BIM, is rising in acceptance around the globe. Not only during the design and building stages, but also throughout the operation phase, BIM may have some clear benefits for a construction project. One of the main concerns for building projects is conflict and the early discovery of it. It takes time and requires the synthesis of remarkable design skills to manually find incompatibilities. In order to evaluate BIM's capacity for conflict detection throughout the design process relevant information is collected and structured in this project to enable a complete study of the details of construction. The 2D design layouts for the structural, electrical, and mechanical structures are among these specifics. This project is broken up into parts, with the first step consisting of identifying the source of clash incidence using an online survey. And for the project's second phase, a case study of residential construction has been selected. The study is measuring the efficiency of BIM for conflict detection using Autodesk products including AutoCAD, Autodesk Revit, and Autodesk Navisworks Manage for modelling.

II. OBJECTIVES

1) Study on clash Detection benefits through BIM
2) Learn about the major reasons of clashes while BIM Modeling.
3) Analyze the nature of Clashes and its early identification through questionnaires from BIM Modelers.
4) Creation of 3D Model of different disciplines using Revit Software as follows;
a) Architecture
b) Structure
c) MEP (Mechanical, Electrical & Plumbing)

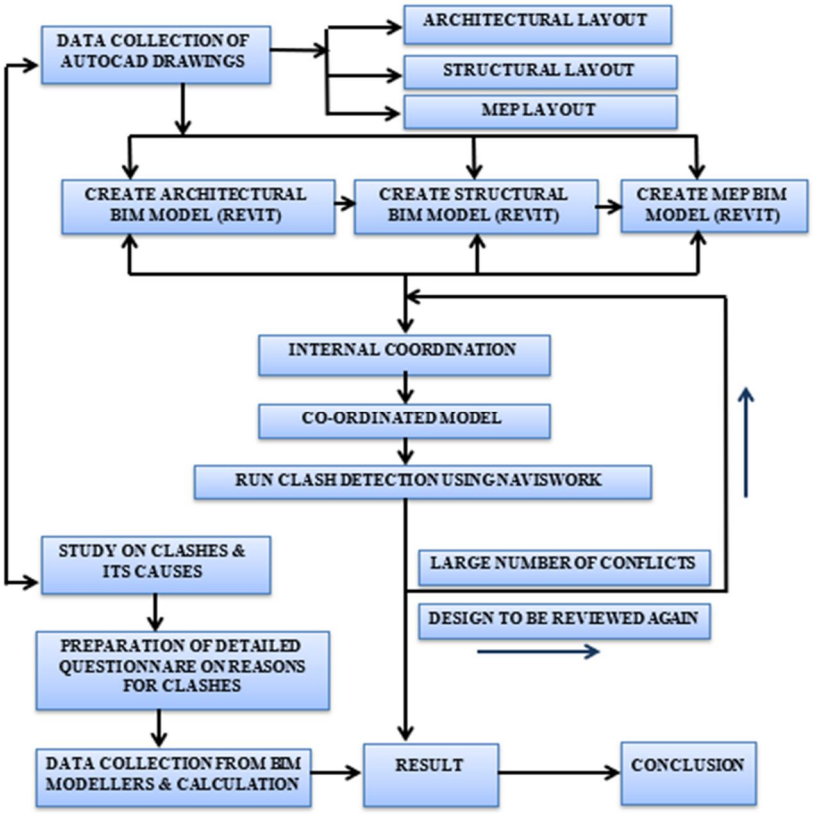
5) Creation of CO-ordinated Model through Naviswork and Run for clash detection to know the behavior of clashes and the reasons behind it.

6) Analyze the data to get the industrial knowledge on the working methodology on clash detection and to check its workability.

III. METHODOLOGY

A. General

The approach used to conduct the study is covered in this chapter. Flowchart of the methodology is as follows;



B. Data Collection of AutoCAD Drawings.

Auto CAD creates precise drawings in the 2D plan that is the foundation of the original sketch design. The DWG file format is used for 2D plans. Initial designs, which were in 2D as depicted in the AutoCAD figures, were received from legal sources. For the purpose of conflict identification, the two components of Architectural & structural were selected. Fig 1& 2 shows the respective layouts.

Fig 1: Architectural Layout

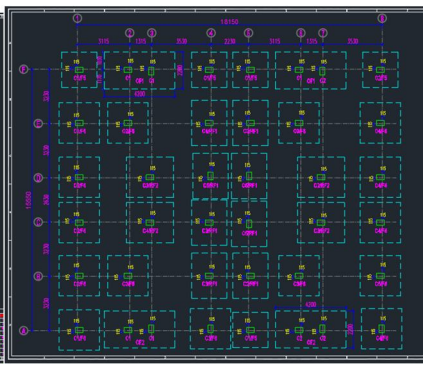


Fig 2: Structural Layout

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C. Create Architectural, Structural & MEP BIM Model

This project's model creation process was intended to create three-dimensional models from simple two-dimensional sketches. The project's eventual goal of conflict detection is taken into consideration when doing this. Various pieces of software are utilized for this, however in this case, Autodesk Revit 2020 is used. To do this, each level of the Arch Autocad 2D drawing layout is linked to Revit with the corresponding units taken into account in Autocad being maintained for the Revit model Based on this, the 2d layout specification is used to represent the components of the 3D model. The materials of all elements and sizes of the doors and windows must precisely match the specifications.

Below figures shows the Architectural Modeling done in Revit;

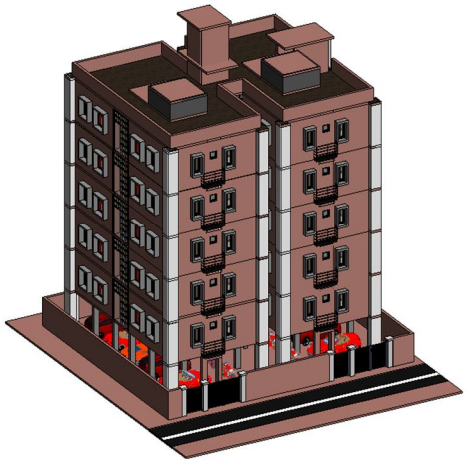

Fig 3: 3D View of the Architectural Model

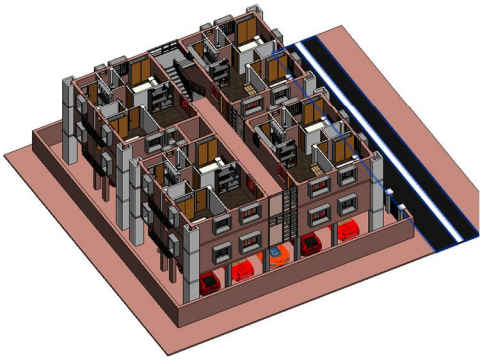

Fig 4: Basic Interiors of Architectural model

Based on the 2d drawings from AutoCAD, similar process of linking AutoCAD 2d for each level is done. In addition to it Revit arch model is linked. Both 2d drawings the 3d layout will fall in the same place giving it a baseline to model the structural element i.e., Slabs, beams, column, footing and load bearing walls are modeled. Since the features of the arch model have already been decided upon, it is quite unlikely that they will alter moving forward. Therefore, we had to align every element with the Arch model. Our objective was to provide the best solution to maintain such structure with good stability while keeping in mind that the requirement of the Arch model will mostly be about the aesthetic point of view. Fig 5 shows the structural model.

Similarly, MEP (Mechanical, Electrical & Plumbing) All the three disciplines were modeled in the single model. Professionals who work in MEP engineering should use Revit MEP. Mechanical, Plumbing and electrical designs were implemented using Arch and structural model for MEP 3D modelling in Revit. Below Fig. represent the MEP Model. Fig 6 shows the MEP model

Fig 5: Structural BIM Model

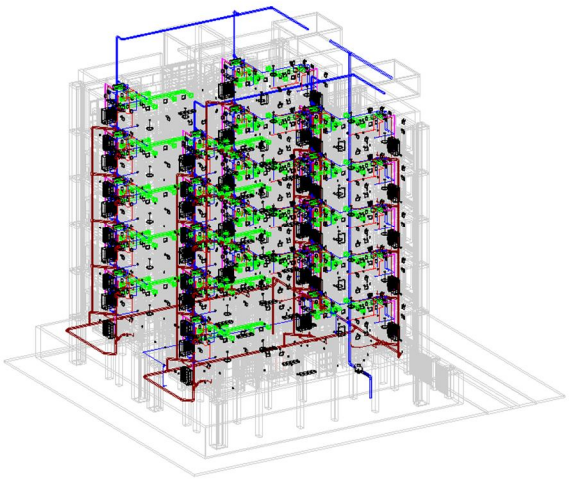

Fig 6: MEP BIM Model

D. Internal Coordination & Coordinated Model

Any clashes noticed while modeling the three model will be documented. This documentation was ensured to reach each department to rectify any major changes. The majority of the case the document was required the Arch or Structural element places clashing with MEP. This had to be further checked with clash detection software to know the intensity and the importance of clashes and the need for the particular change. Once there is a clear identification is done based on the reports the Internal coordination process to be carried out. After the three models are done, the files were exported as .Nwc format of each file to Naviswork for clash detection to make a Co-ordinated Model. Fig 7 shows the coordinated Model from Navisworks.

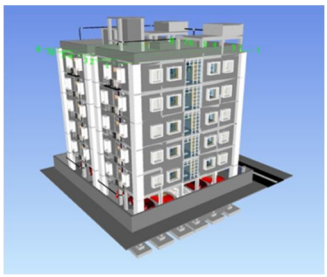

Fig 7: Coordinated Model

E. Clash Detection Using Navisworks

When using Autodesk's Navisworks, a clash report is always generated between two design models. The Navisworks program was used to upload the first discipline's existing design model. Any two design models can be selected in order to produce potential conflicts between them in the coordinated model. Using Write Report option available in Navisworks it provides full report and specific photos that demonstrate the clashes between the two designs Select the necessary data required for the report and Write Report.

IV. RESULT

While performing the clash detection in Navis Work, there are basically 3 types of testing possible.

1) Hard Clash
2) Duplicate Clash
3) Clearance Clash

All the above types are tested in this study, Hard clash of 50mm tolerance, Clearance clash and Duplicate clash are done.

A. Hard Clash with Tolerance 50mm

Hard clash identifies potential collisions when geometry is not intersected. Table 1 & Fig 8 shows the Hard clashes in between all the three disciplines i.e. Architectural, structural and MEP for all Levels and Fig 8 shows the Hard Clashes for all Disciplines by level wise.

Table 1. Hard Clashes with Tolerance 50mm

	Structure v/s MEP	Architecture v/s MEP	Structure v/s Architecture
Hard Clashes (50mm)	484	681	2012

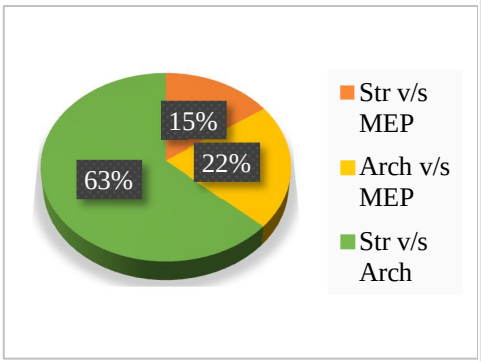

Fig 8: Hard Clash (50mm Tolerance)

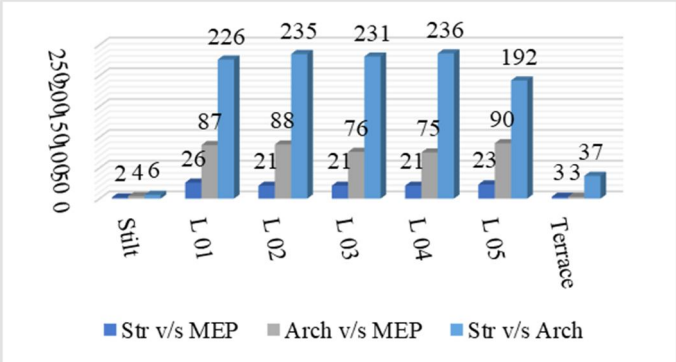

Fig 9: Hard Clash (50mm Tolerance) level wise

Based on the result, Fig 1 shows the maximum number of clashes are in structure and Architecture being 63%. This is mainly due to the minimum coordination that took place between Arch and structure as they were done parallelly. This shows that coordination is very crucial in the BIM modelling and it ill lead to majority of the clashes if unnoticed. And the others at 21% and 15% of Arch v/s structure and structure v/s MEP respectively. Level wise distribution of thee cashes are shown in Fig 9 this means that these models need multiple number of coordination before the issue of the drawings.

B. Hard Clash with Tolerance 50mm

Table 2 illustrate the number of Clearance clashes that occurred in the clash detection test with the tolerance of 10mm. Clearance clash Verifies the minimal distance that must exist between two things. Majority of the clashes occurred in structure v/s Architecture. Total number of clashes are 10177. It is basically done to check the accuracy of the drawings.

Table 2. Clearance clash with tolerance 10mm

	Structure v/s MEP	Architecture v/s MEP	Structure v/s Architecture
Clearance Clashes (10mm)	1980	4743	9454

Figure 10 shows the percentage of clearance clash for all the levels. Similarly with respect to the hard clash the result shows that majority of it is in Structure v/s Arch at 59%.It is for similar reason as hard clash. By obstructing the space surrounding the object's physical volume, a soft collision may result. Instead of using the object's actual shape, the geometry is modelled based on the designer's perception. Sometimes the close proximity of two pieces will not allow for adequate building accessibility.

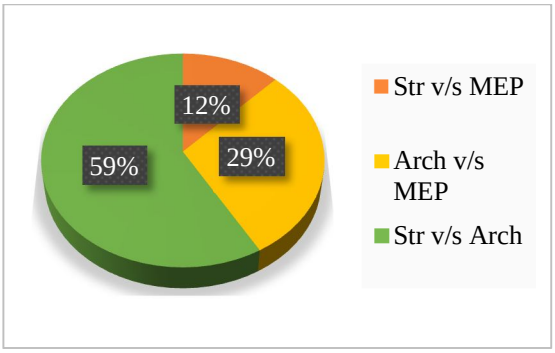

Fig 10: Clearance clash (10mm) between three disciplines**.**

Table 3. Clearence Clashes with Tolerance 50mm by Level wise

Discipline / Level	Stilt	L 01	L 02	L 03	L 04	L 05	Terrace
Structure v/s MEP	2	150	151	151	151	147	3
Architecture v/s MEP	5	516	523	458	456	482	3
Structure v/s Architecture	263	922	1017	925	913	903	227

Uncertainty throughout the design process was one of the primary causes of a significant amount of hard collision in the case study. Another factor is the lack of agreement on the development of a given system and how it might work in relation to other systems without causing any disturbances. Additionally, the project's complexity and the short timeline for completion can result in serious conflicts. Another reason for hard collisions is bad design, which results from the designer being ignorant of a dimension or location of one or more construction components. Fortunately, there were no duplicate clashes that was done while modelling.

C. Survey on Reasons for Clashes in BIM project Encountered by BIM Modelers

It is crucial to understand the primary causes of conflicts that BIM professionals have when working in the BIM environment. The respondent was required to rate nine given reasons on a five-point Likert scale question. The questionaries was sent through an online survey in-terms of Google form for the BIM modellers to understand the reason why clashes occur. Below Table . Below are the question and the likart scale had option of choosing Strongly Agree, Agree, Disagree, Strongly Disagree and Uncertain as its options. And the results are in-terms of Percentage. Total number of sent applications were 100 and the respondents were 48.

Table 4. Survey on Reasons for Clashes in BIM

Questionnaire	Strongly Agree	Agree	Strongly Disagree	Disagree	Uncertain
Due to Time Constraints	31.3	56.3	10.4	0	2
Due to Usage of Different File Formats by Different Teams of the Project	31.3	52.1	14.6	0	2
Inadequate Details on Object Modelling	35.4	60.4	14.6	2.1	2.1
Errors While Modelling the Design	20.8	54.2	16.7	4.15	4.15
Using 2D instead of 3D	29.2	52.1	14.6	2.1	2.1
Communication Issues Among Different team Members of Same Project	35.4	52.1	10.4	0	2.1
Scarcity of Skilled and Trained Professionals	18.8	70.8	8.3	0	2.1
Due to Design and Modelling Complexities	20.8	64.6	4.2	0	10.4
Due to Design Uncertainties	25	58.3	12.5	0	4.2
Balancing Between Model Accuracy versus Meeting the Deadline	27.1	64.6	8.3	0	0
Is it an Iterative Process?	16.7	72.9	6.3	0	4.1

	Architectural	Structural	MEP
Where Does Major Collison Occur?	18.8	33.3	47.9

Table 4 represents the major reason why the clashes happen while Modelling. The use of various file formats, a lack of time during the design stage a lack of appropriate object model information, and the complexity of the modelled objects are the primary causes of conflicts in the BIM tools. The outcome demonstrated that the computed values lack statistical significance. Reports state that construction companies encounter issues with data interchange since they do not adhere to a single neutral, interoperable standard. The process is iterative, there is a lot of back and forth required to reduce the number of clashes and make the model clash free. Major collision occurs in the MEP at 47.9% and with structural at 33.3%, the results of this as inconclusive in nature.The results highlight the need for greater openness during collaborations where designers from various backgrounds can work together concurrently to create.

V. CONCLUSION

In order to guarantee the quality of the BIM model that will be utilized in the following stages of the project lifecycle, this project describes the method of design clash detection, which is a component of a significant workflow of design coordination. If effectively used, the technique can assist designers in switching from clash detection to clash avoidance, which can result in significantly greater advantages. These findings demonstrate BIM's high level of accuracy and demonstrate how well it can be used to re-document existing structures and identify conflicts between them. To show the workability that can be achieved by BIM enabled clash detection, the schema was developed using a qualitative and inductive research methodology (i.e., using literature and expert reviews).

If the respondents in the initial sample group of 100 who did not answer to the survey had different viewpoints from those who did (46), there may have been an elevated likelihood of a non-response bias. Under such conditions, extrapolating the results beyond the study's sample is frequently impossible. It was then validated by implementation on a case study of a significant Residential project. The schema involved identifying conflicts, categorizing conflicts, identifying typical conflicts within each category and its effects if they weren't resolved prior to construction. The findings showed that BIM Clash detection is a quicker, easier approach that also completely reduces the field of human errors during implementation. Design conflicts that arise within construction components are correctly identified by Navisworks. As the conflicts were not resolved between the three components to zero, the process need to be complete by the co-ordination and then our system is ideal for use in a larger building project. The construction component collision detection was the main focus of this study. In order to resolve conflicts that have already occurred during building, more study is needed.

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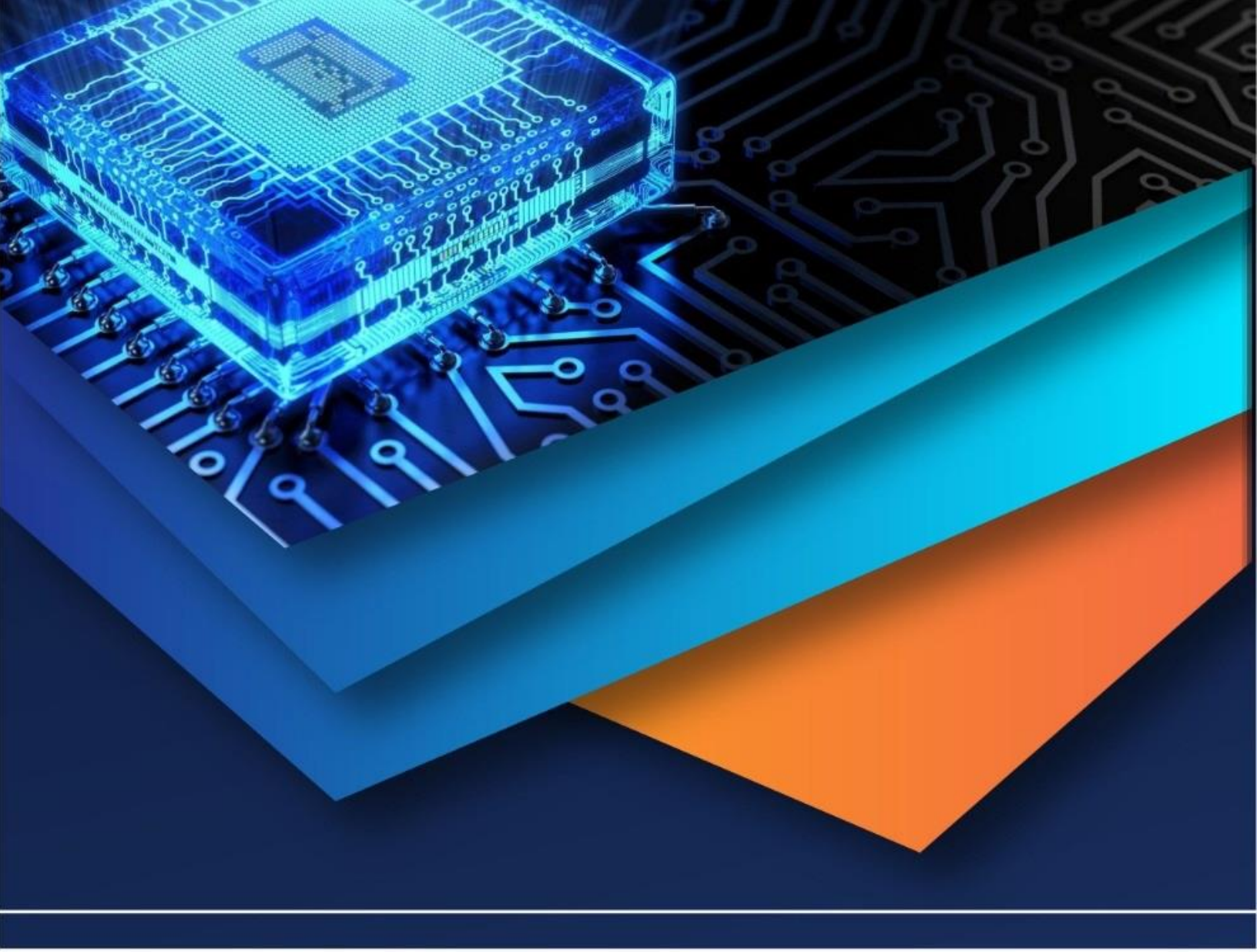

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