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Hydraulic Forklift "Easy Stacker"

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Abstract: Material handling process is the movement of raw materials, finished goods through various stages of production and warehousing. Generally, a forklift is used in many industries for different applications such as lifting, delivery of material such as huge boxes, Raw materials, etc. The device that we are planning to manufacture known as "Easy Stacker" is designed for similar operations but is specifically built for small warehouses or commercial spaces. Currently the work of stacking goods in such spaces requires manual effort and also consumes a lot of time. In order to meet the ever-increasing needs of the customer, shopping stores have to make their staff work extra to make stacking of goods possible. Hence such a device can be used in alike spaces for stacking easily and efficiently. The device is cost effective, compact in size, and can easily be operated by a single person and navigate through the narrow alleys.
Keywords: Hydraulic Forklift, Hydraulic Actuator, Bearings, Fork, Deformation

I. INTRODUCTION

The shopping culture in today's times has increased the need for retailers to upgrade the way they used to sell things. In earlier days, when India was not on par with globalization, the categories or the brands of various goods were extremely limited. Hence, the size of the shops that used to sell these products was also less and was able to be run by either one or two persons. Such shops were generally referred to as Kirana Shops or General Merchant Stores. In 1990's with globalization, India started to become an open market, and all the huge giants wanted to play. As and when more and more companies entered the bullpen, the variety of products and the availability of various categories also increased. Later, the sense of competition in the market fueled the length of product range. To keep the business running, it was very important for retail shop owners to provide the complete product range or variety available in the market to their consumers. And hence, the local Kirana Shops were not sufficient enough in order to store or house all the varieties available in the market. Thus, in order to transform of upgrade themselves, the Kirana Stores were turned into convenient stores and later into Super markets or Malls. A supermarket is a self-service store that is divided into sections and offers a broad selection of food, beverages, and home items. This type of store is larger and offers a wider selection than older grocery stores, but it is smaller and offers a smaller selection than a hypermarket or big-box market.

This huge range of product availability is fulfilled by storing or rather stacking the goods tactically in shopping racks or shelves. The goods are to be stacked regularly as and how the sales takes place in order for the racks to look full.. Hence, the goods stored are daily Stacked, Re-stacked or Removed from these shelves. The task is really daunting as the it can consume a lot of time of the employees. Not only that, but this activity requires more than one employee to perform the activity. These shelves or racks could reach upto greater heights, the goods could be asymmetric and heavy. The stacking on to these shelves becomes further more difficult. To solve this problem, the most viable solution available in the market is the usage of a forklift.

Conventional forklift cannot be used for this purpose hence this makes the usage of this product extremely necessary, as it uses a thrust bearing attached to the fork mechanism which allows the fork to turn 180˚. Hence the whole frame stays still while only the fork rotates. The machine designed is capable of lifting weights upto 50Kgs which is more than enough as compared to the goods usually present in the super market.

II. LITERATURE REVIEW

A. Three Wheel Drive Forklift for Industrial Warehouse

Rajat Rajendra Wade, Digvijay.K. Take, Mahesh.S. Deshmukh, Pranav.A. Raut - The paper under study shows designing and fabrication of a 3-wheel driven forklift. This forklift is generally designed to be used for the Industrial application. The forklift is driven with the help of a 12V DC Motor and the operation of the forks of the forklift is done by using the hydraulic actuation mechanism. The above paper under study generally focused on the detailed history of the forklifts. It focusses on a device that is mainly propelled through industrial or warehouse alleys without any human intervention. The forklift under study is a self-propelled vehicle.

B. Design, Construction & Testing of Two Wheel Drive Forklift

Dr. Pravin Potdukhe - The paper under study generally focusses on a forklift that is made in order to transfer the goods and raw materials from one place to another with minimum cost & safety. The different approach taken by the researcher is that, the forklift is battery operated and also cost effective. It is designed so in order to be able to easily lift load of about 250-300 Kgs for a height upto 1.8m.

C. Fabrication of Battery-Operated Remote-Control Forklift Machine

Aditya chawke, Lakhan Raut, Nikhar Dholwani, Irfan Sheikh, Nilesh Karluke, Prof. Ajay Wagh - The paper was published to design a battery-operated forklift which can be controlled by a remote controller. This forklift was designed specifically in order to maintain the safety of the operator. As in the case of other forklifts, they have to be physically operated by an operator which leads to improper handling of material, is also dangerous to other people working in the factory if the operator does not focus on the task in his hand and is also risky for the operator himself if the machine malfunctions. Also, this machine was designed keeping in mind the narrow passages through which the other forklifts have a problem in navigating.

III. METHODOLOGY

The Easy Stacker is Manually Operated material handling device. It uses Forks for raising and lowering weights of and on a typical shopping display rack. The process of lifting and lowering is based on the principle of hydraulic linear actuation, where it uses fluid pressure to apply force and move and position the actuator; therefore, a small amount of human effort would be enough for lifting heavy weights also ensures the safety of the person operating the device. The functioning of the device demands input from not more than a single person.

Along with lifting and lowering, a thrust bearing is used which allows the machine to give 180˚ free rotation to the forks while carrying the weights. This will help in managing the problem of smaller space in shopping alleys. These smaller spaces do not allow the usage of conventional forklifts in which case, the forklift is to moved or rotated in order to rotate the load.

The load to be lifted can be placed on a pallet which is then rested on the fork of the forklift. The operation mainly involves a hand operated lever which actuates the hydraulic piston connected to the fork.

The forward and backward movement of the device is done manually with the help of wheels.

The Main parts of the device are as follows:

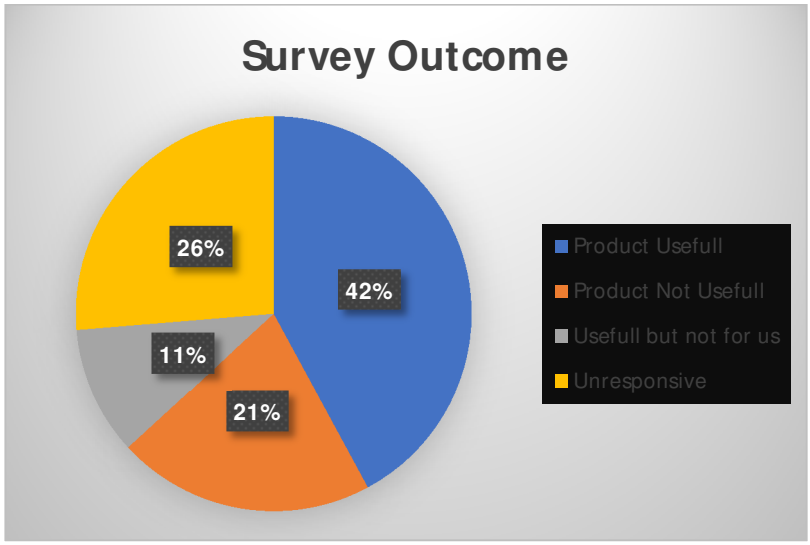
- Forks
- Frame
- Handle
- Lever
- Hydraulic Actuator
- Wheels

Hydraulic Forklift "Easy Stacker"

IV. MARKET SURVEY

A market survey was conducted for validation of the product. The main aim of this survey was to find out whether the problem taken to consideration for solving, really existed in practicality and whether the proposed solution did work it out.

- The survey was conducted by visiting 13 shopping complexes/malls throughout Pune within the time span of three weeks.
- Various Managers, Deputy managers and Floor Managers were interviewed with a set of prepared questionnaires.
- Their answers and suggestions were analyzed, and a final outcome was prepared by the team.



It was found that the avg. number of racks per shop contained was 25 and each rack at least took 30 minutes every day. Also, the staff found it difficult in lifting weights especially on a ladder, where the height of the shelve would be around 6-7Ft. The goods were of various size and shapes and some goods needed to be kept on the shelf individually thereby consuming a large amount of their time.

The Shops also conveyed that during certain festive seasons, the shop had to hire people especially for stacking, coining the term "All Night Stacker". Where a person was hired to stack up goods in shelves all night long before the festive day. Especially during Diwali and Christmas season. The survey concluded that, the product had the potential to solve the problem of stacking for Supermarkets.

V. COMPONENTS OF EASY STACKER (HYDRAULIC FORKLIFT)

A. Trolley

A shopping cart/trolley has been provided with device. The main function of which is to hold or support the load. The trolleys are made of Stainless steel having approximately 100cm in height. The trolley also castor wheels in order to navigate the whole system. The maximum load that the trolley can hold is more or less 100 Kgs.

B. Lifting Forks

They are the main part of the forklift system. The function involves directly lifting or raising the load from its position. Area of fork = 50.8 X 25.4 X 1.2mm L= 600mm

C. Guide Column

The guide column is used to support the load, lifting forks etc. and to enclose whole assembly. They are MS channels and are erected on both sides, housing bearings attached to the fork. These bearings in place slide in the channel and help fork move up or down.

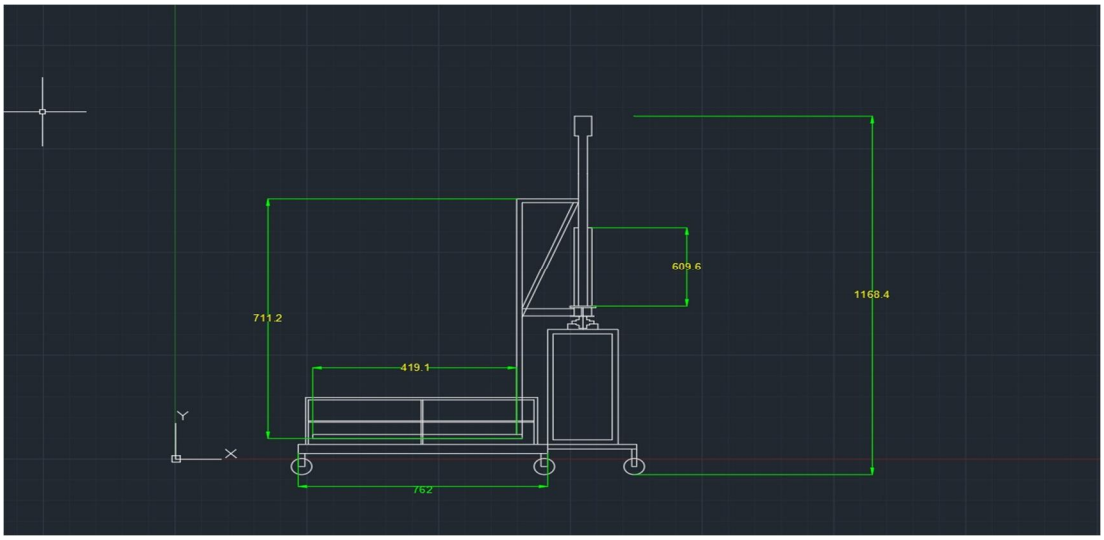
D. Hydraulic Bottle Jack

A hydraulic bottle jack is mounted on the lower part of the assembly. The actuator of the jack is connected to the lifting fork assembly. The actuation takes place manually through a hand lever.

VI. WORKING

The mechanical forklift works on the principle of Hydraulic Linear Actuation. The hydraulic bottle jack is a device used for lifting heavy weights that are not humanely possibly by the application of minimum amount of force. This follows the principle of Pascal's law, that states that intensity of pressure is transmitted equally altogether in all directions through a mass of fluid at rest. This Jack is actuated manually through a foot pedal.

It was observed in the above model that the amount of height required to be achieved, was only achievable if the stroke length of about 3ft is achieved. This is possible only if such hydraulic actuators are made available. These actuators are not readily available and need to manufactured on customized basis. The other way of achieving this kind of height is possible if a proper motor and a pulley mechanism is used. This again increases the costing of Electric Motor and Electric Batteries. Electric linear actuators can also be used, only drawback being the maximum height that can be achieved through such an actuator. Hence it was well discussed among the group members and the guide to produce a Scale-Down-Model of the above-mentioned design. This new model is designed in a such a way that it truly represents all the function the original model can perform. Only difference that is present would be the height that can be achieved, the maximum load carrying capacity and speed of actuation. The decision to manufacture a scale down model also came into being by keeping the ease of availability of the material and the manufacturing processes.



AutoCAD Design of the scale-down model

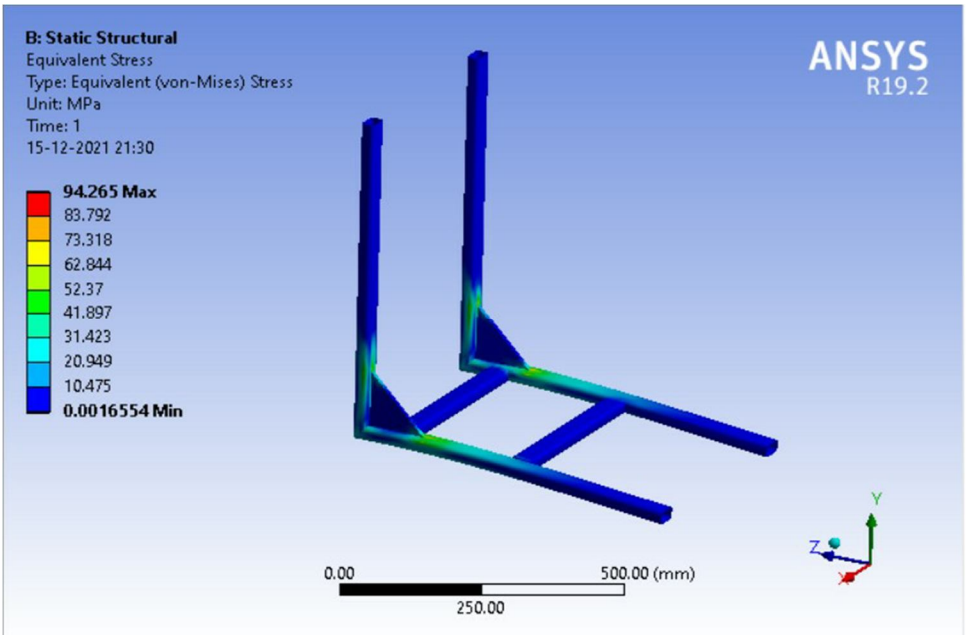
VII. DIMENSIONS OF THE MANUFACTURED MODEL:

Length	762mm
Width	508mm
Height	1168.4mm
Weight	20Kg
Height of Fork	711.2mm
Fork Length	419.1mm
Fork Width	381mm
Height for Hydraulic Jack (from ground)	609.6mm

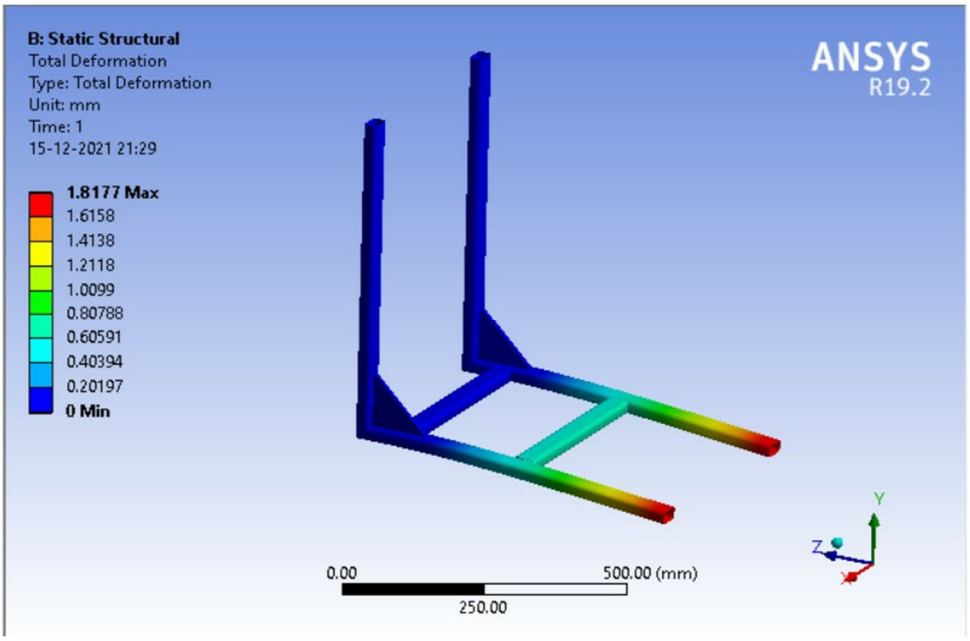
VIII. ANALYSIS

The following were the tests performed on the fork; as the maximum load is beard by it.:

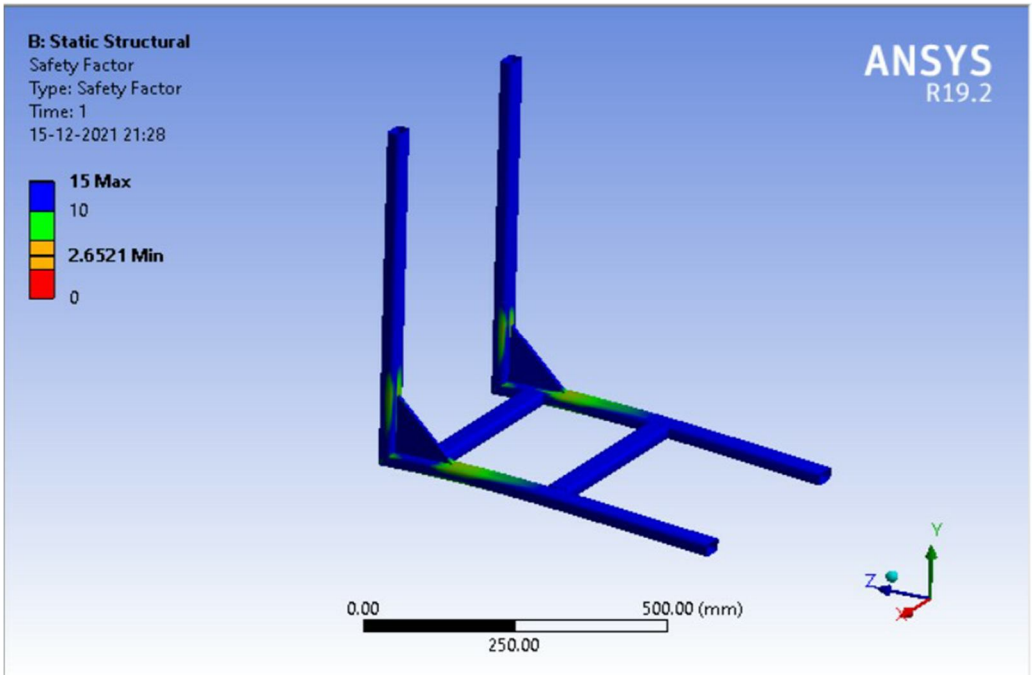
- Static structural test for Equivalent Stress
- Static structural test for Total Deformation
- Static structural test for Factor of Safety



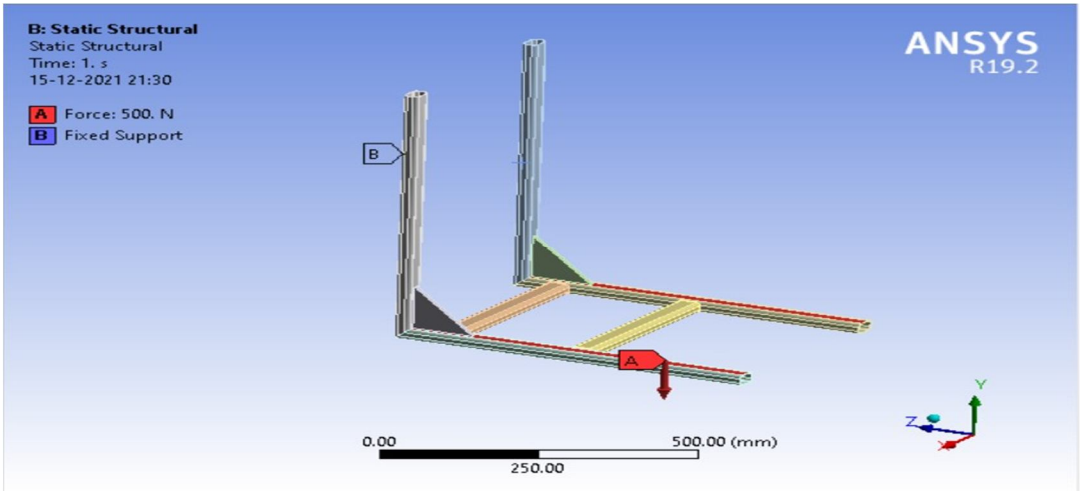
Equivalent stress at 500 N



Deflection in mm at 500 N



Factor of Safety at 500 N



Load Conditions

LOAD	Maximum Deformation	Equivalent Stress	Factor Of Safety
500N	1.8 mm	94.265 MPa	2.6
1000 N	3.63 mm	188.53 MPa	1.326
1300 N	4.72 mm	245.09 MPa	1.02

After completing the Analysis on ANSYS Software, it was made evident that:

- *Result:* When Load is increased beyond **1305 N** i.e., **133.07 Kg,** it is observed that the Factor of Safety decreases than 1 (**FOS<1**), thereby indicating possible failure.

IX. EXPERIMENTAL VALIDATION

Weight checking before lifting

180˚ turn of the fork with the load

X. COMPONENTS SPECIFICATION

Sr. No	Part Name	Parameters	Material	Quantity
1.	Frame Square Pipe	A= 50mm×50mm	Mild Steel	4
2.	Square Pipe	A= 25mm×25mm	Mild Steel	4
3.	Fork Square Pipe	A= 20mm×20mm	Mild Steel	2
4.	Bay	Diameter= 8mm	Mild Steel	1
5.	Wheels	Diameter= 4inch	Rubber	2
6.	Caster Wheels	Diameter= 3inch	Rubber	2
7.	Sliding Follower	Diameter= 1.5inch	Steel	3
8.	Thrust Bearing	ID= 20mm	Steel	2

XI. CONCLUSION

The Market survey did result in a positive response from various retailers. The designing of the project made it seem to be a simple structure possibly showing no signs of complexity or future failure when the required load is applied. The project has the potential to be further developed for higher loads and to provide efficiently in fore coming future. If multiple disciplines of Engineering are involved, this could be easily turned into a Smart Device; that can be added Control Systems, Cameras and Motorized Actuation so as to provide a complete automation in the stacking process. The results from the experimental validations also proved to be fruitful as the device was successfully capable of lifting and lowering of the weight. It was rotating with great smoothness in a full 180˚ turn. The operation seemed to be extremely easy and quick as compared to a conventional forklift. If it is synchronized with the Inventory Software so that the Merchandised can be placed in the order pertaining to their Expiry dates or Arrival's policy.

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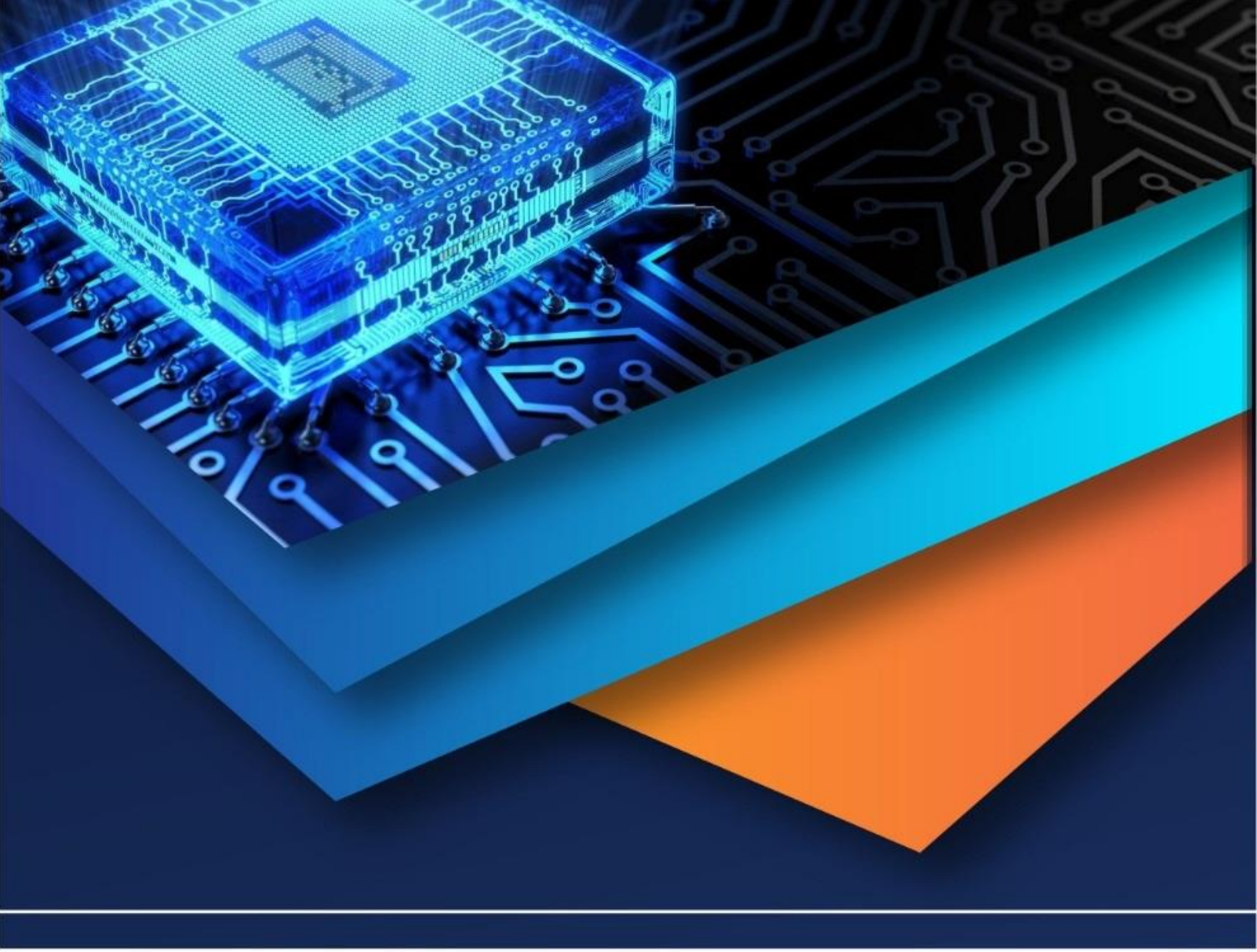

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