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Structural Analysis of RFID Based ID Card Using FEA on Simcenter 3D Software

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Abstract: ***This research paper explores the application of Finite Element Analysis (FEA) in the design and optimization of Radio-Frequency Identification (RFID) based Identification Cards (ID cards). RFID technology is being opted by many manufacturing industries because of its efficiency in data identification and tracking. The integration of RFID technology into identification cards enhances security and facilitates seamless access control. This study focuses on employing FEA techniques to evaluate and improve the mechanical and structural aspects of RFID-based I cards, ensuring durability and reliability in real-world applications.***
Keywords: RFID, FEA, Structural analysis, CAE, Regenerative design,

I. INTRODUCTION

RFID (Radio Frequency Identification). This technology helps in tracking and identifying object by using radio waves. It has two main components: RFID tags and RFID readers.

RFID tags are of three types such as:

1) *Passive RFID Tags:* These tags work without any power source and depend on the energy emitted by an RFID reader to transmit their data.
2) *Active RFID Tags:* These tags work with their own power source as a battery and can actively transmit data to an RFID reader without depending on external energy.
3) *Semi-passive RFID Tags:* These tags have a small battery as a power source to certain functions, such as the onboard sensor or additional features, but still depends on the RFID reader for communication.

RFID readers emit radio waves and communicate with RFID tags within their range. They capture data by the help of tags and the received data is being processed by the computer system. Readers can either be fixed or handled. Fixed readers are often used in industrial settings, supply chain management, and coordination, while handheld readers are more convenient for applications like inventory management.
The use of RFID technology in identification cards has become increasingly prevalent due to its advantages in secure and convenient access control. However, the mechanical properties of RFID-based ID cards are crucial to their long-term functionality. FEA provides a powerful tool for analysing and optimizing the structural aspects of these cards to enhance their performance and longevity.

The primary goals of this research are as follows:

- To conduct a literature review on RFID technology and its application in identification cards.
- To analyse the mechanical properties of RFID-based I cards using Finite Element Analysis.
- To optimize the design of RFID-based I cards for improved structural integrity and durability.

This section provides an overview of RFID technology, its evolution, and its integration into identification cards. It also reviews existing literature on FEA applications in the design and analysis of RFID-based devices.

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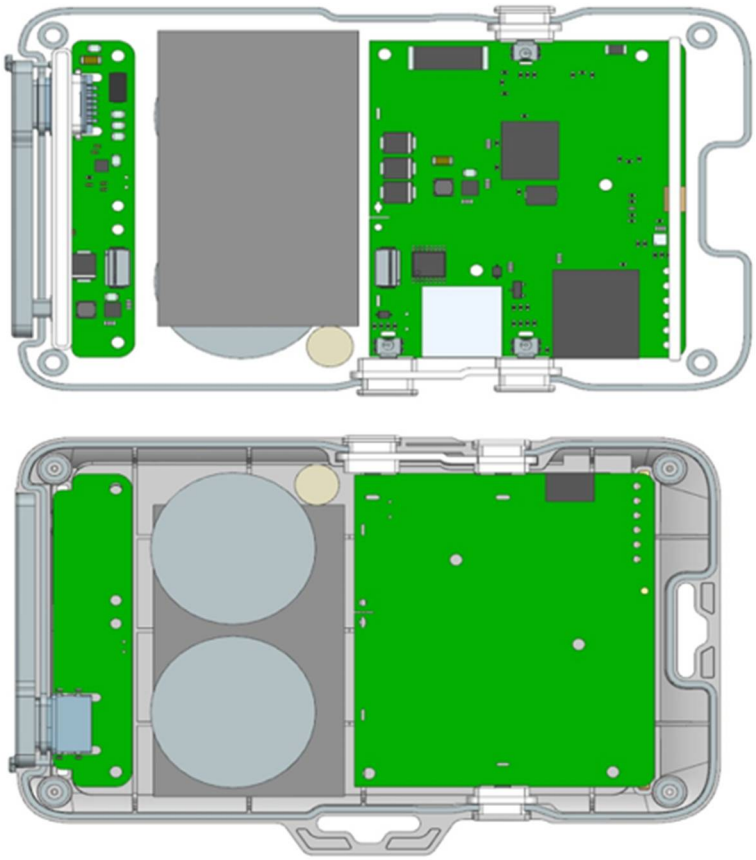

Fig.1: RFID based ID Card.

Dr. Thangavel V in 2023, gave an overview on the current global use in identification, verification, and authorization applications of smart cards by concluding their ability to support transaction processing, and multiple applications such as information management on a single card. It also includes the early development and application of smart cards with their inventions also[1]. Nawal Kaleem, et al. in 2020, performed An Extensive Case Study in WSNs that includes smart ID cards designing and implementation. According to them, WSNs (Wire Sensor Networks) are a group of miniature junction (node) which are used in physical sensing of environment conditions like temperature, sound, motion etc but by the help of their research, WSN is developed and now it is being used in academic environment as student ID cards because it helps in maintaining the records of student attendance, their entries and exits of classrooms etc[2]. Praveen Kumar Singh et al. in 2018, researched on the evolution of smart ID cards as viable technology, they observed that users of all the professions started to be prefer smart ID cards even without integrating its application. Therefore, through their research they discussed about evolution of smart card technology as a viable technology for a ID verification solution and its capability to increase the reliability of ID cards by performing various functions with strong access control[3]. Dr. Kshitij Singhal and Neelam Shrivastava in September 2017, they researched on the application of WSN (Wireless Sensor Network) in agriculture sectors especially, in potato crop production. This technology increased the standard of agriculture and improved the production also. By the help of WSNs, farmer could identify the various requirements of the crops such as fertilizer, irrigation, depth of water, soil water tension etc[4]. Pankaj Kumar et al. in 2017, Introduced a signature scheme with certificateless aggregation for healthcare wireless sensor network with the help of which patients got their health report available online by avoiding any delays after the patient's checkups but the main concern was the data privacy. So, they proposed a novel scheme called certificateless signature (CLS) for making communication strong in healthcare wireless networks and to prevent unauthorised users to access online data[5]. Vinoth Rengaraj and Kamal Bijlani in 2016, performed an overview about the smart identity cards implementation for child security. Since, the crimes like human trafficking, sex trafficking was increasing continuously, and a report said that more the 75% of human trafficking was done for sex exploitation.

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Trafficker's targets victims most often after school programs so, to reduce child trafficking they provide an initiative to develop child safety systems in smart ID cards[6]. Aakula Lavanya et al. in 2015, Investigated in designing Unique ID Card for personal transaction of data, in this they used the concept of embedded systems and majorly it consists of three modules that includes smart card reader, last finger print module and , the controller which are used for high security in banks, airports and many more[7]. Moshaddique Al Ameen, et al. in 2012, they introduced a new field of WSN as WBAN (Wire Body Area Network) because the application of WSN in healthcare field including the heart rate monitoring, blood pressure monitoring and endoscopic was growing fast. In this article, they worked to elaborate the concern of major commercial applications such as security and privacy caused by sensor network applications. They tried to analyse these two issues and their causes as well as efforts and aware the general public about the benefits and implications so that they would prepare[8]. Jung Y., et al. in 2010, Researched on the National Identity Card Design Development, in this they did the study on the newly developed NID (National Identity) cards and e-NID cards that includes the requirements, hardware and software system design, graphic design of NID card. The best feature of this recently launched NID card was that they are a mixture of both half size and standard size cards. The standard size cards were being used as a traditional identity card and the half size cards were suitable for supporting confidential protection for modern globe/society, accurately with the help of digital security and encapsulated data[9]. Amos Fiat and Adi Shamir in 1999, Discussed about the simple identity and schemes for signature that enables any user to declare their identity and the creditability of their messages without sharing to any other user. So, they created unforgettable ID cards which were based on the emerging technology of smart cards for application in various commercial and military operations. These cards distinguished three levels of protection which includes Authentication Scheme, Identification Scheme and Signature Schemes. The most unique feature of these new cards was that it was possible to change their levels of security [10].

II. METHODOLOGY

A. Cad model Preparation

Modelling work on I-card was done on UG-NX software. Surface level modelling was done to develop this I-Card. Two pockets were given for hanging this ID card, first one is vertically and second is horizontally. The sliding mechanism was given for inserting card base I-card in this I-card shell.

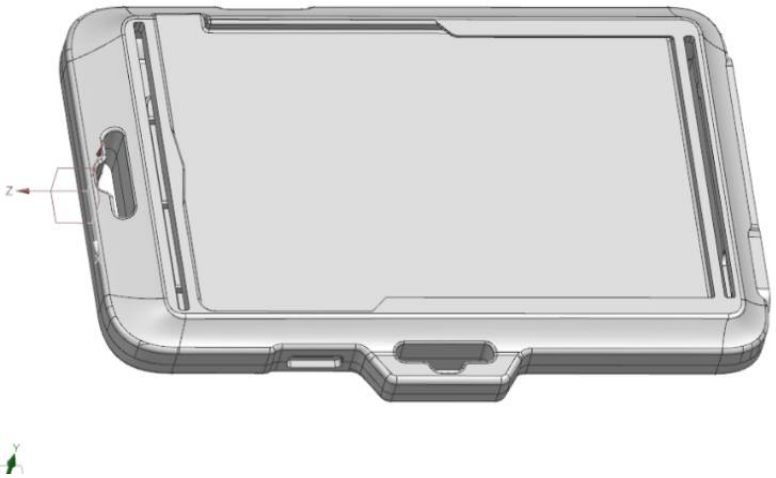


Fig. 2: CAD Model od ID Card.

B. FEA Analysis of the Model

FEA stands for Finite Element Analysis. It is a mathematical strategy the used in designing field to optimize the performance of structure or component under different loading situations. FEA includes splitting a complicated shape/construction into little, effortless elements, and then calculating the behaviour of each element. The solution from these separate elements is then merged to predict the overall performance of the entire structure.

The basic steps involved in FEA are as follows:

1) *Preprocessing:* This process involves defining the geometry of the structure, applying materials, properties, and specifying boundary conditions and loads.
2) *Meshing:* The structure is divided into small elements, usually triangles or quadrilaterals in 2D analysis or tetrahedral or hexahedral elements in 3D analysis. This process is known as meshing.
3) *Defining Material Properties:* This process includes assigning the properties to the materials like Modulus of elasticity, Poisson's ratio, and density of the elements.
4) *Applying Boundary Conditions:* Specifying constraints and loads to simulate real-world conditions.
5) *Solving:* Solving the system of equations that govern the behaviour of each element, often using numerical techniques.
6) *Post processing:* Analysing and interpreting the results, which may include stress distribution, displacement, and other relevant information.

In FEA, the process starts with geometry clean-up and then apply boundary condition on the side pockets. Additionally in primary FEA, a force of 50 N was applied on the front face of I-Card and both ends were fixed. Secondly, a pulling force of ten newtons was applied on the ribbon pocket on the upper side of ID cards. After solving stress and Displacement results will be generated.

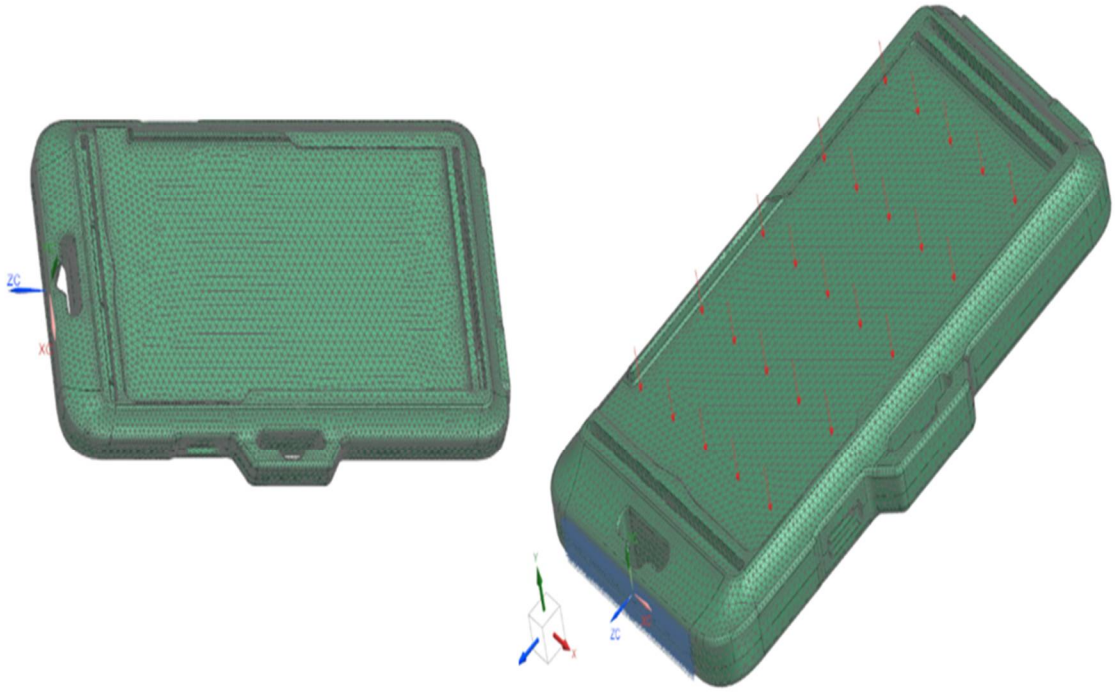


Fig. 3: Meshed model and Boundary condition of ID Card.

III. RESULTS AND DISCUSSION

This section presents the results of the FEA simulations, including stress distribution, deformation patterns, and potential failure points. It also discusses the implications of these results on the structural integrity of the RFID-based I card. Based on the FEA results, this section explores potential design modifications to enhance the RFID-based I card's structural integrity, durability, and overall performance.

1) *Case1: A force of 50 N exerted on the top face of ID Card*

In this case, a uniformly distributed force of 50N exerted on the top face of ID card by applying the fixed constraint on the side body. As a result of this, the whole stress of (0-7.43) MPa will occur on the top face (refer Fig. 4) as the force is exerted because mathematically stress is directly proportional to the force/load applied.

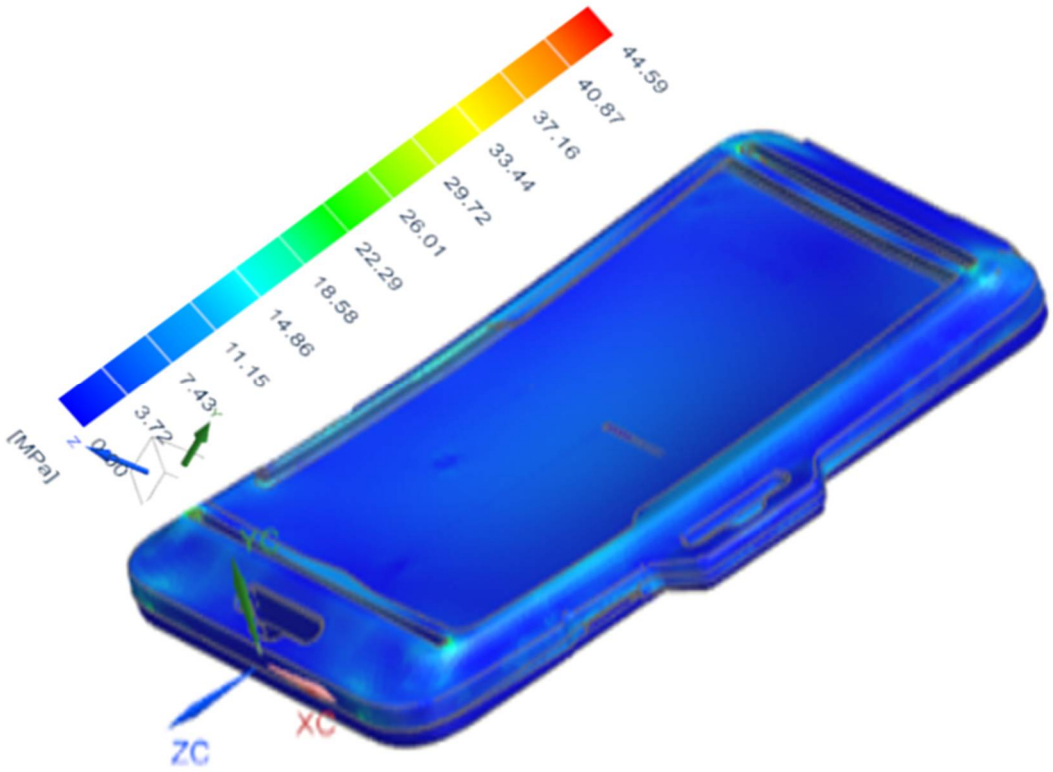


Fig. 4: The Stress analysis result of ID Card.

Due to this stress, the deformations on the various portions of ID card were found (in Fig5) as: The deformation will be maximum in the red region (middle part pf the face) and lesser in the yellow region. The deformation will be average in the green region and minimum in the blue region.

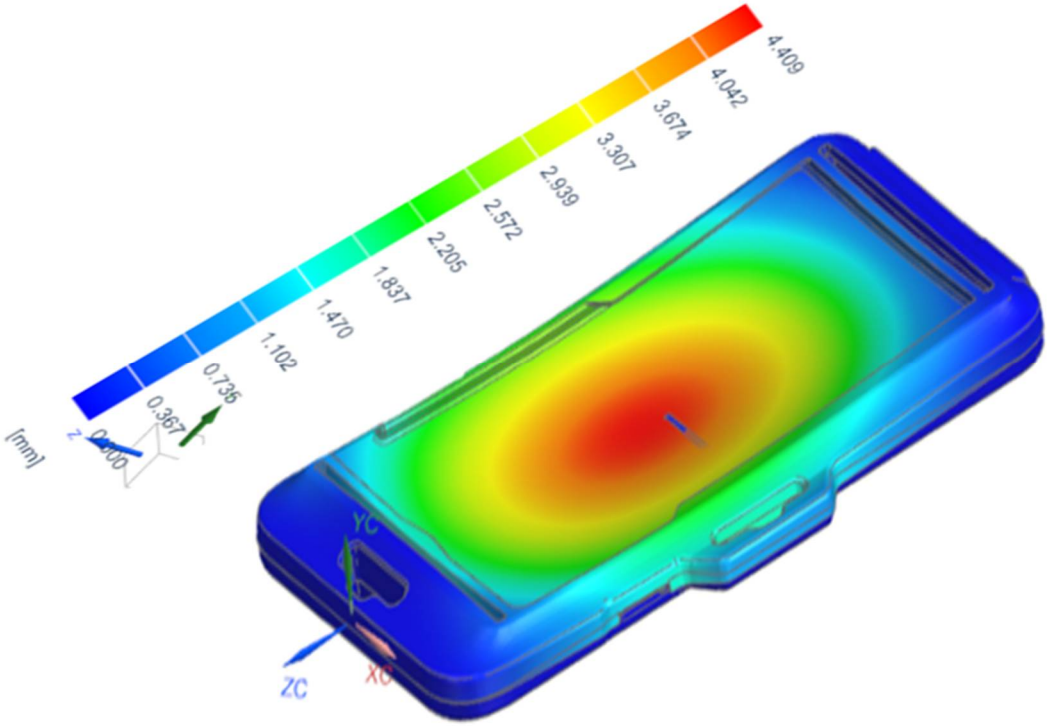


Fig. 5: The deformation analysis result of ID Card.

2) Case 2: A pulling force of 10N exerted on the pocket of ID Card in which ribbon will be inserted

In this case, A pulling force of 10N exerted by the pocket of ID Card in which ribbon will be inserted by applying fixed constraints on the lower body of the ID card. As a result of this, the different stresses on various parts of the ID card were found (refer Fig. 6): The stress will be maximum in the red region (The top portion of the card). The stress will be lesser in the yellow region. The stress will be average in the green region and the stress will be minimum in the cyan region and almost negligible in the blue region.

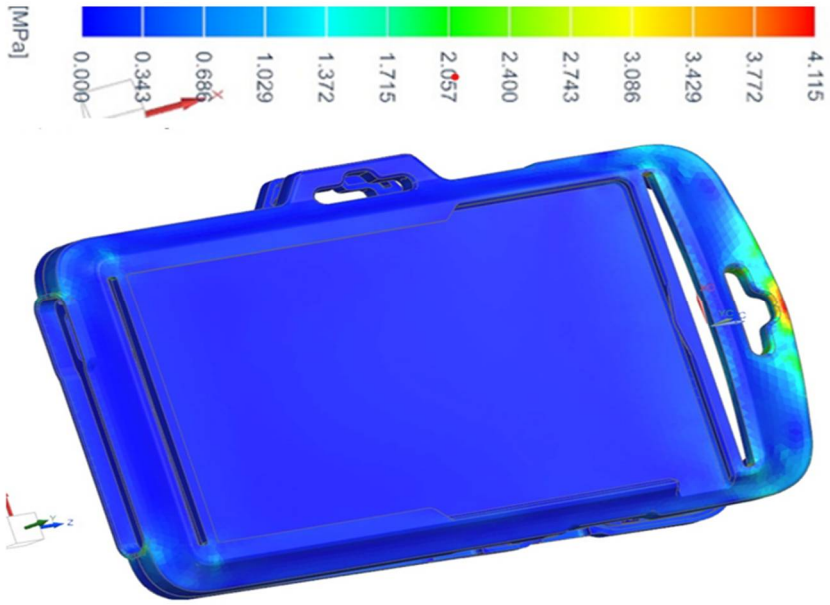


Fig. 6: The stress analysis results of the ID card.

Because mathematically, the stress is directly proportional to the force/load applied. And due to this stress, the deformations on the various portion of the ID card were found (refer Fig.7) as: The deformation will be maximum in the red region (The top portion of the card) and lesser in yellow region. The deformation will be average in green region. The deformation will be minimum in cyan region and almost negligible in blue region.

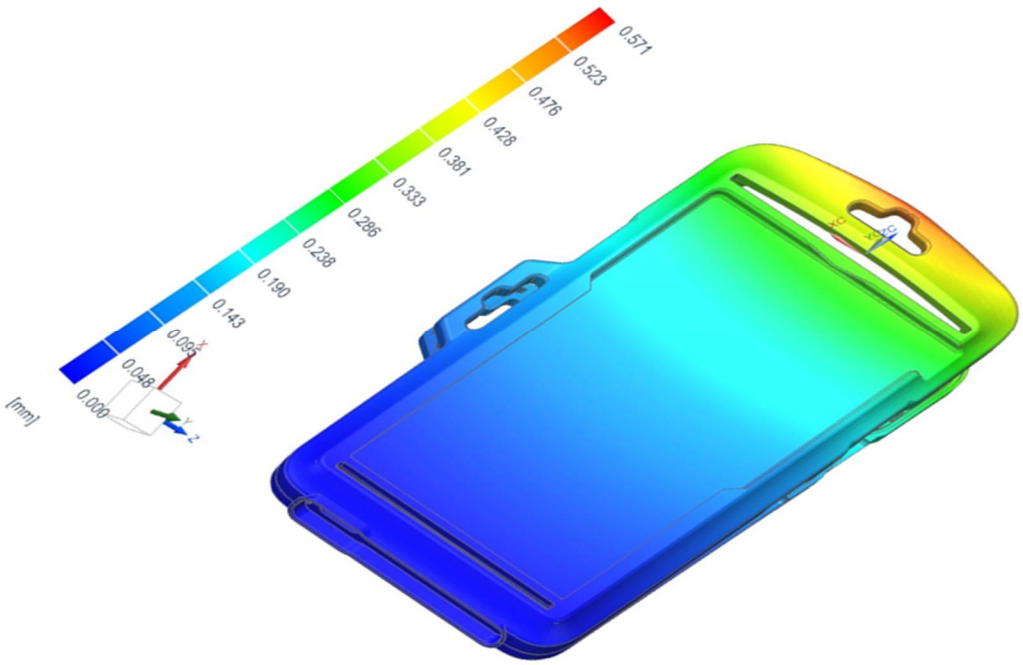


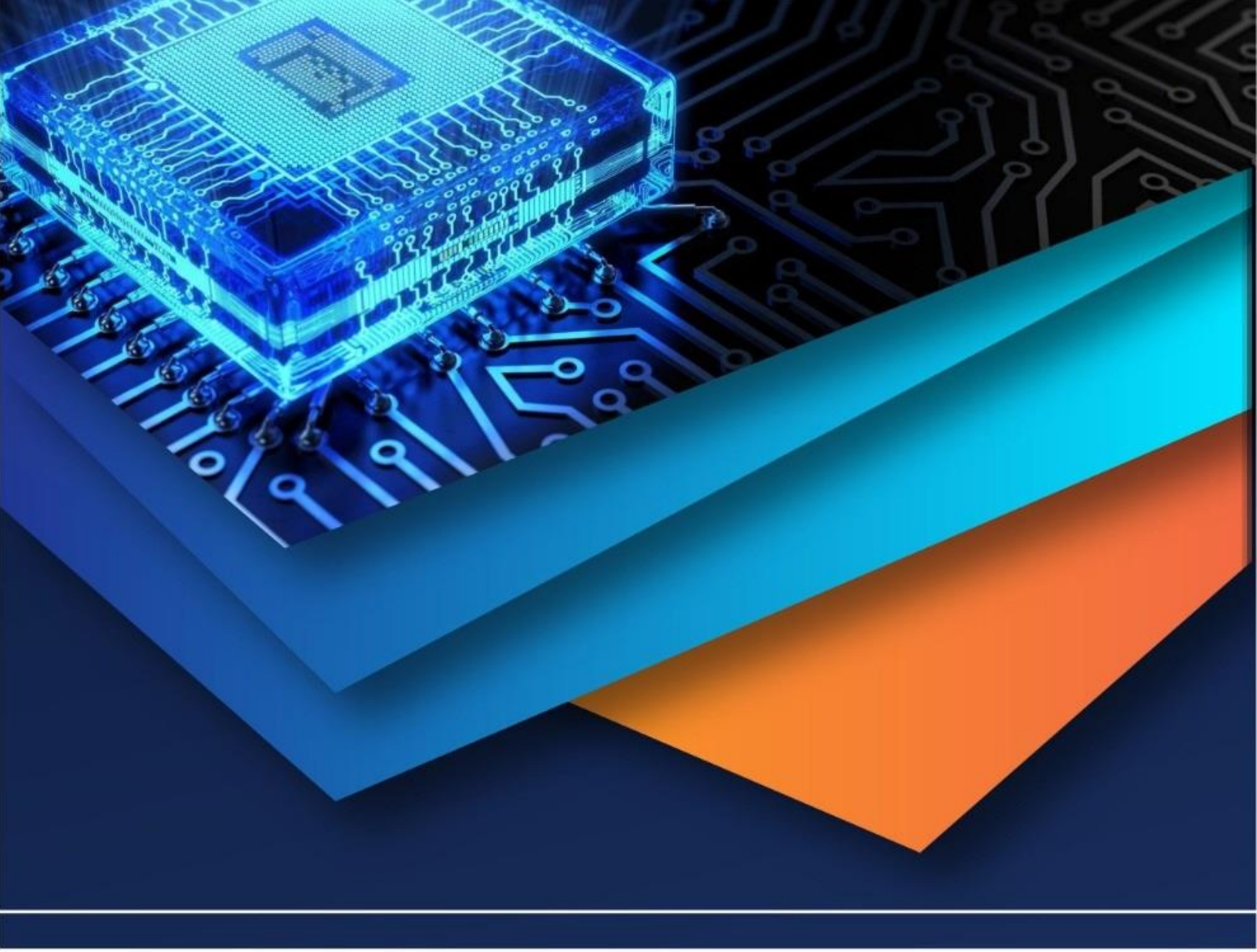
Fig. 7: The Deformation analysis result of ID Card.

IV. CONCLUSIONS

A summary of the findings, implications, and recommendations for future research in the field of RFID-based I card design using FEA. A parametric study was done on the CAD model of ID card, simulation on the same model with two different cases of force application was found, with this Design if ABS material is considered this will give a reliable product with a good strength and factor of safety. Although investigation on the structural analysis was done, but in the future, the RFID Component based study where PCB testing will be done, and study about the heat dissipation from PCB for this CFD will be done.

REFERENCES

[1] Thangavel, V., Global Identification of Smart Card Technologies-Safe and Secure: A Research.
[2] Khan, N.K., Alnatsheh, E., Rasheed, R.A., Yadav, A. and Alansari, Z., 2020, August. A quantitative case study in WSNs: Design and implementation of student smart ID card. In 2020 International Conference on Computing, Electronics & Communications Engineering (iCCECE) (pp. 27-32). IEEE.
[3] Singh, P.K., Kumar, N., and Gupta, B.K., 2018. Smart card ID: an evolving and viable technology. International Journal of Advanced Computer Science and Applications, 9(3).
[4] Shinghal, D.K. and Srivastava, N., 2017. Wireless sensor networks in agriculture: for potato farming. Available at SSRN 3041375.
[5] Kumar, P., Kumari, S., Sharma, V., Sangaiah, A.K., Wei, J. and Li, X., 2018. A certificateless aggregate signature scheme for healthcare wireless sensor network. Sustainable Computing: Informatics and Systems, 18, pp.80-89.
[6] Rengaraj, V. and Bijlani, K., 2016, July. A study and implementation of smart ID card with M-learning and child security. In 2016 2nd International Conference on Applied and Theoretical Computing and Communication Technology (iCATccT) (pp. 305-311). IEEE.
[7] Lavanya, A., Naveen, S. and Nagaraju, A., 2015. Unique ID Card Design for Personal Data Transaction.
[8] Al Ameen, M., Liu, J. and Kwak, K., 2012. Security and privacy issues in wireless sensor networks for healthcare applications. Journal of medical systems, 36, pp.93-101.
[9] Jung, Y., Baik, M., Yang, K., Lee, K. and Kim, M.S., 2010. development of national identity card design (3) Creating the New Value of National Identity Card based on Users Need. In proceedings of the annual conference of JSSD the 57th annual conference (pp. B16-B16). Japanese Society for the Science of Design.
[10] Fiat, A. and Shamir, A., 1986, August. How to prove yourself: Practical solutions to identification and signature problems. In Conference on the theory and application of cryptographic techniques (pp. 186-194). Berlin, Heidelberg: Springer Berlin Heidelberg.



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