Design and Development of a 3-axis Pick and Place Robot for Industrial Use

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Abstract - *The primary goal of this research and development project is to Design and develop a pick and place robot for industrial use. The system is so designed that it eliminates human error and human intervention to get more precise work. This robotic arm can pick and place objects. The robot was designed, assembled, implemented in various fields such as; in bottle filling industry, and packing industry, and then programmed using a pneumatic circuit. The end effector is designed to grab the object, lift it and place it in the desired location.*

1. INTRODUCTION

The use of pick and place robots is common in production lines with repetitive tasks. A human doing the same task over and over again will be inefficient and mentally disturbed because it becomes a repetitive, tedious task with ease, and speed: allowing for faster cycle times and accuracy in comparison to human counterparts. The consistent output along with its quality and repeatability are unmatched. Industrial robots are machines that are used in the industry, and they are usually automatically controlled and reprogrammable. They can be used in three or more axes, which makes them versatile and able to do a variety of tasks. The design of the robot was determined by the cylinder specifications and weight requirements of the robot. In the industrial manufacturing sector, pick and place robots have been used in a variety of material-handling applications ranging from palletizing and depalletizing, case picking, bin picking, kitting, machine loading and unloading, parts feeding, and parts delivery. Such robots with improvements have also been used in storage/ retrieval systems and case packing and sorting.

1.1 Methodology

The project entails the design, construction, and pneumatic circuitry of a 3-DOF robot. This design served as the inspiration for the robot's fundamental mechanics. Following pneumatic cylinder selection, the required link lengths were determined and made using carbon steel bars. The final design of the robot is as follows. The design of the robot underwent significant changes throughout the assembly.

1.2 System Description

The project consists of the design, and building of a 3-DOF robot, the pneumatic circuits..

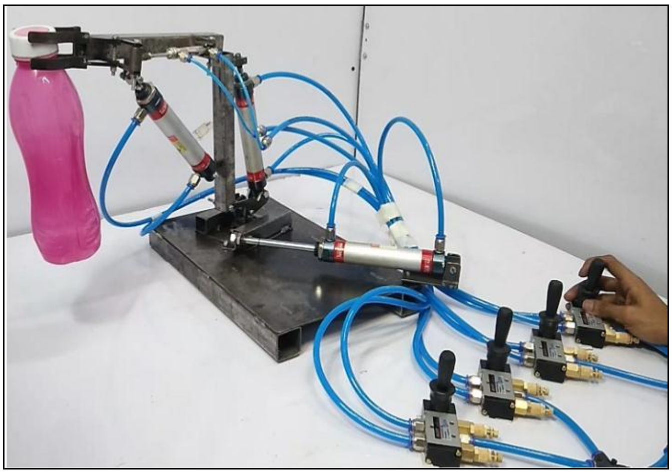

Fig No:- 1 System

2. Selection of Material

2.1. Material Selection for Frame

Function- To support the load

Objective-To reduce the Weight

Constraint- Forces, and Length

Variable-Size and material selection

2.2. CAD Design

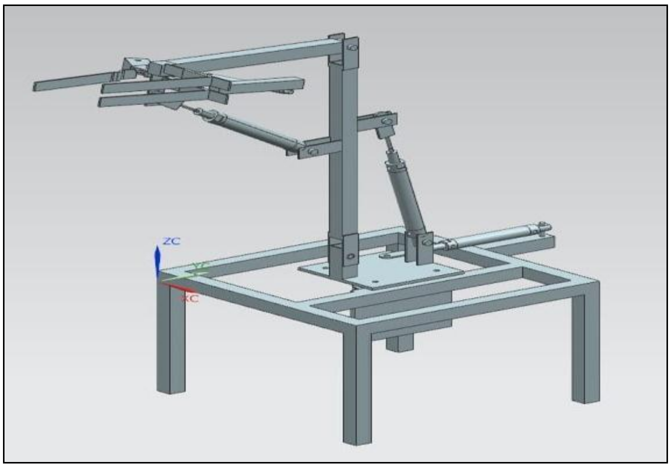

Fig -2: CAD Design

2.3. Working

As Pneumatic air is the main source for working of the project. The main air source will be supplied to the power pack of the project which includes 4 no. of 5/2 hand-operated valves.

The first 5/2 Valve given for rotation of all the links means all links assembly will be rotated towards the stroke length of the first cylinder.

The second 5/2 Valve is given for taking moment against the central pivot point and it is placed at some distance from the central arm which is vertical.

Third 5/2 Valve given for taking moment against inclined not perfect horizontal but given lengthwise moment to up and down.

Fourth 5/2 Valve given for taking fork moment.

3. Force Analysis

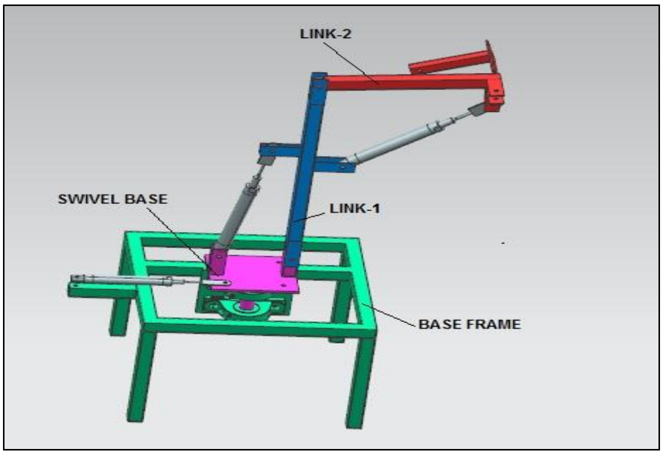

Fig -3: Design Analysis

3.1. Force Analysis of Link-2

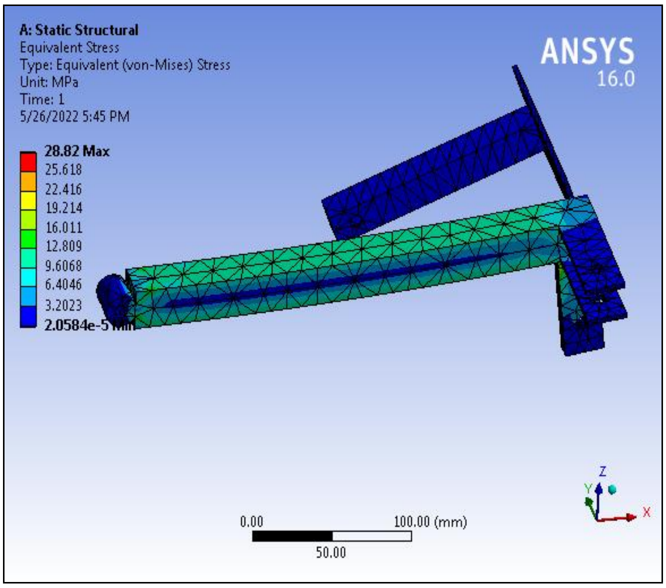

Fig -4: Link 2

The analytical stress is 28.82 MPa thereby suggesting that the design of link-2 is safe under a given system of forces.

3.1.1. Deformation

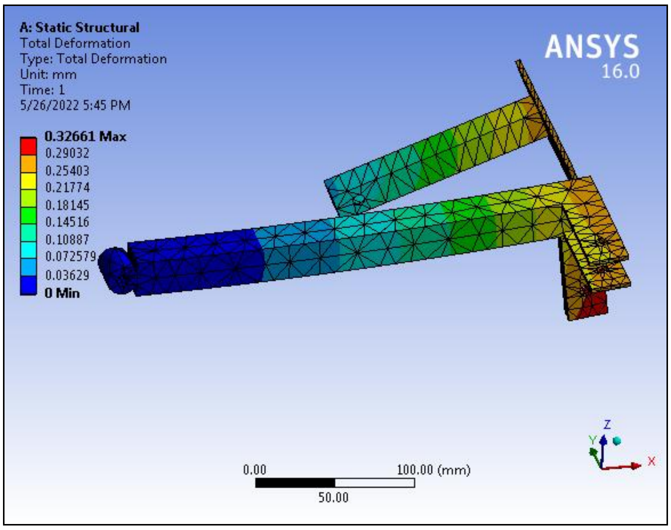

Fig -5: Deformation of Link 2

The maximum deformation is 0.32661 mm which is very negligible hence the link-2 is safe under a given system of forces.

3.2. Link-1

Von-Mises Stresses

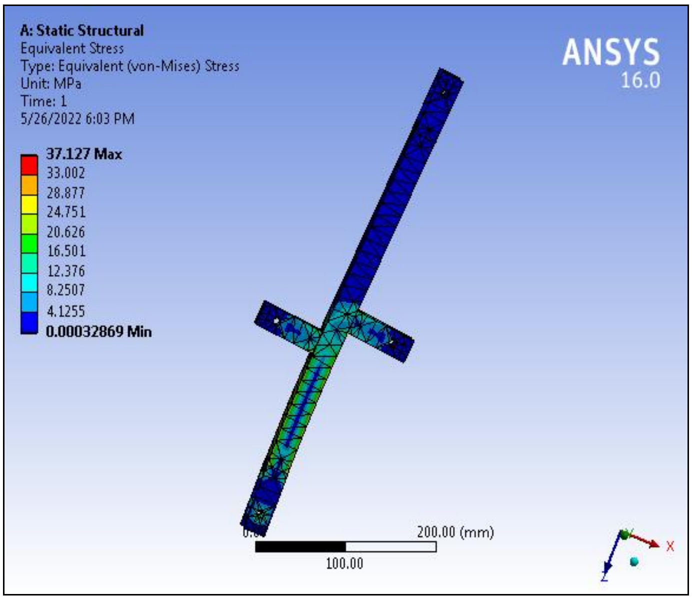

Fig -4: Link 1

The analytical stress is 37.127 MPa thereby suggesting that the design of link-1 is safe under a given system of forces.

3.2.1. Deformation

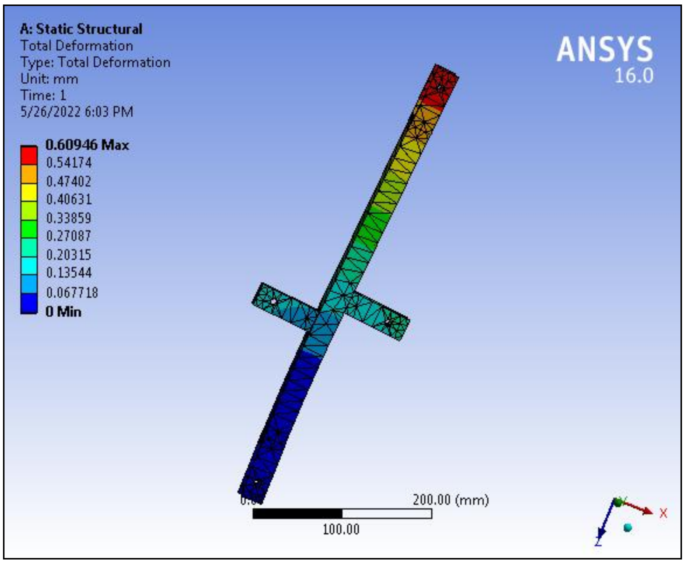

Fig -5: Deformation of Link 1

The maximum deformation is 0.609 mm which is very negligible hence the link-1 is safe under a given system of forces.

3.3. Swivel Base

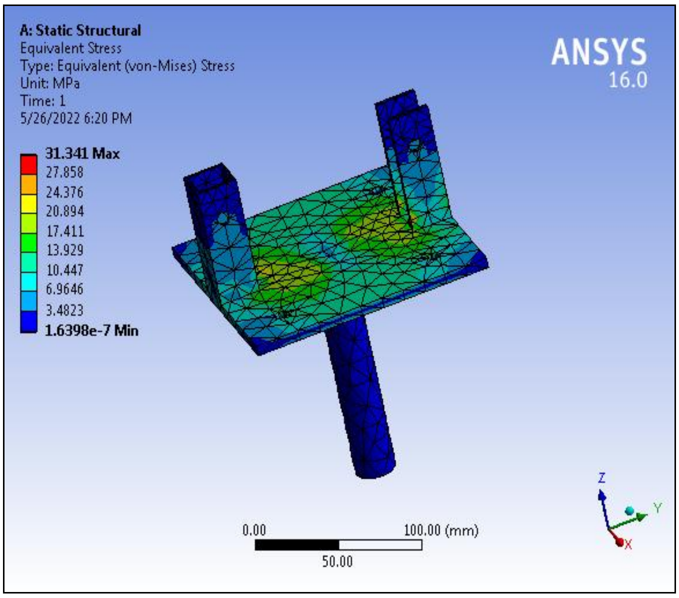

Fig -6: Swivel Base

The analytical stress is 31.341 MPa thereby suggesting that the design of the Swivel base is safe under a given system of forces.

3.3.1. Deformation of Swivel Base

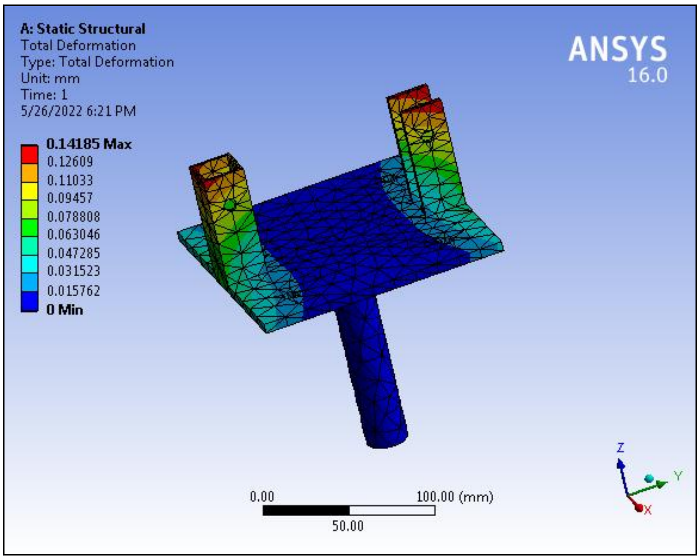

Fig -7: Deformation of Swivel Base

The maximum deformation is 0.14185 mm which is very negligible hence the Swivel base is safe under a given system of forces.

3.4 Base Frame

Von-mises Stresses:

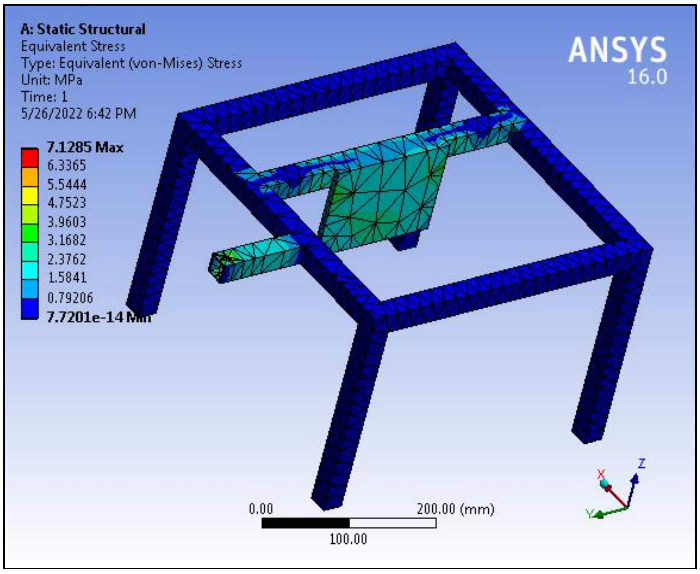

Fig -8: Base Frame

The analytical stress is 7.1785 MPa thereby suggesting that the design of the Base Frame is safe under a given system of forces.

3.4.1. Deformation of Frame

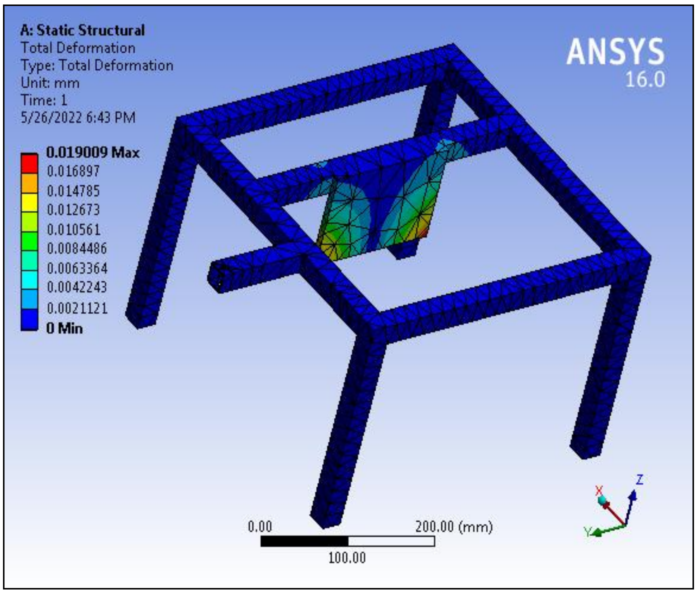

Fig -9: Deformation of Frame

The maximum deformation is 0.019 mm which is very negligible hence the base frame is safe under a given system of forces.

3. CONCLUSION

The system works well till 12 kg but fails at 13 kg. The analytical stress is 37.127 MPa thereby suggesting that the design of link-1 is safe under a given system of forces. The maximum deformation is 0.609 mm which is very negligible hence the link-1 is safe under a given system of forces. The analytical stress is 28.82 MPa thereby suggesting that the design of link-2 is safe under a given system of forces. The maximum deformation is 0.32661 mm which is very negligible hence the link-2 is safe under a given system of forces. The analytical stress is 31.341 MPa thereby suggesting that the design of the Swivel base is safe under a given system of forces. The maximum deformation is 0.14185 mm which is very negligible hence the Swivel base is safe under the given system of forces.

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REFERENCES

[1] Nishigandha Patel1, Vaibhav Ahuja1, Shaunak Hedaoo1, Tushar Rotti1, A Review Paper on the Pick and Place Robotic Arm, IRJET Volume 08|02, February 2021.

[2] Automation of Mobile Pick and Place Robotic System for Small Food Industry, IEEE 2012. Mir Sajjad Hussain Talpur and Murtaza Hussain Shaikh.

[3] Design and Implementation of Multi-Handling Pick and Place Robotic Arm by S.Premkumar, K. Surya Varman, and R. Balamurugan, IJETT March 2016.

[4] Pick and Place Robotic ARM Using PLC, Abhiraj Bhalerao, Prasad Doifode, Kunal Chopade, and Jitendra Gaikwad, IJERT August 2019.

[5] S. Mohanavelan, M. Madhan Kumar, K. Mohanprabhu, M. Narendhiran4, B. Om Adhavan, Design and Analysis of Pick and Place Robot, IJESC 2019.

[6] Dr.T. Sunil Kumar, K. Sarath, Sd.Famil, A.V.S.Bhagyesh and Sk.Althaf, Design, and fabrication of pick and place robotic arm, ResearchGate August 2020.