WWW.IJRPR.COM

**International Journal of Research Publication and Reviews**

Journal homepage: www.ijrpr.com ISSN 2582-7421

# Automation of Special Purpose Rolling and Cutting Machine in Industry

***[1]Shambhuraje Ghorpade, [2]Rohit Jadhav, [3]Rushikesh Muley, [4]Sumit Sharma, [5]Dr.Sachin Jambhale, [6]Vipin Vibhute***

[1,2,3,4]Department of Mechanical Engineering, D Y Patil College of Engineering, Akurdi-44, Pune, India
[5]Asst. Professor, Department of Mechanical Engineering, D Y Patil College of Engineering, Akurdi-44, Pune, India
[6]Asst. Professor, Department of Instrumentation and Control, D Y Patil College of Engineering, Akurdi-44, Pune, India

**ABSTRACT.**

The manufacturing industry heavily relies on sheet metal rolling and cutting machines for various applications. Traditional operation methods involve skilled workers, but the emergence of automation technology has introduced the possibility of unmanned operation. This research paper presents the development of a fully automated sheet metal rolling and cutting machine to address the limitations of the current process. The proposed machine aims to achieve higher accuracy, reduce material wastage, enhance machining time, and improve job reproducibility. Through the utilization of CAD software, simulation analysis, and the integration of automation components, this project successfully eliminates the need for an operator, providing cost-saving benefits and increased competitiveness for Sharada Industries.

***Keywords***- Automation, Higher accuracy, Simulation analysis, Competitiveness.

## 1. Introduction

The manufacturing industry relies on sheet metal rolling and cutting machines for various applications, contributing to the production of diverse products [1]. However, traditional methods involving skilled workers are associated with drawbacks that compromise accuracy, increase material wastage, prolong machining time, and hinder job reproducibility [2]. The advent of automation technology offers an opportunity to address these limitations and enhance manufacturing efficiency.

Primary objectives are, to reduce human involvement, operation time, avoid human errors [3,4].

Sharada Industries, located in MIDC Bhosari, Pune, currently utilizes a semi-automatic sheet metal rolling and cutting machine. The reliance on a fixed operator salary, coupled with human error, increased material wastage, slow machining time, and reduced job reproducibility, places unnecessary cost burdens on the company and affects its competitiveness in the market.

The objective of this project is to identify the drawbacks of the current process and propose an optimal solution utilizing the latest automation technologies. The proposed solution should be economically feasible, offer high accuracy, reduce material wastage, enhance machining time, and improve job reproducibility [5,6].

## 2. Constructional details

### *2.1. Job Supporting Table*

The table is a functional and robust supporting structure for cut jobs, made with mild steel and sheet metal and designed in a way that uses gravity for easy job movement. Its innovative design ensures easy directing of jobs towards the collecting tray, making it ideal for manufacturing and production facilities

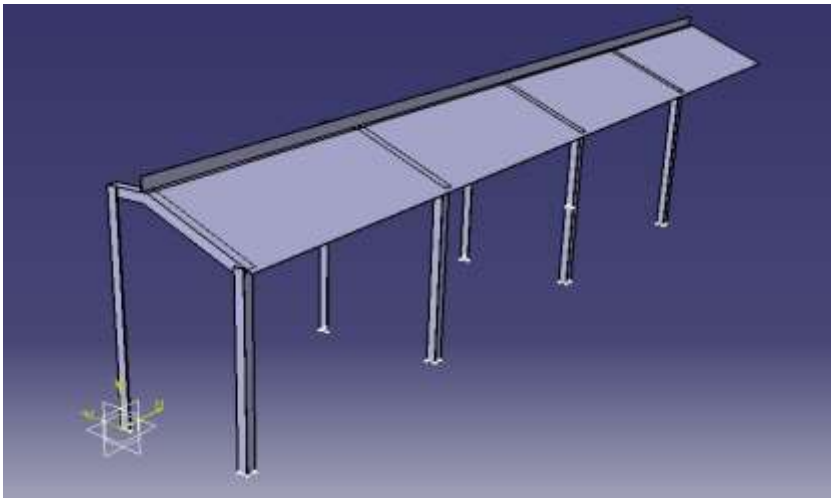

Fig.1 (a) Isometric View

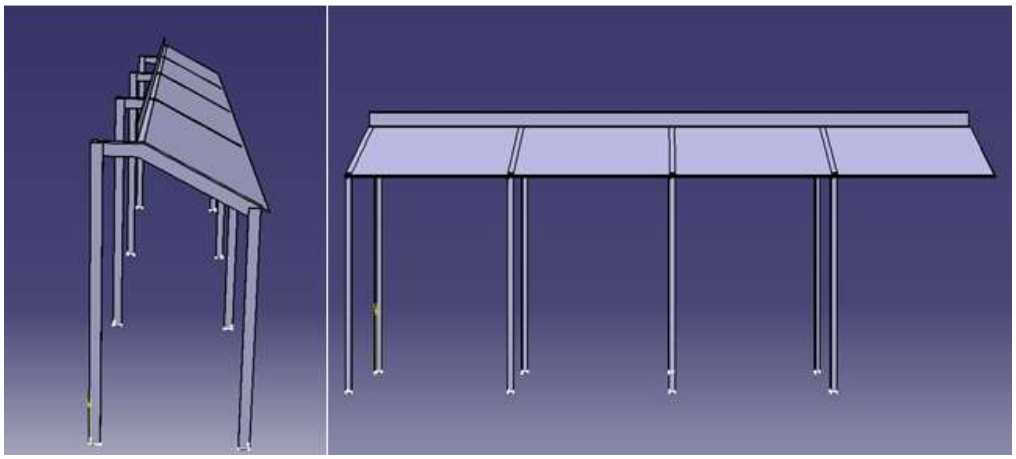

Fig.1 (b) Side View

Fig.1 (c) Front View

### *2.2. Job collection rack:*

The job collection rack is a highly efficient storage solution for finished jobs, designed with high-quality MS hollow square tubing and Creo 3D modeling software. Its unique triangular structure and sliding mechanism ensure secure and smooth movement of jobs, maximizing storage capacity and providing easy access.

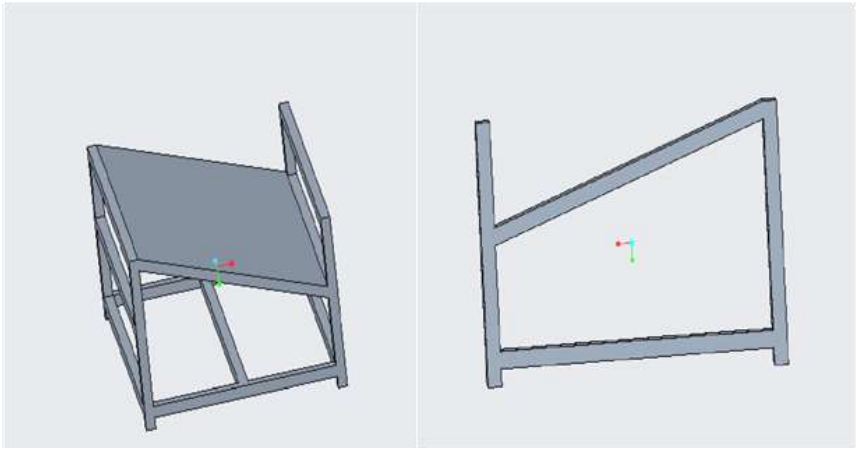

Fig.2 (a) Isometric View

Fig.2 (b) Side View

### *2.3. PLC (Programmable Logic Controller):*

The SIPLUS LOGO! 230RCE PLC from Siemens is a high-performance controller that monitors and records data, automates processes, and generates alarms in harsh industrial environments. It's a ruggedized computer and an essential component of industrial automation capable of automating specific processes, machines, or entire production lines.

### *2.4. Contractors:*

L&T Contactor ML3 and Siemens Air Break Contactor 3TF32 00-0A are essential components in PLC automation used to control electrical circuits. They handle high currents and voltages and provide reliable switching for heavy-duty industrial and commercial applications. Their durability and reliability make them ideal for use in PLC-controlled systems.

### *2.5. Relay Switches:*

The PLA 2C/O-MPC 240A-5 and PLA MPC-3C 240A 5A-L relays are commonly used in PLC

automation systems to control high currents in industrial machinery. These relays can be used to control the motor and blade in an automatic rolling and cutting machine. The relays have a high switching capacity and low coil power consumption, making them ideal for use in PLCs. PLCs can easily control the on/off state of these relays using digital outputs, allowing for precise and reliable control of the machine.

### *2.6. Push buttons:*

Push buttons are an input device used in automation systems to provide manual control. Green push buttons are likely used to start/stop the machine or control other functions. The "NO" element refers to a Normally Open contact used in conjunction with the push buttons. Normally Open contacts ensure the machine doesn't operate accidentally, preventing safety hazards.

### *2.7. LED Indicators:*

LED indicators provide visual feedback on the status of automation systems. Red indicates an error or alarm, green indicates normal operation, blue indicates a specific function or mode, and yellow indicates standby or waiting state. They allow for efficient monitoring and control by operators.

### *2.8. PLC Cabin:*

A PLC cabinet is an enclosure used to house PLCs and related components in industrial control systems. It provides a safe and secure environment, protecting the PLC from environmental factors. Cabinets may have cooling systems and be wall or floor-mounted. They ensure efficient and safe operation of the system.

### *2.9. Wires, Lugs, Ferrules:*

Wires, lugs, and ferrules are essential components used in automation systems to establish reliable and secure electrical connections between components. Lugs provide a secure connection between the wire and the terminal block or other components. Ferrules terminate stranded wires and prevent fraying of wire strands.

These components are used to minimize the risk of electrical faults and failures that may cause system malfunctions. Their usage ensures reliable and efficient operation of the automation system, making them a critical part of the overall design.

### *2.10. Process Chart*

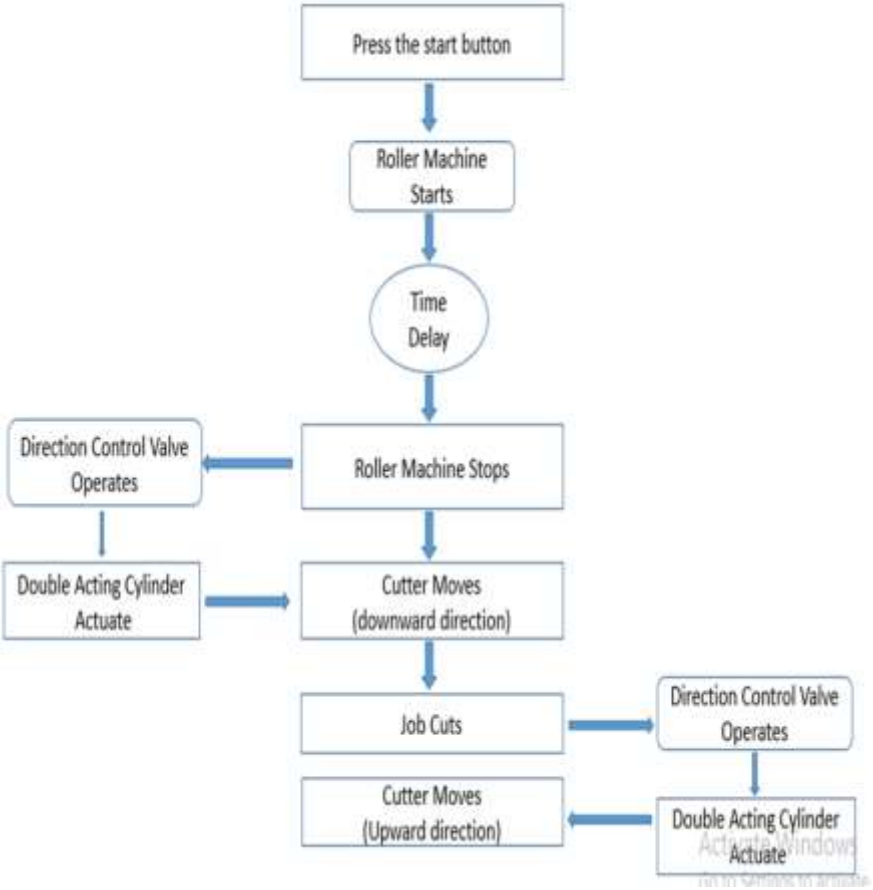


Fig.3. Process Chart

## 3. Analysis of Current Process

Limitations of the Semi-Automatic System An analysis of the current semi-automatic sheet metal rolling and cutting machine reveals issues related to operator dependence, compromised accuracy, increased material wastage, prolonged machining time, and limited job reproducibility. These limitations impact the overall productivity and cost-efficiency of Sharada Industries.

Impact on Accuracy, Material Wastage, Machining Time, and Job Reproducibility The dependence on human operators introduces the potential for errors, resulting in reduced accuracy. Additionally, manual intervention increases material wastage due to imprecise cutting and rolling. The slower machining time affects the overall production rate, and the lack of job reproducibility hinders efficient scheduling and planning.

## 4. Proposed Solution

Overview of the Fully Automated Sheet Metal Rolling and Cutting Machine To overcome the limitations of the current process, a fully automated sheet metal rolling and cutting machine is proposed. The automated system eliminates the need for an operator by incorporating advanced automation technologies.

Selection of Automation Technologies Automation technologies such as Programmable Logic Controllers (PLCs), solenoid valves, laser object-detecting sensors, and limit switches are chosen to achieve full automation. These technologies enable precise control, accurate measurements, and efficient material handling.

Design and Fabrication of Components CAD software, including ANSYS, Creo, and CATIA, is utilized to design and fabricate the necessary components for the automated system. The job collecting tray and table are designed based on the standard dimensions specified by Sharada Industries.

Integration of Automation System The automation components are seamlessly integrated into the sheet metal rolling and cutting machine. The PLCs, sensors, and switches enable autonomous operation, ensuring accurate and efficient cutting and rolling processes.

## 5. CAD Software Utilization

ANSYS for Loading and Testing Analysis ANSYS software is employed for loading and testing analysis to validate the design. Through simulation and calculation, the structural integrity, performance, and functionality of the automated machine are assessed. This analysis ensures that the components can withstand the applied loads and operate effectively under different scenarios.

Simulation and Calculation for Supporting Validation In addition to ANSYS, simulation and calculation techniques are utilized to further validate the proposed design. This involves simulating the cutting and rolling processes, evaluating the accuracy of measurements, and assessing the overall efficiency of the automated system. The simulation results provide insights into the expected performance and allow for optimization before implementation.

## 6. Calculations

I. Dimensions of table

- a. Width 500 mm
- b. Length 4000mm
- c. Height 850mm and 690 mm
- d. Angle of inclination 23°

II. Dimensions of Job

- a. Width 5 mm
- b. Length < 4000 mm
- c. Thickness 2 mm
- d. Weight 2.65 kg for 4000 mm

## 7. Analysis

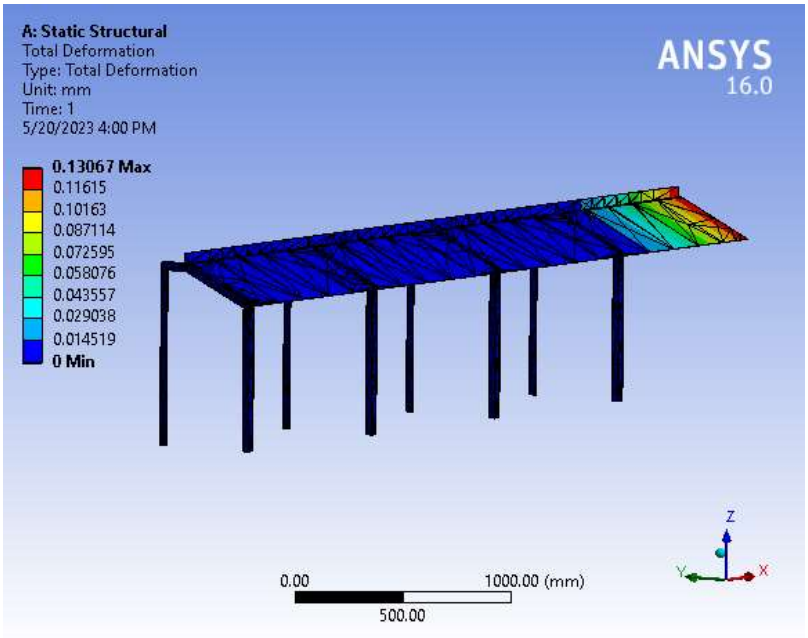


Fig.4.Total Deformation

Above figure shows the (maximum) total deformation of job supporting table is **0.13067 mm**

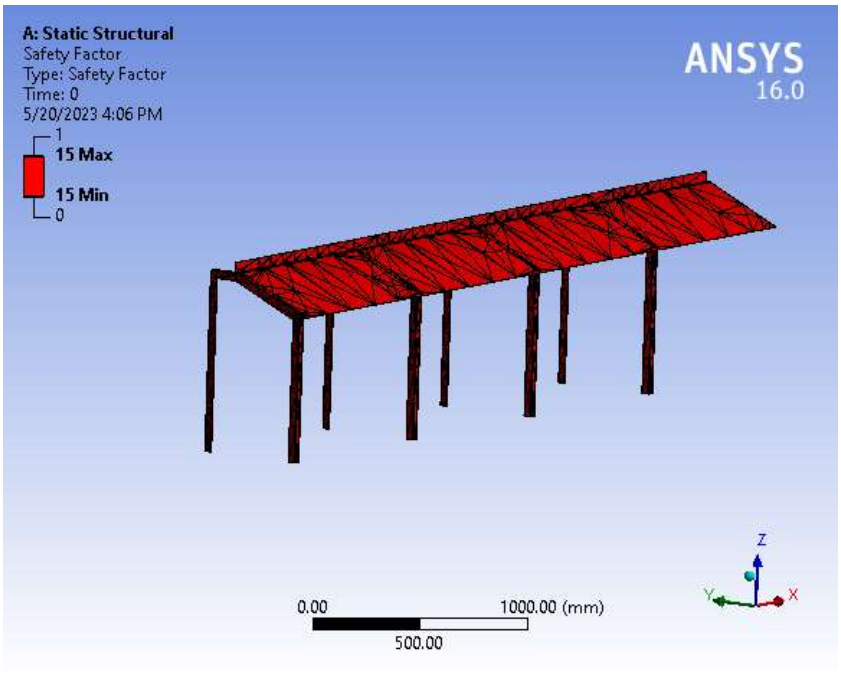


Fig.5. Safety Factor

Above figure shows the maximum Safety factor of job supporting table is 1.

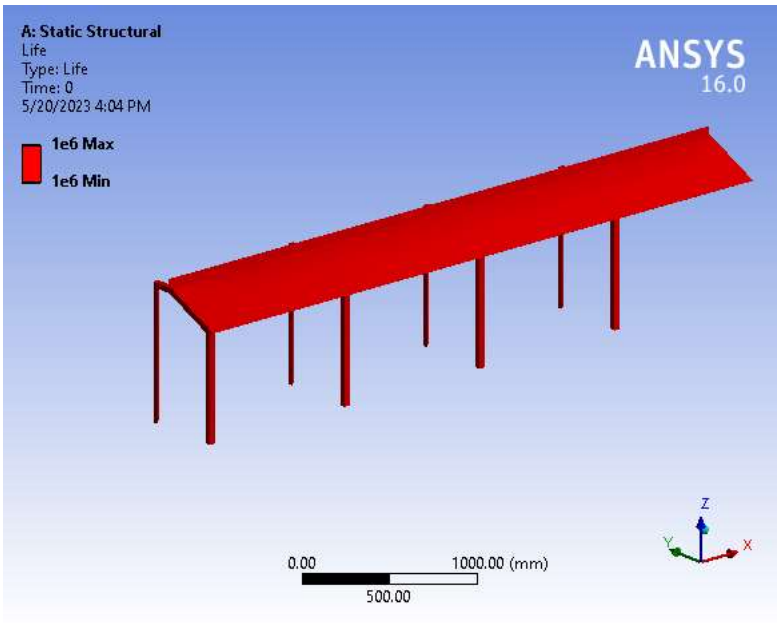


Fig.5. Life

Above figure shows the life of job supporting table is 1e 6

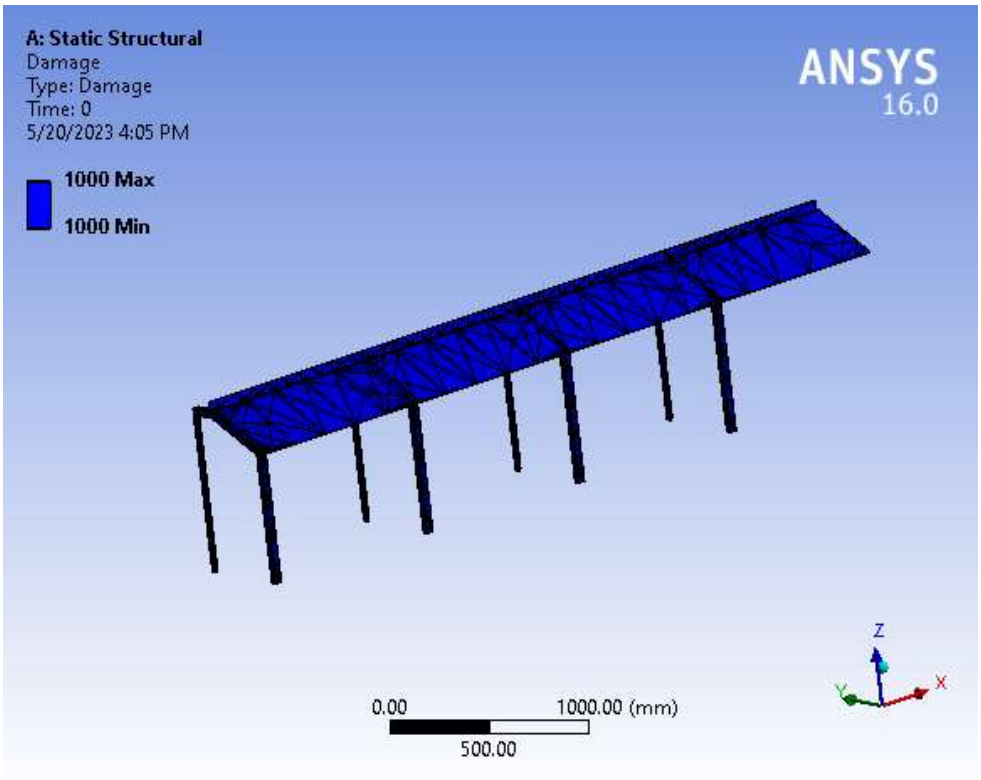


Fig.6. Damage

Above figure shows the maximum damage of job supporting table table is 1000

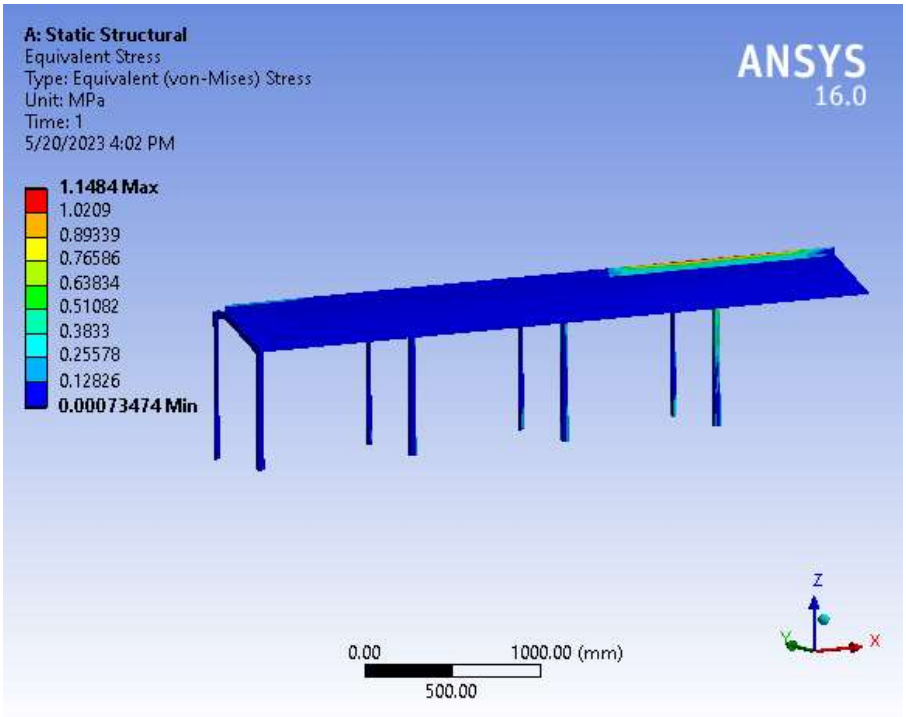


Fig.7. Equivalent Stress

Above figure shows the maximum equivalent stress of job supporting table is 1.1484 Mpa

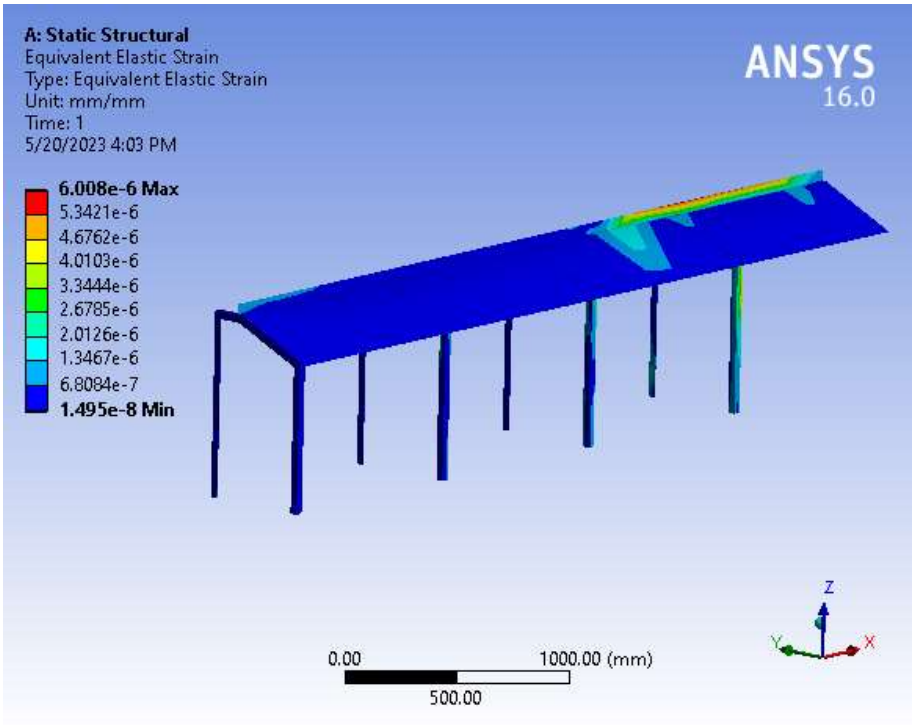


Fig.8. Equivalent Elastic Strain

Above figure shows the maximum equivalent elastic strain of job supporting table is 6.008e-6

## 8. Results and Discussion

Successful Integration of Automation System The developed automation system is successfully integrated into the sheet metal rolling and cutting machine. The operator's role is eliminated, and the machine operates autonomously, leading to reduced dependency on human intervention.

Elimination of Operator Requirement By removing the need for an operator, Sharada Industries can significantly reduce labor costs and eliminate the potential for human errors. The fully automated machine ensures consistent and accurate operations, improving overall product quality.

Benefits in Accuracy, Material Wastage, Machining Time, and Job Reproducibility The automated machine offers higher accuracy in cutting and rolling processes, minimizing material wastage and improving material utilization. The precise control and measurements provided by the automation system also lead to shorter machining time, enhancing productivity. Furthermore, job reproducibility is improved, enabling efficient scheduling and planning of production tasks.

Cost Reduction and Enhanced Competitiveness for Sharada Industries Implementing the fully automated sheet metal rolling and cutting machine results in cost savings for Sharada Industries. The elimination of the operator's salary, reduced material wastage, improved efficiency, and increased productivity contribute to overall cost reduction. This enhanced cost-effectiveness enables the company to remain competitive in the market and potentially explore new business opportunities.

## 9. Conclusion

Summary of Achieved Objectives The development of a fully automated sheet metal rolling and cutting machine successfully addresses the limitations of the current semi-automatic process. The project achieves the objectives of improving accuracy, reducing material wastage, enhancing machining time, and improving job reproducibility.

Significance of Technological Advancement The adoption of the latest automation technologies in the manufacturing industry presents significant benefits. The fully automated machine enhances operational efficiency, reduces costs, and improves product quality, contributing to the overall competitiveness of companies.

Implications for the Manufacturing Industry The successful implementation of a fully automated sheet metal rolling and cutting machine at Sharada Industries showcases the potential of automation in the manufacturing industry. This project highlights the need for companies to embrace automation technologies to optimize their processes, remain competitive, and adapt to the changing market dynamics.

## 10. Future Direction

Potential Enhancements and Upgrades Continued research and development can focus on further enhancing the automation system. This may involve integrating advanced sensing technologies, machine learning algorithms for adaptive control, and real-time monitoring for predictive maintenance.

Integration of Additional Automation Technologies Exploring the integration of other automation technologies, such as robotic material handling and computer vision systems, can further streamline the sheet metal rolling and cutting processes. This integration can lead to increased efficiency, accuracy, and flexibility in manufacturing operations.

Implications for the Workforce and Skilled Workers The advancement of automation technologies raises concerns about the impact on the workforce. Companies need to consider providing re-skilling and upskilling opportunities for employees affected by automation, ensuring a smooth transition and continued utilization of their skills in other areas of production.

**11. References**


1. Arunkumar Gopal,Lakshmi Sankar : Design and development of automatic sheet metal cutting machine
2. Michael Foster George Fox University: In this paper author discussed about introductory information about PLCs
3. Muthu Siva Bharatha, Arunkumar Gopal: Author discuss about the application of automation in a field of sheet metal industries where they give detail component information used in the automation such as Actuators, Arduino, Sensors etc.
4. Bryan Wilcox, Harry Dankowicz: In this paper author discuss Limit-switch sensors are input-output devices that switch operating state in reaction to the crossing of a threshold value of their input.
5. Abhishek Gaonkar et al, International Journal of Research in Engineering and Technology, IJERT Publishers,2015, pp. 652-658.
6. Montmitonnet P (2006) Hot and cold strip rolling processes. Comput Methods Appl Mech Eng 195(48):6604–6625.