International Journal of Research Publication and Reviews

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

DESIGN AND DEVELOPMENT OF AUTOMATED SCREW JACK

Atharv V. Jadhav[1], Aditya R. Sharma[2], Yash R. Gopale[3], Prof. Swapnil Mane[4]

[1]Student, Department of Mechanical Engineering, Vidyavardhini's College of Engineering and Technology, Vasai, Maharashtra, India, [email: jatharva36@gmail.com] [phone: +918291226206]

[2]Student, Department of Mechanical Engineering, Vidyavardhini's College of Engineering and Technology, Vasai, Maharashtra, India, [email: aditya.sharma.r07@gmail.com] [phone: +919324397192]

[3]Student, Department of Mechanical Engineering, Vidyavardhini's College of Engineering and Technology, Vasai, Maharashtra, India, [email: yashgopale90@gmail.com] [phone: +919372940184]

[4]Professor, Department of Mechanical Engineering, Vidyavardhini's College of Engineering and Technology, Vasai, Maharashtra, India, [email: swapnil.mane@vcet.edu.in] [phone: +919860170151]

ABSTRACT :

The goal of the project is to improve efficiency and user-friendliness in a variety of industrial applications through the design and development of an automated screw jack system. The investigation starts with a review of the current screw jack systems, noting drawbacks such poor speed and manual operation. The suggested method incorporates automation technologies to address these problems and improve operational efficiency.

The load-bearing frame, control unit, and motor-driven mechanism are essential parts of the automated screw jack. By replacing manual cranking with a motorized system, lifting and lowering operations may be precisely controlled. Furthermore, precision and safety during operation are guaranteed by the integration of sensors and feedback devices. The control unit controls all of the system's functions, making it possible for users to operate the system easily and change its parameters as needed.

To maximize performance and dependability, the design process included conceptualization, prototyping, and iterative testing. A variety of materials and production processes were investigated in an effort to strike a balance between cost, weight, and strength. To improve long-term usability, durability and maintenance considerations were included. Comparing experimental results to conventional screw jack systems, it is clear that there have been major advancements in speed, accuracy, and user ease. The automated screw jack exhibits versatility and adaptability to a range of industrial environments. Potential avenues for further research include remote operation and integration with smart manufacturing systems, which could yield real gains in terms of use, safety, and efficiency.

***Key Words*:** [automation], [efficiency], [user-friendliness], [conceptualization], [prototyping]

INTRODUCTION :

Electronic screw jacks are a major breakthrough in mechanical engineering, giving the industry easy access and more accurate ways of lifting super heavy structures. They are unique in comparison with the conventional hand-driven screw jacks because these systems utilize power of electricity to push the screws and therefore such drive mechanism could replace the human effort and enhance productivity and boost the efficiency. This type of jacks that provide automation integration help in monitoring and controlling lifting processes making them precise, adjustable, efficient and easy with minimal human interference. Furthermore, they come with advanced safety functions including overload protection and emergency shut-off, so the chances of mechanical failure within the material and fatigue to the staff, both can be avoided in such situations. Moreover, pre-failure conditions can be also determined and accidents can be anticipated pre-maturely. Their multi-faceted nature ensures they cannot be competed with and can prove to be unreplaceable in all sectors such as automation lines to construction sites and automobile industries where heavy lifting is experienced on a regular basis. The focus of this paper is on the exploration of design principles, performance characteristics, advantages/disadvantages and applications of automated/electric screw jacks, in the purpose of adding to the accumulative communications of engineering knowledge, industry applications and serving to inform the decisions on their efficient adoption.

MECHANICAL SCREW JACK :

Mechanical screw jacks are very simple and widely used tools for lifting heavy structures and goods in various industries, pre-dominantly in automobile industries. They consist of screw and shaft mechanism with are threaded and a nut that moves along the threaded path. A handling mechanism is provided so that the steering/controlling the movement and direction of the screw jack becomes possible. By turning the handle, the screw rotates and transfers the motion to the nut, causing it to move up and down. As these types of jacks are manually operated, they require considerable human strength to lift the load. The heavier the load, the greater amount of effort will be required to lift it. Apart from having slower speed from their hydraulic/pneumatic rivals, they do offer the luxury of simplicity and cost-effectiveness to the consumer. Additionally, they can be used in wide range of lifting tasks throughout various domains of the industry.

TRANSITION TO ELECTRIC SCREW JACKS (3)

The transition from mechanical to electrical marks a special tribute to automation, which is one of the main pillars of industry 4.0 fundamentals. The characteristics of enhanced efficiency, user-friendliness, and convenient aura get integrated into the screw jack by adapting to the industry 4.0 standards. Since, electric screw jacks are equipped with an electric motor, the need for human effort is eliminated to a great extent. Time cutting and rebooting flaws can be also easily achieved by comprehending automation in this transition. With the push of a button which requires negligible effort to a human, lifting and de-lifting tasks can be performed at maximum efficiency. In case of an amateur operator or a female practitioner, it was found that in maximum cases, they were not able to comprehend the effort required to operate the mechanical jack and therefore they encountered various difficulties and achieved success at the cost of time. Therefore, motivated by industry 4.0 principles and with an aim to automatize the industries starting from domestic level, we bring upfront, Design and Development of Automated Screw Jack. (3)

ADVANTAGES OF AUTOMATED SCREW JACK

1. Efficient and precise lifting capabilities.
2. Automation and control features.
3. Enhanced safety mechanisms.
4. Versatility and Adaptability.
5. Industrial use at domestic scale.
6. Increased efficiency.
7. Less effect of friction.
8. Advanced safety features.

CONCEPT MECHANISM (4)

The threaded screw is the central component of the mechanism. It is also known as the lifting screw. Corresponding to the screw, we also have a matching nut. The screw is designed with helical grooves (threads) on its surface and the nut has corresponding threads that engage with the screw. An electric motor is used to provide the rotary motion required to turn the screw. The motor has a gearbox that will allow and facilitate smooth torque manipulation. As the motor turns, it rotates the screw. Due to this co-relation, the rotary motion is converted into linear motion along the length of the screw. A capacitor is used so that the direction can be reversed and controlled as per the operator's will. The nut is connected to a loading platform like actuator. The structure to be lifted will be placed on this loading platform. As the nut moves, it will carry the load along with it, allowing direction control in vertical axis. Additionally, a portable support frame is also used for support and guidance.

METHODOLOGY (5)

1. Setting up the domain by specifying parameters such as load capacity, lifting height, speed, power source, control mechanism, safety features, and failure precautions.
2. Conducting research on existing designs, critical evaluation on existing design, determining flaws in it and how to improve them.
3. Selection of components for best possible mechanism in terms of efficiency.
4. Design using CAD (computer-aided-drafting). [software used – SolidWorks]
5. Selection and Integration of electronic components such as sensors, actuators, capacitors, gearboxes, controllers, etc.
6. Integration of mechanical and electrical components.
7. Automation in micro-controllers using Programmable Logic Controllers (PLC) for feedback and speed control.
8. Testing of the Prototype.
9. Documentation, Certification and Billing.
10. Induction at maximum efficiency and maintenance.

Design and Development

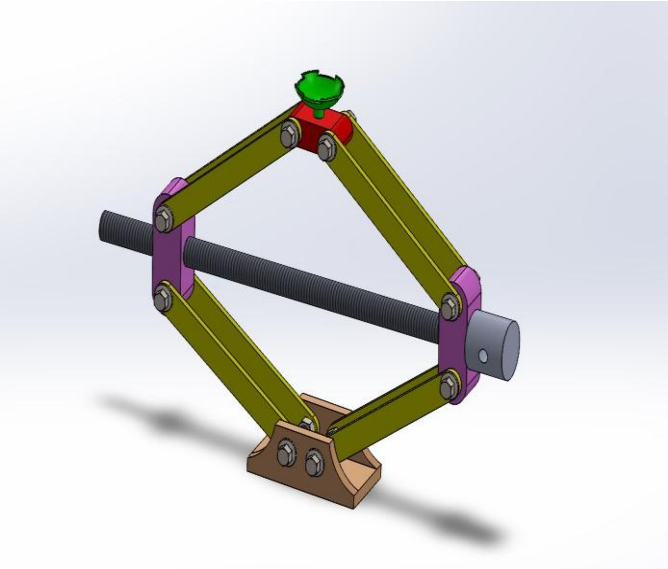


Fig 1.0 Assembly [isometric view]

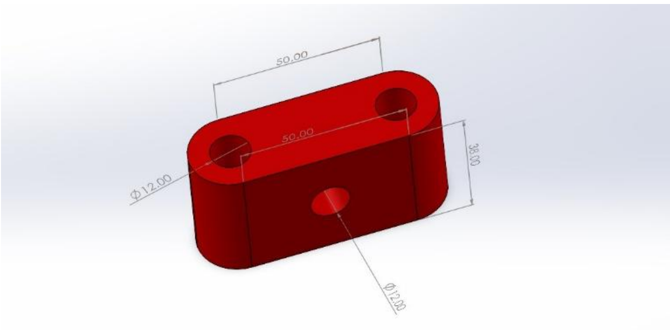


Fig 1.1 [Top support]

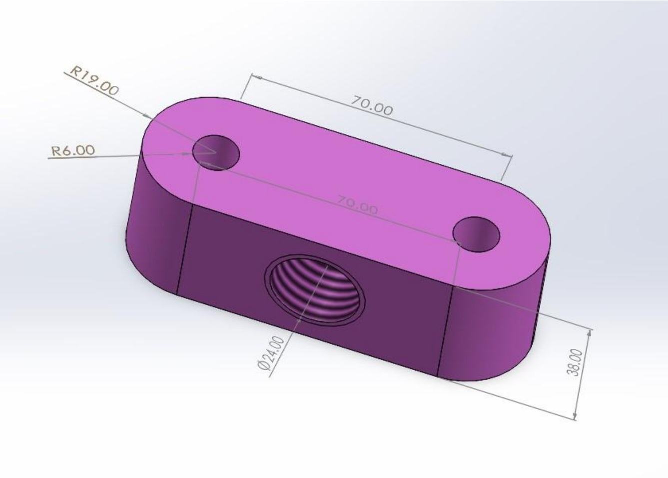


Fig 1.3 [Hinges]

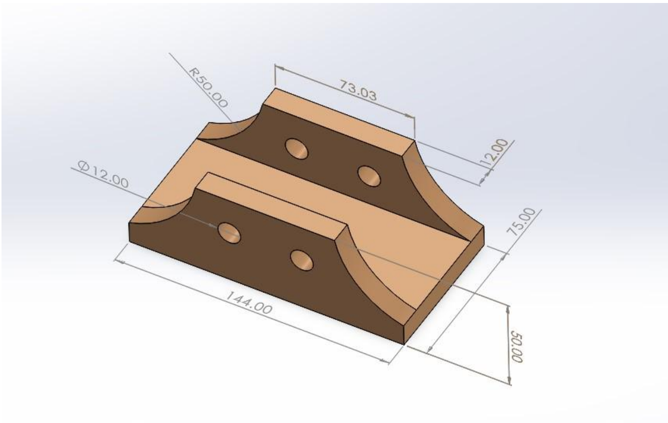


Fig 1.4 [Base support]

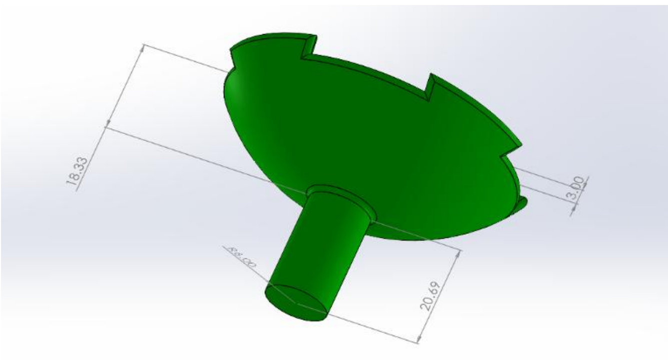


Fig 1.4 [Lifter]

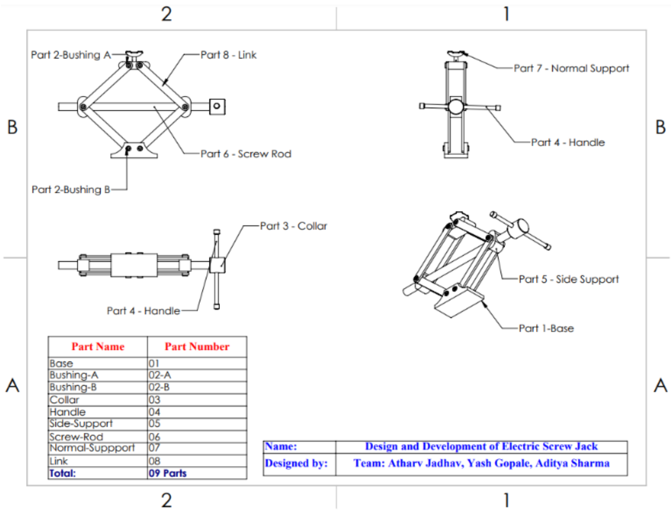


Fig 1.5 [Sheet]

Material Bill	
Base	01
Bushing	06
Collar	03
Handle	01
Side-Support	02
Screw-Rod	01
Normal-Support	01
Link	04
Total:	19

Table 1 – Material Bill

LOADING AND STRESS (6)

For each one second, corresponding to the rated power of the motor, the screw jack will lift 1 Kilo-Newton of weight. Beyond 30 Kilo-Newton, breaking stress point will be reached and the structure would tend to fail at any moment. At 30 Kilo-Newton of weight, the jack will start to experience maximum stress conditions and therefore to work within safe stress limits, at rated power, a maximum of only 25 Kilo-Newton of weight can be lifted. To increase the weight lifting capacity of the jack, a high rated power motor can be used.

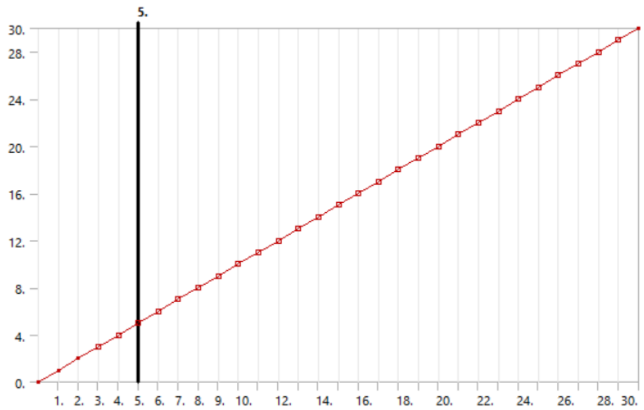
Time [sec]	Force [KN]
1	1
2	2
3	3
4	4
5	5

6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30

Table 2 – Time vs Force

The graph below shows the relation between the Force applied and Time taken. It represents the linearity and uniformity of force applied per second of time. Due to this uniformity, a straight line can be observed passing through points recorded at every second up to 30 seconds. The X-axis represents the time and the Y-axis represents the force.

Note*: The above calculations are done using Ansys Mechanical APDL software.



Graph 1 – Force vs Time

CONCLUSIONS :

In conclusion, the Automated Screw Jack built as per the industry 4.0 principles and vision offers highly relevant advantages over the ones that already exist in the market. Additionally, some of the characteristics in the existing model are also catalyzed for example precise control, higher load capacity, enhanced safety features, increased efficiency, etc. Their integration with automation and industry 4.0 vision and characteristics gives them a strong foothold as a debutant in the current market. Apart from the catalyzed existing characteristics, the automated screw jack comes with certain new characteristics such as improved productivity, lesser maintenance and quieter operation. This gives them preference over the ones already existing in the market. As technology continues to evolve, the automated screw jack will play a vital role in leading the lifting accessory market and advancing automation in diverse industry domains.

ACKNOWLEDGEMENT :

We are highly indebted to our project guide **Prof. Swapnil Mane** for giving us an opportunity to work under his guidance. Like a true mentor, he motivated and inspired us through the entire duration of our work. We express our gratitude towards our Head of Department **Dr. Uday Asolekar** for his support throughout the project work.

We are also grateful to the Mechanical Department for assisting us and guiding us throughout the project. We also extend our thanks to the supportive staff of Mechanical Department for providing us all the necessary facilities to accomplish this project. Last but not the least, we express our profound gratitude to the almighty and our parents for their blessings and support without which this task could have never been accomplished.

REFERENCES :

1. De Simone et al., 2022
2. “Retraction: Design and Manufacturing of Internet of Things Based Mobile Application Controlled Automobile Screw Jack (IOP Conf. Ser.: Mater. Sci. Eng. 1145 012030),” 2021)
3. Ezurike & Okwu, 2017
4. Singh & Mishra, 2015
5. Patel et al., 2013