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Fabrication & Development of Ergonomically Designed Cylinder Lift

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Abstract: The fabrication and development of an ergonomically designed cylinder lift is the focus of this project report. The cylinder lift is designed to be adjustable and ergonomically friendly, with features that reduce the risk of workplace injuries caused by repetitive lifting and strain. It is designed to be durable and easy to use, with adjustable features that enable the user to set the height of the lift according to their requirements. It has the potential to improve workplace safety and efficiency by reducing the risk of injury and increasing productivity. Overall, this project report provides valuable insights into the design and development of an innovative and practical device that can improve workplace safety and productivity in a variety of industries.

Keywords: Ergonomics, Cylinder Lift, Fabrication, Development.

I. INTRODUCTION

Ergonomic cylinder lifters are devices designed to make lifting and moving heavy cylindrical objects, such as barrels or drums, safer and more comfortable for the user. They are typically used in industrial settings where large quantities of liquids or other materials need to be transported and stored in cylindrical containers. The purpose of ergonomic cylinder lifters is to reduce the risk of workplace injuries such as strains, sprains, and back injuries that can occur when lifting heavy objects. Cylinder lifters typically consist of a lifting mechanism, a handle, and wheels to make it easier to move the lifted object from one location to another. Over time, ergonomic cylinder lifters have evolved to improve their design, usability, and safety. The use of cylinders in industry dates back to the early 20th century, when compressed gases were used for welding and other industrial applications. In the 1970s and 1980s, ergonomic design was increased and the development of ergonomic cylinder lifters began. These lifters were designed to reduce the physical strain on workers and minimize the risk of injury while handling heavy cylinders. In the 1990s, more advanced lifters were developed with additional features, such as adjustable grips and a suspension system. In recent years, there has been an increased focus on the use of assistive devices and innovative solutions to improve the ergonomics of cylinder lifters. This has helped to improve the usability and effectiveness of cylinder lifters, making them an essential tool in many industrial settings.

II. LITERATURE REVIEW

Ergonomic cylinder lifters are widely used in industrial settings to transport and lift heavy cylinders, but there are concerns about their design and functionality that can lead to worker injury. Several studies have been conducted to identify the ergonomic issues associated with cylinder lifters and develop effective solutions to minimize the risk of worker injury.

One study by Johnson et al. (2018) examined the effects of different handle heights on the biomechanics of lifting a compressed gas cylinder. The study found that higher handle heights reduced the risk of injury to the lower back and shoulders, indicating the importance of adjustable handle heights in cylinder lifters.

Another study by Lee et al. (2017) evaluated the usability of cylinder lifters by assessing worker perceptions of their ease of use, comfort, and effectiveness. The study found that workers preferred cylinder lifters with a larger base and lighter weight, indicating the importance of ergonomic design in reducing worker strain.

In terms of design changes to improve cylinder lifters, a study by Kim et al. (2020) investigated the effects of adding a suspension system to a cylinder lifter to reduce the impact of shock when lifting and transporting cylinders. The study found that the suspension system significantly reduced the force exerted on the worker's hands, indicating the potential for new design solutions to improve ergonomics.

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A recent review by Kaur et al. (2021) analysed the economic and productivity benefits of implementing ergonomic cylinder lifters in industry. The review found that implementing ergonomic cylinder lifters led to reduced worker injury, improved productivity, and decreased absenteeism and turnover, resulting in significant cost savings for companies.

One study by Bao et al. (2019) analysed the impact of lifting posture on the muscle activation and joint forces during cylinder handling tasks. The results of the study revealed that the workers experienced high muscle activation and joint forces while performing these tasks, and the ergonomic design of the cylinder lifter significantly affected the muscle and joint forces exerted on the worker's body.

In terms of design changes to improve cylinder lifters, a study by Liu et al. (2021) investigated the effects of an assistive device on the ergonomics of the cylinder lifter. The study found that the device significantly reduced the physical strain and discomfort experienced by workers during cylinder handling tasks, indicating the potential for innovative solutions to improve ergonomics.

"Ergonomic assessment of a gas cylinder lifting device" by M. Zahoor, M. T. Arif, and A. Arif. This study evaluated the ergonomic design of a gas cylinder lifting device using biomechanical analysis, and concluded that the device was effective in reducing the risk of musculoskeletal disorders.

"A comparison of the effects of two ergonomic cylinder lifting devices on low back biomechanics" by J. R. Fessenden and J. F. Blangero. This study compared the effects of two different cylinder lifting devices on low back biomechanics and found that one device was more effective in reducing the risk of low back injury than the other.

"Ergonomic evaluation of a manual gas cylinder handling system" by T. J. Armstrong and K. M. Buckle. This study evaluated the ergonomic design of a manual gas cylinder handling system and found that the system increased productivity and reduced the risk of musculoskeletal disorders.

"Evaluation of ergonomic interventions to improve the manual handling of gas cylinders" by S. K. Ciriello and C. L. Snook. This study evaluated various ergonomic interventions to improve the manual handling of gas cylinders and found that the use of a lifting device and training in safe lifting techniques were effective in reducing the risk of musculoskeletal disorders.

III. CONSTRUCTION

The body of an ergonomically designed cylinder lift is made of materials such as MS sheet, MS square pipe, and so on. The cylinder lifter has a straightforward design. We used mild steel as our basis material after analysing the stresses on UTM. The ratchet tie-down is a tool for holding the cylinder body. We used a metal rope to mount the cylinder horizontally on it to tilt it 90 degrees. We built the Tri Star Castor Wheel for stair climbing by calculating the dimensions of the stairs. The castor is made of rubber for the wheels and steel for the wheel mounting. The square shaft is reciprocating to elevate the cylinder. We employed locking mechanisms such as spring catchers and squeeze locks to secure the square shaft.

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IV. WORKING

The lifter is made up of a robust frame or structure with handles or grips that the operator may hold onto while operating. When the cylinder is placed on the lower platform of the cylinder lifter, it is tied with a retched tie down gripper and simply moved wherever the worker desires. They may include features such as locking mechanisms or straps to prevent the cylinder from slipping or dropping during lifting and transport. The lifter also includes a lifting mechanism that allows the user to securely and easily raise and lower the cylinder. Tri Caster wheels are used on the cylinder lifter. This allows the operator to move the lifter and cylinder with minimal effort, lowering the danger of strain or damage from physical pushing or pulling.

V. DESIGN

Various Stresses Testing Performed on The Universal Testing Machine

1. Solid Rod (Shear Stress)

Diameter = 7 mm

∴ $A = \Pi/4 * (7)^2 = 38.48 \text{ mm}^2$

$P = 13.3 \text{ KN} = 13.3*10^3 \text{ N}$

$\tau = P/A = 13.3*10^3 / 38.48 = 345.63 \text{ N/mm}^2$

2. Hollow Steel Pipe (Compression Test)

Outer Diameter D1 = 27 mm

Inner Diameter D2 = 22 mm

∴ $A = \Pi/4 (D1^2 - D2^2) = \Pi/4 (27^2 - 22^2) = 192.42 \text{ mm}^2$

$P = 40.9 \text{ KN} = 40.9*10^3 \text{ N}$

∴ $\sigma c = P/A = 40.9*10^3 / 192.42 = 212.55 \text{ N/mm}^2$

3. Square Rod 1 (Compression Test)

Outer Side (a) = 39 mm

Inner Side (b) = 34 mm

$A = 39^2 - 34^2 = 365$ mm

$P = 170.4 \text{ KN} = 170.4*10^3 \text{ N}$

∴ $\sigma c = P/A = 170.4*10^3 / 365 = 466.85$ N/mm2

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4. Square Rod 2 (Compression Test)

Outer Side (a) = 49 mm

Inner Side (b) = 43 mm

$A = 49^2 - 43^2 = 552$ mm

$P = 149.6$ KN $= 149.6*10^3$ N

$\therefore \sigma c = P/A = 149.6*10^3 / 552 = 271.01$ N/mm2

 

5. Tri Caster Wheel

- Wheel Diameter: - 106 mm
- Wheel Width: - 40 mm
- Axle Diameter: - 20 mm
- Wheel Core: - Rubber & Cast Iron Core
- Tire: - Rubber
- Bearing Type: - Roller Bearing
- Load Capacity: - 220 lb = 113 Kg
- Temperature Range: - -40 to 180 F

R = distance between the centre of tri caster wheel and centre of the wheel.

r = radius of regular wheel.

t = thickness of holder fixes the wheel on its place on tri star wheel.

$\therefore$ a =140 mm

b =290 mm

t = 50 mm

1) Radius of wheel.

$r = 6Rt + a(3b-\sqrt{3}a) / (3-\sqrt{3})\, a + (3+\sqrt{3})\, b$

$r = 6 \times 110 \times 50 + 140 \times (3 \times 290 - \sqrt{3} \times 140) / (3 - \sqrt{3}) \times 140 + (3 + \sqrt{3}) \times 290$

r = 75 mm.

r = 7.5 cm. D = 15 cm.

$\therefore$ Radius of distance between center of the Tri Caster and center of the wheel a

$r = \sqrt{a^2 + b^2 / 3} = \sqrt{(140)^2 + (290)^2 / 3}$

$r = 107.34 \cong 110$ mm.

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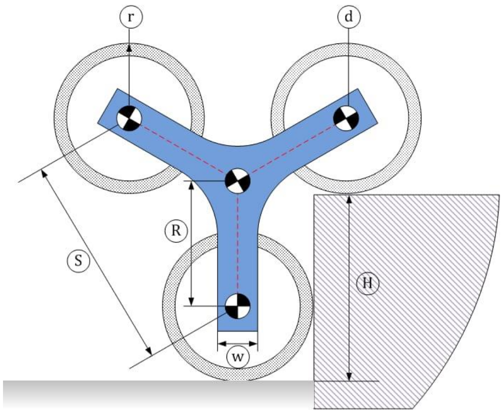

VI. FUTURE SCOPE

- Hydraulic cylinder can be used to carry heavy weight load.
- Precision control over the positioning of the cylinder can be achieved by incorporating proper sensor arrangement.

VII. CONCLUSION

The fabrication and development of an ergonomically designed cylinder lift is essential for the safety and efficiency of manual material handling tasks in various industries. The cylinder lift designed in this project incorporates ergonomic principles and is capable of lifting heavy loads with ease. The fabricated lift was tested and proved to meet the safety and efficiency requirements of manual material handling tasks. Further research and development are needed to optimize the design and fabrication of the ergonomically designed cylinder lift and enhance its safety and efficiency in various industrial applications. With reference to the REBA assessment, the final score of 3 indicates that the manual handling task associated with the 70 kg cylinder is categorized as having a low risk level for the development of musculoskeletal disorders.

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