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Design and Fabrication of Stair Climbing Trolley

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Abstract: *This project presents the design and fabrication of a stair-climbing trolley aimed at simplifying the transportation of goods across stairs. The trolley uses an innovative wheel mechanism and powered system to enable smooth movement up and down stairs, improving efficiency and reducing manual effort. Key features include a durable yet lightweight structure, ergonomic handling, and stability during operation. The project demonstrates a practical solution for industries like logistics and healthcare, enhancing mobility and ease in transporting items across multi-level environments.*

Introduction: The movement of goods across multi-level buildings is often hindered by stairs, making it challenging to transport heavy items. Traditional trolleys are ineffective on stairs, which leads to increased manual effort and inefficiency. This project aims to design and fabricate a stair-climbing trolley that can easily ascend and descend stairs while maintaining stability and reducing user strain. By integrating a specialized wheel system and motorized assistance, the trolley offers a practical solution for industries such as logistics, healthcare, and retail, where stairways are common obstacles. The goal is to provide a lightweight, durable, and efficient tool for safer and more efficient material handling.

Keywords: stair-climbing trolley

I. INTRODUCTION

The Design and Fabrication of a Stair Climbing Trolley focuses on developing a mobility aid that can efficiently transport loads up and down stairs, overcoming a significant challenge for individuals with limited mobility or for applications in logistics and delivery services. This innovative device integrates advanced mechanical design principles, ergonomic features, and sometimes automation, to enhance the efficiency, safety, and ease of use. The trolley's key design considerations include load-bearing capacity, stability on stairs, wheel configuration, and durability of materials used. The objective is to create a functional, cost-effective, and user-friendly solution that can navigate various stair types while minimizing physical strain. The research aims to explore different mechanical systems, including manual and motorized mechanisms, to optimize performance and address real-world challenges in environments with stairs or uneven terrain.

II. CONSTRUCTION PROCESS

1. Design and Planning: The first step includes creating a detailed design of the trolley, selecting materials for durability and lightweight properties, and deciding on the mechanism to be used for stair-climbing, such as a specialized wheel system.

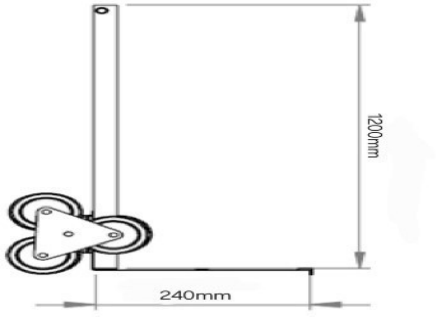

Fig 1.1 CAD DESIGN WITH DIMENSION.

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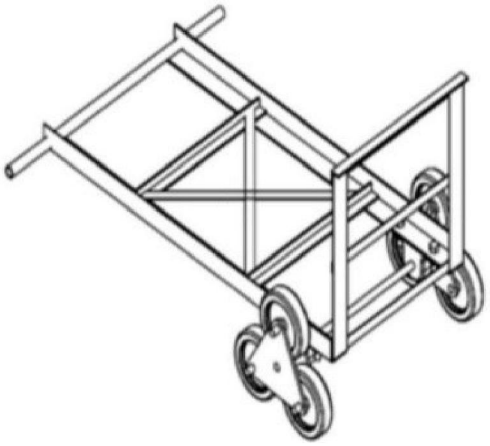

Fig 1.2 CAD DESIGN

2. Material Selection: Appropriate materials like steel for the frame, rubber or plastic for the wheels, handle for grip.

Fig 2.1 STEEL MATERIA

Fig.2.2 RUBBER WHEEL

3. Fabrication of Components: The frame and chassis of the trolley are fabricated using welding or bolting techniques. The wheel mechanism, designed to grip and move on stairs, is constructed and tested for stability.

Fig.3.1 Wheel Mechanism

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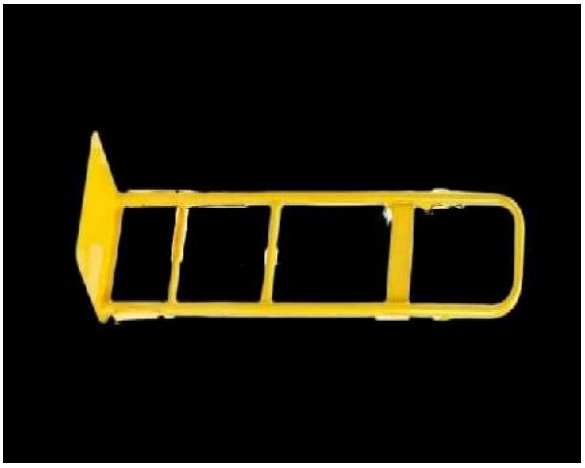

Fig.3.2 Chassis Of Trolley.

4. Assembly: After fabrication, all parts are assembled, including the wheels, and control mechanisms and the control system is installed for operation

Fig. 4.1 Assemble of Trolley

5. Testing and Calibration: tested on different types of stairs to assess its stability, performance, and ease of use. Adjustments are made based on testing to improve efficiency and user experience.

Fig. 5.1 Testing Of Trolley

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6. Final Touches: After successful testing, the trolley is finished with safety features, such as handles and non-slip surfaces, and any aesthetic refinements

Fig 6.1 FINAL TOUCHES

This process ensures the creation of a functional, durable, and reliable stair-climbing trolley that meets the project's objectives.

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III. METHODOLOGY

Various Foreses act on Trolley

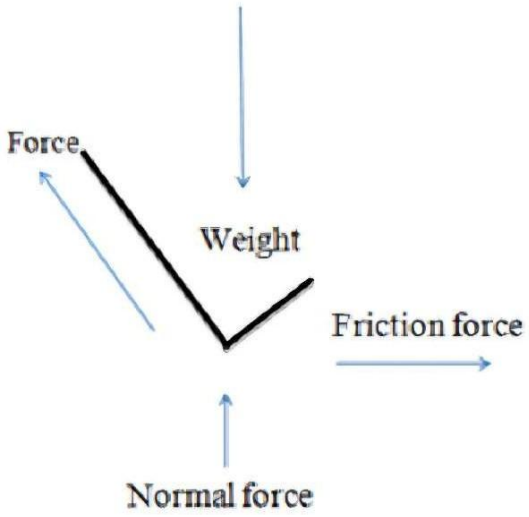

Fig 3.1 FORCE DIAGRAM

The forces acting on trolley in x and y directions are shown in diagram 3.1 the trolley climbed up the stairs the trolley is in incline angle.

From the x-direction,

$F_x = ma_x$

$F \cos \alpha - F_f = ma_x$

$F \cos \alpha - f \times F_n = ma_x$ From the y-direction

$\sum F_y = ma_y$

$F \sin\alpha - W + F_n = m\, a_y$

Where,

F = Maximum force required to pull the trolley

m = Mass of trolley plus carried load

a = Acceleration of the trolley when load carrying on stairs

f = Friction coefficient between trolley wheel and concrete

F_n = Normal force to the trolley

Selection of Bearing

Static and dynamic load can be found the following equations

$C_0 = f_0 \times i \times z \times D^2 \times (\cos \beta)^2$

$C = f_c(i \times \cos \beta) \times z2/3 \times D1.8$

Where,

i = Number of rows of ball in bearing z = Number of balls per row

D = Diameter of the steel ball

B = Nominal angle of contact between the line of action of the ball load and a plane perpendicular to the axis of bearing

f_o = Static Radial Load Constant

f_c = Dynamic Radial Load Constant

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Design of Shaft

For solid shaft,

$$\sigma_b = 32\times M/(\pi\times d^3)$$

For solid shaft

$$\sigma_1 = 32M_1/\pi d^3$$

IV. CONCLUSION

The design and construction of a stair climbing trolley's project, it provides greater mobility and convenience for people in need of transporting goods upstairs and downstairs. This trolley design incorporates advanced features such as multi- directional wheeled or tracked systems that provide balance and movement on rough or staircase surfaces. The construction technique requires the choice of materials that are strong enough to resist fracture and fatigue, but light enough to be manageable. The main difficulties during the design and construction stages was the mechanical sophistication of developing an stairs-friendly ease-of-use system which was safe. These obstacles were tackled with a simple but optimum powered wheel or tread system that evenly distributes weight, reducing the burden on the user and trolley. The testing proved that the stair climbing trolley is functional and able to carry moderate to heavy loads on different staircases. Also, the system is user friendly, meaning that it does not require excessive force from the user.

V. ACKNOWLEDGMENT

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