

A Novel Design of Wheel System for Luggage Carrying on Un-Even Surface

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Abstract: This paper aims to create a way to easily move heavy loads on stairs. The need for such a plan arises from the daily needs of our society. Devices such as handcarts are used to relieve lifting stress while on flat ground. In light of this, the project is trying to design a hand-carriage ladder that can carry heavy ladders with minimal effort compared to manual handling. Several designs were developed that would allow the nonindustrial handcart to move up stairs, roads, or uneven terrain while minimizing stress to the user. In this paper, the trolley is fitted with wheels covered by belt which enables us to carry the load up and down the stairs. It also reduces trolley movement in unfamiliar areas such as holes, bumps, etc.

Keywords: Hand-carriage luggage, Stair navigation, Load transportation, stress reduction

1. INTRODUCTION

A hand-held suitcase is a small transport device used to move heavy loads from one place to another. A very common tool used by many transport tangible products. Also called a hand truck or dolly, a handcart is often used by stock people who organize and recycle sales at retail stores. Used properly, tri wheel can protect people from back injuries and other health problems that can result from lifting heavy loads

2. LITERATURE REVIEW

Pratik wagh et al.[1] The goal of the stair climbing trolley is transport of heavy loads in place of factories and construction sites where states are facing challenges. Tri stair wheels mechanism are used. These wheels are specified designed to climb stairs and other uneven surfaces. This design reduce the physical strain on body compared to traditional methods of lifting.

Suyog bhajankar et al.[2] Study about stair climbing wheelchair using tri wheel mechanism, Now a days

electric powered wheelchairs are morely used to reduce dependence. Braking system and Automation system are use. They use innovative control methods, control by voice and eye control system and also use Tri wheel mechanism and they also analysis the material like stress, strain and deformation analysis.

Muhammad Syafiq Bin Norain et al.[3] study about Tri wheels stair climbing trolley and they build it to use in lacking elevators or escalators. Reduce the risk of MSD while manual lifting and they use Tti wheel mechanism and they use Finite Element Analysis (FEA). In this analysis the trolley carry loads up to 20kg without fail.

Ajay Mahawadiwar et al.[4] The proposed trolley incorporates multi-stage slabs that enhance its portability and functionality. This design allows it to carry loads on both flat surfaces and stairs, addressing the dual challenges of mobility and space efficiency. The study includes a thorough analysis of the structural integrity of the trolley, assessing factors such as static load, shearing stress, and total deformation. The findings indicate that the trolley requires only one fixed support for stability, which is a significant advantage in its design. The authors conclude that the development of this trolley can significantly reduce human effort and alleviate physical discomfort associated with carrying loads up stairs.

Suraj nayak et.al.[5] study about design and fabrication of stair climbing trolley. They investigate on stair climbing vehicles & they design wheels made from roller plates , replacing tradition wheel frames. The maximum bending angle is 44 degrees, which accommodates over 90% of stair tyre and they proposed a alaram system to alert while they reach the limit, ensuring safety during operation and the material used in constructing stair climbing trolley,

including high impact plastics and aluminium alloys. Which contributes to the overall durability and efficiency of the design.

Hardik Gangadia et.al.[6] study about design and modeling of stair climbing trolley. The primary focus of the research is on the stair climbing trolley, which is designed to facilitate the movement of heavy loads across stairs. Traditional hand trolleys are limited in their ability to navigate stairs, making the stair climbing trolley a significant advancement in material handling technology. The paper discusses the design of stair wheels, which replace the single wheel of conventional trolleys. These stair wheels consist of multiple wheels that work together as a single unit, allowing for easier navigation up and down stairs. The research includes a technical analysis of the components involved in the stair climbing trolley, such as the motor selection and gear train calculations. The factor of safety (FOS) is calculated to ensure that the design is robust and can handle the expected loads without failure.

Muhammad Zulkifli Azmin et.al.[7] study about improvement of stair climbing trolley. The project aims to simplify the transportation of heavy items across stairs, addressing the challenges faced by users during lifting tasks. The trolley features a unique design with three wheels on each side, arranged in a triangular configuration, which enhances stability and maneuverability. A comparison of three materials—aluminum alloy, stainless steel, and carbon steel—was conducted to determine the best option based on yield strength and weight. The paper employs Finite Element Analysis (FEA) to analyze the structural integrity of the trolley design. This method is highlighted as a powerful tool for engineers to assess stress, strain, and displacement in the design.

Muhammad Syafiq Bin Norain et.al.[8] study about tri wheel stair climbing trolley. The need for a mechanism that can assist in lifting heavy loads while navigating stairs is critical to reduce the risk of musculoskeletal disorders (MSD) associated with manual lifting. The trolley is designed with a tri-wheel system, which consists of two pairs of quasi-planetary wheel frames that hold three wheels on each side. The trolley frame is constructed from malleable hollow steel, while mild steel is used for the wheel frames due to its high strength and toughness. The paper includes a detailed finite element analysis to assess the structural integrity of

the trolley. The analysis shows that the trolley can safely carry a maximum load of 20 kg without experiencing deformation or failure.

Dr. E. Rajkumar et.al.[9] study about design and analysis of universal trolley carrier with stair climbing mechanism. The paper highlights the difficulties encountered while handling luggage manually, especially in scenarios with limited escalators and the need to navigate stairs. This issue is particularly pronounced for elderly individuals and women, who may struggle more with traditional trolley bags. The design process involved creating a CAD model using SolidWorks, followed by rigorous analysis using workbench.

P. Jey Praveen Raj et.al.[10] study about design and fabrication of stair climbing trolley. The authors referred to various designs and mechanisms that have been previously developed. This analysis helped in determining the strengths and weaknesses of existing stair climbing trolleys, which informed their own design choices. The survey highlighted various applications for stair climbing trolleys, such as in schools, hospitals, and construction sites. The literature review also focused on user needs and the challenges faced when manually carrying heavy items up stairs. The survey provided insights into the technological aspects of stair climbing mechanisms, including the use of gear-motor systems and wheel designs that enhance the trolley's performance on stairs and flat surfaces.

Mahadhir Aiman Mohd Noh et.al.[11] study about design and analysis of a stair climbing hand trolley using design of experiment (DOE). The paper discusses the typical design of hand trolleys, which includes a support frame, wheels, and handles. The design is crucial for ensuring stability and ease of use while transporting goods. The study highlights that most hand trolleys are designed for flat surfaces, which limits their effectiveness on stairs. The research identifies alloy steel as the optimal material for the trolley due to its superior yield strength compared to stainless steel and aluminum alloys. The research employs Design of Experiment (DOE) techniques using Minitab software to analyze various design parameters. The use of SolidWorks Simulation for FEA is highlighted, which helps in assessing the yield strength and displacement of the trolley design. The study concludes that the application of DOE has successfully enhanced the efficiency of the stair climbing hand trolley.

Ayneendra B et.al.[12] study about trolley turning and lifting mechanism. The paper discusses a collapsible trolley that can be adjusted in size, aiming to reduce costs and eliminate common trolley-related problems. This design allows one trolley to perform the functions of two, enhancing efficiency in material handling. It highlights the challenges of transporting heavy loads over stairs, especially in places where lifts are impractical, such as schools and construction sites. The paper details the use of a gear-motor mechanism for wheel rotation, powered by a DC gear motor. The paper also addresses safety issues related to the operation of multiple trolleys connected to a single tractor, which can lead to accident.

Prashantkumar K. Parshive et.al.[13] study about computer aided design of low cost bale trolley. The literature indicates that improving the ginnery's efficiency is contingent upon significantly reducing the initial costs associated with cotton handling systems. This can be achieved by minimizing the weight of the equipment used for handling cotton bales. A.P. Bahale and Dr. S.S. Deshmukh emphasize that material handling systems directly influence logistics costs. Research on automated sensor-operated trolleys shows potential for reducing human effort in material handling. The literature also explores the development of stair-climbing trolleys, which are particularly useful in environments lacking elevator facilities.

Sulgutisai Phani Kumar Reddy et.al.[14] study about design and analysis of stair climbing wheelchair. The survey highlights that there has been minimal advancement in the availability of sophisticated wheelchairs for economically disadvantaged populations in India. The survey involved an extensive review of various intermittent stair-climbing wheelchair models developed by different organizations. The survey specifically examined tracked mechanisms, which were found to be the most adaptable for stair climbing and all-terrain applications. The theoretical dynamic analysis of wheelchair motion was also part of the literature survey, providing insights into the transmissibility of wheelchairs and informing the design of the stair climbing all-terrain wheelchair.

T.Vivekananda swamy et.al.[15] study about design and analysis of motor operated load carrying stair climber. The paper highlights the common issue of transporting goods through stairs in various settings like offices, schools, and industries, especially where

lifts are unavailable or impractical. Introduces a motor-operated stair-climbing wheelchair concept designed to overcome these architectural barriers. The research includes an analysis of various dimensions for square hollow sections used in the chassis of the proposed model. The best dimension is selected based on calculations, and the final assembled model is designed and analyzed using CATIA and ANSYS software, indicating a thorough engineering approach.

Mohammad Mashud et.al.[16] study about design construction of a stair climbing hand truck. The introduction emphasizes the difficulties faced by workers in moving heavy packages, especially in construction sites where elevators are absent. The dimensions of the wheels and the overall vehicle were tailored to ensure compatibility with standard stair dimensions, allowing for efficient use of space. The literature reflects a growing interest in redesigning stair climbing vehicles to be more economical and user-friendly.

Arish Ibrahim et.al.[17] study about design and fabrication of ramp attachment for wheelchair. Manual wheelchairs are popular due to their availability and cost-effectiveness. Although advanced electronic wheelchairs with climbing features exist, they are often too expensive for the average user and may not be practical for daily use in rough terrains. The paper introduces a ramp attachment that allows standard manual wheelchairs to climb curbs without major modifications. The literature suggests that while many mechanisms exist, further research and development are necessary to refine these designs and ensure they meet the practical needs of users.

Urvashi singh et.al.[18] study about design and fabrication of stair case climber for physically challenged person. Sandeep Joshi developed a manually operated staircase climber that is lightweight and utilizes a worm gear for shaft rotation. This design includes a locking system to prevent the wheelchair from slipping while navigating stairs, enhancing safety for users. This vehicle features a unique arrangement of wheels that supports its weight on flat terrain, showcasing the versatility of designs in this field. The literature emphasizes the importance of ergonomics and stability in the design of staircase climbers.

Muhammad Ikman Ishak et.al.[19] study about mechanical design and analysis of new staircase climbing hand truck. The existing literature categorizes staircase climbing hand trucks into three main types basic hand trolleys, convertible hand trucks, and appliance hand trucks. These are typically simple in design, often made from materials like aluminum and stainless steel. Representing the most advanced category, these hand trucks are designed for heavy-duty use, capable of moving large appliances and equipment. The literature suggests that there is a necessity for new designs that incorporate adjustable features, ergonomic considerations, and enhanced stability to better accommodate the diverse needs of users.

Dickson David Dlodu et.al.[20] study about the design and construction of a locally sourced electric powered stair climbing trolley. Various studies have explored the design and functionality of vehicles capable of ascending stairs, including trolleys and wheelchairs. The literature indicates that advancements in stair climbing technology often face challenges, particularly in maintaining speed and stability while navigating stairs. The choice of materials is crucial in the construction of stair climbing trolleys. The paper mentions the use of mild steel for the trolley body due to its affordability and malleability, which are advantageous for creating a durable yet lightweight structure. The design process took into account anthropometric data to ensure that the trolley is user-friendly and meets the needs of individuals who may require assistance in transporting heavy goods.

Gaurav Lodaya et.al.[21] study about design and fabrication of load carrying trolley. The literature indicates that the wheel frame was designed with a curve to prevent the front surface of the arm from colliding with the edge of the stairs. During testing, it was observed that the trolley could carry heavy loads without suffering from deformation or fractures, indicating its potential for real-world applications. The literature emphasizes the importance of creating a hybrid trolley that can function both as a stair-climbing device and a hand trolley on flat surfaces. This dual functionality is essential for meeting various user needs in different environments.

Mr. N. Dileepan et.al. [22] study about design and fabrication of IOT based stair climbing robot. The field of robotics combines mechanisms, sensors, electronics control systems, artificial intelligence,

and embedded systems. The design of a robot begins with synthesizing its mechanism based on its intended application, which is crucial for effective performance in tasks like stair climbing. The design calculations for the stair climbing robot focus on achieving stability during the climbing process. The dynamics of wheel motion are critical for effective stair climbing. The paper explains that the wheel's instant center of rotation is at the contact point with the stair, and the trajectory of the wheel centers during motion is crucial for maintaining stability. The choice of materials, such as wood for the links, is discussed in the context of density and structural integrity.

Benn et.al. [23] study about circulatory responses to weight lifting, walking, and stair climbing in older males. The primary aim was to compare heart rate (HR) and intra-arterial blood pressure (ABP) responses during various exercises, including weight lifting, horizontal and uphill walking, and stair climbing. The RPP, which reflects myocardial oxygen demand, was significantly higher during stair climbing compared to other exercises. A notable increase in RPP was observed after stair climbing, indicating a greater cardiovascular strain during this activity. The findings suggest that different forms of exercise impose varying cardiovascular demands, which is crucial for designing exercise programs for older adults.

O.J.Oyejide et.al.[24] study about development of sensor controlled convertible cart trolley. The paper highlights that in developing countries, manual handling of goods is prevalent, leading to health issues such as waist pain and muscle sprains. The research acknowledges existing trolley systems, noting that many are manually operated and not foldable, which limits their functionality and portability. The design of the cart-trolley incorporates multiple functionalities, allowing it to transform into a cart, an inclined cart, and a full trolley. The use of the ESP8266EX wireless module is significant in the design, enabling efficient control and communication between the cart and a mobile application. The choice of materials, such as mild steel for the cart's structure, is discussed, balancing cost and availability against performance and durability. Sayali H et.al.[25] study about design and implementation of automatic staircase climbing platform. The introduction highlights the significant challenges faced by physically handicapped and elderly individuals in navigating stairs, particularly in older buildings

without lifts. The platform discussed in the paper can be adapted for various uses, such as a staircase-climbing wheelchair, trolley for material transfer, or stretcher. The platform is controlled using a microcontroller (ATMEGA 32) and operates through DC motors, allowing for directional movement (forward, reverse, right, and left). The paper discusses the mechanical design of the robot, which utilizes fixed and flexible links instead of traditional chain rollers. The project aims to provide a comprehensive solution for individuals with disabilities, enabling them to navigate stairs independently

3. METHODOLOGY

Belt System:

Two continuous belts are mounted on the back of the suitcase, positioned vertically. These belts likely rotate to provide traction and movement over steps.

Mechanism:

The belts are probably driven by a ratchet or similar mechanism, allowing them to move in a controlled manner. When ascending stairs, the belts grip the edge of each step, pulling the suitcase upward. Descending would involve a similar process, with the belts providing controlled movement downwards.

Operation:

To use the stair-climbing function, the user would likely engage the belt mechanism. As the suitcase encounters a step, the rotating belts would grip and propel the suitcase upwards. The user would maintain balance and guide the suitcase.

We use open belt mechanism to avoid cast and easy to fix the belt around the wheels. Open belt drive is easy method to transmit power between two or more wheels. Staire climbing suitcase we use manual method to move on stairs by pulling the suitcase down to up and pushing the suitcase up to down.

4. FABRICATION

The fabrication process for the object involves several steps:

1. Material Selection:

A sheet of metal, possibly steel, is chosen for the backing plate. The straps appear to be made of a woven fabric material.

2. Cutting and Shaping:

The metal sheet is cut to the desired size and shape, with rectangular openings cut out for the straps.

3. Drilling:

Holes are drilled into the metal plate for rivets or bolts.

4. Attaching Straps:

The fabric straps are inserted through the rectangular openings and secured to the metal plate, likely with rivets or bolts.

5. Assembly:

The metal plate with straps is attached to the bag, possibly by rivets, bolts, or stitching. The specific tools and techniques used would depend on the materials and desired level of precision.

WHEELS AND SHAFT:

To create a stair-climbing mechanism for a suitcase using these parts, a possible approach involves constructing a system of multiple wheels that can rotate and adapt to the steps. This would likely require a frame or structure to hold the wheels and attach them to the suitcase, as well as a mechanism to allow the wheels to move independently or in coordinated groups. as shown in fig:



Wheel and Shaft

SUITCASE:





Final Assembly of Stair Climbing Trolley

5. RESULT AND DISCUSSION

The fabrication process of a stair-climbing suitcase involves several steps. First, a sturdy frame, often made of metal or durable plastic, is constructed to provide the structural base of the suitcase. Next, a specialized stair-climbing mechanism is integrated into the frame, typically consisting of a set of rotating wheels or a track system designed to navigate steps. These mechanisms are attached securely to the frame to ensure stability and functionality. The body of the suitcase, usually made of hard-shell materials or reinforced fabric, is then attached to the frame, providing storage space and protection for belongings. Handles and any additional features, such as retractable handles or support straps, are added for ease of use. Finally, the entire structure is assembled and tested to ensure its durability and effectiveness in climbing stairs.

Ergonomics: The primary benefit is the reduction of physical strain when navigating stairs, which is particularly helpful for individuals with mobility issues or heavy luggage.

Mechanism: Various designs exist, some using rotating wheels or triangular track systems to "walk" up the stairs.

Weight and Size: A critical factor is maintaining a reasonable weight and size so the suitcase remains manageable on flat surfaces and in crowded areas.

Durability: The stair-climbing mechanism needs to be robust enough to withstand repeated use and varying stair conditions.

Cost: These suitcases can be more expensive than traditional luggage due to the added complexity of the stair-climbing mechanism.

Practicality: Depending on the design, some models may be more effective on certain types of stairs than others.

Maintenance: The mechanism may require occasional maintenance or repairs.

6. CONCLUSION

The stair-climbing suitcase appears to have a mechanism, possibly involving straps and a specialized frame, designed to aid in ascending stairs. The design suggests an attempt to make it easier to transport luggage over obstacles like steps, which can be challenging with traditional suitcases. Further analysis of the mechanism and materials would be needed to determine its effectiveness and durability.

We planned to design a stair climbing trolley in the simple way with low cost. Which is useful to passengers at any place like railway stations bus stops. especially in production lines, where significant amount of labor is used for the manufacturing. The primary goal reduce the stress on the labours also the passengers to carry the luggage.

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