

Design and Fabrication of Stair Climber Trolley

Suraj Nayak, Saurya Pratap Singh

Submitted: 30-07-2021

Revised: 06-08-2021

Accepted: 08-08-2021

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; however, these devices often fail when it comes to carrying a load over short stairs. 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. It also attempts to study the commercial performance and value of such a product. Several designs were developed that would allow the non-industrial handcart to move up stairs, roads, or uneven terrain while minimizing stress to the user. In this paper, the trolley is fitted with Tri-Star wheels 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.

I. INTRODUCTION

A hand-held trolley is a small transport device used to move heavy loads from one place to another. A very common tool used by many industries that 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.

Description

The standard hand trolley has two small wheels located under the luggage platform, the hand cart usually has two handles on its support frame. These handles are used to push, pull and move the phone. The handles can extend to the back of the frame, or one handle can rotate backwards. An empty hand cart is usually L-shaped, and products are usually placed on top of the platform. When the goods are in place, it is tilted back so that the load is balanced between the platform and the support frame. Especially when heavy or weak objects are removed, the person using the trolley should return it to a stationary position, ensuring that it does not fall off the stage. The front of the frame may be square with boxes or bent with drums and drums. In some cases, a hand truck is equipped with a strap to secure the luggage during the trip.

Technology operators prefer to use a hand truck when delivering non-removable items such as boxes, cases or packages. Heavy objects are usually placed on the bottom of a hand truck, and light objects are kept at the top.

Users of hand trucks should be careful not to set it too high so that their view is not blocked or the load is unstable. Generally, it is safe to load a hand truck to the level of its handles or above the frame. The load is then transferred to the wheels in a backward motion. The user can move the goods by moving them left, right or forward.

II. LITERATURE REVIEW

Many investigators have conducted various investigations on vehicles climbing stairs such as trolley, trucks, wheelchairs, forks, etc. It requires an in-depth study of the maximum acceptable load on the skin and how the pressure is transferred to the direction of the wheels.

Pratik H. Rathod et al. designed and designed a hand truck that climbs stairs with minimal effort which is useful for a library, hospital, general carrier etc. the main modification of this truck where the wheels are made using a roller roller plat attached to replace the traditional wheel frame. A machine-based redesign method. Maximum bending time was calculated. A 44-degree inclination plays a major role covering more than 90% of all stairs at this limit. There is a high inclination warning alarm that alerts the operator with a trend of more than 44 degrees. When the truck is operating in excess, the necessary safety measures must be taken.

Md. A. Hussain et al. designed and constructed a staircase car using a modified frame design i.e. a curved wheel frame that moves in rough terrain. To deal with many technical problems in building this car to stabilize and maintain high speed in the car tire design while climbing stairs. Frame layout consists of a sun, a planet, a moving wheel attached to a shaft that reduces load consumption. However, the descent of stairs is also the most important part of this study. The car has four sets arranged on wheels to support its weight when traveling over a flat surface. Each wheel frame has three small wheels attached to the solar wheel using three inactive gears.

Ashish Singh et al. operating a four-wheeled robot will have the ability to climb stairs

to its height. It will have great grip strength and durability during movement in rough terrain due to four-wheel drive design. The main purpose of this relevant research within a project such as a robot should be developed through a variety of application sensors, e.g. cameras, thermal vision, or chemical sensors. For use in any search and rescue or security system, the robot must be operational without changing batteries for at least two hours.

Raj Kishor Kumar et al. Investigate the functionality of the stairs to the structure and function. The product mainly contains viz modules, chair, links and frame. Anthropometric measures are considered in seat measurement. The focus is on different parameters such as form, functionality, technology and product design. The design is confirmed by developing Digital Mockups for specific components that are produced in PRO-E Creo software and integrated to create the final product. The required product evaluation is done in the visible area of the PRO-E Creo software. A real and focused type that reflects the structure and function is developed using thermocol tools. Here the tire carriers are made in RP (Fused Deposition Modeling) using ABS (Acrylo Butadiene Styrene) materials. A wheelchair is attached to something more like an integrated walkway, after collecting customer needs in a variety of subjects.

P. Jey Praveen Raj et al. The design is designed as a hand trolley used to relieve lifting pressures while on flat ground. However, these devices often fail when it comes to carrying loads on short ships carrying heavy objects climbing stairs with minimal effort compared to manual manipulation. you go up the stairs. Under this project we have created a staircase with three-dimensional wheel frames on both sides of the starter and three wheels on both sides are used in a three-dimensional frame. The wheel assembly is rotated by a gear-motor method where a DC gear motor is used to provide the required rotation power and a pinion-gear mesh is used to reduce the rotational speed of the wheel. The vehicle is connected to an acid-powered battery of the same size and is also connected to the DPDT switch.

III. TYPES OF TROLLEY

Different types of these vehicles exist, and the type used is often chosen based on the type of vehicle to be transported. Handmade trolleys are made of a variety of hard materials, including metal, aluminum and high impact plastic. Most handmade trolleys come in standard sizes and are used for standard luggage, but some are specially designed for very small or large products.

Wheeled Trolley

Wheelbarrows made of stainless steel are the most common type of hand trucks used. These are used in areas with heavy transportation, such as retail and industrial stores, and usually have stainless steel wheels. Wheelbarrows and steel wheels are generally very light and are often used to carry light objects.

Those with a frame and wheels made of stainless steel survive and are made strong. This type of vehicle usually has a wide platform for overload. Metal alloy hand trucks are commonly used to transport heavy products, such as metal.

Folding Trolley

A rolled trolley is another type of hand tool, and it is usually made of aluminum proof rust. And it is not heavy but is usually able to carry heavy loads, and can be folded up to take up less space when not in use. This feature also allows it to be easily moved to places where it is needed.

Garden Trolley

A field trolley is a way to use a pull handle. Field wagons often have small profiles so that they can easily get in and out of the road without damaging the plants. These are designed to lift the dry and dry loads commonly found in gardens.

Kitchen Trolley

The kitchen trolley is a serving cart that can be used for storage. It is designed to have more than one component that enables people to handle different dishes and for different purposes.

Sack Trolley

Sack trolley or Sack barrow is a common term that describes a range of light trucks, hand-operated operators or carts used to move boxes, feed bags and sorghum, and other simple, portable goods. Many different materials are used to make sackcloth trucks. These include high impact plastics, stainless steel, aluminum alloy and aluminum alloys.

NEED FOR STAIR CLIMBER TROLLEY

Lifting heavy objects on high issues or lifting patients to higher levels from the ground is not a painless task, especially when there are no lifting devices (elevator, conveyor, etc.). In addition, most buildings are crowded and do not have elevators or escalators. This project could create a new ladder transport option. Staircase strollers can play an important role in those areas to lift loads over short distances.

NEW CONCEPT

A staircase truck is designed to reduce debt rather than increase it. Ordinary hand trucks

work well on flat ground, but their usefulness is reduced when there is a need to move an object to an unfamiliar area. Package managers, for example, often find it necessary to haul hand trucks loaded with short steps to reach the front door of a building. The whole purpose of using a standard hand truck is to avoid lifting and carrying heavy objects.

Lifting a hand truck up the stairs defeats the purpose of the device, because the user has to provide enough lift power to lift the entire cart weight and content. In addition, the geometry of the hand truck makes it difficult to climb with one's legs, as it does with proper posture. More strain is applied to the back muscles and the risk of operator injury increases significantly. Dragging a standard hand truck on the stairs leads to a shaking and pounding motion. This movement can damage objects loaded on a hand truck or cause them to collapse completely. A hand truck that can climb stairs without the need for a user to lift it will improve the safety of moving heavy objects in unfamiliar areas.

In our design, we design and design standard hand-carts with Tri-Star wheels to enable the cart to go up and down stairs.

TRI-STARWHEELDESIGN

The Tri-Star wheel was designed in 1967 by Robert and John Forsyth of Lockheed Aircraft Corporation. It was first designed as a module for the Lockheed Terrastar, a military vehicle for commercial shipping. The Tri-Star wheel acts like a normal wheel on flat ground, but has the ability to automatically climb when encountered with a rolling obstacle. This wheel design has three wheels, each mounted on a separate shaft. These layers are found on the edges of the equal triangle. Three barrels are designed for the fourth, middle shaft (where the car can be attached). If they are designed in this way on the planet, these triangular wheels can talk about a wide variety of landscapes, including sand and mud; they can also allow the car

to climb over small obstacles such as rocks, holes, and stairs. The wheel connection may be driven by gears, with two wheels touching the ground by rolling. The third wheel stays on until the bottom wheel hits the obstacle. The blockage prevents the front wheel from moving forward but does not interfere with the movement of the driving axle. This causes the top wheel to roll in its place like a new front wheel. This wheel usually sits on top of an obstacle and allows the remaining assembly to move along the obstacle. The movement of the Tri-Star wheel is shown in Figure 1.

IV. APPLICATION OF TRI-STAR WHEEL IN OUR PROJECT

For our research, we use this arrangement of the Tri-Star wheel on a hand trolley in place of regular wheels to make the trolley go up and down the sides of the stairs and also until small obstacles such as holes and bumps on the road.

SELECTION AND FABRICATION OF STAIRC LIMBER TROLLEY

MATERIAL SELECTION

Material selection is the process of building any tangible object. In the context of product design, the main purpose of material selection is to reduce costs while meeting product performance objectives. A well-organized selection of the best of the app provided first with the properties and cost of the student material.

Trolley body Material Used- Medium Metal Soft Metal

Soft metal, also called plain-carbon steel, is the most common form of steel because its price is very low while providing optimal properties that are acceptable to many systems, in addition to steel. Low carbon steel contains approximately 0.05-0.3% of carbon which makes it compact and ductile. The middle metal has a relatively low tensile

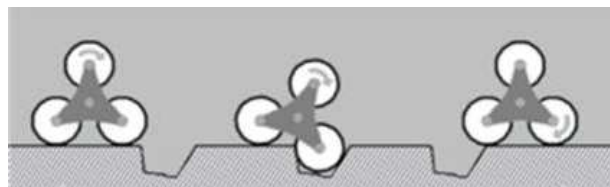


Fig 1 Tri-Star wheel in motion

power, but cheap and commendable; The hardness of the earth can increase with increasing intensity. It is often used when heavy metal is

needed, for example as a cast iron. The bulk of the soft metal is about 7850 kg / cm³ and the Young's modulus is 210 GPa (30,000,000 psi).

Tri-Star wheel web

**Materials Used - Stainless Steel Grade 304
 Stainless Steel Grade 304:**

Iron type 304 variation of base range 18-8, Type 302, with high chromium and low carbon content. Low carbon reduces rainfall of chromium carbide due to heat and its tendency to moderate granular corrosion. In most cases, it can be used in the "as-welded" case, while Type 302 should be shipped to maintain adequate corrosion resistance. Type 304L is a different type of low carbon type 304 with a 0.03% higher carbon content that removes carbide rain due to heat. For this reason, this alloy can be used in "as-welded" cases, or in more severe cases. It usually eliminates the need for welding installation without applications that define pressure relief. It has less mechanical features than Type 304.

BEARINGSELECTION

Ball bearing

Carrying a ball is a type of folding carrier that uses balls to maintain the distinction between the bearing races. The purpose of the ball bearing is to reduce the frictional rotation and to support the radial and axial loads. It does this by using at least two races to contain the balls and to transfer the loads to the balls. In most applications, one race is suspended and the other is attached to a rotating assembly. As one of the races carries around it causes the balls to rotate. Because rolling balls have a much lower equilibrium than having two flat surfaces slip.

Choose a ball with a minimum diameter of 30mm, a small load capacity of 50kg radially and a speed greater than 100rpm

**Bearing Selected - SKF 6006 Open Deep Groove
 Ball Bearing**

30x55x13mm

Internal Width: 30mm Outside Width: 55mm
 Width: 13mm

This ball carrier closed with 6006-2RS

30x55x13-millimeter has a deep groove geometry of high speed and supports radial and axial loads. This lump has rubber markings on both sides of the bear to keep the lubricant in and the contaminants out, and it comes pre-greased to the manufacturer so that no further lubrication is required. This deep groove-filled ball bearing is for use in applications that include radial axis loads, as well as the need for high precision running at high rotational speeds. Such applications include mounds, drives, gearboxes, compressors, pumps, propellers, and printing and textile equipment, among others.

WHEELSELECTION

Wheelmaterialselected–Filledrubber

TypesofWheelMaterial

Filledrubbers

Rubbers on tires are usually lined with particles such as carbon black or silica. They consist of treading with the body. The tread is the part of the wheel that meets the surface of the road. The part that connects to the street at a given time during the contact. The footprints are often designed to meet specific product advertising positions.

Polyurethane

Polyurethane (PUR and PU) is a polymer consisting of a series of organic units composed of carbamate (urethane) compounds. While most polyurethane are thermosetting polymers that do not dissolve when burned, thermoplastic polyurethanes are available. The main ingredients for polyurethane are isocyanates and polyols. Other materials are added to help process the polymer or to modify the polymer properties.

Iron

Iron is a mixture of iron, and carbon is the first compound, up to 2.1% by weight. Carbon, other elements, and metal inserts act as solidening agents that block the movement of naturally occurring particles on iron atom crystal lattices.

Vertical conflict

Table 1 Various Wheel Items and Their Collision Collisions

S.no	Material	Coefficientoffriction
1	Rubber/concrete	.85
2	Polyurethane/C oncrete	.5
3	Steel/Concrete	.45

The surface of the wheel and the rotation of the wheel are not completely smooth. They have the irregularities shown in Figure 2.

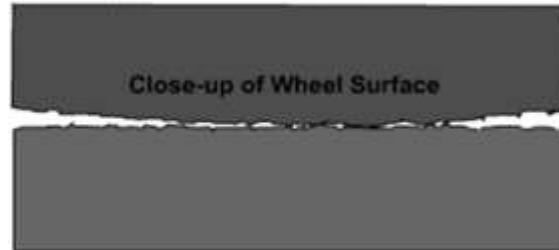


Fig 2 Close-up showing surface roughness

With sliding collisions, this size is a factor in resistance to shape and movement. Although the tire does not slip, the overcrowding causes "giggles" when the tire rolls.

Various Wheelchairs and their co-operation in conflicts

The various Wheel elements and their performance in the proportions of the roads are set out in Table 1 and are clearly shown in Figure 2.

WHEEL FRAME

A specially designed wheel frame is required to hold the three wheels together on each side of the shift. In the existing design, the power transfer to one or two wheelbarrows does not have the function of climbing stairs due to the height of the ladder. The structure of the straight wheel

frame became more complex and had to be modified in order to provide proper driving, which created more friction. For this reason, three wheels mounted on each side of a car attached to the frame are fitted to provide a smooth transmission for climbing stairs without much difficulty. Frame layout is suitable for direct transmission of the speed limit as well. Provided high efficiency and integrated planning with a reliable service. Easy maintenance would have been possible in the event of the replacement of any defective components such as nut, bolt, washer, etc.

4.1.1 Types of wheel frames
 A few types of wheel frames are shown in the figure 3, 4 and 5.

of wheel frames

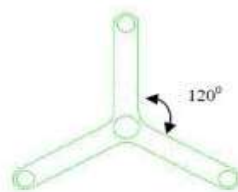


Fig 3 Straight Wheel Frame

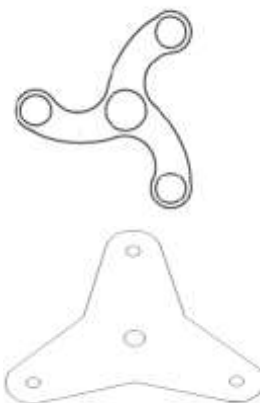


Fig 4 Curved Wheel Frame
 Fig 5 Quasi Planetary Wheel Frame

4.1 CAD MODEL OF TROLLEY

The CAD diagrams of the trolley are shown in the figures 6, 7 and 8.



Fig6 Side View

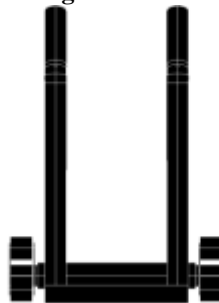


Fig7 Front View



Fig8 Isometric View

We have used plasma arc cutting for cutting four stainless steel webs for the Tri-Star wheel arrangement which is shown in figure 9.



Fig9 Plasma Arc cut Tri-Star wheel web

4.2 PROTOTYPE OF STAIR CLIMBER TROLLEY



Fig10 Side View



Fig11 Front View

The modified hand truck was able to climb stairs while bearing a moderate load

DESIGN ANALYSIS OF TROLLEY LOAD CALCULATION FOR AXLE

Length of the axle = 0.44m
 Distance between welds = 0.40m
 Load applied/ carried = 30kg (distributed equally by the welds to the axle)

$= 15 \text{ kg through each weld} = 147.15 \text{ N}$

Weight of the trolley = 20kg (uniformly distributed throughout the axle)

Bending stress for the given material can be assumed to be $0.66 \times \text{yield strength}$. Thus, the allowable bending stress for the given material is 165 N/mm^2

The calculated bending stress for the material is within the allowable bending stress for the material. Thus, the design is safe.

$= 196.2 \text{ N}$

Neglect the overhang beyond welded points since the wheel provides only negligible reaction

From equilibrium equation $\sum F = 0$

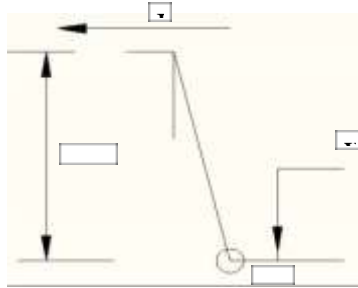
And $\sum M = 0$

Find reaction at the supports, $R_1 = 190.314 \text{ N}$; $R_2 = 190.314 \text{ N}$

Calculate the maximum bending moment for the beam, $M(\text{max}) = 6.7155 \text{ N-m}$

Considering FOS = 1.5, $M(\text{max}) = 10.07 \text{ N-m}$

FORCE NECESSARY TO PULL THE TROLLEY



Maximum load determination

$$F \cdot x = W \cdot y$$

$$F = \frac{y}{x} \cdot W$$

V. CONCLUSION

Although the project had some limitations regarding the strength and construction of the building, it could be considered a small step forward, in terms of Stair Climbing vehicles. During the evaluation of the research, it was felt that it would be a bad idea to think of this heavy load-bearing design up the stairs. This product will be well-publicized if it is not sold to suit your needs. Although the initial cost of the project seemed high but more accurate production will reduce this.

With regard to the commercialization of this product, if this product were completely automated and produced at low cost the acceptance would not be considered. Currently, there are no competitors for this type of product in our market.

REFERENCES

- [1]. Design of machine elements by V. B. Bhandari
- [2]. Design and Manufacturing of a Stair Climbing Vehicle by Md. A. Hossain. Nafis A. Chowdhury, Rubaiat I. Linda, and Shamiuzzaman Akhtar Department of Mechanical 69 Engineering MIST, Dhaka-1216, Bangladesh
- [3]. Hsueh-Er, C., —Stair-climbing vehicle, 2008, — Patent No. US2008164665(A1), Jan 24.
- [4]. Siegart, R., Lauria, M., Mäusli, P., Winnendael, M., 1998, —Design and Implementation of an Innovative Micro-Rover, Proceedings of Robotics 98, the 3rd Conference and Exposition on Robotics in Challenging Environments, April 26-30, Albuquerque, New Mexico.
- [5]. Schilling, K., Jungius, C., 1996. —Mobile Robots for Planetary Exploration, Control Engineering Practice, Vol. 4, No. 4.
- [6]. McTamane, L.S., Douglas, B.D., Harmon, S.Y., 1989, —Mars Rover concept development, Proc. SPIE Conf. 1007, Mobile Robots III.
- [7]. Ashish Singh, A Thesis On Design, Analysis And Fabrication Of A Reconfigurable Stair Climbing Robot, Institute Of Technology Rourkela, India, May 2015.
- [8]. Raj Kishor Kumar, Shahbaz Ahmad, Shahid Khan, Shankul Behari, Shubham Rai, A Project Report On Automated Stair Climbing Wheelchair.
- [9]. P.Jey Praveen Raj, P.M.Mohamed Fuge, R.Paul Caleb, G.Natarajan, Design and Fabrication of Stair Climbing Trolley, international journal of advancement in engineering technology, Management & Applied science, Volume 3, Issue 5 May 2016 ISSN No; 2349-3224.

- [10]. RoshanAlaspure, ChaitaliBarmase, SnehalChambhare, Manish Mandhre, Prof. Yogesh G. Joshi (Guide), Fabrication of Stair Climbing Wheel Mechanism: Alternate for lifting goods, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 05 | May-2016 www.irjet.net p-ISSN: 2395-0072
- [11]. PrajanPradipGondole, KamleshDilipraoThakre, Himanshu Anil Moon, Shubhamyengalwar, Mr. S SMarathe ,Stair Climbing Hand Trolley, Journal of Emerging Technologies and Innovative Research (JETIR) www.jetir.org April 2016, Volume 3, Issue 4, JETIR, ISSN-2349-5162.
- [12]. R.S.Khurmi, J.K.Guptha, A text book of Machine design, S.Chand publishing house (P) Ltd. 10. Dr.R.K.Bansal, A text book of Strength of materials, LaxmiPublications(P) Ltd