# Design and Fabrication of Stair Climbing Trolley

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***Abstract-*** *This project aims at developing a mechanism for easy transportation of heavy loads over stairs. The need for such a system arises from day-to-day requirements in our society. Devices such as hand trolleys are used to relieve the stress of lifting while on flat ground; however, these devices usually fail when it comes to carrying the load over short fleet of stairs. In the light of this, the project attempts to design a stair climbing hand cart which can carry heavy objects up the stairs with less effort compared to carrying them manually.*

***Keywords***- Tri star wheel, Dc motor, sprocket, Chain

## I. INTRODUCTION

A typical hand trolley consists of two small wheels located beneath a load-bearing platform, the hand trolley usually has two handles on its support frame. These handles are used to push, pull and maneuver the device. The handles may extend from the top rear of the frame, or one handle may curve from the back. An empty hand trolley usually stands upright in an L-shape, and products are usually stacked on top of the platform. When the goods are in place, it is tilted backward so that the load is balanced between the platform and the support frame.

Especially if heavy or fragile materials are moved, the person operating the trolley should return it to an upright position carefully, to insure nothing falls off the platform. The front of the frame may be squared off for boxes or curved for drums and barrels. Sometimes, a hand truck also has straps for securing loose freight during transport.

Professional material handlers prefer to use a hand truck when moving stackable items such as boxes, crates or packages. Heavier items are usually stacked on the bottom of the hand truck, with lighter objects saved for the top. Hand truck users must be careful not to stack it so high that their vision is blocked or the load becomes unstable. Generally, it is safe to load a hand truck to the level of its handles or the top of the frame. The load is then shifted onto the wheels with a backwards lifting motion. The user can maneuver the cargo by steering it left, right or forward.

HAND TROLLEY

Different types of these trolleys exist, and the type used is often chosen based on what type of material it will move. Hand trolleys are made of various types of hard materials, including steel, aluminium and high-impact plastic. Most hand trolleys come in standard sizes and are used for general loads, but there are some that are specifically designed for very small or large products.

TRI STAIR WHEEL ARRANGEMENT

The Tri-Star is a novel wheel design—originally by Robert and John Forsyth, assignors to Lockheed in 1967—in which three wheels are arranged in an upright triangle with two on the ground and one above them. If either of the wheels in contact with the ground gets stuck, the whole system rotates over the obstruction. Its most famous application was the Land master, a unique armored personnel carrier (APC) from the film Damnation Alley. Its common application is employed as a stair climber.

Lifting objects ,loads such as books, food grains etc. to store above the ground level, or even patients to move upper level from ground is not easy job, especially where there is no lifting facilities (elevator, conveyer, etc) Moreover, in most of the buildings in the world does not have elevators or escalators. In this case human labors are considered to be the only solution. Labor is becoming costly as well as time consuming in the developed countries, where growth rate is getting negative. This problem can be solved if a vehicle can lift loads while traveling through stairs.

The tri star wheel is the option for transportation of the loads over the stair. Most of the buildings of the country are structurally congested and unavailing of elevator facility so it is difficult and laborious to lift up heavy loads. The stair climbing hand truck can play an important role in those areas to lift loads over a short height, like libraries, hospital, and in construction area. The vehicle, which can move upper level through stairs, or run in very rough and rocky surfaces, is called stair climbing hand truck or say stair climbing vehicle. Stair climber trolleys have a total of six wheels, three on each side. They are set in a triangular pattern. The uppermost wheel rests on the upper step, with the other two wheels set on the

lower step. This allows you to apply leverage as you pull the trolley up a set of stairs..

## II. LITERATURE SURVEY

The present invention relates to hand trucks intended for transporting heavy load and more particularly, to an improved and simplified hand truck which is adopted to move heavy loads easily up and down from the stair; with the help of this truck we can lift the load easily up and down from stairs. Due to this the man effort is reduced and time to lift the load is also reduced.

After studying various options it was decided to build a hand truck that could be carry load across stair, also it was decided to power it manually so as to keep it in reach of many users. This will enable efficient handling of goods across stairs with less human energy. before delving into the theory behind complex stair-climbing mechanisms, it should first be noted that it is possible to climb stairs using an ordinary wheel.
The large wheels necessary for this task make this method of stair-climbing somewhat undesirable. Also, the climbing motion produced by simply rolling over stairs is a jarring motion rather than a smooth one. In addition, the frictional force between the wheel and the edge of the stair must be sufficient to allow the wheel to grab and roll over the stair. A friction coefficient of too small a magnitude will cause the wheel to slip against the stair rather than climb.

A problem with prior art hand trucks or carrying carts is that is difficult for the operator to keep the truck under control when going down the stairs, and it is even more difficult to move heavy loads up on stairs because the operator is substantially pulling the load and the truck. It is common to have braking device operable to help prevent the truck from running away during its movement down the stairs. Another problem with existing hand trucks and carrying carts is that they are unsatisfactory for transporting heavy products. The trucks typically have pair of ground engaging wheels which wear quickly because of the heavy loads bearing downwardly directly on the wheels.

The stair-climbing hand truck is designed to reduce liability rather than increase it. Conventional hand trucks work well on flat ground, but their usefulness decreases when it becomes necessary to move an object over an irregular surface. Package deliverymen, for example, often find it necessary to drag loaded hand trucks up short flights of stairs just to reach the front door of a building. The entire purpose of using a conventional hand truck is to avoid having to lift and carry heavy objects around.

Stair climbing truck, Mr. Pratik H. Rathod, Mr. Ravi R. Mishra, Mr. Nitin A. Waghamare in sept-2013 ,Published in International Journal of Emerging Trends in Engineering and Development.

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Stair climber trolleys have a total of six wheels, three on each side. They are set in a triangular pattern. The uppermost wheel rests on the upper step, with the other two wheels set on the lower step. This allows you to apply leverage as you pull the trolley up a set of stairs. Though this project had some limitation as a first step of making any Stair Climbing hand truck, it was a pioneer project. During the test run of this project, it was realized that it would capable of carrying heavy load without suffering any deformation or local fractures if it would go into real world production at an ideal scale. Though the initial cost of the project seemed to be higher but more accurate manufacturing would shorten this.
Stair climbing hand trolley , Prajan Pradip Gondole , Kamlesh Diliprao Thakre in april-2015 , Published in Journal of Emerging Technologies and Innovative Research (JETIR)

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The large wheels necessary for this task make this method of stair-climbing somewhat undesirable. Also, the climbing motion produced by simply rolling over stairs is a jarring motion rather than a smooth one. In addition, the frictional force between the wheel and the edge of the stair must be sufficient to allow the wheel to grab and roll over the stair. A friction coefficient of too small a magnitude will cause the wheel to slip against the stair rather than climb.

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The stair-climbing hand truck is designed to reduce liability rather than increase it. Conventional hand trucks work well on flat ground, but their usefulness decreases when it becomes necessary to move an object over an irregular surface. Package deliverymen, for example, often find it necessary to drag loaded hand trucks up short flights of stairs just to reach the front door of a building. The entire purpose of using a conventional hand truck is to avoid having to lift and carry heavy objects around.

Stair Climbing Vehicle, Md. A. Hossain, Nafis A. Chowdhury, Rubaiat I. Linda in jan-2010 , Published in International Journal Of Research Publications In Engineering And Technology.

Lifting recurring loads like books, food grains etc. to store upper level, or even patients to move upper level is not easy job, especially where there is no lifting facilities (elevator).The project introduces a new horizon for the transportation of the loads over the stair. Most of the buildings of the country are structurally congested and unavailing of elevator facility so it is difficult and laborious to lift up heavy loads.

The stair climbing vehicle can play an important role in those areas to lift loads over a short height, like libraries, hospital, and in construction area. The vehicle, which can move upper level through strain, or run in very rough and rocky surfaces, is called stair climbing vehicle.

In the initial design, each wheel contained frame, a sun wheel and three planetary wheels. The planetary wheel was connected with the sun wheel through an idler. The purpose of using the idler was to rotate the planetary wheels in the same direction of sun wheel. Each planetary wheel was aligned in a straight line with idler and sun wheel. The straight wheel frame takes more thrust to tilt the wheel frame to engage next planetary wheel. The length of each arm is high and thus creates vibration and the vehicle would be unstable. In the present design, the wheel frame was made curve so that the front surface of the arm could not collide with the edge of the stair.Fig.2.1

## III. OBJECTIVES

- Design a 3D view and fabricate of stair climbing trolley
- The task is mainly focussed towards helping small scale industries and hospitals
- The equipment is designed with tri wheel ,bearings ,motor, chain sprocket and battery
- The idea is to provide the equipment with a reasonable cost to the industries and hospitals to avoid use of lift
- The developed product is intended to reduce the overall investment on industries
- Minimize the use of electricity

## IV. METHODOLOGY

The stair-climbing hand truck is designed to reduce liability rather than increase it. Conventional hand trucks work well on flat ground, but their usefulness decreases when it becomes necessary to move an object over an irregular surface. Package deliverymen, for example, often find it necessary to drag loaded hand trucks up short flights of stairs just to reach the front door of a building. The entire purpose of using a conventional hand truck is to avoid having to lift and carry heavy objects around.

Lifting a hand truck up the stairs defeats the purpose of the device, since the user must provide enough upward force to lift the entire weight of the cart and its contents. Furthermore, the geometry of a hand truck makes it nearly impossible to lift with one's legs, as is the proper form. Considerable strain is placed on the back muscles and the risk of operator injury is sharply increased. The pulling up of a standard hand truck up the stairs results in a bumpy and jarring

motion. This motion may damage the items loaded on the hand truck or cause them to fall off entirely. A hand truck that could climb stairs without requiring the user to lift would improve the safety of moving heavy objects over irregular surfaces.

In our project, we are designing and fabricating normal hand trolleys with Tri-Star wheel in order to enable the trolley to move up or down the stairs. And also by giving the battery powered motor to the wheel reduces the much manual effort.

By switch on the motor to run. By using gear train mechanism the power of motor is transferred from one shaft to another by gear and pinion mechanism. Here driving shaft is the motor shaft and driven shaft is the working shaft, when this shaft rotates a turning moment is created to rotate the wheel. Due to this the tri-wheel cluster will rotate and third wheel which is idle in the air lands on the next stair. This is the way how a stair case load carrying mechanism works**.**

## V. OUTCOME OF PROJECT

- A complete manually operated and Ease of use
- Less complicated with fewer components leads to Ease of maintenance and Low complexity of components
- Ultimate objective is to benefit to small scale industries with less cost utility equipment
- Development of Durable product to small scale industries and hospital

## VI. DESIGN CALCULATIONS

LOAD ON THE AXLE

1. Length of the axle=0.44m
2. Distance between welds =0.40m
3. Load applied/carried =30kg (distributed equally by the welds to the axle) =15kg through each weld =147.15N
4. Weight of the trolley =20kg (uniformly distributed throughout the axle) =196.2N
5. Neglect the over hang beyond welded points since the wheel provide only negligible reaction
6. From equilibrium equation ΣF =0
    i. and ΣM =0
7. Find reaction at the supports,
    a. R1=190.314N ; R2=190.314N
8. Calculate the maximum bending moment for the beam,
9. Considering FOS=1.5
10. M(max)=10.07N-m
11. Bending equation,
12. M/I =σ/Y
13. 10. Substituting M(max)=10.07N-m
    i. I = (πr^4)/4
    ii. Y =D/2
    iii. σ = 3.8N/(mm^2)
14. 11. Youngs modulus of mild steel of mild steel is 200gpa
15. 12. Thus, the allowable bending stress for the given material is
16. 165 N/(mm^2)
17. 13. The calculated bending stress for the material is within the
18. Allowable bending stress for the material,
19. 14. Thus the design is safe.

## VII. CAD MODELS

1. MODEL

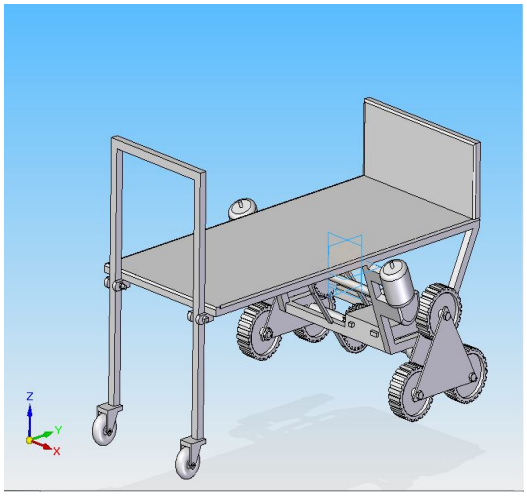

**Fig.1 Model**

2. Front view

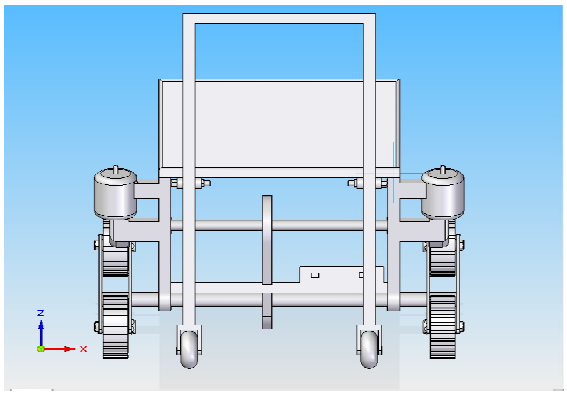

**Fig.2 Front view**

3. Top view

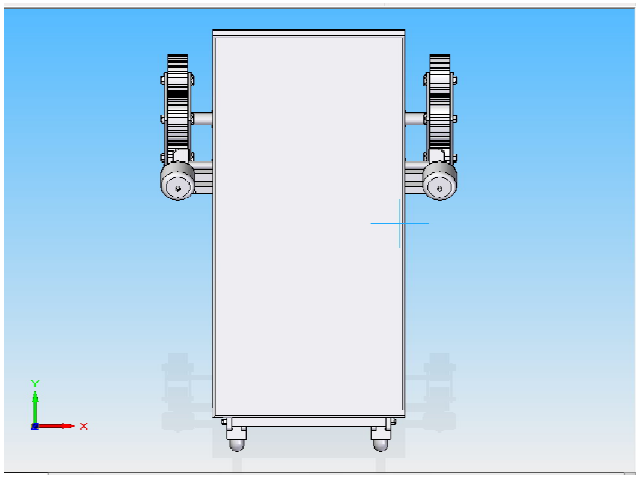

**Fig.3 Top view**

## VIII. RESULTS

- This is machine used for transporting the goods on the stairs
- This machine will be helpful for small scale industries and hospitals
- The machine is simple in construction as there is not so much complication in design.
- The machine is designed in such a way that it will require minimum space to install.

## IX. CONCLUSION

Though this project had some limitations regarding the strength and built of the structure, it can be considered to be a small step forward, as far as Stair Climbing Vehicles are concerned. During the test run of this project, it was realized that it wouldn't be a bad idea to consider this design for carrying heavy loads up the stairs. This product will be well acclaimed if it can be commercialized to suit the needs. Though the initial cost of the project seemed to be higher but more accurate manufacturing would shorten this.

As far the commercial aspects of this product are concerned, if this product can be fully automated and produced at a lower cost the acceptance will be unimaginable. Presently, there are no competitors for such a kind of product in our market.

- Doing better work with lesser effort has been the main objectives of human beings in any field.
- The main aim of the project is stair case climbing mechanism for load carrier with decreasing effort.
- By taking the main project as platform we try to present mechanized stair climbing load carrier with reducing effort.

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