DESIGN AND FABRICATION OF STAIRCASE 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 Staircase climbing hand cart which can carry heavy objects up the stairs with less effort compared to carrying them manually. It also endeavors to study the commercial viability and importance of such a product. Several designs were conceived that would allow a non-industrial hand trolley to travel over stairs, curbs, or uneven terrain while reducing the strain on the user.

In our project, the trolley is equipped with Tri-Star wheels which enable us to carry load up and down the stairs. It also eases the movement of trolley in irregular surfaces like holes, bumps, etc..

KEY WORDS: *Tri-star wheels, hand trolley, stair climbing hand cart, nonindustrial trolley*.

INTRODUCTION:

Nowadays, mechanical artifacts are commonly found in our daily life. They are currently used in many fields of applications such as office, hospital operation, industrial automation, military tasks and security systems. It is not difficult to observe that mechanical designs play an important role in assisting human tasks.

Stairs are one of the most commonly faced mobility challenges for robotic applications. With the inspiration from the Industrial Center of the Hong Kong Polytechnic University, our group has been involved in a project to design and develop a mechanical STAIR-CLIMBER that can climb up and down the stairs in a stepwise and safe manner.

After studying various options it was decided to build a trolley 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

HAND TROLLEY:

A hand trolley is a small transport device used to move heavy loads from one place to another. It is a very common tool used by a large number of industries that transport physical products. Also called a hand truck or a dolly, the hand trolley is often used by stock persons who arrange and restock merchandise in retail stores. When used properly, trolleys can protect people from back injuries and other health problems that can result from lifting heavy loads.

TYPES OF 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.

WHEELED TROLLEY:

Wheeled trolleys made from stainless steel are the most common type of hand trucks used. These are used in places with heavy loads to move, like retail stores and factories, and typically have wheels made out of stainless steel as well. Welded steel and metal wheel trolleys are typically much more lightweight and are often used to carry lighter materials.

Those with a frame and wheels made of a metal alloy are heavier and sturdily made. Trolleys of this type usually have a wider platform for oversized loads. Metal alloy hand trucks are typically used to transport heavy products, such as items made of steel.

FOLDING TROLLEY:

A folding trolley is another type of hand tool, and is often made of rust-proof aluminium. It is also lightweight but is usually able to carry heavy loads, and can fold to take up less space when not in use. This feature also allows it to be easily transported to places where it is needed.

GARDEN TROLLEY:

The garden trolley is a maneuverer with the use of a pull handle. Garden trolleys tend to have narrow profiles so that they will fit easily on paths and walks without damaging plants. These are designed so that they are capable of lifting both dry and marshy loads which are most commonly found in gardens.

KITCHEN TROLLEY:

A kitchen trolley is a serving cart that can also be used for storage. It is designed that it has more than one section in it which enables people to carry various utensils and for various purposes.

SACK TROLLEY:

Sack trolley or Sack barrow is a fairly generic term describing a range of light, single operator hand trucks or trolleys used to move cartons, feed and grain sacks, and other light, stackable goods. Lots of different materials are used to make sack trucks. This includes high impact plastics, tube steel, aluminium steel, and aluminium excursion.

PROBLEM IDENTIFICATION:

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 oftoo 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 wheels develop flats spots and other irregularities on their exterior surfaces which make it difficult for the operator to maneuver the truck after extended use.

LITERATURE SURVEY:

OVERVIEW:

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. We have done market survey to collect the information regarding the utility of this .machine for small scale industries and other cottage industries customers. Also we carried away the market survey to see the raw material cost along with the finished product of the material required to fabricate our unit. We referred different books and journals along with the periodicals, industrials magazines to collect the information regarding our unit.

1. HANDELING LARGE ,BULKY.OR AWKWARD ITEM

The information searched on the handling large, bulky or awkward item give the information that when implementing risk controls at your workplace, you must look at your hazards, assess the risk, and determine whether the risk can be eliminated or reduced as far as reasonably practicable. The *Occupational Health and Safety (OHS) Act 2004* (s. 35) from 1 January, 2006, will place a duty on employers to consult with employees, so far as is reasonably practicable, in this process. Your health and safety representatives (HSRs) and employees will often be the best source of information and ideas on workplace design, layout, work methods and new technology when looking at ways to manage risks arising from handling large, bulky or awkward items. They will also be able to identify whether the proposed solutions will lead to the introduction of other risks.
You should also consider involving people such as designers, consultants, suppliers and purchasing officers, particularly when looking at ways to influence what occurs in the supply chain upstream and downstream of your workplace. The criteria for „large, bulky or awkward" items used in this Guide are items weighing 25kg or more and having one dimension 500mm or more. However, you may find the principles in this Guide will help make your work safer, even if the items you handle do not fit thesecriteria. In looking at ways to eliminate or reduce the risk in consultation with your employees, you should consider the three elements below. Bear in mind that these are not necessarily discrete steps, and that the most practicable method to control risks in your situation may involve a combination of redesigning or repackaging, using mechanical aids, and/or team lifts.
It is expected that in most cases, team lifting would be the least preferred or a short-term solution, or used to supplement the handling of items where other ‚non-manual handling methods have been investigated and applied where reasonably practicable. The information contained in this Guide is indicative and will not necessarily cover every workplace situation. Consideration must always be given to the Occupational Health and Safety *(Manual Handling)* Regulations 1999 *('Manual Handling Regulations 1999')*, when ascertaining the most practicable risk controls for your particular situation. These mechanisms are made by INDG398 and published in10/13. But in these mechanisms the disadvantage is that it is very large in construction so in our project we overcome these problems and made very robust mechanism.

2.STAIRCLIMBING TRANSPORTER:

The information searched on stair climbing transporter gives us the information that it is a combination of rigid or restraining bodies so shaped and connected that they move upon each other with definite relative motion. A machine is a collection of mechanisms which transmits force from the source of power to the load to be overcome, and thus performs useful mechanical work. Robotics is the area of automation which integrates the technology in variegated fields like mechanisms, sensors & electronic control systems, artificial intelligence and embedded systems. The synthesis of mechanisms is the very first step in any robot design depending upon its application. These mechanism is very costly so we make a very cheaper transporter.

3. LIFTING AND HANDLING AIDS:

The information searched on Lifting and handling aids gives the information that how to transport the load from one place to another. Frequent and heavy lifting and handling can cause back injuries. But using lifting and handling aids can remove or reduce that risk and keep workers healthy and at work. This guidance is intended for managers, employees and their representatives and others involved in the selection of lifting and handling aids.In these mechanism they made a simple traully which help to transport the large load but it cannot help to carry a load from stair so in our project made atraully which help to carry a load from stair easily.It make very noise at working site these problem is solve in our project.

Fig 1.1Side view of on trolley

Fig 1.2 [SW isometric view of on trolley]

Fig 1.3 [Ball bearing]

METHOLOGY:

When a man will pull the handle of truck, the wheel „A" will fix in corner which is made by the ground and step 1. After that when man will pull handle again the wheel „B" will fixed in corner which is made by step 1 and step 2. Again man pull the truck, the wheel „C" will fixed to the position at corner of step 2 & step 3 and so on. This working is repeated again and again while climbing on stairs vice versa.

DESIGN OF EXPERIMENT:

OVERVIEW :

We made stair climbing hand truck of

- Height – 4 feet.
- Lower frame 38 X 38 cm.
- Length of each arm of trigonal geometry 15 cm.
- Diameter of shaft 15 mm.

TECHNICAL DATA:

Following part are used in the fabrication of project work named "stair climbing hand truck".

- Square bar cast iron pipe.
- Round bar shaft SAE 1030
- Rubber rest.
- Caster wheels (industrial rubber).
- Iron plate.
- Long guzzon pin.

We use following data while designing our hand truck:

SHAFT:

In general, a ROTATING member used for the transmission ofPower.

AXLE:

Generally a STATIONARY member used as a support for rotating Members such as bearings, wheels, idler gears, etc.

SPINDLE:

A short shaft, usually of small diameter, usually rotating, e.g. Valve spindle for gate valve, but consider also the headstock spindle of a lathe, which is quite large and usually has a wholeright through its center.

STUB SHAFT:

A shaft which is integral with an engine, motor or prime moverand is of suitable size, shape and projection to allow its easy connection to other shafts.

DESIGN STEPS:

ASSUMING DATA:
N= 43 RPM
Weight=W=539N
Power=P=Weight * velocity
P=539*v
P =539N * V (m/s)
But, V= (ΠDN)/60
Here assume, D=0.01m
V= (π*0.01*43)/60
V=0.0225 m/s
Therefore, P=539*0.0225
P=12.12 Watt

DESIGN OF SHAFT:

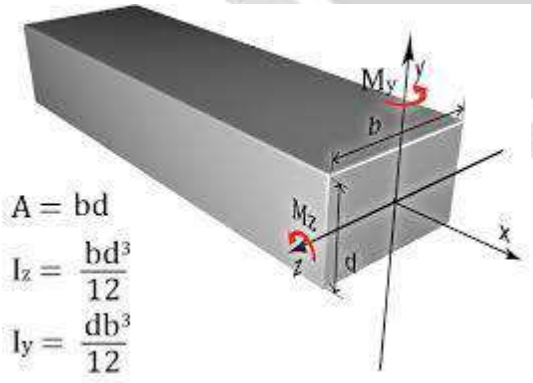

Fig 1.4 Design of shaft

Step: 1

Design Torque, T_d, N-m
$T_d = (60*P*K_I)/ (2ΠN)$
Where, K_I=1.0
T_d= (60*12.12*1.0)/2π43

T_d=2.69 N-m

Step: 2

Reaction calculations:

ΣFY =0

V_A-270sin45-270sin45+VD=0

V_A+VD=381.83N ……. (1)

Taking moment about A,

ΣM_A=0

270sin45*80+270sin45*380-VD*460=0

V_D=161.03N

Put this value in eqn 1

V_A+161.03=381.83

V_A=220.8N

HORIZONTAL BENDING MOMENT CALCULATION:

Taking B.M. about A

M_A=0

B.M. at B, M_B

M_B=0

B.M at C, M_C

M_C=270cos45*300

M_C=57275.64N-mm

B.M. at D, MD

M_D=270cos45*380+270cos45*80

M_D=15764.42N-mm

VERTICAL BENDING MOMENT CALCULATION:

Taking V.B.M at A, V_A

V_A=0

Taking vertical B.M at B, V_B

V_B=220*80

V_B=17664 N-mm

Taking V.B.M at C, V_C

V_C=220*380-270sin45*300

V_C=26628.35 N-mm

Taking V.B.M at D, V_D

V_D=220*460-270sin45*380-270sin45*80

V_D=13745.33 N-mm

RESULTANT BENDING MOMENT CALCULATION:

R_{MA}=0

R_{MB}= $(02+17664_2)_{1/2}$ =17664 N-mm

R_{MC}= $(57275.64_2 + 26628.35_2)$ =63163.02 N-mm

R_{MD}= $(15764.422 + 13745.33_2)_{1/2}$=20915.33 N-mm

Taking maximum resultant bending moment:

M=R_{MC} =63163.02 N-mm

MATERIAL FOR SHAFT:

Assume shaft material as SAE-1030

S_{ut}=527 N/mm_2

S_{Yt}=296 N/mm_2

S_{ys}=183 N/mm_2

Assume factor of safety is 1

Bending stress, 6_b=S_{yt}/F.O.S

=296/1

=296 N/mm_2

$\underline{T}$MAX=0.30 S_{yt}or $\underline{t}_{MAX}$=0.18 S_{ut}

=0.30*296 or =0.18*527

=88.8 N/mm_2 or =53.28 N/mm_2

So take

$\underline{t}_{MAX}$= 88.8 N/mm_2

For solid shaft,

$\underline{t}_{MAX}$=16*10_3/Πd_3 * (M_2 + $T_{D2)1/2}$

88.8==16*10_3/Πd_3 * $(63.1632+2.69_2)_{1/2}$

d=15.36 mm

ADVANTAGES:

- Easy to load carrying
- To used for domestic work were elevator not present
- To reduce labour cost
- They are cheap to buy

DISADVANTAGES:

- The product we made carry only one heavy objects at a time
- Physical effort is more

SCOPE OF PROJECT:

- To reduce man power
- To reduce labour cost
- Easy to carrying loads
- No need any energy source
- Easy to handle

APPLICATION:

- It is used for carring loads in stair.
- To used for domestic work were elevator not present .

CONCLUSION:

The project work thus carried out exhibits expected result, and carried load across the stair very easily thus climbing across stairs transportation of goods very easily.

This type of project work can be of very much use for industrial use, dispatched with new household.

New chair with three mechanisms like, starwheel and simple driving mechanism will help to prepare a chair that will be able to climb chair without anyone's assistance or with assistance. This chair will helpful to climb chair with a particular height and width. According to the dimensions of stairs we can change dimensions of chair parts.

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