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Fabrication of Stair Climbing Trolley for Material Handling

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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 trolly 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.

I. INTRODUCTION:

Lifting recurring loads like books, food grains etc. to store upper level, especially where there is no lifting facilities (elevator). More over, in most of the buildings in the world does not elevators or escalators. In this case human labors are considered to be the only solution. Labor is becoming costly in the developed countries, where growth rate is getting negative. This problem can be solved if a trolley can lift loads while traveling through strains.

The project introduces a new option for the transportation of the loads over the stair. The vehicle is designed in such a way that it has three wheels on each side. They are set in triangular pattern. This work focuses on the maximum ergonomically beneficial to human being. The present project related to load carrying equipment of a type that is automatically operated of moving upwardly and downwardly on flight of stairs. Load carrier is a wheeledmechanism device, is generally used to carry a loads. It is use to reduce human efforts.

The objective here is to design and manufacture a multi functioned trolley that serves different purposes which includes moving on the floor and climbing the stairs. In the early designs, a single wheel or a set of wheels set on each side is merely capable of moving the vehicle on flat surfaces. Here the modelling is done in such a way that it has tri wheels on every facet that enables shifting the load over stairs. It comprises of two sets of three wheels attached to a frame at 120 degree, positioned at the bottom of the trolley which works as a single unit. Handles are provided to give support to the frame and apply the human effort either to push or pull the trolley. The size, shape, selection of the frame, position of the trolley changes as per the working load and requirement. With bearing support, the wheels are mounted on the shaft. Material selection is also a main consideration. Stainless steel is used to carry heavy loads and mild steel is preferred for moderate loads.

The various applications may be carrying bundles of answer sheets in a school or a college, carrying furniture in different buildings, in hospitals, carrying electronic items in houses and offices. So there should be a way to carry the object through the stair in a more comfortable and tireless manner without forcing the user to apply more force. Herecomes the application of stair climber material handling.

II. OBJECTIVE :

1. To design the different component of stair climbing trolley.
2. To fabricate the component of trolley frame, wheel arrangement, bearing and assembled them.

III. LITERATURE SURVEY :

Pratik H. Rathod et al. [1] : Designed and fabricated a hand truck which climb stair with less effort which is useful for library, hospital, regular goods carrier etc. the main modification in this truck where made at wheels using plat surface roller plat attached instead of traditional wheel frame. The mechanism based on retched arrangement mechanism. The maximum bending moment was calculated. The inclination of 44 degrees plays a major role which covers more than 90% of all stairways within this limit. There is an optional maximum inclination warning alarm that alerts the operator of an inclination of more than 44 degrees. When truck operated with exceeding the limit there should be taken the necessary safety precautions.

Md. A. Hussain et al. [2] : Designed and manufactured a stair climbing vehicle using modified form of frame arrangement i.e a curved wheel frame which move on rough surface. To address several technical issues in designing this vehicle is stability and maintain high speed at vehicle wheel arrangement while climbing stairs. The frame arrangement consists of sun, planetary, idler wheel which are assembled to the shaft which reduces application of load. However, the steepness of the stairs is also the important concern of this study. The vehicle has four set of wheels arrangement to support its weight when it moves over the flat terrain. Each wheel frame consists of three sub-wheels attached with the sun wheel through three idler gears.

Ashish Singh et al. [3] : Worked on four-wheeled robot will have the capability of climbing the stairs of height equal to its diameter. It will possess maximum gripping capacity and stability during motion in rough terrain owing to the 4 differential driven wheel configurations. The main

 goal of this investigation involved within this project such as the robot should be upgradeable with a variety of application sensors, e.g. cameras, thermal vision, or chemical sensors. To be usable in any search and rescue or security application, the robot has to be operational without changing batteries for at least two hours.

Raj Kishor Kumar et al. [4]: Investigated on stair climbing functionality is embedded in the design through its structure and mechanism. The product mainly consists of modules viz. seat, links and frame. Anthropometric measures are considered in the dimensioning of seat. Focus is laid on different parameters such as form, functionality, technology and architecture of the product. The design is validated by developing Digital Mockups of individual parts are generate in PRO-E Creo software and are assembled to form the final product. Necessary simulations of theproduct are generated in virtual environment of PRO-E Creo software. The physical and focused prototype indicating the structure and functionality is developed using thermocol material. Here wheel carriers are made in RP (Fused Deposition Modelling) using ABS (Acrylo Butadiene Styrene) material. Wheelchair is embedded with some additional features like integrated commode facility, after gathering costumer requirements from different subjects

P. **Jey Praveen Raj et al. [5]** : Designed device such as hand trolley used to relieve the stresses of lifting while on flat ground. However these devices usually fail when it comes to carrying the load over short fleet to carry heavy objects up the stairs with less effort compared to carrying them manually .The main objective of the project is to find an efficient and user friendly method of carrying various objects through stairs using minimum effort from the user and to also provide a smooth movement while climbing the stair. Under this project we have manufactured a stair climber with tri lobed wheel frames at both sides of the climber and three wheels on each sides are used in the tri lobed frame. The wheel assembly is rotated by a gear- motor mechanism where a DC gear motor is used to provide the necessary power for rotation and a pinion-gear mesh is used for reducing the rotating speed of the wheel. The motor is connected to a lead acid battery of similar ratings and they are in turn connected to DPDT switch.

Q. **Roshan Alaspure et al. [6]** : Designed and fabricated a Stair Climbing Wheel Mechanism which can be considered as Alternate for lifting goods in such a way that it can be climb a stepped path with its modified wheel structure using manual metal arc welding (MMAW) or stick Welding. Anelectric current is used to strike an arc between the base material and consumable electrode rod orstick. The electrode rod is made of a material that is compatible with the base material being welded and is covered with a flux that gives off vapors that serve as a shielding gas and provide a layer of slag, both of which protect the weld area from atmospheric contamination.

R. P. P. Gondole et al. [7] : Fabricated a stair climbing hand trolley with proper dimensions of Height 4 feet, Lower frame 38 X 38 cm, Length of each arm of trigonal wheel axial geometry 15 cm, Diameter of shaft 15 mm. The major components used to fabrication process are square bar cast iron pipe, Round bar shaft of SAE 1030, rubber rest, caster wheels (industrial rubber), iron plate, long guzzon pin. Mathematical calculations are made to this work to exhibits expected results and carried load across the stair very easily thus climbing across stairs transportation of goods very easily.

IV. METHODOLOGY :

1. To fabricate our trolley first we have designed a cad model. "To craft our trolley, precision begins with the meticulous design of a CAD model, capturing every detail in a digital blueprint. This foundational step ensures the seamless fabrication of our innovative and high-performance vehicles."
2. Selected the material which suitable model. “Choosing the appropriate material is crucial for an effective model. Consider factors such as durability, conductivity, and cost to select a material that aligns with the specific requirements of your model.”
3. Construction and fabrication of the wheel and the trolley frame. Inspect the wheels and frame for damage, ensure the load is secure before movement.
4. Assembly of the different component.
5. Testing and checking the safety consideration do not exceed the trolley weight capacity and carry proper weight for lifting the material from stairs.

Requirements: **[Components of Trolley]**

Sr. No.	Name of Components
1.	Plummer Block Bearing
2.	Rubber Wheel
3.	Shaft
4.	Square Rod
5.	Metal Sheet

Design Calculation:

Stair climbing trolley is design to lift a load of 150kg. The hollow shaft connecting the two tri-star wheels is made of mild steel and the dimeter is designed in such a way that shaft overcome the bending stresses acting on it. So it will act a simple supported beam

Total weight F = 150KG = 1417N

Under equilibrium condition sum of all vertical forces is zero,Calculation of end reaction at support RA - 735.5 – 735.5 + RB =0

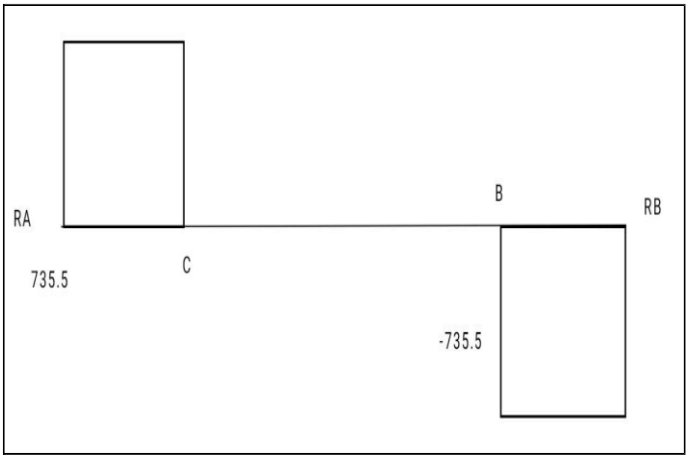
RA + RB = 1471N

Taking moment about A ΣMa = 0

(100 * 735.5) + (350 * 735.5) - (RB * 450) = 0

RA = 735.5

RB = 735.5



Shear force at A = 2942 N Shear force at C = 0 N Shear force at D = -2942 N Shear force at B = O N

Bending Moment diagram :-

Bending Moment at A = 0 N mm Bending Moment at B = 0 N mm

Bending Moment at C = 735.5 X 100 = 73550 N mm Bending Moment at D 735.5 X 100 = 73550 N mm Comsider the maximun bending moment

M = π\32 x d3 x σb (considering F.S = 2)

Where, σb = σyt / FOS

Yield stress σyt = 350 N/mm^2 - (from data book) Therefore σb = 350/2 = 175 n/m^2

73550 = π\32 x d^3 x 175 D= 16.23 mm

D=17 mm

Power Calculation

Weight of the material:

W=150kg

Therefore, W=150×9.81 W=1471.5N

Hight to be climb :

Convert the hight of the stress force from millimeter to meter H = 200mm – 0.2m

Work done :

Work Done Against Gravity:

The work done (Wd) to lift the load can be calculated as:

Wd = *W*x*h* Wd=1471.5x0.2 Wd=294.3J

Bearing :

Plumming block bearing Given,

Plumming block bearing Fa=735.5N, Fr=1471.5N,

Average life = 100 million

∴ e = 0.25, x= 0.56,

y= 1.6

Fa/fr = 5.075 x 0.56 = 1.6

∴ fe = (x fr + y fa) KS KO KP KR KO = 1.0

KP = 1.0

KR = 1.0

KS = 1.5

∴ (0.56 x 144.92 + 1.6 x 735.5) x 1 x 1 x 1 x 1.3 Fe = 1635.34 KN

Life of Bearing

100 x 10^6 = (c / 1635.34)$^{10/3}$ x 1.0

C = 7590.51

Bore no= 04

Bore diameter= 20

V. CONCLUSION:

The primary objective of bearing heavy load like 120-150 kg is achieved during testing. The performance is slightly complicated when the straight frame was tested for varying step sizes. But when tested with Quasi-static frame, the trolley exhibited greater performance even for stairs with different dimensions. Static structural analysis demonstrates that it is capable of moving heavy loads with less deformation and without any fracture.

Usually, its minor shortcoming is its noise. But it is very ergonomic to operate on stairs, inclines and uneven surfaces. It is efficient, economical and easy to assemble. It is proposed for material handling. Several advantages with this machine are effortless transportation of Heavy luggage, furniture from one floor to other. Bricks of different models and sizes can be easily carried in construction sites. The overall performance of the vehicle is observed as high with uniform steps.

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