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DESIGN, MODELLING OF COMPACT STAIR CLIMBING HAND CART

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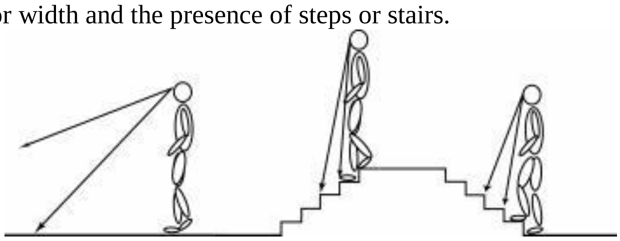
Abstract: A hand cart is a small transport device used to move heavy loads from one place to another. It is a very common tool used by a large number of industries that transport physical products. Also called a hand truck the hand cart is often used by stock persons who arrange and restock merchandise in retail stores. When used properly, carts can protect people from back injuries and other health problems that can result from lifting heavy loads.
Keywords: Tri-Star wheel, Tri-Star wheel Hub, wheel frames

I. INTRODUCTION

A typical handcart consists of two small wheels located beneath a load-bearing platform, the hand cart usually has two handles on its support frame. These handles are used to push, pull and maneuver the device. An empty hand cart 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. Stairs provide a means of ascent or descent. Stairs represent spatial efficiency, and minimum risk in regard to slipping compared to slopes, however stairs have come to be virtually representative of "barriers". The term "barrier free" is increasingly used in a broader context, however the basic concept originated from reference to an environment that did not impede access to a manually propelled wheelchair. Major impediments to wheelchair access have been and continue to be consideration for width and the presence of steps or stairs.



(a) Flat (b) Stair descent (c) Stair ascent
Fig. 1 Approximate areas of focus while walking on the flat and up and down stairs

NEW CONCEPT
The stair-climbing handcart is designed to reduce liability rather than increase it. Conventional handcart work well on flat ground, but their usefulness decreases when it becomes necessary to move an object over an Irregular surface.

TRI-STAR WHEEL DESIGN
The Tri-Star wheel was designed in 1967 by Robert and John Forsyth of the Lockheed Aircraft Corporation. They were first developed as a module of the Lockheed Terra star, a commercially unsuccessful amphibious military vehicle.

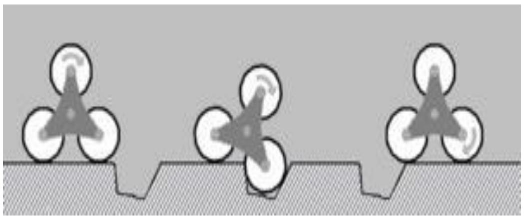


Fig 2 Diagrammatic representation of Tri-Star wheel

A. Conceptual Sketches
To make this design realistic, we decided to make a working prototype and test the ease with which it moves up stairs and whether it requires less force than a single wheel design. The aesthetics, final design and choice of material were chosen and developed using functional decomposition.

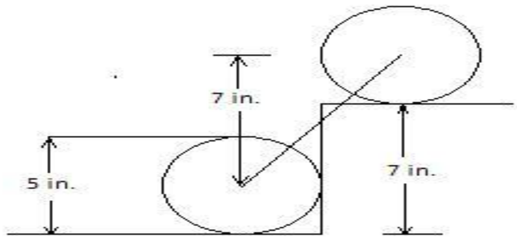


Figure 3: Shows the conceptual sketch

MATERIAL SELECTION
Material selection is a step in the process of designing any physical object. In the context of product design, the main goal of material selection is to minimize cost while meeting product performance goals.

FORCE ANALYSIS
The purpose of the force analysis was to determine whether the tri-wheel design would improve the force users would have to apply to the cart to pull it up multiple steps.

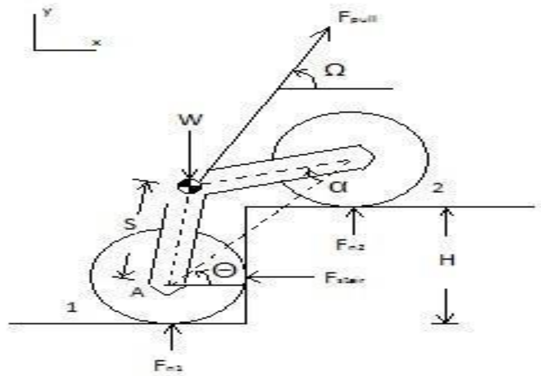


Figure 4: Tri-Wheel Analysis

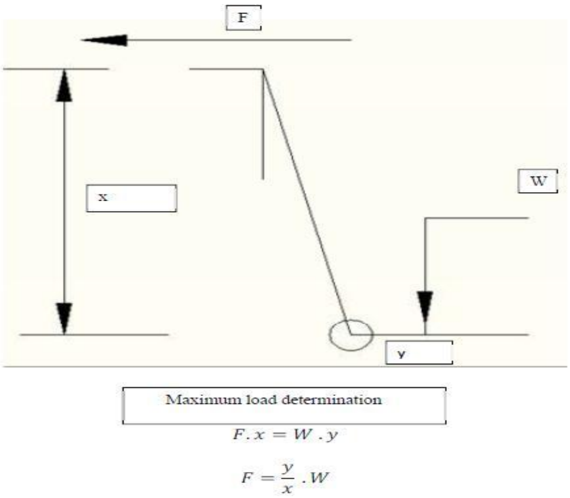


Figure: 5 Force Necessary to Pull the Trolley

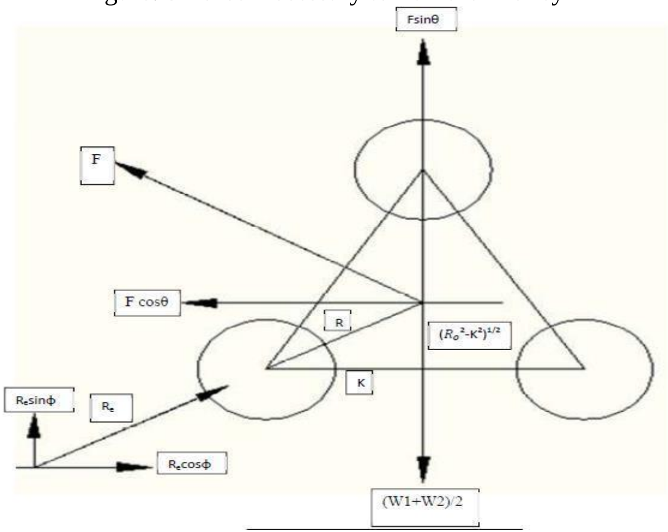


Figure 6:- Force Analysis on Wheel Frame

W1= weight of object to be carried.
W2= weight of the trolley.
Re = reaction force on one side.
F = force applied (on one lever).
Ro = distance of centroid from centre of wheel.
K = distance between centre of wheel and line of action of weight.

$$\left(\frac{W1+W2}{2} - Fsin\theta\right).k = Fcos\theta.\sqrt{R^2 - k^2}$$

$$R_e cos\varphi = Fcos\theta$$

$$R_e sin\varphi + Fsin\theta = \frac{W1+W2}{2}$$

$$R_e = \sqrt{(Fcos\theta)^2 + (\frac{W1+W2}{2} - Fsin\theta)^2}$$

$$tan\varphi = \frac{W1+W2-2Fsin\theta}{2Fcos\theta}$$

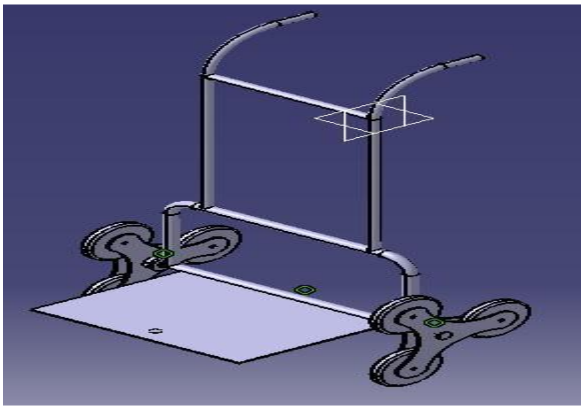


Figure 7 Isometric View of Cart.

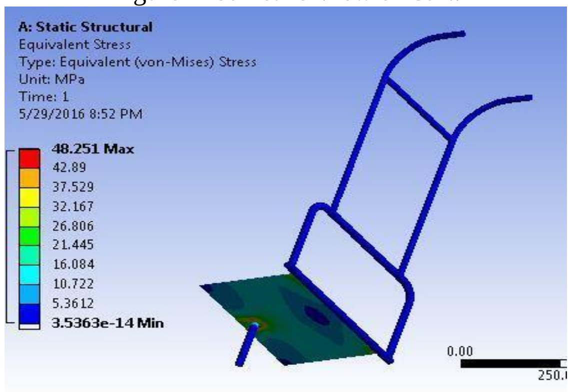


Figure 8.Stress analysis of Frame

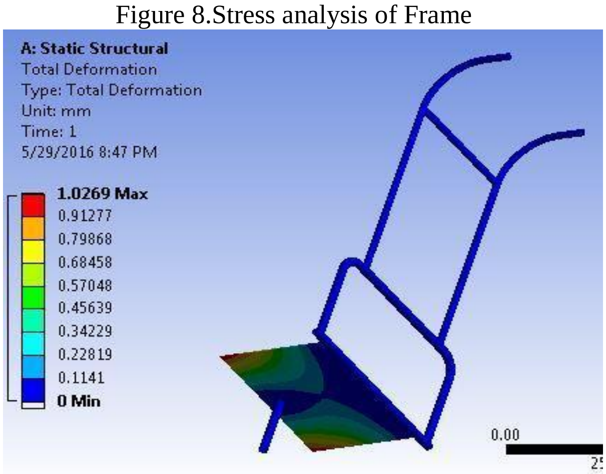


Figure 9. Total Deformation of Frame

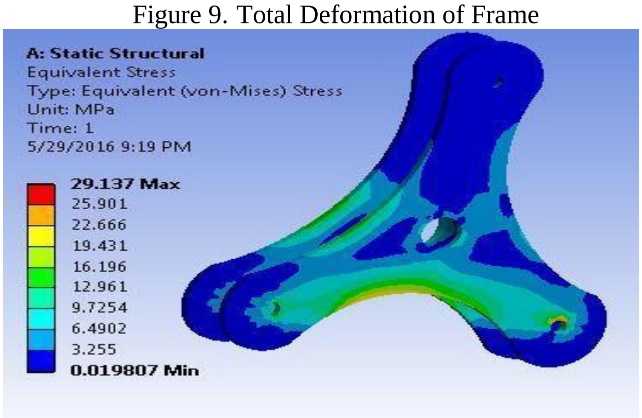


Figure 10. Stress Analysis of Tri Star Hub

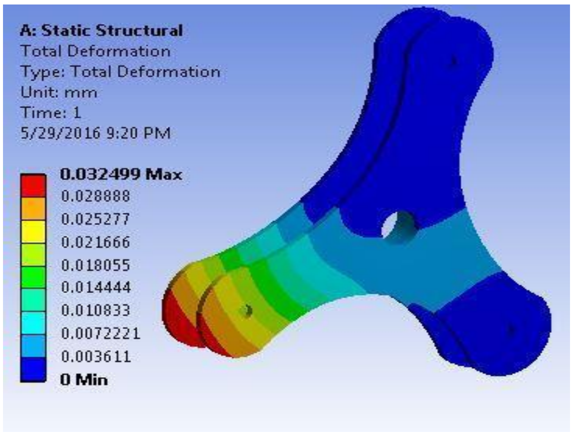


Figure 11. Total Deformation of Tri Star Hub

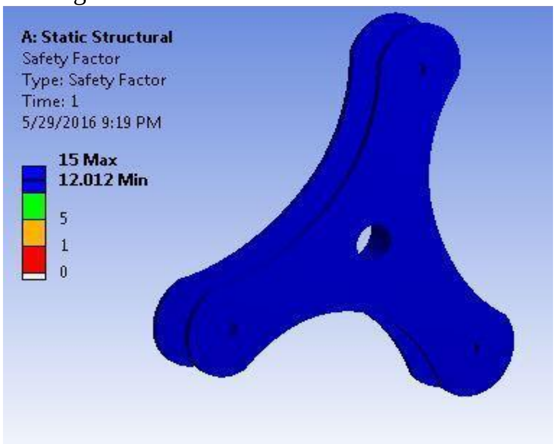


Figure 12 Factor of Safety

Manufacturing Process
[1]Gas cutting (Oxy-Fuel cutting)
Oxy-fuel cutting is a cost-effective method of plate edge preparation for bevel and groove welding. We have used this cutting to cut the measured lengths of hollow mild steel pipes and flat bottom plate as per our design.
[2] Pipe bending
human powered-tube bending process to bend two mild steel hollow pipes to make 90deg bent handles.

II. CONCLUSION

[1] 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 would not be a bad idea to consider this design for carrying heavy loads up the stairs.
[2] 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.

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