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Design, Analysis and Development of a Portable Trolley for Stair Climbing

Ajay Mahawadiwar

G. H. Raisoni University, Mechanical EngineeringDepartment, Saikheda, India
E-mail : ajay.mahawadiwar@ghru.edu.in, amahawadiwar@gmail.com

Abstract: The investigation proposes an inventive minimal effort setup of a stage that can without much of a stretch ascend stairs. This stage fills the need of a robot. The stage's structure can be used to define many variations, such as stair climbing and stair climbing trolleys for transferring materials. The driving wheels have a shape that perfectly matches the means' profile. Complex components are discarded. In this manner, this stage is advantageously relevant in the arrangements helpful for climbing staircases. The versatile plan additionally diminishes the space when not being used. The sliders given in the trolley, slides the articles on trolley and thus diminishes the human endeavors.

Keywords: staircase-climbing trolley, climbing staircases, portability, less space, less human effort

1. Introduction

In our daily lives, we might have run into situations where we had to carry a lot of different-sized items up and down stairs, particularly in places like offices, schools, colleges, hotels, industries, apartments, etc. where there might not be a lift or elevator available, it might be crowded with people, it might not have much room for carrying items, or it might be undergoing maintenance. Carrying different items up stairs by hand so frequently is incredibly exhausting and could result in injury. Since there are typically no lifts or elevators placed in buildings, the only option is to use human labor. We can't deny the fact that labour these days is expensive [1,2].

Sometimes even space is a problem when the trolley is idle and it will occupy some space [3]. The solution is, if a trolley (Fig.1 shows earlier designs) can lift loads while traveling through stairs and also be portable and at low cost. It would be convenient for people to use and thus reduce fatigue and space [4,5].

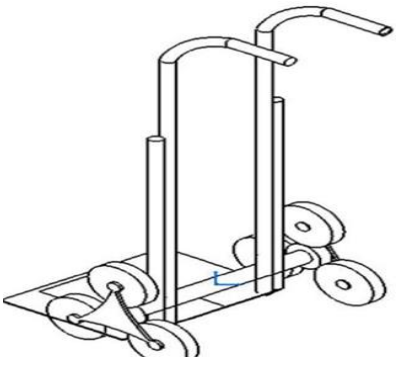

Figure 1. Trolley with tri-wheel [2]

In this project, a method for carrying goods up stairs is introduced. The tram has three wheels on each side thanks to its unique design. They are arranged in triangle shapes. And step-by-step levels have been added, which makes it a tool for multiple purposes. Mainly focused on ergonomics and fixes the problem of idle space covering. It also reduces human effort.

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I.1 Purpose of study

In day to day life people face many problems in carrying the weight on floor as well as stairs, it becomes more difficult for a female to carry load weather it's in industryor in a hospital or even on railway station. So to conquer the situations mentioned above and to find a solution, this study is performed and given the name design, analysis, and development of a stair climbing portable trolley. In this study, the trolley is so designed that it can carry loads on the floor as well as on stairs. It is provided with multi-stage slabs, which enable the features of portability and extension. The space occupation is also an issue nowadays for residential as well as commercial use. In this study this problem is also focused.

This study also focuses on ergonomics and reduces the stress of uneven lifting of weight. Mostly this happenswhen lifting load on stairs the posture of body is not correct which causes pain in certain body parts of a operator, thus a solution is required to solve the issue.

I.2 Project objective

- The main aim behind construction of this trolley isto reduce the efforts while taking the objects onstairs.
- Also to reduce the space when the trolley is not in use.
- As the name suggests it is portable which means when not in use it can be folded and carried around.
- It can be used for small purpose also.
- It can also form double decker structure if necessary.
- As given in name the project can also climb stairs.
- Analyze the above design to get a limit and a deformation point to use the project safely and use itefficiently.

2. Designing Model

2.1 Designing

The first step was designing which was done according to requirement of load that is to be carried on trolley. The design of trolley was made on the software calledAutoCAD, Fig. 2 and Table I, considering the size of load that is to be applied, initially the design of trolley was expected to be big since portability was also a priority and to decrease weight also to make the trolley climb stairs few adjustments should be considered. Thus the size of trolley should be decreased as bigger the trolley the more difficult it is to make it climb the stair, The size of stairs should also be considered.

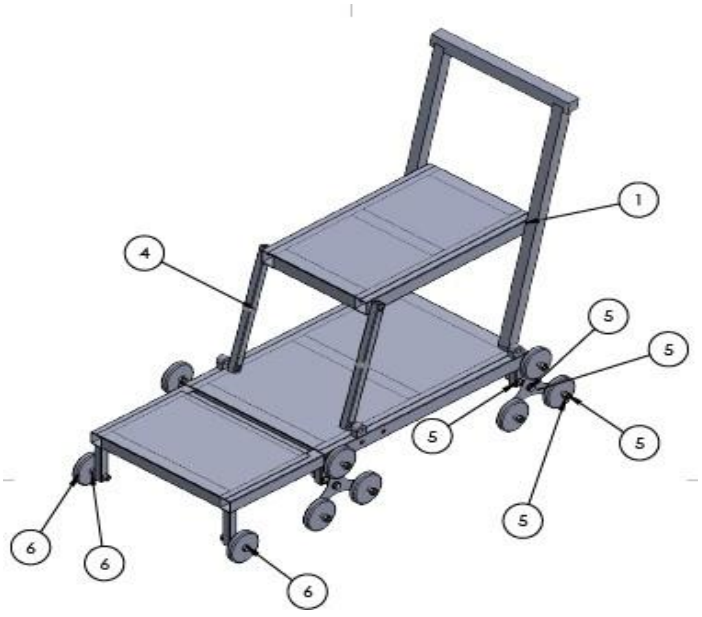
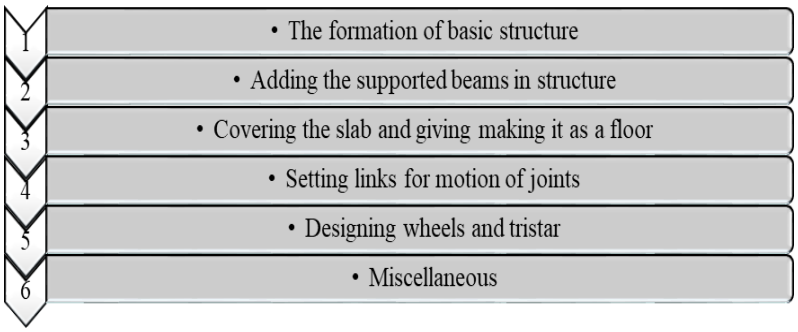


Figure 2. Proposed Design

Table 1. Parts of the Proposed Design

Item No.	Part Number	Quantity
1	Handle Bar	1
2	Bottom Base Assembly	1
3	Upper Base	1
4	Support Column	2
5	Tri-star Assembly	4
6	Front Base Assembly	1

The procedure for creating the design



3. Analysis and Evaluation

Weight analysis on the project is done on software named ANSYS Workbench, Figure 3.

Weight analysis is a necessary test that should be performed on any project as the project is based on bearing load it was the most important aspect of it. Weight analysis shows the maximum load that an objectcan bare also it tells about the points that will deform if load exceeds, it also shows the maximum limit that the object can bear. In this project each and every link has undergone analysis so as to get a limit and a deformation point to use the project safely and use it efficiently.

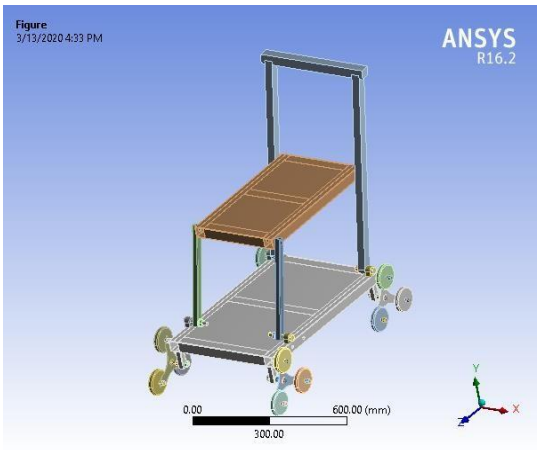


Figure 3. Geometry

3.1 Fixed supports

It can withstand a moment as well as vertical and horizontal forces. They are also referred to as rigid supportssince they restrict both translation and rotation. Accordingly, a structure only requires one fixed support., Fig. 4, to maintain stability. It is possible to satisfy all threeequilibrium equations.

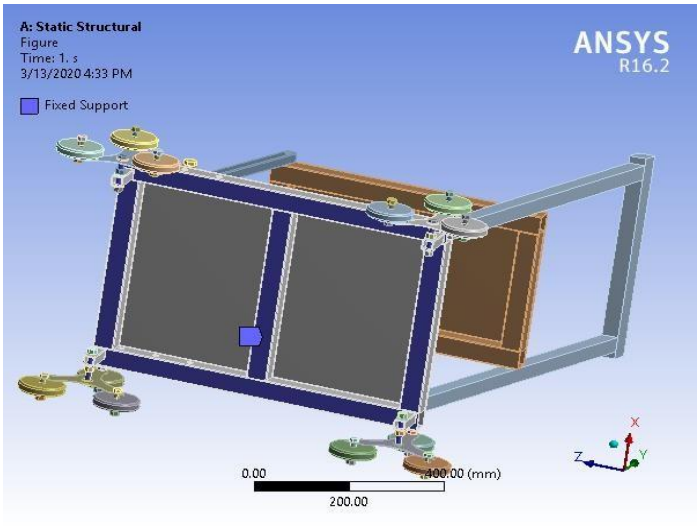


Figure 4. Fixed support

3.2 Static loading

This load remains constant throughout time. Static loads, shown in Fig. 5, are typically well specified in engineering and require less safety factor than dynamic loading. For instance, a static load on an overhead crane would be the constant weight of the foundation, structure, foundationblock, etc.

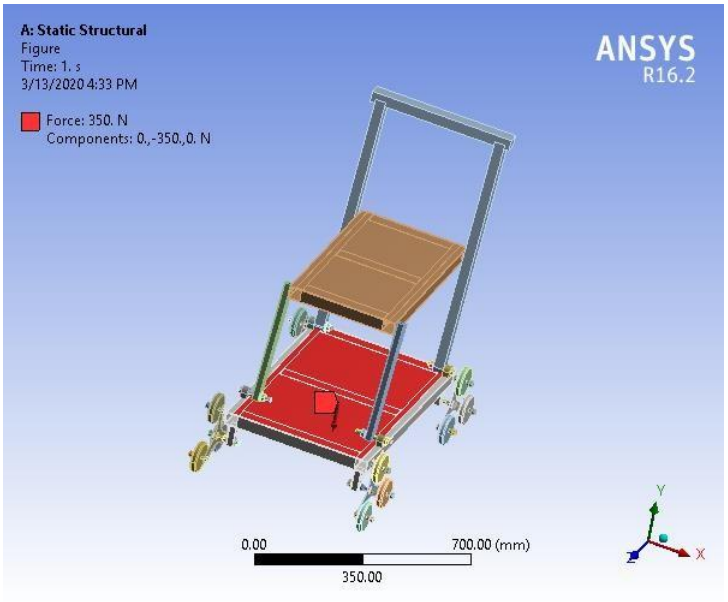


Figure 5. Static load

3.3 Maximum principle stress

When shear stress is taken into account as zero, it is defined as the normal stress measured at an angle (Fig. 6). Major principal stress is the maximum value of normal stress, and minor principal stress is the minimum value of normal stress. 2-D and 3-D are the principal stresses and asstated above these are the two different types.

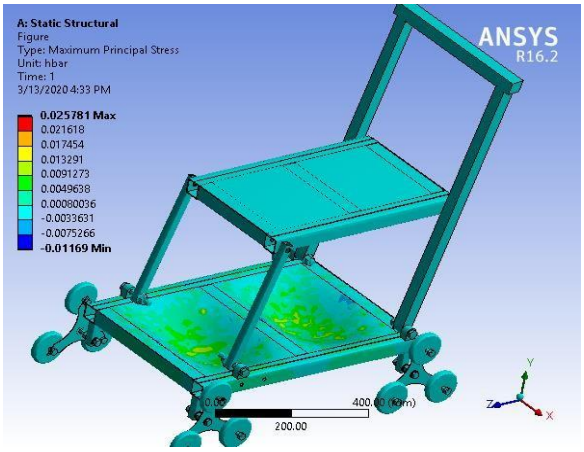


Figure 6. Maximum principle stress

3.4 Shearing stress

A force known as shearing stress, seen in Fig. 7, causes layers or pieces to slide against one another in opposing directions. The force acting on nut and bolt assembly pulling each other in opposing directions is an illustration of the shearingstress.

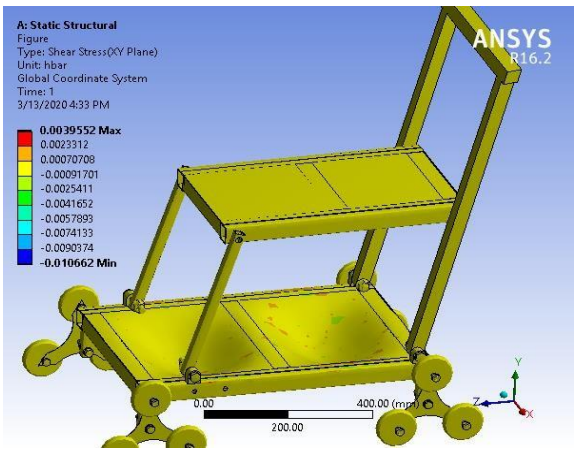


Figure 7. Shearing stress

3.5 Total deformation

In continuum mechanics, deformation is the change in a body's reference configuration to its present configuration. A configuration is a collection of all the positions of a body's particles, Fig. 8.

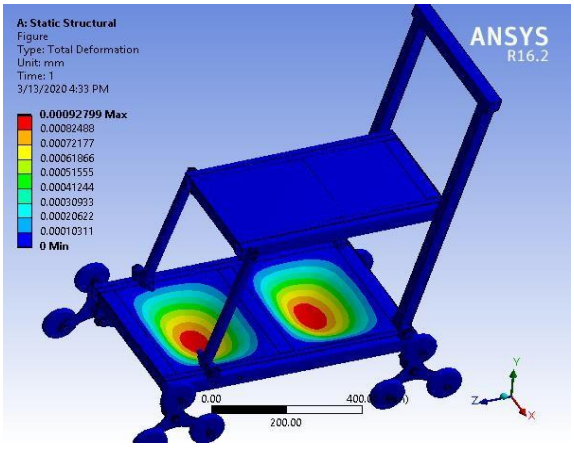


Figure 8. Total deformation

Change in the shape of a body caused by the application of a force (stress). Deformation is proportional to the stress applied within the elastic limits of the material. Sometimes things can happen in a factory that will cause a deformation and you will need to get it fixed quickly.

4. Result and Discussion

- A structure only requires one fixed support., Fig. 4, to maintain stability. It is possible to satisfy all three equilibrium equations.
- A static load of 350N⇩ was applied (Fig. 5) and the structure showed results with minimum of stress.
- Shearing stress (Fig. 7) was found within safezone and with less chance of parts to get teared off.
- The Total Deformation (Fig. 8) was very negligible when compared with the load applied.

5. Conclusions

The study assessed the stress due to Static load, Shearing Stress and the Total Deformation and also arrived at a conclusion that it only requires one fixed support in orderto be stable. The following are the conclusions:

- Reduction in human effort, aches in body joints, and serious issues brought on by ascending stairs in malls, hospitals, etc.
- It offers a service to substitute people in hazardous environments who must move materials up and down stairs and across flat surfaces, such as in an underground storage facility where oxygen is scarce.
- The notion of a stair climber material handling system is used in this work to eliminate the need for human labor in places like offices, colleges, and factories when it comes to handling materials on stairs.
- It provides easy sliding of materials that are to be kept on trolley.
- It provides a compact structure which reduces its size when not in use.
- Analyzed the above design with rigorous trial and the results obtained to get a load limit (350N) and a deformation point to use the project safely and use it efficiently.

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References

[1] B. Mohammad Osman Tokhi, G. S. Virk, M. A. Hossain “Climbing and Walking Robots”, publish in Proceedings of the 8th International Conference. https://doi.org/10.1007/3-540-26415-9

[2] J Lawn, Member, IEEE, and TakakazuIshimatsu, “Modeling of a stair-climbing wheelchair mechanism with high single step capability Murray”. IEEE Transactions On Neural Systems and Rehabilitation Engineering, Vol. 11, No. 3, September 2003. https://doi.org/10.1109/tnsre.2003.816875

[3] Salunkhe Rohit, ‘Advance material handling trolley using tri- wheel mechanism’, International Journal of Recent Research in Civil And Mechanical Engineering (IJRRCME) Vol. 2, Issue 2, Pp: (160-165), Month: October 2015 – March 2016.

[4] P. Jey Praveen Raj, P.M. Mohamed Fuge, R.Paul Caleb, G.Natarajan, “ Design and Fabrication of Stair Climbing Trolley”, International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME) Vol. 2, Issue 2, pp: (160-165), Month: October 2015 – March 2016.

[5] Prajan Pradip Gondole, Kamlesh Diliprao Thakre, “Stair Climbing Hand Trolley”, Journal Of Emerging Technologies and Innovative Research (JETIR), (2015).