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Design of Staircase Climbing Wheelchair For Physically Challenged Person

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ABSTRACT: The project deals with the Designing and Manufacturing of an operated by hand staircase climber which may be used for both levelled flat also as staircases. The key concern during this project was to supply stability to the one that is travelling in it and simultaneously maintaining the entire center of gravity as low as possible. Keeping the above mention criteria in observance all calculations was performed. This project will support physically disabled people in their day-to-day lives and it'll be moderately useful in rural and semi-urban areas. The general cost of the project is positively low as compared to the commercially available staircase climbers.

KEYWORDS: Wheelchair, Angle of stair, Centre of Gravity, Design, Staircase.

I. INTRODUCTION

People with disabilities are an important part of society that needs the help of humanity to increase their participation in practice and knowledge. As a result, it becomes increasingly important to work hard in order to assist this segment of society in leading a better life. As a result of the various types of disabilities and the changing demands of everyday functions, there are many methods of assistance. Perhaps the capacity to move is one of the most crucial everyday duties that each person need since it is the foundation for doing various tasks. As a result, several ways of movement have been developed that may be utilized by the disabled by themselves or by others to achieve their goals.The wheelchair is one of the most used methods and activities for allowing impaired people to move around.And, because of the importance of this wheelchair for this part, as well as to improve the disabled's comfort and make chair use easier, a lot of effort was put into developing each aspect of it, and numerous designs and innovations were made with varied speeds and ways of using it.

A wheelchair is a mode of mobility for persons who are unable to walk due to disease or disability. It may be moved by rotating the wheels or using the handles. There are several varieties and types of wheelchairs available today, including manual wheelchairs, motorized wheelchairs, and transport wheelchairs. Hand rims, armrests, footrests, castors, seat and back upholstery are among the mechanical components of a wheelchair.However, the current wheelchair has flaws, such as insufficient ergonomics to suit the needs of users.

II. PROBLEM DEFINITION

2.1 Problem Statement

- Existing wheelchairs are ineffective in their functions, such as requiring human power to move.
- The user must move the wheel by hand and may become exhausted if they do so for an extended amount of time. Aside from that, existing wheelchairs have flaws. It isn't secure enough, and it's also not very pleasant, because the form and location can't keep the user's body in place.
- The design of a wheelchair must be both pleasant and safe for the user. It should also prevent significant problems from arising, which might result in an accident.
- The desired ergonomic design of the wheelchair that provides appropriate variable features and other items that can be customized by the user who has to come up with some ideas and evaluate them according to human factor engineering and equipment selection.

2.2 Objective

- To Analyze wheelchairs based on human factors engineering and material choices.

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- To Design a wheelchair climbing stairs for individuals with different abilities with lower limb disabilities to increase mobility.
- To Build a wheelchair upstairs for mobility-impaired persons with lower limb disabilities.

III. NUMERICAL METHODOLOGY

3.1 Introduction

Wheelchair is a device that helps a disabled and old aged people to empower and enable to live a normal and independent life. Though wheelchair is helping the physically disabled people for their mobility it not equivalents to normal people. Many hospitals, public places, government buildings, society are not provided with ramps or elevators which helps the disabled people in their mobility. It's getting tough for them to travel. The idea of manufacturing a stair climbing wheelchair is a small step in reducing their problems.

3.2 Numerical Strategy

Stair dimensions
Run: 260 mm ∵ (220mm – 300mm)
Rise: 185 mm ∵(150mm – 220mm)
Slope of stair (θ):$\tan^{-1}\left(\frac{185}{254}\right)$=36°

Total mass acting = 100 kg = 100×9.8981 N
Normal force acting (F_n) = mgcos θ
= $100 \times 9.81 \times \cos(36°)$
800.77 N
Frictional force (F_f) = μF_n
= 0.2×800.77
= 160.15 N
Opposing force (F_o) = mg sin θ
= $100 \times 9.81 \sin(36°)$
= 581.79 N
Torque required = $(F_f + F_o)r_w$
= (160.15 + 581.79)0.18
= 133.54 N-mm

A. Mechanics during downstream of staircase climber

Downstream, the system self-powers. When the small wheel turns on the level floor, the action of the weight causes the reaction of the bottom floor and rim will be stable. The moment the wheel exits this reaction on the first step downstream, the mechanism and calculations start and this position is shown in the figure below.

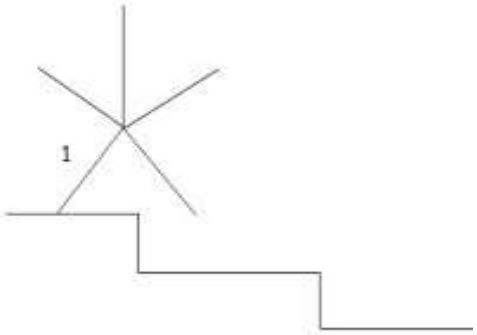

Fig.1 Downstream of staircase climber

Assume,
12 stairs=36 seconds
1 stair -72°=(2π/5)
Therefore,
ω= (2π/15) = 0.419 rad/s
N = 4 rpm
Neglecting inertia effect of rod,
I = 5*1*0.3² = 0.45 kgm²

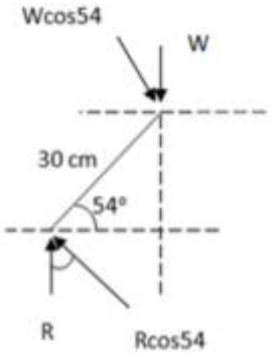

Fig.2 FBD of link 1

Torque available (applied),
T = -Wcos(54°) * 0.3
= -1000cos(54°) * 0.3
= -176.435 Nm
Power,
P = -73.82W
(-Ve sign means resist motion during downstream is resisted to attain terminal velocity.)
Effort = Power/V
= P/ (rω)
= 73.82/ (0.3*0.419)
= 587.296 N (which is almost 60 kg)

B. Mechanics during upstream of staircase climber

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The upstream mechanism begins as the wheels make contact with the stairs. The wheel's tangential force is provided by the blockage supplied by the stairs, allowing the rim to rotate. The more force applied; the more blocking force will be and in turn the tangent force will be more. In a critical situation where the reaction is maximum, a greater applied force will cause the rim to start climbing over the stairs. This state of rim is shown in figure below.

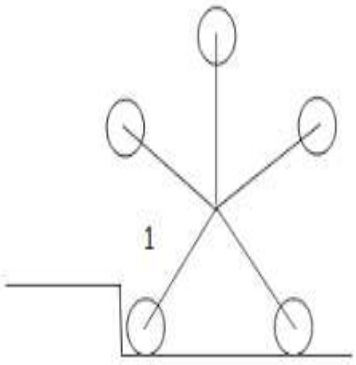

Fig.3 Upstream of staircase climber

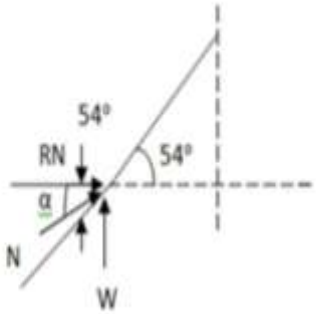

Fig.4 FBD of link 1

To have net +Ve torque available, angle between RN and N (resultant of RN and W)

$\alpha < 54^{o}$

$\tan^{-1}(W/RN) < 54^{o}$

$(500/RN) < \tan 54^{o}$

$RN > 363.289$ N

Hence if effort applied is more than 370N then wheelchair will climb.

3.3 Pentagon wheel arrangement

Penta wheel arrangement constructed of mild steel makes up the bottom half of the rolling chair. Each end of the Penta projection is mounted with round wheels.

Fig.5 Solid model of Penta arrangement

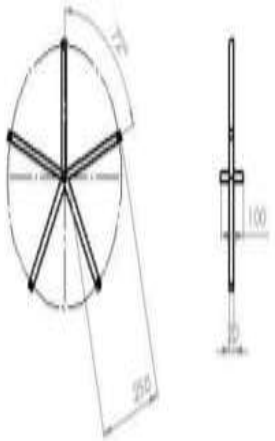

Fig.6 Dimensions of Penta arrangement

3.4 Mini wheels

These are constructed of rubber since they must support the entire weight of a person seated in a chair, and the turning wheels are rubber-coated radial bearings.

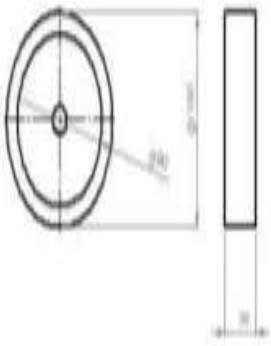

Fig.7 Wheel with its dimensions

IV. CONCLUSION

- The effort required to hoist the wheelchair has been empirically verified to be almost equivalent to that estimated theoretically.

- Because there is a strong man-machine interaction in this project, all ergonomic considerations have been made to ensure that the machine is easy to use.
- Because the project's weight is comparable to that of a regular wheelchair, even an inexperienced driver will be able to operate it.

V. FUTURE SCOPE

- By employing high-strength lightweight materials like composites and carbon fiber, the frame's weight may be lowered.
- Electronics may be used to automate the wheelchair so that it can automatically detect and ascend the steps.

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