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Stair Climbing Wheelchair

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***Abstract* - The wheelchair was an invention that helped the masses to a great extent. It can be used to transport the injured and disabled with ease. But the difficulty that we face right now is while taking it over the stairs. Every building which have more than one stories are generally equipped with stairs, from hospitals to schools and even at home in most cases. In India, although some schools and hospitals have been provided with lifts, majority of the population rely on stairs. And whenever an injured or disabled needs to be carried over them, it is a laborious and very stressful task. And hence we achieved the motivation to come up with a solution for the same. This led to the idea of designing a wheelchair that could help us carry people over the stairs.**
Hence, we planned to design our own wheelchair that will prove to be a better alternative in the process of taking people over stairs as it is a growing problem that most of us may face in our life and a solution for the same will not only help us but will also be a great invention for mankind.

Key Words: Stair Climbing, Wheelchair, Rubber Track Mechanism

1.INTRODUCTION

In India, with growing population density, multi-story houses are built to accommodate more people. Hence, most of the buildings incorporate steps to access different floors. Taking a disabled person over the stair is a major problem as there is no reliable method to comfortably do so.
A wheelchair is a chair with wheels, used when walking is difficult or impossible due to illness, injury, or disability. Since wheelchairs are already a means to carry the disabled, we decide to work upon it to design and develop a wheelchair with stair climbing ability.
Initially we started by looking into the available solutions to overcome the problem. Here, we came across multiple designs using the planetary wheel design to accomplish the task. But like in most cases, this design came with its own set of flaws in regarding to comfort and safety. Hence, we were looking forward to eliminate this design and come up with a more reliable solution. Our design will employ a rubber tracker mechanism opposed to most favored planetary wheel system since human comfort and ergonomics are taken into consideration.

2. OBJECTIVES

- Replace the existing planetary based design by offering more comfort and safety during operation.
- Enhance value for money proposition by constructing a model at reasonable price.
- Provide safety to the person on board and the operator.

3. LITERATURE SURVEY

I. A Star-Wheel Stair-Climbing Wheelchair by Zhang Li, WU Bo, JIN Ai-min, Jiang Shi-hong, Zheng Yu-fei, Zhang Shuai: Designed and analyzed a star wheel stair climbing wheelchair with two functions of climbing stairs and moving on the ground.

II. Analyzing Foot Step Wheel on Stair Climbing Wheelchair by Sadamhussain N, Vasanthakumar C: Designed, analyzed and fabricated a footstep wheel that was later installed on chair with served the purpose of climbing the stairs. The footstep wheel design is evolution of planetary wheel system which offered more traction.

III. Mechanically operated stair climbing wheelchair by Sandeep Joshi: Designed and developed a mechanically operated wheelchair with gears and chain mechanism to climb stairs.

4.DESIGN AND ANALYSIS PROCESS

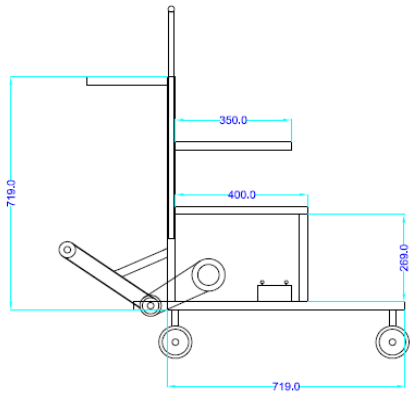

FIG-1. 2D Design of Wheelchair

2D sketches are the prime necessary of any given project, and hence we decided to make sketches on CAD with exact dimensions applicable for the model. This also helped us to calculate the total weight of the structure since all the dimensions are drafted.

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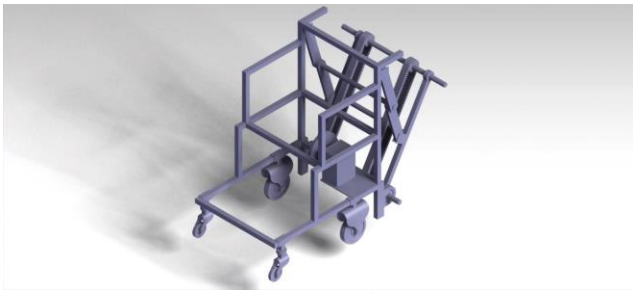

FIG-2. CATIA model of Wheelchair

The further designing was carried out on CATIA to render more details. This was also created to the actual dimensions. The CATIA models were also helpful for the analysis process.

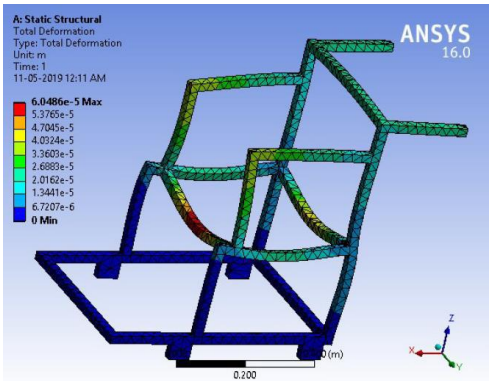

FIG-3. Frame deformation analysis to analyze stability

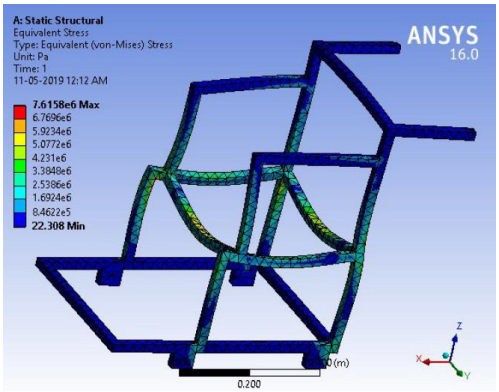

FIG-4. Stress analysis of the wheelchair frame

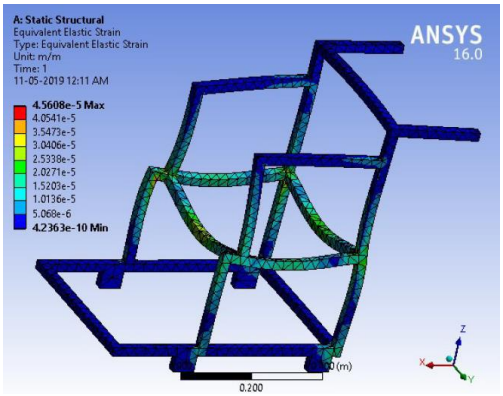

FIG-5. Strain analysis of the wheelchair frame

In our project, it was necessary to do the analysis process in order to ensure the safety of the person who is intended to use the wheelchair. Hence, it is necessary for our project to meet the minimum safety standards.

The main ideology behind this is to create a product that is dependable and stays reliable over time. Hence, we first carried out the stress analysis to make sure the structure is capable of holding the load without deformation.

For the analysis process, point load condition was considered and a load of 100 kgs were applied at all four bars. The flex can be seen for a total load of 400 kgs, but considering real world operation conditions the structure proves safe to use under any circumstances.

5. CONSTITUENT DESCRIPTION:

Here, we explain the various components used and its specifications: -

5.1 FRAME: -

- The frame of the wheelchair is fabricated from mild steel.
- This is done for ease of fabrication, and to reduce the overall weight.
- The chassis was designed to take a static load of 80kg.
- The flange which holds the motor was designed and also fabricated using mild steel and is welded to the chassis.
- The driving motor can easily be accommodated under the seat.

5.2 PLUMMER BLOCK: -

It is a component used to provide support to the rotating shafts. Therefore, we have used four plummer blocks in total to support two rotating shafts of which one obtains power from the motor through a chain drive.

5.3 RUBBER TRACKS: -

- Rubber tracks are the parts of the wheelchair that come in contact with the stairs when ascending or descending.
- The tracks obtain the power through the motor that is further connected to the shaft.
- There are two shafts at the end of the structures which are encased in plummer blocks.
- The rubber tracks increase the traction between the chair and steps. Therefore, gives better stability and control.

5.4 CHAIN DRIVE: -

A chain drive is used to transmit power from the motor to the shafts over which the rubber tracks rest. And so, the chain drive contains a bigger sprocket and a smaller one placed on the motor and the shaft respectively.

There is a chain connecting the two sprockets and hence the power developed by the motor is transmitted to the shaft via this chain drive.

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5.5 BATTERY AND SMPS: -

- The power to drive the motor is obtained in two ways.
- A battery can be used and an AC power supply can also be used.
- A DC motor is used hence power from the battery can be directly used to drive it.
- But the AC power supply is converted to DC using an SMPS and hence the DC current obtained can also be used to drive the motor.

5.6 DC MOTOR: -

- Electric energy is converted into mechanical energy by a motor.
- It works on the principle of Fleming's left-hand rule that mechanical force is experienced when a current carrying conductor is placed in a magnetic field.
- This is the main component which supplies power to the rubber tracks to assist the wheelchair over the stairs.

FIG-6. Final prototype front

FIG-5. Final prototype rear

6. FUTURE SCOPE

As this was our first attempt at this design, the final model still needs improvements.

- The rubber trackers can be provided with a swingarm throughout the length for better stability.
- More powerful motor can be incorporated for further reducing the effort during stair climbing process.
- Custom belt can be designed and fabricated for more traction over the stairs.
- The complete structure can be made lighter by fabricating the product using light materials resulting in easier and more convenient product.
- With further enhancement and by inheriting modern technology, the wheelchair can be completely automated.

7. CONCLUSION

The main aim of this project is to come up with a design that would provide necessary comfort for the rider while the wheelchair climbs up and down the stairs. Our idea was to come up with a design that would provide better stability and offer more comfort than the planetary wheel design. Hence, we introduce the rubber track mechanism to accomplish the task. With this, we were able to design a mechanism that was more efficient than the planetary wheel system. Unlike few designs, this can be used both on normal surfaces and during stair climbing operation readily. So as discussed, we can see that the materials being used are easily available and can be machined to specifications readily. Hence, the cost of the product is low and is easily available. In the longer run, the product is easier to maintain as the spares are easily available. The product is light and compact compared to the competition and would be easy to operate.

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