

Design and Development of Wheelchair Accessible Ramp for Scooters

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ABSTRACT: An automobile is the most preferred form of daily commute in both cities as well as rural areas. Due to stringent government regulations and lack of wheelchair accessible vehicles, disabled individuals are heavily dependent on public transport for their commute. There are close to 5.4 million people in India who have disability in movement and a majority of them face difficulties in traveling by themselves. A wheelchair accessible vehicle will enable such individuals to commute on their own to different places such as offices, hospitals, banks etc. A WAV (wheelchair accessible vehicle) is a car that has been customized to accommodate a wheelchair. One of the main reasons wheelchair-bound individuals do not have access to such vehicles is their exorbitant price. While traveling in public transport, the wheelchairs used to be placed sideways for better efficiency and convenience. This orientation was dangerous for the occupants and has been changed over the years. In order to protect the patient in case of a frontal crash, belt restraints were provided. Advanced docking systems are also available to restrain the individual in a particular position. A few of the docking mechanisms comply with the SAE J2249 standards.

I. INTRODUCTION

Two-wheelers are one of the widely used means of transport in India. Individuals who are handicapped in the lower part of their body usually opt for a scooter or bike with a side wheel attachment. Although this method serves the purpose, the handicapped individual requires the assistance of an able person to alight and egress from the scooter. This system does not allow them to be completely independent. There are four types of disabilities found in individuals. The individuals could be disabled at birth or the disability could have been caused by an accident. A few of these conditions are chronic in nature and individuals suffering from chronic conditions require assistance for their daily commute. The four types are:

Paraplegics-Paraplegia, paralysis of the lower part of the body, commonly affecting both legs and often internal organs below the waist.

Paraparesis- Paraparesis (paraplegia) refers to partial (-paresis) or complete (-plegia) loss of voluntary motor function in the pelvic limbs.

Hemiplegics- Hemiplegia is a condition that causes half of the body to be paralyzed (unable to move). It may also be referred to as hemiparesis and is a form of cerebral palsy. It's caused by damage to one half of the brain; specifically, when that damage affects the parts of the brain responsible for motor movements.

Amputees-Amputation is the surgical removal of all or part of a limb or extremity such as an arm, leg, foot, hand, toe, or finger.

The aim of this project is to build a scooter that a wheelchair bound individual can access independently. Safety features as per the ANSI (American National Standards Institute) will also be followed and a WTORS (Wheelchair Tie down Occupant Restraint System) will also be in place. The vehicle will also be reasonably priced.

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II. EXISTING MODELS

There are a few systems in the market using which a disabled person can commute to different places on a vehicle. Most of the current systems available in the market are not ideal due to their lack of safety features and expensive price tag. The disabled mobility systems available in the market are:

SIDE WHEEL ATTACHMENT



FIG 2.1: SIDE WHEEL ATTACHMENT FOR SCOOTER

The side wheel attachment is available for bikes and scooters. These attachments are approved by ARAI (Automotive Research Association of India) and comply with necessary government regulations. A major disadvantage of this side wheel attachment is that the handicapped individual is not completely independent and requires the help of another person to use the scooter. With our project, the individual will be able to alight and egress from the vehicle on their own.

WHEELCHAIR ACCESSIBLE MODIFIED SCOOTER



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Fig 2.5: Wheelchair accessible modified scooter – 2

The wheelchair accessible modified scooter is a ramp attached to a scooter to enable the wheelchair bound person to board and egress from the vehicle. This model has a few disadvantages. There are no safety measures in place to secure the position of the handicapped individual on the scooter. The design is bulky as the engine is mounted on the side of the vehicle. A motorized wheelchair is required to use the ramp to alight the scooter. Our project uses WTORS and safety measures that comply with international standards. Also, any wheelchair-bound individual can access our scooter regardless of the make of the wheelchair.

HUKA PENDEL



Fig 2.6: Huka Pendel

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Huka Pendel is an electric scooter that can accommodate a wheelchair. It has the top speed of 25 kmph and can be used to commute in a radius of 60 kms. It has lesser power as it runs on electricity and its range is also significantly reduced for this very reason.

III. DESIGN

The major factors that were kept in mind while designing the prototype were to ensure the safety of the rider while making the vehicle agile and reliable. Following is a brief description of the various subsystems that are vital to the smooth operation of the vehicle.

1. Frame

The frame behaves as the backbone of the vehicle. It houses all the systems within it. The frame was designed keeping in various factors like the overall width of the vehicle, structural strength, etc. The frame was constructed out of Mild Steel tubes of 50mm x 50mm with a wall thickness of 1.5mm. This ensured a factor of safety of 3.5.

2. Ramp

The ramp was designed with reference from the Americans with Disabilities act's (ADA). It recommends an angle of 9.5° for self-propelled wheelchairs. The ramp angle that was used was 14.5° but mechanical propulsion was provided to ensure minimum effort of the user.



Fig. 3.1 User boarding the vehicle using the mechanical propulsion system

3. Wheelchair Tiedown and Occupant Restraint System

The safety of the rider was ensured by the use of Wheelchair Tiedown and Occupant Restraint System (WTORS). WTORS restricts movement of the user once he/she boards the vehicle within a certain limit.

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Fig 3.2 WTORS

4. Drive Train

The Drivetrain used is a 100cc 2 stroke engine coupled with a CVT. The power from the CVT is split to both the rear wheels using a differential. Along with this, reverse gear was incorporated into the drive to ensure that the user has complete manoeuvrability and can use the vehicle with ease in cramped spaces.



Fig 3.3 Mock-up of the Drivetrain

5. Steering

The steering tube was designed to ensure that the steering would be located at a height which is ergonomically optimum for the user. Further, the rake angle considered is optimum without affecting the stability while not increasing the steering effort from standard scooters. The turning radius was set to 2.5m which is less than those of the commercial auto-rickshaw. This ensures the vehicles manoeuvrability through city traffic.

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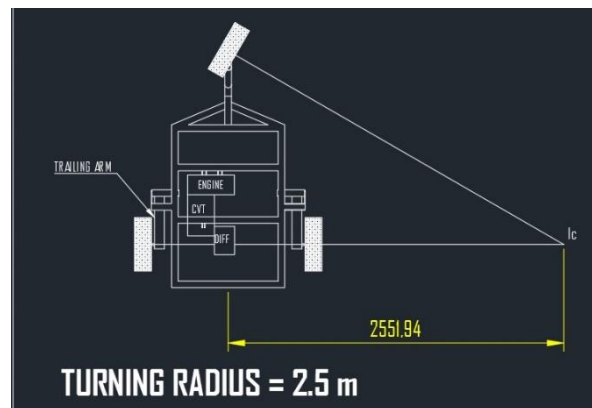


Fig 3.4 Turning Radius

IV. OUTCOME

The vehicle was tested to ensure the reliability of the machine. It was found that the vehicle could endure the daily requirements of the user. However, there were a few shortcomings:

1. The vehicle had a lower top speed owing to the excess weight that was required in order to ensure the safety of the user. This problem can be resolved by using an engine of higher capacity. This will ensure that the vehicle can endure more load.
2. The time required to board the vehicle was around 4 minutes. This would prove to be a cumbersome process for daily use. This duration was because of the mechanical reduction provided in the propulsion system provided. However, in order to reduce the user effort, this is the best time achievable without using any external aid for propulsion such as electric motors, etc.



Fig 3.5 Wheelchair accessible scooter

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These shortcomings are a result of trying to reduce the overall cost of the vehicle while making it a standalone system and ensuring the safety of the user. The propulsion mechanism used is completely mechanical, if the electrical counterpart has to be provided, the system will have to rely on external source of energy – a battery, which would further increase the weight of the vehicle and the user will have to ensure that he/she always checks the battery capacity before using the vehicle will have to recharge the battery very often.

The safety of the user was of utmost importance and no compromise in this was made. The four point tie down system used ensured that the user had enough freedom to position himself in a comfortable position while restricting overall movement to a minimum. The propulsion system also used a ratchet and pawl mechanism which would lock if the system were to fail. This ensured the user would always be safe while entering and egressing the vehicle.

V. FUTURE SCOPE OF WORK

The concept of wheelchair accessible vehicle is very promising. Such a system that ensures users with complete independence while ensuring the safety of the rider is sought after. The existing system can be improved by further reducing the user's effort and also providing alternative methods for propelling. The safety of the user and also be improved by using more advanced occupant restraint system and also adding a wheelchair docking system which will ensure the user will automatically align to the riding position.

VI. CONCLUSION

The vehicle that was built met all the objectives that were intended. It ensured that the user was independent and did not rely on any external aid for operating the vehicle. The WTORS ensured that the user would remain safe under adverse conditions. Even though there were certain shortcomings, the vehicle proved to be reliable and can be further improved for better performance.

REFERENCES

- [1] L.H.V. van der Woude, H.E.J. Veeger, A.J. Dallmeijer, T.W.J. Janssen, L.A. Rozendaal. Biomechanics and physiology in active manual wheelchair propulsion. 10 August 2001.
- [2] Dmitry V. Balandin, Nikolai N. Bolotnik, Walter D. Pilkey, Sergey V. Purtsezov, C. Gregory Shaw, "Concept of a platform-based impact isolation system for protection of wheelchair occupants from injuries in vehicle crashes", Medical Engineering & Physics, 12 March 2007
- [3] Lawrence W. Schneider and Miriam Ashley Manary, "Wheeled mobility tie down systems and occupant restraints for safety and crash protection", Elsevier Mosby, 2006
- [4] Karen L. Frost, Gina Bertocci, and Craig Smalley, "Ramp-Related Incidents Involving Wheeled Mobility Device Users During Transit Bus Boarding/Alighting", Archives of Physical Medicine and Rehabilitation, 2015
- [5] Wendy J. Hurd, Melissa M.B. Morrow, Kenton R. Kaufman, Kai-Nan An, "Wheelchair propulsion demands during outdoor community ambulation", Journal of Electromyography and Kinesiology 19 (2009) 942–947, 13 May 2008
- [6] Chung Sik Kim, Donghun Lee, Sunghyuk Kwon, Min K. Chung, "Effects of ramp slope, ramp height and users' pushing force on performance, muscular activity and subjective ratings during wheelchair driving on a ramp", International Journal of Industrial Ergonomics, 3 July 2014
- [7] Ray Lee, "Wheelchair restraint affixment straps", US Patent 5,391,030, 21 Feb 1995
- [8] Meyer Ostrobrod, "Personnel lifting-lowering system", US Patent 5,927,438, 27 July 1999
- [9] Jean Marc Girardin, "Wheelchair restraint system", US Patent 6,287,060, 11 Sep 2001
- [10] Zdravko Salipur, Gina Bertocci, Miriam Manary, Nichole Ritchie, "Wheelchair Tiedown and Occupant Restraint System Loading Associated with an Adult Manual ANSI WC19 Transit wheelchair with a Seated 50th percentile ATD Exposed to Rear Impact", University of Michigan Transportation Research Institute, 2007s