Wheelchair Anti-Rollback Device

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Abstract

Wheelchairs provide essential mobility to those without use of their legs. However, travelling on inclines presents a problem, as without proper control wheelchairs can roll backwards. This poses an unnecessary risk of serious injury to the user.

Design Objective

The scope of this project was to create an anti-rollback device for easy attachment to wheelchairs. The design should allow only forward gain while reducing physical burden on the user when travelling on inclines.

Market Research and Benchmarking

In order to prioritize the design requirements an online survey was created and distributed amongst the Disabled Students Program at UCSB, the results of which are summarized in Fig 3.

Prioritized Design Features:
1. Safety
2. Stability
3. Ease of Use
4. Durability
5. Weight and Mobility
6. No Obstruction to Current Functionality
7. Universal Connection
8. Smooth Transition
9. Cost
10. Weather Resistance
11. Automation
12. Noise

Analysis and Testing

Components were analyzed based on the maximum performance parameters being a weight of 250lbs (Chair: 30lbs, User: 220lbs), an incline of 45° and an allowable rollback of 2°. Hand calculations of forces on the ratchet gear and pawl returned a safety factor of 3.6. The displacement and Von Mises stress on the ratchet gear under maximum load (753 lbs) was analyzed using FEA, the results of which are shown in Fig 5.

Concept and Prototype

The final design concept is shown in Fig 3. It involves use of a ratchet gear and pawl system, with a cable engaging mechanism. The main components are manufactured in Stainless Steel 304 (σ_{yield} = 30000 psi and E = 2.76x10^7 Pa) for optimum strength and weather resistance.

The engineering challenges which presented themselves during design included limited space between wheel and frame, designing pawl for optimum contact with ratchet, designing attachment from gear to wheel, and creating a spring loaded pawl mechanism.

Conclusion

The benchmark wheelchair brake allowed for 12" of incline rollback. By introducing the ratchet device this has been limited to 2", completely eliminating required human response. Furthermore, the next project is to incorporate a more refined automated engaging mechanism, and universal connection.

Acknowledgments

Stephen Laguette, Trevor Marks, Dave Bothman, Gary White (DSP UCSB), Nicole Holstrom, Andy Weinberg

References


US Patents 5197750 6253880 6371503 6655503 were consulted during design.