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Research Paper

DESIGN AND FABRICATION OF STAIRCASE CLIMBING WHEELCHAIR

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The commercially available wheel chairs for amputees donot have the functionality for climbing staircases. In our project, we have designed a manually operated wheelchair that can travel on both plane terrains and also in the staircases. In our project, instead of using normal wheels we have used penta wheel. The steel rod is penta shaped and each rod is equally inclined of 72° from each other. At the time of climbing, one wheel that is the idle wheel will be in contact with the ground and the another wheel will be in contact with the stair. The motion takes place only when we pull the wheel chair backwards towards the staircase. The main aim of our project is to provide stability to the person who travels in the wheel chair (i.e., a large support base and maintain the overall centre of gravity as low as possible). The main aim of our project is to afford this stair climbing facilities for middle class people. The main drawback of electric powered stair climbing wheel chair is its cost and weight. In our project, we tried to fabricate a low cost stair climbing wheel chair that can be bought by a middle class people.

Keywords: Penta wheel, Stair climbing, Base area, Low cost

INTRODUCTION

Autonomy in the area of mobility has always been highly valued, but is sometimes impaired by some form of disability. In many cases this results in reliance on some form of external transport mechanism. In this regard traditional wheelchairs and powered wheelchairs continue to play a vital role. However wheelchairs to date provide a high level of mobility only in artificial or "barrier free" environments. There remains a significant gap between the obstacle negotiating ability of a wheelchair and that of the average able bodied person. This aspect is perhaps most apparent when considering stair-climbing. While modern architecture and new policies continue to make newly built areas as "accessible" as possible to persons with a wide variety of disabilities steps will always be a reality in the "real world". The commercially available wheel

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chair for amputees doesn't have the functionality for climbing staircases. In our project we have designed a manually operated wheel chair that can travel in both plane terrains and also in the staircases. Instead of using normal wheels, in our project we have used penta wheel. The steel rod is penta shaped and each rod is equally inclined of 72° from each other. At the time of climbing, one wheel that is the idle wheel will be in contact with the ground and another wheel will be in contact with the stair. The process continues and the motion takes place only when we pull the wheel chair backwards towards the staircase.

MATERIALS AND METHODS

The whole component of the wheel chairs is fabricated using mild steel material due to its high strength and low cost. The components used are penta wheel arrangement, frame of the chair, mini wheels and fasteners. For the frame of the chair we have used 14" mild steel Square pipe and for penta wheel arrangement we have used the rollers of the rolling chair and computer chair was made of mild steel. The mini wheels are of rubber as it has to bear the whole load of the person sitting in the chair and the turning wheels are made of plastic material.

Table 1: Materials Requirements

S. No.	Materials
1.	14" Mild Steel Square Pipe 2
2.	Roller (2 Nos.)
3.	Handle Plate 4"
4.	Wheels (10 Roller Wheels and 2 Turning Wheels)
5.	Shaft (3/4")
6.	Nuts, Nolts, Washer

DIMENSIONS OF THE CHAIR

Frame dimensions at base = 38 × 38 cm

Frame dimensions at back = 38 × 38 cm

Length of the handle for moving the wheelchair = 15 cm

Length of hand rest = 23 cm

Total height of the wheelchair = 77 cm

Width of the wheelchair = 61 cm

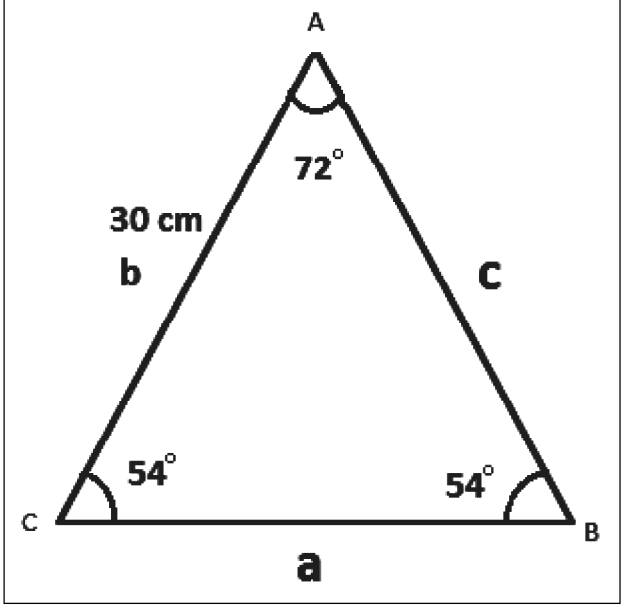
Height of the legs = 46 cm

Radius of the spokes = 31 cm

Diameter of the wheels = 9.5 cm

Average height of the steps = 13 cm

Figure 1: Law of Sines



METHODS USED FOR FABRICATION

In our project the fabrication consists of three phases. The first phase consists of fabrication of chassis including cluster wheels, the second phase consists of fabrication of frame (i.e.) the part below the seating arrangement and the

third phase is the fabrication of two penta wheels.

Phase 1: The seat arrangement consists of eight hollow square steel tubes and it is joined by gas welding. The cluster wheels are fitted in the mild steel hollow circular tubes is then welded at the front portion of the seat arrangement. Since the selected material has low thermal conductivity, gas welding had been done.

Phase 2: The frame was fabricated as per the standard design, as it requires high accuracy;it determines the centre of gravity and stability for the person who is travelling. The frame was made of thick mild steel tubes, with width of 2.5 cm. The frame arc welded with the shaft between the two penta wheels. The kinematic links have been used to link the frame and seating arrangements.

Phase 3: The bottom part of the rolling chair consists of penta wheel arrangement. Circular wheels were fitted to the each end of penta projection. The shaft is welded with the frame.

RESULTS AND DISCUSSION

Calculation for Stability

According to law of sines (Figure 1) for the slant length 30 cm the required base length is calculated by formula,

$$\frac{a}{\sin(A)} = \frac{b}{\sin(B)} = \frac{c}{\sin(C)}$$

where,

b and c – Radius of the spokes

a – Base length

$$a = \frac{b\sin(A)}{\sin(B)}$$

$$= 30X \frac{\sin 72}{\sin 54}$$

a = 35.26 cm

This base length must be there for the stability but the base length that we have is 35.56 cm hence our design is safe for wheel stability.

Calculation for Rolling Resistance

Coefficient of rolling resistance [C_{rr}] = (0.0048) $(18/D)^{(1/2)}$ $(100/W)^{(1/4)}$

where,

D = Diameter of the rolling wheel in inches

W = Load acting normal to the wheel chair in lbs.

Rolling Resistance [F] = $(W.C_{rr})/R$

The diameter of the wheel = 9.5 cm

= 3.74 in

The maximum load acting normal to the wheel chair = 85 kg

= 187 lbs.

$C_{rr} = (0.0048)\ (18/D)^{(1/2)}\ (100/W)^{(1/4)}$

$C_{rr} = (0.0048)\ (18/3.74)^{(1/2)}\ (100/187)^{(1/4)}$

$C_{rr} = 0.009$

$F = (187 \times 0.009)/1.87$

F = 0.89 lbs

F = 0.404 kg

F = 4.04 N

Rolling resistance for the wheel chair is calculated because it determines the stability of the rolling wheels. The rolling resistance is inversely proportional to the speed of the wheel chair.

For the normal wheel chair the rolling resistance is about 3.74 N.

Figure 2: Pro/E Model of the Project

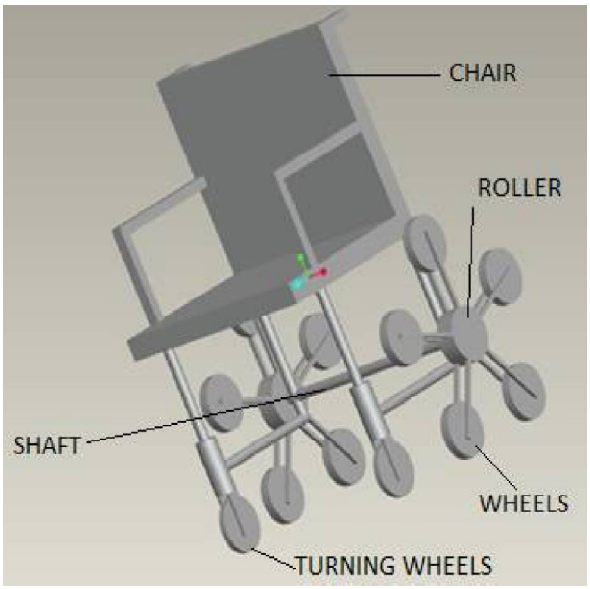


Figure 3: Model Wheel Chair

CONCLUSION

Thus by implementing this project, we can help the amputees for climbing the stairs. While comparing the cost of the electrically operated stair climbing wheel chair which is around Rs. 15,000 and the cost of the normal wheel chair available in market is Rs. 5,500. We have fabricated this wheelchair for Rs. 3,000 which is more economical when compared to the above mentioned varaities of wheelchair. This low cost wheel chair can be best suited for middle class people.

FUTURE ENHANCEMENTS

The future enhancement of our project is we have to rectify the problems that we have encountered during descending of the wheel chair in stairs. We had a smooth travel while ascending but while coming down from the steps, we found some vibration problem and to overcome this we have planned to install springs and braking system, so that wheel chair will be in a good control while descending also.

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