

# DESIGN AND ANALYSIS OF HANDICAPPED STEERING TRICYCLE

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## Abstract

Conventional tricycles for handicapped require a lot of human effort to operate. They generally come with separate arrangements for providing motion and giving direction to the vehicle. These separate arrangements cause asymmetric use of hands and this results in discomfort of the rider. To alleviate this discomfort, a new arrangement which is mechanically more efficient than the conventional handicapped tricycle has been introduced, contains a single unit for providing motion and giving direction to the tricycle. Push and Pull motion of the steering results in forward and backward motion of the chair, while rotational motion of the same gives direction to the chair. In this paper, structural analysis is performed on the handicapped steering tricycle. Modelling is done on Solidworks 14 and ANSYS Workbench 15 is used to perform structural analysis.

**Keywords:-** Lever-propelled wheelchair, Handicapped Steering Tricycle, Structural Analysis, and Design optimization.

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## 1. INTRODUCTION

About 1.85% of the total world's population, that is 7.1 billion, 130 million need wheelchairs or handicapped tricycles. Out of these 130 million, nearly 120 million population live in developing countries. Developed countries easily fulfill the demands of handicapped vehicles because of better technology and strong economy. On the other hand, in developing countries, due to limited resources in terms of economy and technology, the handicapped vehicles are required to be made cheaper, durable, comfortable, and efficient. There are cheaper materials available which are durable too, but the main area of concerns are comfortability and efficiency.

Conventional handicapped tricycles are tedious because of their asymmetrical mechanisms and inefficient drive systems. Handicapped steering tricycle is a better substitute because of its better motion and steering unit and drive system.

### 1.1 Handicapped Steering Tricycle

Handicapped Steering Tricycle uses a crank-lever mechanism for its forward and backward motion. It is equipped with a small diameter steering wheel which can provide both: direction and motion to the tricycle. By pushing and pulling this steering, the rider can move the tricycle and by rotating the steering the rider can direct the tricycle. A braking lever is provided just beneath the steering wheel to apply the brakes.



Fig -1: Handicapped steering tricycle

### 1.2 Materials Used and Dimensions

Due to their higher strength to weight ratios, better machinability, low cost and durability, metals are used for manufacturing these tricycles. They are easily available and they can be used specifically for a desired mechanical or physical property.

The metal used to assign to all the parts except chassis is: Stainless Steel 304. Material properties are given in Table-1.

Table -1: Material properties of Stainless Steel (SS-304)

S. no.	Material Property	Value
1.	Density	8000 kg/m <sup>3</sup>
2.	Young's Modulus (E)	193 GPa
3.	Poisson's ratio	0.27
4.	Tensile Strength	500 MPa
5.	Coefficient of Thermal Expansion	17×10 <sup>-6</sup> /°C

Chassis is made by assigning the material: Structural Steel. It is a very common material, used for constructing frames of automobiles. Foam is used for seat. Material properties of SS-304 are given in Table-2.

**Table-2:** Material properties of Structural Steel

S. no.	Material Property	Value
1.	Density	7850 kg/m <sup>3</sup>
2.	Young’s Modulus (E)	210 GPa
3.	Poisson’s ratio	0.3
4.	Tensile Yield Strength	210 MPa
5.	Coefficient of Thermal Expansion	12×10 <sup>-6</sup> /°C

Dimensions of Handicapped Steering cycle are given in Table-3.

**Table-3:** Dimensions of Handicapped steering cycle

S. no.	Part	Dimension (in inches)
1.	Diameter of pipe	2.5
2.	Diameter of wheel	50
3.	Distance between rear wheels	85
4.	Height of seat from the ground	80
5.	Length and width of seat	70
6.	Height of axle from the ground	25
7.	Width of the chair bottom	80
8.	Length of rod supporting front wheel	133
9.	Angle of the rod supporting front wheel	43°

**1.3 Solidworks Model**



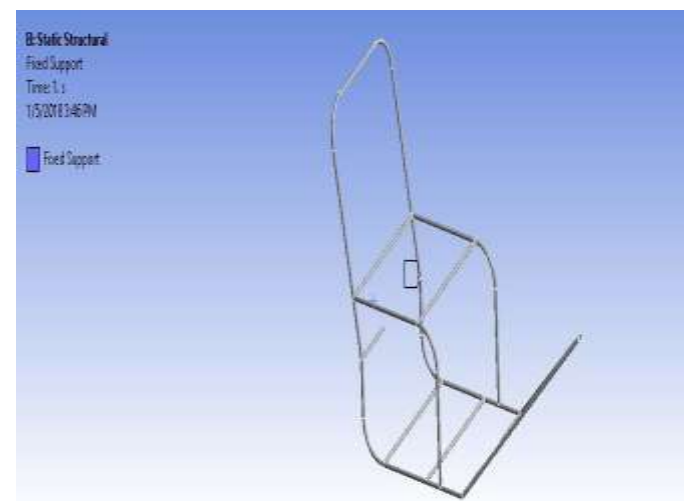
**Fig -1:** Solidworks model of handicapped tricycle.



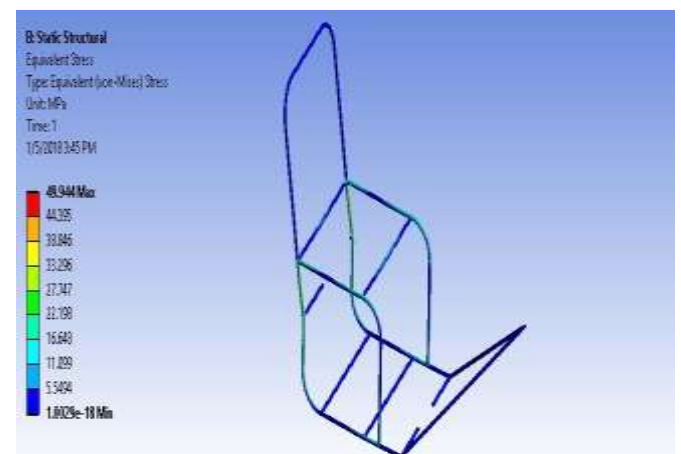
**Fig -2:** Handicapped tricycle without seat.

**2. ANSYS RESULTS**

ANSYS Workbench 15 is one of best Finite Element Analysis software in the simulation industry. Structural analysis is performed on the tricycle. To make the problem easier, analysis is done only on the chassis rather than the whole cycle. The chassis is fixed at point A, assuming the wheels to be fixed, and a load of 1000 N is applied in downward direction from the bottom of the seat. 1000 N is approximately 100 kgs i.e.; weight of rider and the cycle. ANSYS results are shown in Figures 4, and 5.

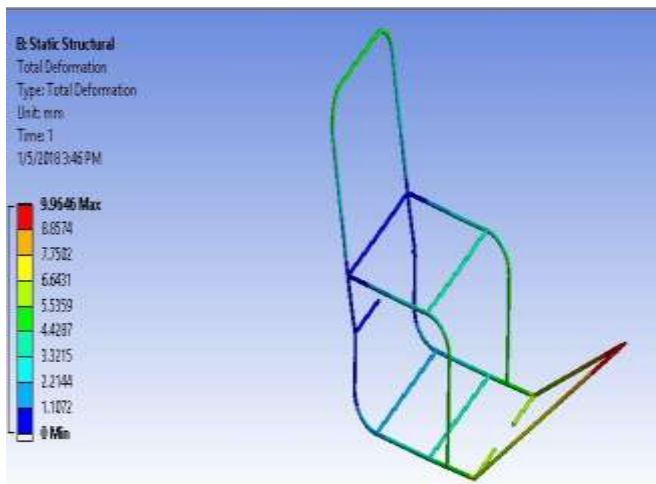


**Fig -3:** Support and traction



**Fig -4:** Equivalent stress in tricycle at load 1000 N.

Equivalent stress at the load 1000 N, in tricycle is found to be nearly 50 MPa. Tensile Yield strength of Structural Steel is 210 MPa, so the chassis is safe.



**Fig -5:** Total deformation in tricycle at load 1000 N.

Total deformation in the chassis is found to be 1.15 mm. It is mostly concentrated near the seat.

### 3. CONCLUSION

Results from structural analysis of this handicapped steering cycle shows that the stress and deformation is within the limits. If it is compared with conventional handicapped cycles then it is found to be easy to maneuver, control, and move. It is driven with subtle and periodic motion of hands, and less power is required by the rider to drive it. It can be said that it is more comfortable and efficient than the conventional handicapped steering cycles.

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