International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 02 | Feb 2020 www.irjet.net p-ISSN: 2395-0072

Design & Development of Pneumatic Powered Tricycle for Handicaps

Pratyaksh Mishra[1], Rishabh Narwariya[2], Sakshi Porwal[3], Santosh Verma[4]

[1,2,3,4]*Student, Dept. of Mechanical Engineering, Acropolis Inst. of Tech & Research, Indore, M.P, India*

Abstract – *The main objective of our project is to design and fabricate a tricycle which is operated by pneumatic sources. Which reduce human effort and also provide pickup torque.it is rear wheel drive. The conceptual design of this model taken from manually operated tricycle. The complete body looks like a tricycle in which manual operation is replaced by automatic operation.*

Key Words: Pneumatic System, Recumbent delta, Thrust Force, Pneumatic Ratchet

1. INTRODUCTION

Tricycle is a three wheeled cycle which is generally used by the handicapped people for means of transportation. A tricycle is an air-operated one-person capacity vehicle that is specially designed for low mobility. It is generally used by those who have difficulty walking or moving frequently from one place to another (Handicapped people). Tricycles are available in variety of designs, those intended for outdoor use. A tricycle is different from a manually operated wheel chair as source of supply is air motor which utilize freely available air as the working medium that is to transmit power from the source to destination.

The aim of this project is to add pneumatic system and control system in the current hand-powered tricycle, facilitating freedom in travel and contribution to the community. It is found by the observation while they ride on the tricycle more is the effort required and this effort is difficult to handle by handicapped people.

So we identify the problem and proposing such attachment which assist the tricycle pneumatically. This attachment is helpful to provide the initial effort to tricycle. This attachment is equipped with pneumatic ratchet, chain sprocket drive, pedestal bearings, shaft, holder, ratchet nut.

1.1 Type of Tricycle

There are two categories in which tricycle is divided [1].

i. Human powered tricycle

ii. Motorized tricycle

I. Upright Tricycle

Upright resembles a two-wheeled bicycle, traditionally diamond frame, or open frame, but with either two widely spaced wheels at the back or two wheels at the front.

II. Recumbent delta

Recumbent delta is similar to an upright, with two wheels at the back and one at the front, but has recumbent layout in which one rider is seated in a chair like seat.

III. Recumbent tadpole

Recumbent tadpole or reverse trike is a recumbent design with two steered wheels at the front and one driven wheel at the back through one model has front wheels driven while the rear wheel steers.

IV. Other designs

Another design is an in line three wheeled vehicle with two steered wheel one at the front and other in middle or at the rear.

1.2 Principle of Pneumatic System

Pneumatics is essentially a technique to convert electricity into mechanical motion using compressed gasses rather than motors or electromagnets. For many applications, this can be far more efficient and practical. Systems typically include an air compressor, which stores compressed air in a cylinder and release it under control. The gas is nearly always ordinary air because it's free and non- toxic. Often the air is slightly modified by removing a number of the water vapour and adding a little amount of atomized oil to form the gas more machine friendly. Pneumatic systems in fixed installations, like factories, use compressed gas because a sustainable supply are often made by compressing atmospheric air. The air usually has moisture removed, and a little quantity of oil is added at the compressor to stop corrosion and lubricate mechanical components.

Any gas aside from air is an asphyxiation hazard—including nitrogen, which makes up 78% of air. Compressed oxygen (approx. 21% of air) wouldn't asphyxiate, but isn't utilized in pneumatically-powered devices because it's a fireplace hazard, costlier, and offers no performance advantage over air.

2. OBJECTIVE

The main objective is to develop a tricycle which can be run by the compressed air as well as it should be operated manually by means of handle.

The main objectives are:-

1) Reduction of human effort.
2) Development of compact design and lightweight system.
3) Fully suitable for handicaps.
4) Developing a tricycle in affordable price.

3. DESIGN AND CALCULATION

3.1 Required Acceleration of the Tricycle

To obtain the acceleration of the tricycle, consideration is taken from condition of rest (0 km/h, to time (say 10 second) when the vehicle attains the speed of 30 km/h (for almost tricycle)

Acceleration, a = (v2 – v1)/ t

Acceleration, a = (30 – 0)/10

Acceleration, = .833 m/s2

3.2 Thrust Force (Tractive Effort)

The thrust force represents the force needed for the tricycle to be in motion.
F = Froll + Facc
F = Crr mg + ma
Crr = rolling resistance co-efficient (approximately 0.015), m = mass of the tricycle with loading (120 kg)
F = 0.015 x 120 x 9.81 + 120 x .833
F = 118 N

3.3 Torque required to accelerate the Tricycle, T

The torque required to accelerate the tricycle was derived from multiplying the tractive effort by the radius of the tire used.
T = F R
T = 118 0.35 = 41.3 Nm

3.4 Power required by the ratchet

Maximum pressure – 7 bar
Atmospheric pressure – 1.013 bar
Operating pressure – 2 to 4 bar
Air consumption – 0.00286 m3/sec
Maximum Torque = 70 Nm
Maximum Rpm = 300
Maximum power = 2πNT/60 = 2π x 300 x 70/60 = 2199.11watt

3.5 Diameter of shaft

d = diameter of the shaft
From machine design data book standard value of shear stress for mild steel
τ = shear stress = 42 Mpa (mild steel)
Power = 2199.11 Watt
Maximum Torque = 70 N.m. = 70 10 ^{3} N.mm
Torque transmitted by shaft T = π/16 × τ × d^3
70 10 ^{3} = π/16 × 42 × d^3
d^3 = 70 10^3 × 16 / π × 42
d^3 = 8488.26 mm
d = 20 Standard diameter

3.6 Design of air storage tank

Here is no generally accepted method of sizing air receivers but a commonly used formula is based on the mass balance
C pa t = V (p1 - p2)
That can be transformed to
t = V (p1 - p2) / C pa
Where
V = volume of the receiver tank (m cube)
t = time for the receiver to go from upper to lower pressure limits (min)
C = free air needed (m3/min)
Pa = atmosphere pressure (1.013 bar)
p1 = maximum tank pressure (20 bar)
p2 = minimum tank pressure (2bar)
t = V (p1 - p2) / C pa
V = π/4 x (D^2) x L + π/6 x (D^3)
V = π/4 x (320^2) x 320 + π/6 x (320^3)
V= 0.042 m^3
t = 0.042 (20– 2) / .11 x 1.0132
t= 6.81 min

4. COMPONENTS

4.1 Air Tank Assembly

It is the cylindrical pressure vessel which is design for storing highly compressed air inside it. This air tank provide the compressed air to operate the pneumatic ratchet to this project. An Air Receiver Tank Is An Integral And Important Part Of Any Compressed Air System. All components such as Air Tank, Air Tank Holders and Belt are modeled in CREO 3.0 Software. With taking proper Geometry dimension and Tolerances. The air is designed in such a way so that it sustain maximum 22 bar air pressure. Material used for air tank assembly is mild steel.

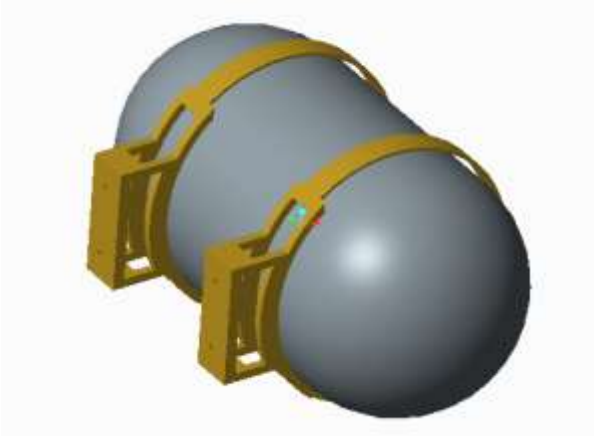

Fig -1: Air Tank Assembly

4.2 Ratchet

It is a pneumatic tool used to tighten and loosen the nuts .it is very simple in operation. Compressed air is used as an inlet

source to actuate. This tool uses a small turbine to convert compressed air into rotational mechanical energy that develops a torque to drive mechanical fasteners via standard hex sockets.

Fig -2: Ratchet

4.3 Pneumatic Hoses

A Pneumatic hose is a flexible hollow tube designed to carry fluids from one location to another. Hoses are also sometimes called pipes (the word pipe usually refers to a rigid tube, whereas a hose is usually a flexible one), or more generally tubing. The shape of a hose is usually cylindrical (having a circular cross section).

Fig -3: Hose

4.4 Chain Sprocket

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. Sometimes the power is output by simply rotating the chain, which can be used to lift or drag objects.

Fig -4: Chain Sprocket

4.5 Shaft

Shafts form the important elements of machines. They are the elements that support rotating parts like gears and pulleys and in turn are themselves supported by bearings resting in the rigid machine housings. The Shaft is modeled in CREO 3.0. The Material Used is Mild Steel.

Fig -5: Shaft

4.5 Bearing

A bearing is a machine part, which support a moving element and confines its motion. The supporting member is usually designated as bearing and the supporting member may be journal. Since there is a relative motion between the bearing and the moving element, a certain amount of power must be absorbed in overcoming friction, and if the surface actually touches, there will be a rapid wear.

Fig -6: Pedestal Bearing

Fig -7: Bearing Assembly

4. CAE

The Following Analysis are performed on the Cylinder mounting and Cylinder Assembly with considering Gross weight of Cylinder:

1. Normal Mode Analysis
2. Braking Analysis
3. Bumping Analysis
4. Bump+ Brake+ Cornering Analysis
5. Pressure Analysis

On Shaft Normal Torque Analysis is performed and following results are obtained during the CAE

Table -1: CAE Results

Components	Analysis Type	Force Value	Max. Stress (Mpa)
Air Tank Assembly	Braking	2G	62.5
Air Tank Assembly	Bumping	3G	95.1
Air Tank Assembly	Cornering+ Bump+ Brake	2G+3G+2G	134.2
Air Tank Assembly	Normal Mode		11.1 Hz
Air Tank Assembly	Pressure	22 Bar	93.43
Shaft	Torque	70 Nm	77.83

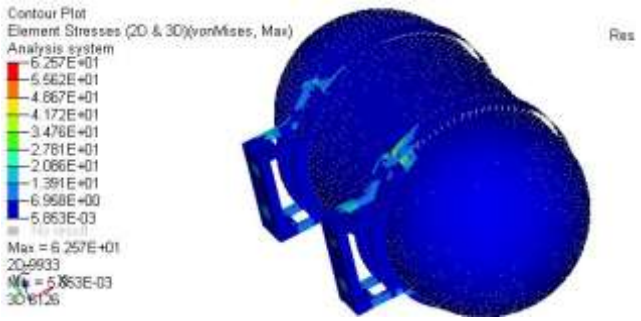

Fig -8: Braking Analysis

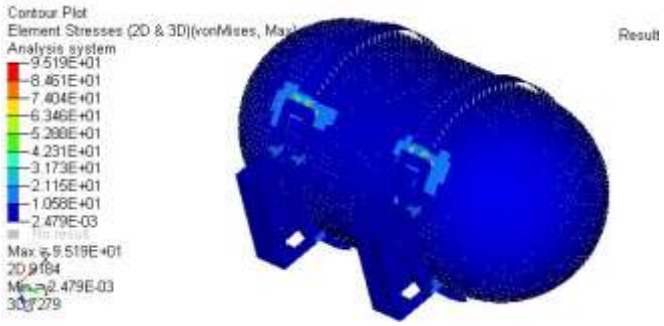

Fig -9: Bumping Analysis

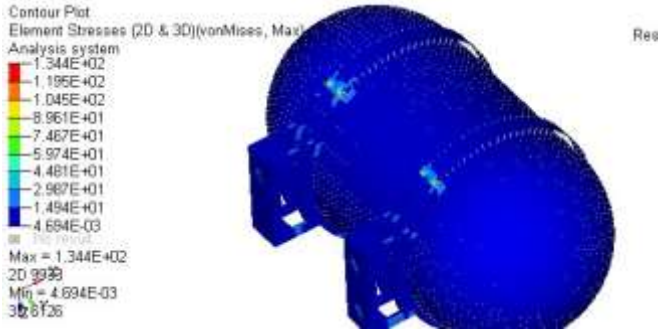

Fig -10: Bumping+ Bump+ Corner Analysis

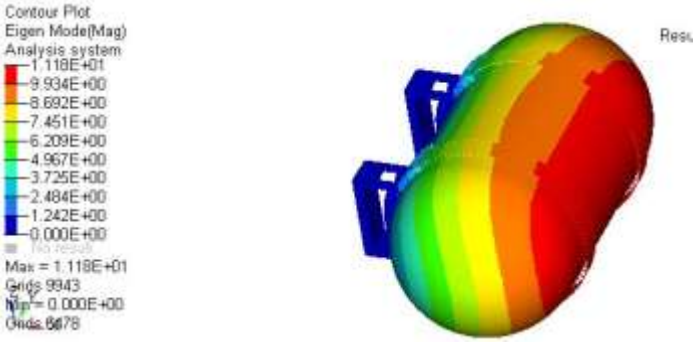

Fig -11: Normal Mode Analysis

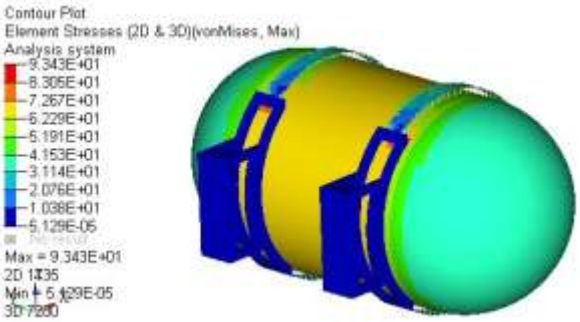

Fig -12: Presure Analysis

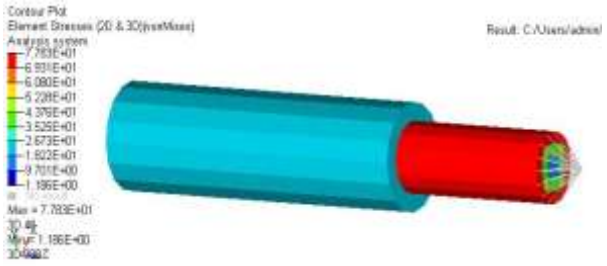

Fig -11: Torque Analysis

5. CONCLUSION

The performance and results studies carried out in a closed environment also demonstrated that Pneumatic tricycle is easy to use in normal use situations as well as to get around obstacles. The survey results clearly show that a large majority of test participants found all cycles movements easy to perform. The evaluation results suggest that Pneumatic tricycle use is appropriate in closed environments, such as major industrial complexes, hospitals, shopping centers and airports. Evaluations under actual operating conditions be continued to help develop a new regulatory framework and to define new technical characteristics and conditions under which Pneumatic tricycle may be used. The reliability and safety of this device when used in urban communities; Social acceptance of power scooters help to reduce traffic problem.

ACKNOWLEDGEMENT

We are thankful to our technical university RGPV, Bhopal that they have given us chance to convert our theoretical knowledge into the practical skills through this project.

Any work of this magnitude requires input, efforts and encouragement of people from all sides. In compiling this project, we have been fortunate enough to get active and kind co-operation from many people without our endeavors wouldn't have been a success. The project work has been made successful by the cumbersome effort of the faculties. We would like to express our deep gratitude to my project guide Prof. Nitin Rathi under whose valuable guidance we were able to complete our project smoothly. We are thankful to our Project Coordinator of Mechanical Engg. Department Prof. Prashant Geete, for encouraging us regularly and providing us each and every facility.

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BIOGRAPHIES

Pratyaksh Mishra student of Mechanical Department of Acropolis Institute of Technology & Research, Indore

Rishabh Narwariya student of Mechanical Department of Acropolis Institute of Technology & Research, Indore

Sakshi Porwal student of Mechanical Department of Acropolis Institute of Technology & Research, Indore

Santosh Verma student of Mechanical Department of Acropolis Institute of Technology & Research, Indore