

Design & Fabrication of Automatic Pneumatic Vehicle

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Abstract - Nowadays almost every industry trying to develop light & efficient vehicles. Today, the all the vehicles running on conventional & non-conventional fuels are known for producing a large amount of harmful gases like CO₂, SO₂, NO₂ etc. which acts increases global warming. The moto of our project is to design & fabricate vehicle running on air pressure for material handling in industries and reduce power consumption. It is rear wheel drive. We develop the concept of pneumatic vehicle from pedal operated tricycle. The vehicle looks like three wheeler in which manual operation is replaced by compressed air pressure.

Key Words: Primary Pneumatic Actuator, Back Air Fill Acuator, Gear & Pinion, Chain Sprocket, Pneumatic Control System

1. INTRODUCTION

By the past 30 years, human beings along with all living things hardly suffering from many environmental problems like global warming, ozone depletion. Burning of many conventional fuels in the automotive vehicles are highly responsible for various environmental troubles of global warming & depletion of natural energy sources. Regarding the environmental protection, the issue of energy expenditure and saving was taking as a serious issue. Now days, automobiles work on a large amount of fossil fuels with somewhat lower efficiency. However, the consumption of fossil fuels results & transforms in to many serious environmental problems, such as global warming, ozone layer depletion and fine particulate matter. For reduction in such environmental problems, the use of renewable energy sources like solar energy, wind emphasis on the use in automotive vehicle.

The term "Pneumatics" is derived from Greek word "Pneum" which means air. The pneumatic system deals with the use of air pressure along with its control system for moving things also provide clean system. A Tricycle is a popular & highly used type of cycle as urban & rural means of transportation mostly used by handicapped peoples. A Tricycle is often abbreviated to Trike is three wheeled vehicle. Our project of tricycle is an air-operated one-person capacity vehicle that is specially designed for low distance mobility generally used in industry. It is generally used where it is frequent work of transportation of materials

generally in the industries & those people who having difficulty walking or moving frequently from one place to another (Handicapped people).

It is much unusual that compressed air can be used to drive vehicles. However that it is true, that the "air car", is popularly known, has caught the attention of many engineers worldwide. It has zero emissions and is ideal for city driving conditions and suitable for industry transportation applications. Although it seems to be an environmental-friendly solution, one must consider its well to wheel efficiency. The electricity requirement for compressing air has to be considered while computing overall efficiency. Nevertheless, the compressed air vehicle will contribute to reducing industrial air pollution in the long run.

A Compressed-Air Vehicle (CAV) is powered by a air pressure along with control system, using compressed air, which is stored in a reservoir with high pressure. Instead of using the mixture fuel with air and burning it in the engine cylinder to drive pistons with hot expanding gases, compressed-air vehicles uses the high pressure of a compressed air stored in reservoir to drive their pistons.

2. LITERATURE REVIEW

Rakesh P. Shende, Surbhi A. Tode, Dr. R.U. Sambhe in the article "Design and fabrication of pneumatic tricycle." describes that pneumatic tricycle is stable, operated quietly and smoothly and gave users the feeling of being in control of vehicle. The ergonomic evaluation also demonstrated that pneumatic tricycle is easy to use in normal use situation. The devices also compare favorably with other types of cycles particularly in terms of stability, where they seem superior to other vehicles such as bicycles and mopeds. 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.

Navin Kumar, Utsav Banka, Manas Chitransh, Jayati Takkar, Vasu Kumar, Unish Gupta, Sushant Singh in the article "Compressed Air Retrofit kit for existing motor vehicles." They conclude that this kit provides alternative to current energy scenario by modifying vehicles which are more efficient and affordable. Also based on availability,

economy, & environment friendly it demands more attention at zero pollution.

3. OBJECTIVE

The aim of our project is to reduce the problem generally we face in industries. The aim can be achieved by objective further.

- Industrial material handling effectively.
- To save energy and reduce power consumption.
- Energy input saves as in case of pneumatic vehicle after filling air in reservoir we just only recirculate in the system.
- Better speed is obtained in case of pneumatic vehicle is high compared to AGV's used in industry for material handling.

4. COMPONENTS OF PNEUMATIC VEHICLE

- 1) **Pneumatic Actuator** - The compressed air is fed in one direction of actuator which reciprocates the piston to and fro by the impact of high pressure air. Cylinder is manufactured generally from Aluminum & aluminum alloys with central bore on lathe machine. We uses cylinder of SC Series of size 50×100.



Fig.4.1.1 Pneumatic Actuator

- 2) **Solenoid Valve** – Solenoid valve is a valve operated & controlled electromechanically. Firstly the electric current controls the valves through solenoid, the valve is on or off when it is of 2 ports. Solenoid valve gives high reliability, fast & safe switching, and long service life. Valves are made from cheaper materials (e.g. aluminum and polymer). For our system we uses solenoid valve of DV4-08, Pressure: 0.16-0.8 MPa.



Fig.4.2.1 Solenoid Valve

- 3) **Air Circulating Devices** - The compressed air is stored in an air receiver from which air is drawn out in to application point by means of air circulating devices. PU tubes are made up of Polyurethane. It has sufficient strength to handle high pressure of compressed air.



Fig.4.3.1 Air Circulating Devices

- 4) **Air back fills Actuator** - It is used to refill the actuator with air which is used to run vehicle according to revolution of wheels. It is actually a pneumatic actuator but in our project we use 2 actuators of different capacity for 2 different applications. It is connected rear wheels to work according to wheel revolution. We used actuator of model 25M100, pressure range 0.1 – 0.15 MPa.
- 5) **Limit Switch** –Limit switch is operated by the motion of machine parts or by presence of the object. It is a mechatronics device that mechanically controls the actuator links to set of contacts. When an actuator comes in contact with the actuator, the device operates the contacts to make or break electrical connections. It is used to actuate primary & back air fill actuator alternately according to wheel revolution.



Fig.4.5.1 Limit Switch

6) **Gears** – It is used to obtain desired speed & gear ratio as per our need. In our project we need more speed & torque than power developed at actuator, so we placed first gear & then pinion in transmission lines to obtain comparatively more speed. In our system we have gear teeth difference of 30 so we obtained gear ratio of 2.

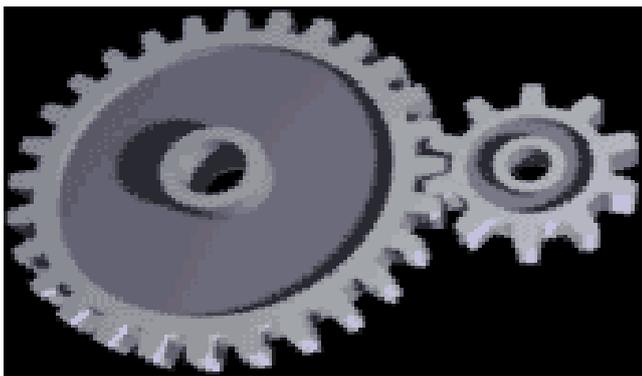


Fig.4.6.1 Gears

7) **Chain & Sprocket**- In chain & sprocket, sprocket is a toothed wheel with only one directional rotation restricted by suitable mechanism. Chain drive is considered as positive drive as there is no slip occurs in chain drives. It is used to transmit power obtained at actuator from pinion to the rear wheel shaft.



Fig. 4.7.1 Chain & Sprocket

8) **Bearings** – It is used to reduce friction between two rotating part in order to reduce wear & tear of rotating materials.



Fig.4.8.1 Bearings

9) **Chassis** – Chassis is the foundation of any vehicle from which system is developed. It is supported on wheels using that it have to sustain all the loads of the system. It is the base of vehicle on which whole components and Pneumatic control system of the vehicle is mounted systematically, our chassis size is of trapezoidal shape made up of MS angle bar of cross section : (22×22×2) mm.

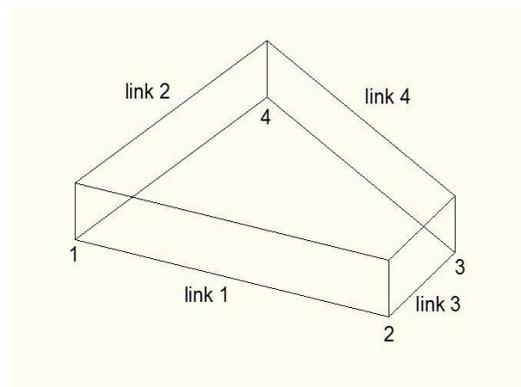


Fig.4.9.1 Structure of Chassis

5. Working

Working of our vehicle is same like typical pneumatic System but with some different aspect. Firstly compressed air from compressor is stored in tank. Then air from passing through control system according to our requirement and speed conditions.

Then air allows passing through primary actuator by which piston rod of actuator pushes the gear and pinion

system & subsequently chain and sprocket to move by only half revolution of wheel.

For next half revolution of wheel, limit switch is there, which actuates at the extreme end of piston rod of Primary actuator. Limit switch then actuates solenoid valve and also then activates back air fill actuators placed at rear wheels.

Back air fill actuate circulates air back to reservoir for moving remaining half revolution of the wheel.

6. Design of Parts

1. Chassis - Material: MS Angle Bar (22*22*2)
 Total Weight acting on Frame = 981 N
 $\sigma_{\text{permissible}} = 100\text{N/mm}^2$
 $\sigma_{\text{actual}} = 90.57\text{ N/mm}^2$

2. Wheel Shaft - Material: C 45
 Torque to be Transmitted = 48.45 N-m
 $T_{\text{max}} = 74.25\text{ N/mm}^2$
 $d = 14.93\text{ mm} \cong 20\text{ mm}$

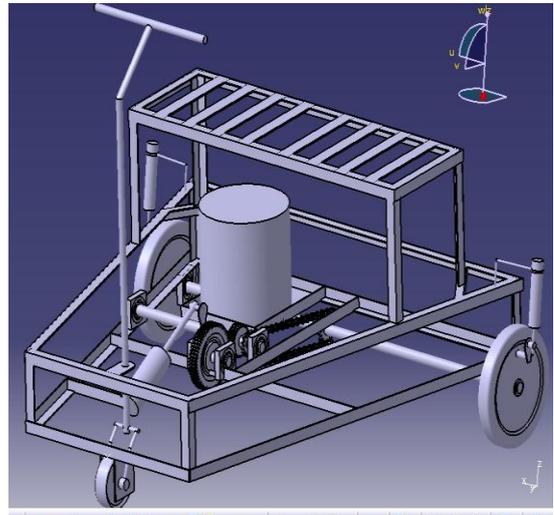
3. Bearing - $d = 20\text{ mm}$, $D = 47\text{ mm}$, $B = 14\text{ mm}$;
 $C = 1000\text{ N}$, $C_o = 655\text{ N}$
 Designation: 6204
 Equivalent Load, $P_o = 245.25\text{ N} < C_o$

4. Gear & Pinion - Selected as Standard,
 $D_G = 120\text{ mm}$, $Z_G = 60$;
 $D_P = 60\text{mm}$, $Z_P = 30$

5. Pneumatic Actuator - Selected as Standard,
 Bore Diameter, $D = 50\text{ mm}$,
 Stroke Length = 100 mm,
 Minimum Pressure required to start
 Vehicle, $P_{\text{min}} = 0.027471\text{ bar}$
 So, selected $P_{\text{max}} = 4\text{ bar}$

6. Reservoir - Diameter of Reservoir = 170mm
 Height of reservoir = 280 mm
 Volume, $V = 6.3\text{ Litres}$,
 Diameter of tyres = 300 mm
 For 1 rotation distance covered = 0.94 m

7. CAD MODEL



8. ANALYSIS

1. Chassis

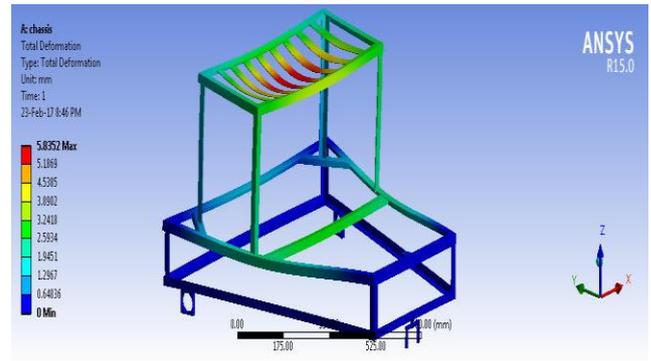


Fig.8.1.1 Deformation under Load

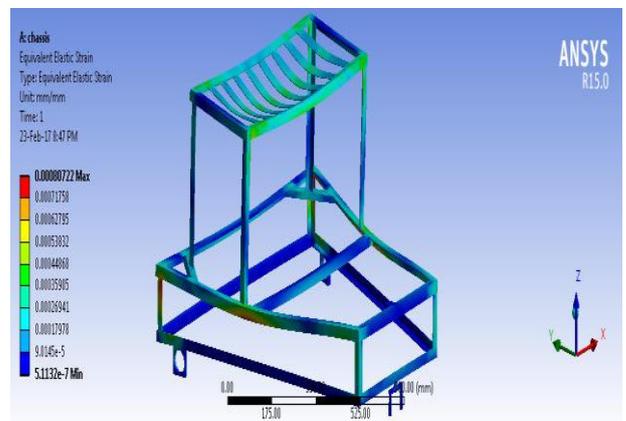


Fig.8.1.2 Straining of Frame under Load

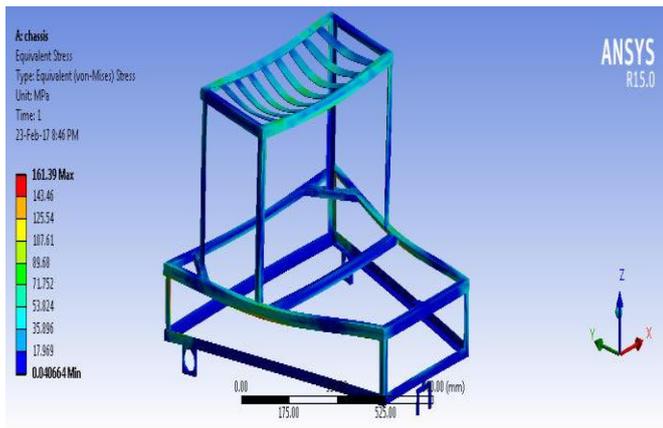


Fig.8.1.3 Stress Analysis of Frame under load

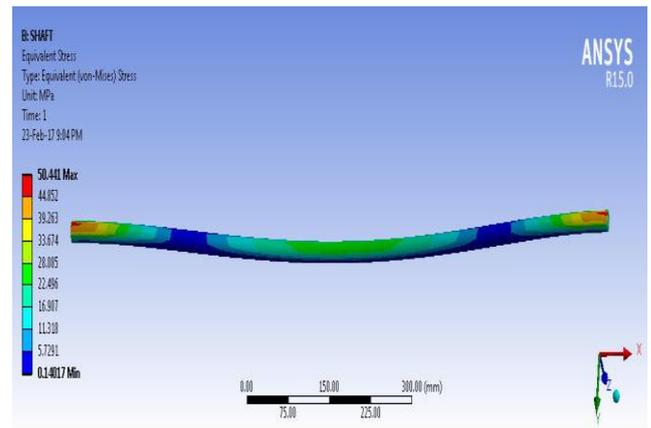


Fig.8.2.2 Stressing of Shaft

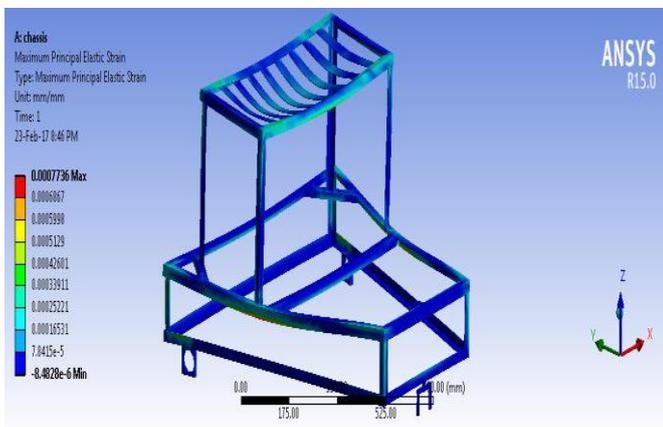


Fig.8.1.4 Maximum Principle Strain Analysis

2. Shaft

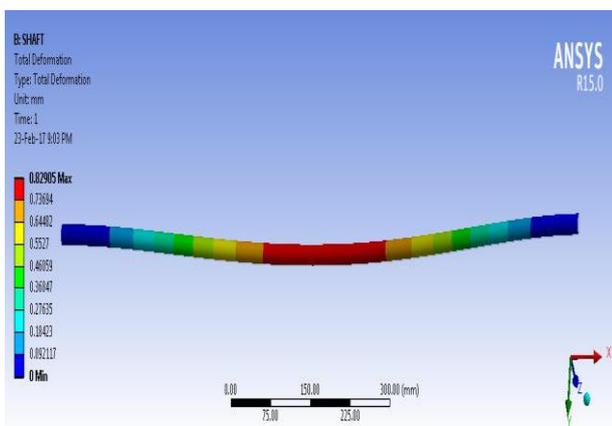


Fig. 8.2.1 Shaft Deformation under Load

9. CONCLUSION

Even though the vehicle is in early stage of development, it holds a lot of promise and provides scope for further research. Thus we designed and manufactured the vehicle model which is eco-friendly and does not cause pollution like internal combustion engines. This vehicle will help in reducing the problem of global warming since internal combustion engines contribute to the problem the most.

It uses non-conventional energy source i.e. atmospheric air. This will help to save the non-renewable sources of energy. So, the successful policy for the 21st century will depend on the non-conventional sources. Pneumatic vehicle can prove solution to depleting natural resources and can be the technology of tomorrow.

In this project a model of pneumatic vehicle is designed and manufactured. The load carrying capacity of pneumatic vehicle is 60 kg. The volume of air receiver tank is 6.3 lit. and is stored at pressure of 4 bar. Once the compressed air is filled in tank the vehicle can move up to a distance of 15 to 20 m.

10. REFERENCES

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