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Design of Automatic Pneumatic Vehicle

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ABSTRACT- It is hard to believe that compressed air can be used to drive vehicles. Nowadays almost every industry trying to develop light and effective vehicles. The technology of pneumatics has gained tremendous importance in the field of workplace rationalization and automation. Today all the vehicles running on conventional and non-conventional fuels are known for producing a large amount of harmful gases like carbon-dioxide, nitrogen-dioxide, sulphur-dioxide etc. The motto of our project is to fabricate vehicle running on air pressure for material handling in industries and reduce power consumption. It seems to be environmentally friendly solution. The compressed air vehicle will contribute to reducing air pollution in the long run. So the pneumatic systems should be used extensively in industry, and factories which are commonly plumbed with compressed air or compressed inert gases. It is a rear wheel drive. We develop the concept of pneumatic vehicle from pedal operated tricycles. The vehicle looks like three wheeler in which manual operation is replaced by compressed air pressure.

Keywords – Pneumatic Actuator, Back Air Fill Actuator, Solenoid Valve, Gear & Pinion, Chain & Sprocket, Pneumatic Control System.

I. 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.

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II. OBJECTIVES

The main objective of our project is to design the Automatic pneumatic vehicle which is used to reduce the problems which we generally face in industries. It is used for material handling purpose in industries.

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 reticulate in the system.
- To develop compressed air vehicle this can be run by the compressed air.
- Our environment must be protected against various contaminants.
- For example, Nitrogen oxide (NOX) after oxidation forming nitric acid, contributes to acid rain which causes severe damage to environment.
- These benefits result simple design, simple construction and less weight.
- Thus compressed air technology satisfies present demand and can prove to be future transport medium.
- Better speed is obtained in case of pneumatic vehicle is high compared to AGV's used in industry for material handling.

III. LITERATURE REVIEW

In general terminology, sustainability can be stated as; meeting the needs of current and future mankind/generations through simultaneous environmental, social and economic improvements, whereas sustainability of the energy resources to preserve the oil and make brighter future of mankind by adding alternative energy sources such as: non-conventional and or renewable energy which is going to help current problem to some extent. Now worldwide researchers/inventors are paying full attention towards this issue. It is also learnt that there are two distinct reasons for search of alternative to fossil fuel and make sustainable energy source; the first one is depletion of oil resources which is causing civilization vulnerable, thereby many researchers, technologists and scientist have spoken as to why alternative to fossil fuel is required another one is higher rate of emission due to rapid use of hydrocarbon fuel. Behaviour of compressed air Compressed air is clean, safe, simple and efficient. There are no dangerous exhaust fumes of or other harmful by products when compressed air is used as a utility. It is a non-combustible, non-polluting utility.

Rakesh P. Shende, Surbhi A. Tode, Dr. R.U. Sambhe says "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 favourably 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.
Economy, & environment friendly it demands more attention at zero pollution.

IV. WORKING OF AUTOMATIC PNEUMATIC VEHICLE

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.

V. COMPONENTS

A. Pneumatic Actuator

A pneumatic control valve actuator converts energy (typically in the form of compressed air) into mechanical motion. The motion can be rotary or linear, depending on the type of actuator. A Pneumatic actuator mainly consists of a piston or a diaphragm which develops the motive power. It keeps the air in the upper portion of the cylinder, allowing air pressure to force the diaphragm or piston to move the valve stem or rotate the valve control element.

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 Aluminium &

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aluminium alloys with central bore on lathe machine.

Fig –1: Pneumatic Actuator

B. 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. aluminium and polymer).

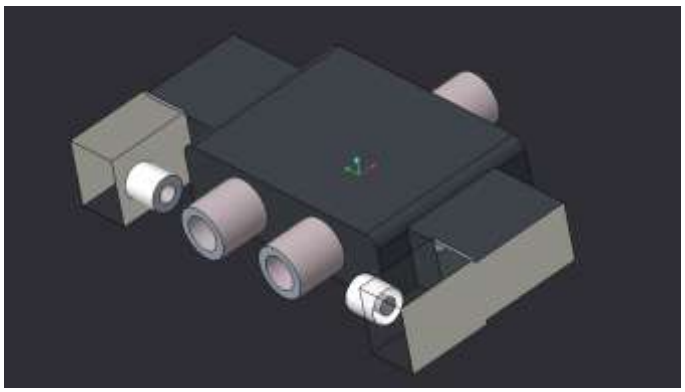

Fig –2: Solenoid valve

Solenoid valve is an electromechanically-operated valve. Solenoid valves differ in the characteristics of the electric current they use, the strength of the magnetic field they generate, the mechanism they use to regulate the fluid and the type and characteristics of fluid they control.

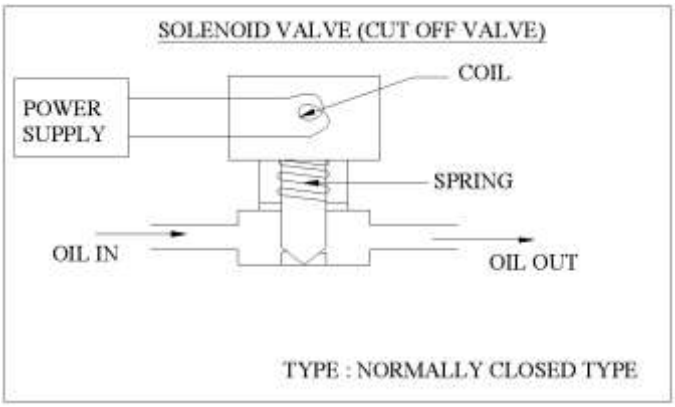

Fig: 3. Solenoid Valve (cut off valve)

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C. 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 30.

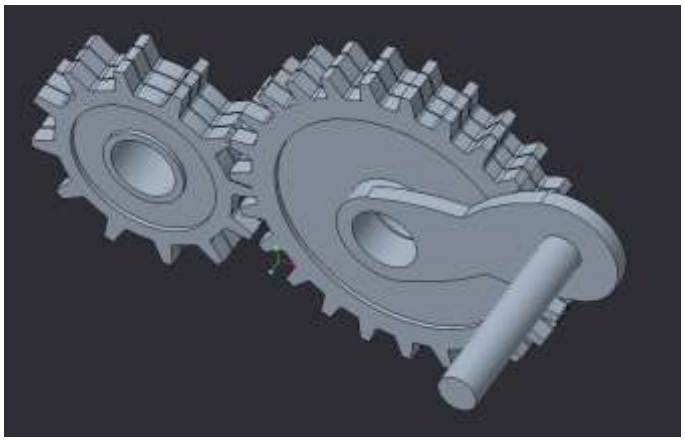

Fig: 4: Gears

D. Air Compressor

When air is compressed, it is under pressure greater than that of the normal atmospheric pressure and it characteristically attempts to return to its normal state. Since energy is required to compress the air, energy is released as the air expands and returns to atmospheric pressure. Air compressors were designed to compress air to higher pressures and harness this potential energy source.

Fig: 5: Air Compressor

E. Control Valve

A control valve is a valve used to control fluid flow by varying the size of the flow passage as directed by a signal from a controller. This enables the direct control of flow rate and the consequential control of process quantities such as pressure, temperature, and liquid level.

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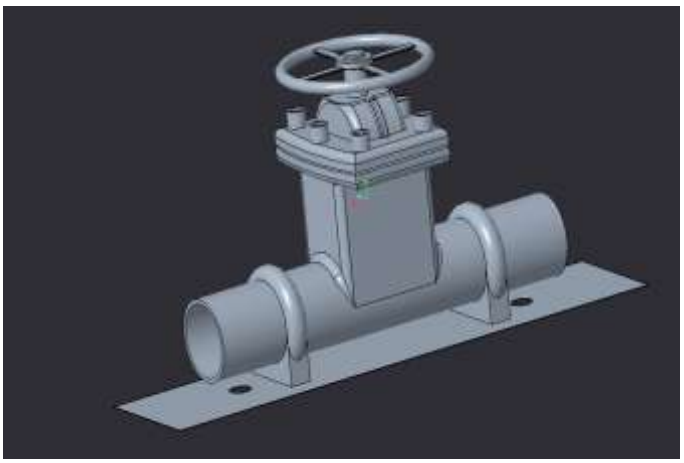

Fig – 6: Control Valve

F. 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 – 7: Air circulating devices

F. Battery

A battery is a power source consisting of one or more electrochemical cells with external connections for powering electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode.

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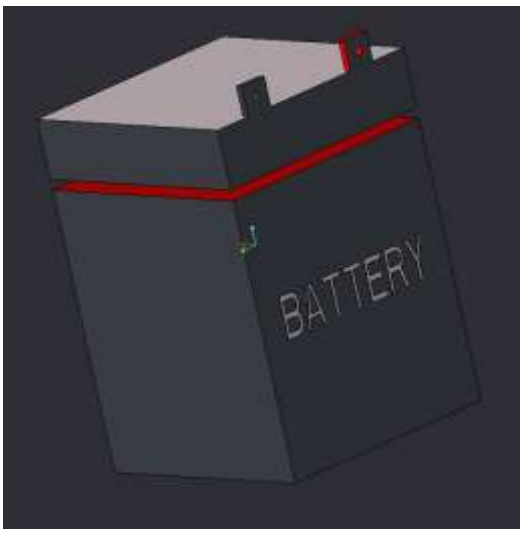

Fig – 8: Battery

G. Steering Wheel

A steering wheel is a type of steering control in vehicles. Steering wheels are used in most modern land vehicles, including all mass-production automobiles, buses, light and heavy trucks, as well as tractors.

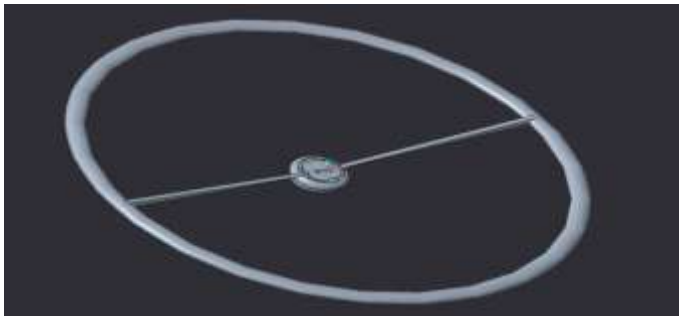

Fig – 9: Steering wheel

H. Chain and 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 of the wheel shaft.

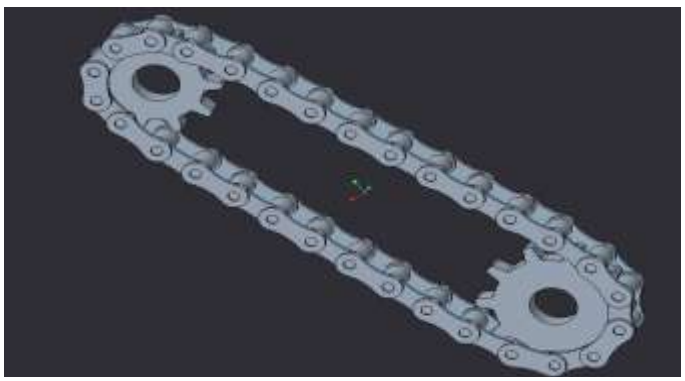

Fig 10: Chain and sprocket

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I. 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.

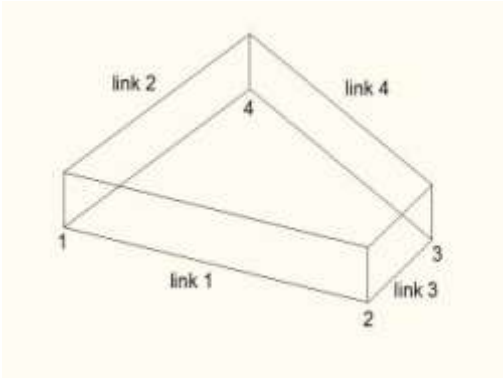

Fig 11: Chassis

The whole assembly is mounted on this frame. The complete frame is made up of mild steel.

VI. MATERIALS USED FOR DESIGN

S.No	Parts	Materials
1	Pneumatic Actuator	Stainless Steel
2	Solenoid valve	Stainless Steel
3	Gears	Cast Iron
4	Air Compressor	Cast Iron
5	Control Valve	Carbon Steel
6	Bearings	Chrome Steel
7	Air Circulating Devices	_
8	Air Back Fills Actuator	_

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9	Battery	Nickel
10	Chain and Sprocket	Alloy steel
11	Limit Switch	Aluminium
12	Chassis	Mild Steel

VII. CALCULATIONS

1. Chassis –
Material: MS Angle Bar (22*22*2)
Total Weight acting on Frame = 981 N
Permissible Stress = $1000 N/mm^2$
Actual stress = $90.57\ N/mm^2$

2. Wheel Shaft
Material: C 45
Torque to be Transmitted = 48.45 N-m
Tmax = $74.25 N/mm^2$
d = 14.93 mm

3. Bearing –
d = 20 mm, D = 47 mm, B = 14 mm; C = 1000 N,
Co = 655 N
Designation: 6204
Equivalent Load, Po = 245.25 N < Co

4. Gear & Pinion –
Selected as Standard,
DG = 120 mm, ZG = 60;
DP = 60mm, ZP = 30

5. Pneumatic Actuator –
Selected as Standard,
Bore Diameter, D = 50 mm,
Stroke Length = 100 mm,
Minimum Pressure required to start Vehicle,
Pmin = 0.027471 bar
So, selected
Pmax = 4 bar

6. Reservoir –
Diameter of Reservoir = 170mm
Height of reservoir = 280 mm
Volume, V = 6.3 Litres,
Diameter of tyres = 300 mm For 1 rotation distance covered = 0.94 m

VIII. CAD MODEL

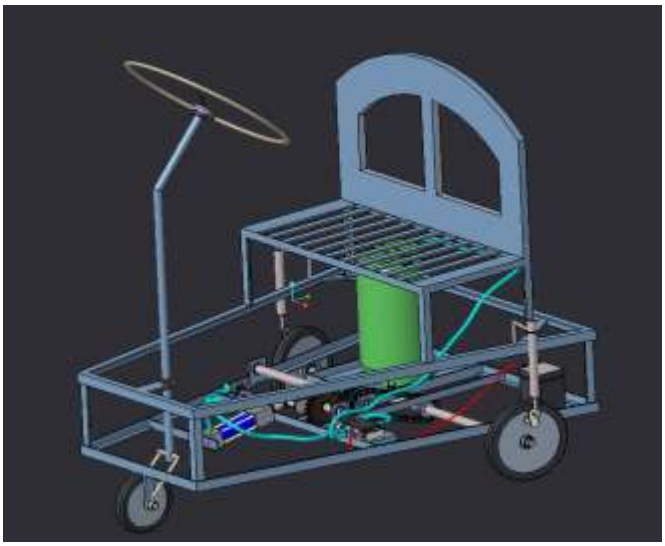

Fig : Automatic pneumatic vehicle

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IX. ANALYSIS

1. Chassis

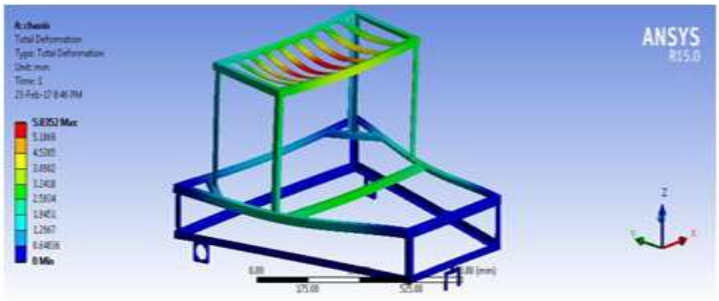

Fig.9.1.1 Deformation under Load

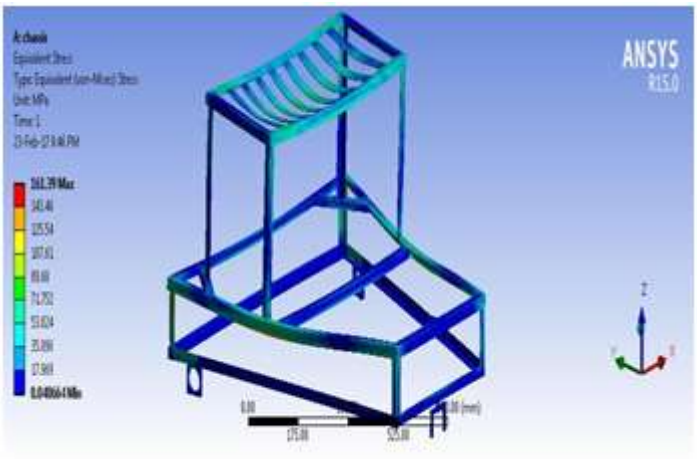

Fig.9.1.2 Straining of Frame under Load

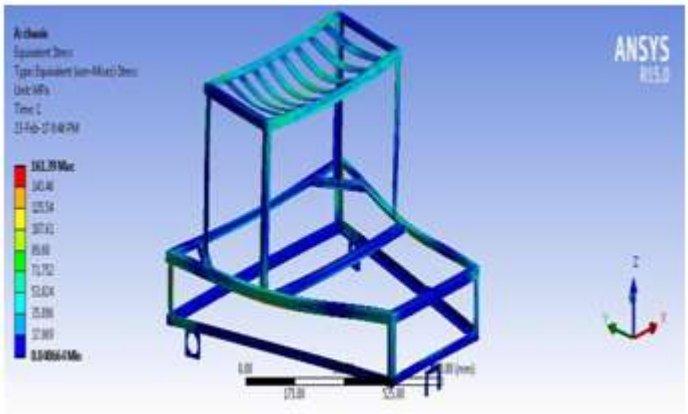

Fig.9.1.3Stress Analysis of Frame under load

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2. Shaft

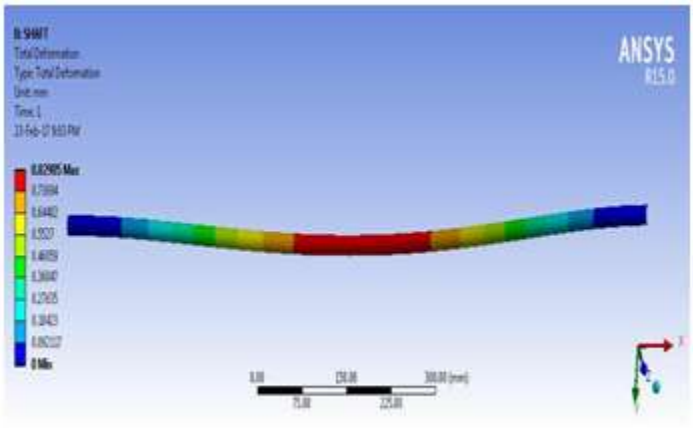

Fig. 9.2.1 Shaft Deformation under Load

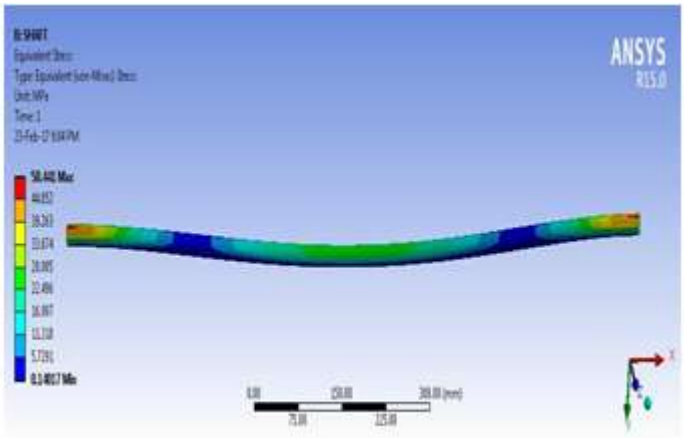

Fig.9.2.2 Stressing of Shaft

X. CONCLUSION

Even though the vehicle is in early stage of development, it provides scope for future research. Thus we designed the model which is eco-friendly and does not cause pollution. This vehicle helps in reducing the problems of global warming. It uses Non-conventional energy source i.e., atmospheric air. This vehicle is used for material handling in industries.

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