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DESIGN AND FABRICATION OF AIR POWERED VEHICLE

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Abstract: The fossil fuel engines which were good enough for us before 30-40 years but now they are one of the sources of contributor of global warming and pollution with fossil fuel crises. The Air Powered Vehicle is an eco-friendly vehicle which works on compressed air. An Air Powered vehicle uses air as a fuel. An Air Powered Vehicle uses the expansion of compressed air to drive the pistons of an engine. An Air Driven Engine is a pneumatic actuator that creates useful work by expanding compressed air. There is no mixing of fuel with air as there is no combustion. In this project, we are using a 5/2 solenoid valve connected to a flasher which is connected to a double acting pneumatic cylinder which is in turn connected to a modified piston head which rotates the flywheel and moves the engine forward thus creating motion.

Index Terms: Air Powered Vehicle, 5/2 Solenoid Valve, Double Acting Pneumatic Cylinder.

I. Introduction

An air compressor does most of its work during the compression stroke. This adds energy to the air by increasing its pressure. Compression also generates heat, however, and the amount of work required to compress a quantity of air to a given pressure depends on how fast this heat is removed. The compression work done will lie between the theoretical work requirements of two processes:

Adiabatic: a process having no cooling, the heat remains in the air, causing a pressure rise that increases compression work requirements to a maximum value.

Isothermal: a process that provides perfect cooling, thus, there is no change in air temperature and the work required for compression is held to a minimum."

So, during the compression process, if we remove the heat from the air not only do we capture energy that would otherwise be wasted, we also move the process closer to isothermal so that it takes less energy to compress the same amount of air.

A pneumatic motor (Air motor) or compressed air engine is a type of motor which does mechanical work by expanding compressed air Linear motion can come from either a diaphragm or piston actuator, while rotary motion is supplied by (Adder et al 2011) either a vane type air motor, piston air motor, air turbine or gear type motor.

(OR)

A Compressed-air engine is a pneumatic actuator that creates useful work by expanding compressed air. A compressed-air vehicle is powered by an air engine, using compressed air, which is stored in a tank. Instead of mixing fuel with air and burning it in the engine to drive pistons with hot expanding gases, compressed air vehicles (CAV) use the expansion of compressed air to drive their pistons.

II Working Principle

Through literature surveys following observations are made:

1. Air Tank
 A gas air tank is a mechanical device that increases the pressure of a gas by reducing its volume. Air tanks are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe. The compressibility of the air was first investigated by Robot Boyle in 1962 and that found that the product of pressure and volumes of particular quantity of gas. The usual written as, PV =C (or) P1V1=P2V2. The tank may be able to be refilled more often and in less time, with refueling rates comparable to liquid fuels. The tanks used in a compressed air motor have a longer lifespan in comparison with pumps, which after a while suffer from a reduction in performance.

2. Air compressor
 An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use.

3. Chassis
 A chassis consists of an internal vehicle frame that supports an artificial object in its construction and use, can also provide protection for some internal parts. Which is made up of carbon steel. The parts above mentioned are assembled to the chassis.

4. Piston Cylinder arrangement

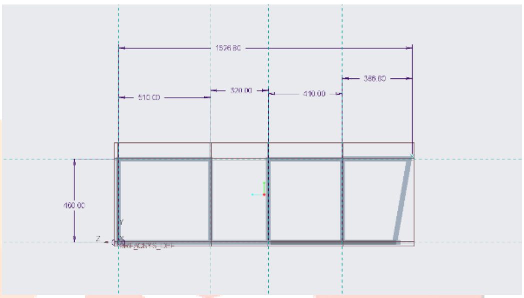
 The cylinder of an internal-combustion engine is closed at one end by a plate called the head and open at the other end to permit free oscillation of the connecting rod, which joins the piston to the crankshaft. The cylinder head contains the spark plugs on spark-ignition (gasoline) engines and usually the fuel nozzle on compression-ignition (diesel) engines; on most engines the valves that control the admission of fresh air–fuel mixtures and the escape of burned fuel are also located in the head. On most engines the cylinders are smoothly finished holes in the main structural component of the engine that is known as the block, which is generally made of cast iron or aluminum. On some engines the cylinders are lined with sleeves (liners) that can be replaced when they become worn. Aluminum blocks employ centrifugally cast iron liners that are placed in the mold when the aluminum is being cast; these liners are not replaceable, but they can be rebored.

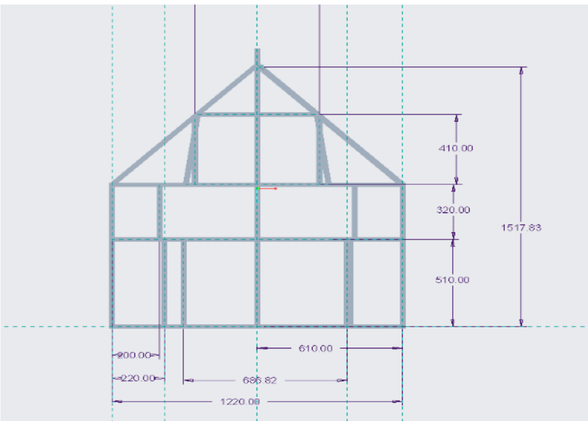
iii Design

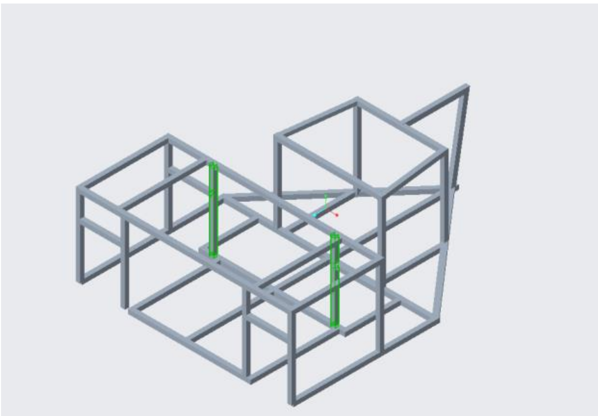
Automobile chassis refers to the lower body of the vehicle including the tires, engine, frame, driveline and suspension. Out of these, the frame provides necessary support to the vehicle components placed on it. Also, the frame should be strong enough to withstand shock, twist, vibrations and other stresses. The chassis frame consists of side members attached with a series of cross members Stress analysis using Finite Element Method (FEM) can be used to locate the critical point which has the highest stress. This critical point is one of the factors that may cause the fatigue failure. The magnitude of the stress can be used to predict the life span of the truck chassis. The accuracy of prediction life of truck chassis is depending on the result of its stress analysis. Designing of the chassis plays crucial part in providing the desired strength, endurance, safety and reliability to the vehicle. To choose the optimal design we did an extensive study, The strategy behind selecting this design for roll cage was to achieve maximum strength through arc welding, good bending stiffness, minimum weight and maximum strength for the pipes. Many of vehicles properties are strictly connected with the chassis or frame. Dynamic properties and static or geometric parameters of the vehicle depends on chassis or frames. The following dimensions were used in this particular design

- Outer member length: 25 mm
- Inner member length: 22 mm
- Wall thickness: 3 mm
- Total length of vehicle (Wheel end to Wheel end distance): 1220 mm
- Total vehicle length (end to end): 1626 mm
- Tyre diameter: 72 mm

With the above the following dimensions the following design of chassis is developed using Creo 4.0 (all the units are in mm)







IV Material Selection

Based on our requirement and cost effectiveness for everyday use along with a desire to use the best materials possible we have considered to use low carbo steels or mild steels which are commonly available. Based on extensive survey of materials available in market we have selected the following materials based on their properties to opt a single material for fabrication.

The materials which have been selected

1. AISI 1045
2. AISI 1020
3. AISIS 1060

Table 3.1: Comparison of Selected Material Properties
(Metric units)

Properties	**AISI 1045**	**AISI 1020**	**AISI 1060**
Tensile strength, ultimate	**565 MPa**	**394.72 MPa**	**620 MPa**
Tensile strength, yield	**310 MPa**	**294.74 MPa**	**485 MPa**
Modulus of elasticity	**200 GPa**	**200 GPa**	**190-210 GPa**
Bulk modulus (typical for steel)	**140 GPa**	**140 GPa**	**140 GPa**
Shear modulus (typical for steel)	**80 GPa**	**80 GPa**	**80 GPa**
Poissons ratio	**0.290**	**0.290**	**0.27-0.30**
Elongation at break (in 50 mm)	**16%**	**36.5%**	**10%**
Reduction of area	**40%**	**66%**	**45%**
Hardness in Brinell	**163**	**111**	**183**

V ANALYSIS

The frontal impact is considered to be an elastic collision. The linear velocity remain 60 kmph (or) 16.667 m/s. The value of force is calculated by the mass moment equation. Generally, the collision takes place for very short duration of time. We assume this time to be AT 1.01s. The total weight of the vehicle is considered to be 290 kg along with the driver weight. The following calculations are done in order to design the frame the best way.

The moment of the Vehicle at 45kmph is given by, P=M*V P= 290*16.667 = 4833.43kgm/s And the frontal impact force is given by, $F=P/\Delta T$ F=4833.43/1.01=4785.57N

Therefore, the impact force by speed limit is 4785.57N.

The 4 wheeler will have maximum of 1.68G force under acceleration limit. Therefore, the impact force is given by F=1.68*M*a=1.68*290* 9.81=4779.432N.The values of the force are practically comparable. According to a research the body has to pass 6.8G force for extreme worst-case collision. Therefore, for static frontal analysis the force is calculated as,

F= 6.8 * m*a F=6.8 x 290 x 9.81 F=19345.32N

Therefore, the worst impact force = 4779.432+19,345.32= 24,124.752.Now this calculated force should be placed on the front part of the frame in ANSYS for static structural analysis of the cage

Similarly

S.No	**Direction Of impact**	**Load (N)**	**Total Deformation(mm)**	**Stress (Mpa)**
1.	Front	24125	198.27	871.12
2.	Side	9530	10.389	3589.3
3.	Rear	13,3371.03	689.57	244.08

VI Performance Test and Evaluation

Force(F)generated by the cylinder: F=PXA P=internal pressure in tank=10bar=1N/mm2

F=1*πr^2(r=radius of the cylinder=30mm) ; F=1*π*30^2 ; F=2827.4333

Torque on the shaft:=Fxr

T=2827.4333N*25 ; T=70685.825N-mm ; T=70.68N-m

- Air Consumption by Pneumatic Cylinder:

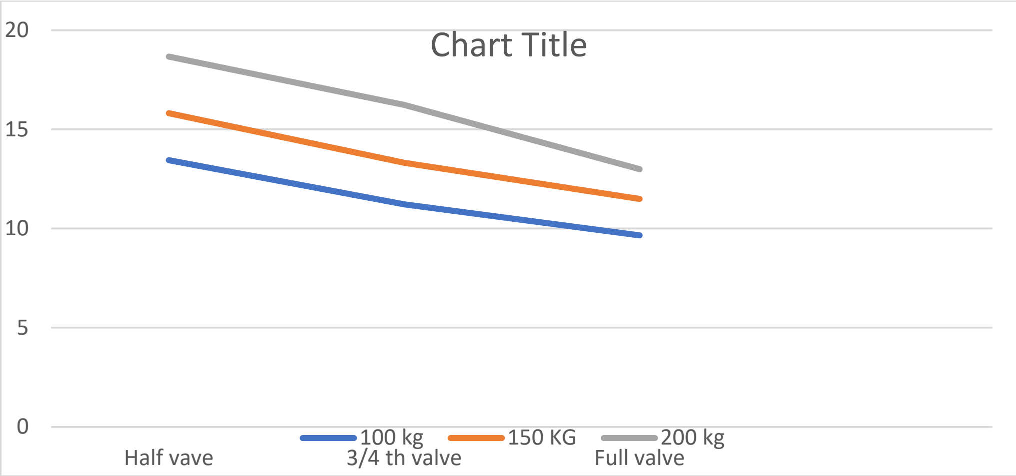
$$A_{cf} = \frac{\pi \times (D^2)}{4} \times l \times P \times s \quad A_{cr} = \frac{\pi \times (D^2 - d^2)}{4} \times l \times P \times s$$

Acf=3.14*0.25*(60)^2 *14*10*80 ; Acf=31.65lit/min

For reverse stroke Acr= 3.14*0.25*(60^2-20^2)*14*80*1; Acr=28.134 lit/min

Therefore, the total air consumption is = 31.65+28.134=60 lit/min

Condition of Valve	Load in Kg	Time taken to move a distance of 10mt
Half Valve	100	13.45
	150	15.82
	200	18.66
3/4 th valve	100	11.22
	150	13.32
	200	16.24
Full valve	100	9.65
	150	11.5
	200	13



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