Design and Fabrication of Compressed Air Vehicle

[1]Vineet Kumar Rai,[2]Abhinav Vishwakarma,[3]Lucky Upadhyay,[4]Vivek Singh,[5]Shivendra Pratap Gautam

[1]Head of Department,[2345]Student

[1]Mechanical Engineering

[1]Institute Of Technology & Management Gida Gorakhpur

Abstract: Life in the twenty-first century is very fast and many times knowingly or unknowingly we pollute our environment by using non-renewable energy resources in vehicles. We are excessively dependent on non-renewable energy resources we need to search possible chances in the alternative of fossil fuels in vehicles. In exploring the possible chances we get one is a compressed air car in which the engine runs on the compressed air. A compressed air engine is a type of pneumatic actuator that makes useful work by compressed air. A compressed air vehicle is triggered by an air engine using compressed air which is stored in an air tank. In place of mixing fuel with air combust it in the engine to steer pistons with hot expanding gases. A compressed air car utilizes the expansion of compressed air to steer the piston. The compressed air car is an unconventional substitute for transportation challenges as this technology claims to zero tailpipe emissions while offering the power and performance needed for light-duty vehicle applications. As this compressed air car does not consume fossil fuel or other non-renewable energy it is claimed to be greener and cheaper. For more research and advanced techniques, the results and Ansys analysis of our design and our experimental test have great importance.

Key Words - *CAV, Eco-friendly car, Pneumatic car, Zero tailpipe emission*

1. INTRODUCTION:-
From the few decades every living thing (human, animals, etc), everyone suffering from many environmental problems like global warming, ozone depletion from the use of many non-renewable fuels in the automotive vehicles are highly responsible for environmental problems. Nowadays vehicles are work on a large amount of fossil fuel. From the use of renewable energy resources like solar energy, wind energy, hydro energy we can reduce environmental problems.

The compressed air vehicle system deals with the use of air at high pressure along with its control system for moving things. It also provides a clean system. Four-wheeler is very popular in rural and urban places for transportation. Our project of four Wheeler is an air-operated one-person capacity with few means of transport at transportable thing's capacity vehicle that is designed for low distance travel generally used in industries.

In our project we will use a compressor as an energy source or power source which contains very high-pressure air nearly 8 bar, the compressor will be directly connected with the modified engine with the help of a hose pipe. We will use a Hero Honda 110 cc engine with the few modifications in the lobe normally in an engine contain one side lobe, but we modified it into two lobes resulting convert its 4 stroke engine into 2 stroke engines and blocks all the possible leakage points. There is no need for a carburetor, spark plug. Engine run perfectly with the help of high pressure compressed air and our designed chassis, as well as all body of the vehicle, will run perfectly without any issue. Our vehicle can easily perform its work with a load capacity of 120-150 Kg.

2. RESEARCH OBJECTIVES:-
Our project aims to reduce the problem in the internal combustion engine and industries.

- To save conventional energy by the use of non-conventional energy.
- Compressed air vehicle's speed obtained is better than compared to automated graded vehicles which can be used in industry for material handling.
- Control of pollution which is caused by the internal combustion engine by using of compressed air engine.
- Design and fabrication of compressed air vehicles to improve the load capacity of the vehicle.

3. LITERATURE REVIEW:-
There is lots of exploration and evaluation related to the design of a compressed air vehicle that has been done in the past. There are many research papers present related to the compressed air vehicle which is published in the past. Many methods are used for the developing of a compressed air vehicle which is used for modifications and improving the performance for the compressed air Engine. Here are some scientists or researchers who have studied or developed methods for improving the compressed air power in compressed air cars.

Anirudh Addala et. al. [1] has studied the compressed air car in which the compressed air has been used as the working medium. He fabricated a model that produces the power to weight ratio of 0.0373kW/kg. Many kinds of research have still been carrying out in many organizations in the R&D stage in all over the world.

B.R. Singh et. al. [2] have described the method in which the vehicle can run without the use of fossil fuels as a source to move the vehicle. He emphasizes on the compressed air driven engine which utilizes compressed air to trigger the engine. An engine is being designed to use the enormous potential of compressed air.

Ruchil Patel et. al. [3] has been described comparing the 4 stroke engine and compressed air engines by finding the differences in the camshaft of compressed air engines. In the compressed air engine, there are 2 lobes on the cam profile and 4 stroke engines have 1 lobe.

Vishwajeet Singh et. al. [4] has modified a 4 stroke engine into the 2 strokes for the making of the compressed air engine. He has modified the camshaft, speed ratio, inlet value, inlet, and outlet valve springs.

A.A. Keste et. al. [5] have studied the working of a vehicle which run by the help of Pneumatic power. In this, he developed a system of double-acting slider-crank mechanism which changes the linear reciprocation of the cylinder piston rod into the oscillatory motion of the driving crank about the piston shaft.

4. COMPONENTS OF COMPRESSED AIR VEHICLE:-

4.1 Compressed Air Tank:- It is a very important part of the air vehicle in this tank compressed air will be stored with the help of compressor & its compressed air used as a fuel of compressed air vehicle. Its size will vary according to the size & use of the vehicle in our project we will use 50 liter capacity of an air tank.

4.2 Air Powered Engine- In this project, we will use a four-stroke petrol engine of 110cc with some modification we made it into a two-stroke air engine. In a four-stroke engine, the camshaft rotates once for every two rotation of flywheel but in the two-stroke engine, the power stroke is obtained in every 360 degrees of crankshaft revolution. For the conversion of four-stroke into the two-stroke engine, it is required to modify the one lobe cam into two lobes supplementary each other. Alteration of the cam profile means, for one rotation of the camshaft of both valves will open twice. The two lift is possible for both inlet and exhaust sides. Thus, in the first quarter of rotation of the camshaft, we get power stroke next quarter exhaust and third quarter again power & fourth again exhaust. The leakage point of the engine will seal property.

4.3 Chassis- Chassis is the part of the vehicle from which the system will develop it is supported by the wheels and it carries all the loads of the vehicle. It is the base of the vehicle in which all the components will mount systematically. Our chassis size of square shape (110*80) cm^2.

4.4 Steering system- In our project, we will use the steering system is rack and pinion type & it is based on the Davis mechanism. The rotary motion of the steering wheel converted into the reciprocating motion of the shaft link attached to the wheels. In the construction of the steering system, we use a rack & pinion arrangement along with the cross attached linkage system and a steering wheel in this steering arrangement is present in front of the front axle.

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

4.6 Bearings- Bearings are used to reduce friction between two rotating parts to reduce wear and tear of rotating material. In our project, we will use 8 bearings and bearing for two front wheels and all bearings are free to rotate and 4 bearings will use in the two rear wheels and rear wheels bearing will be blocked it is not free for rotation. Rear wheels move with the rear axle.

4.7 Hose Pipe- The Hose Pipe is used for connecting the outlet nozzle of a compressed air tank to the inlet of the air-powered engine. It is checked if there is any leakage of air then it is presented by using the grippers.

4.8 Pressure Regulator- A Pressure Regulator is a valve that automatically cuts off the flow of any liquid or gas at the desired pressure. It is used to adjust the pressure coming out of a tank to match what is needed for our work.

4.9 Wheel- In our project, we will use four wheels of 13-inch diameter. Front two wheels will rotate with the help of bearing and rear two wheels will rotate with the axle. Wheels will provide easy movement in the vehicles.

5. WORKING OF COMPRESSED AIR VEHICLE:-
As we know the compressed air wheel run with the help of the compressed air, So the first air is compressed by the help of an air compressor. An air compressor is a device that is used for compresses the atmospheric air[1 atmosphere=1.013 bar]. The compressed air is stored in the tank and the compressed air is supplied to the engine whenever required. There is a pressure gauge is present which is mounted on the tank which is used to indicate the pressure inside the cylinder. The compressed air is supplied from the storage to the motor by which the air gun acts as a flow control valve. The motor is used that pneumatic motor in which rotary actuator used for converting pressure energy of air into rotary motion Torque capacity of the motor is less than our requirement due to which there should be a modification is done from adding the warm and warm wheel gearbox. Worm and worm wheel gear is designing in such a way by using a worm and worm-wheel is considerable. Smaller than one made from plain spur gear and has its drive axes at 90 degrees to each other by a single staring worm each will turn 360 degrees of the worm. The worm wheel proceeds only one tooth of the gear wheel. The gearbox is a mechanical device used to increase the output power. The motor's shaft is attached to one end of the gearbox and through the internal arrangement of gears of the gearbox, Which gives the output force and find the speed by the gear ratio. And worm and worm wheel gear are attached to the shaft to increasing the torque power of the motor by which the wheel moves with force when the gear configuration chain drive is connected to transfer the speed to the wheel of the vehicle. The wheels are contacting directly with the road surface and wheels are rear members of power transmission devices through which wheel move on the road surface and wheel drive the vehicle.

6. DESIGN

a) Chassis-

Measurement of chassis - (110*80) cm^2

Total weight acting on the frame - 65 kg

Permissible stress = 414 MPa

Tensile actual stress = 276 MPa

b) Wheel shaft-

The material of shaft = Cast Iron C45

The diameter of shaft = 20 mm

c) Bearing-

Inner diameter of bearing = 20 mm

Outer diameter of bearing = 42 mm

C = 995 N

C_0 = 655 N

Value of C and C_0 of bearing which is used in Designation

Equivalent load of bearing = 9.95 KN

d) Gear and pinion

Selected as standard

D_a = 120 , Z_a = 60

Dp = 60 mm , Zp = 30

e) Pneumatic Actuator Selected as standard

Bore diameter , D = 50 mm

Stroke length = 100 mm

Minimum Pressure Required to start the vehicle, P_{min} = 8 bar

Maximum pressure to start the vehicle, P_{max} = 12 bar

f) Reservoir

Diameter of reservoir = 33 cm

Height of reservoir = 77 cm

Volume of reservoir = 50 lit

Diameter of tyres = 5.07 inch

Diameter of wheel = 13 inch

Circumference of wheel = 40.82 inch

7. DESIGN ON CATIA & ANSYS ANALYSIS:- There are some designs of chassis and axle which are done on 3d designation software (Catia). And after that we have analyzed chassis and axle on Ansys software which are as follows:
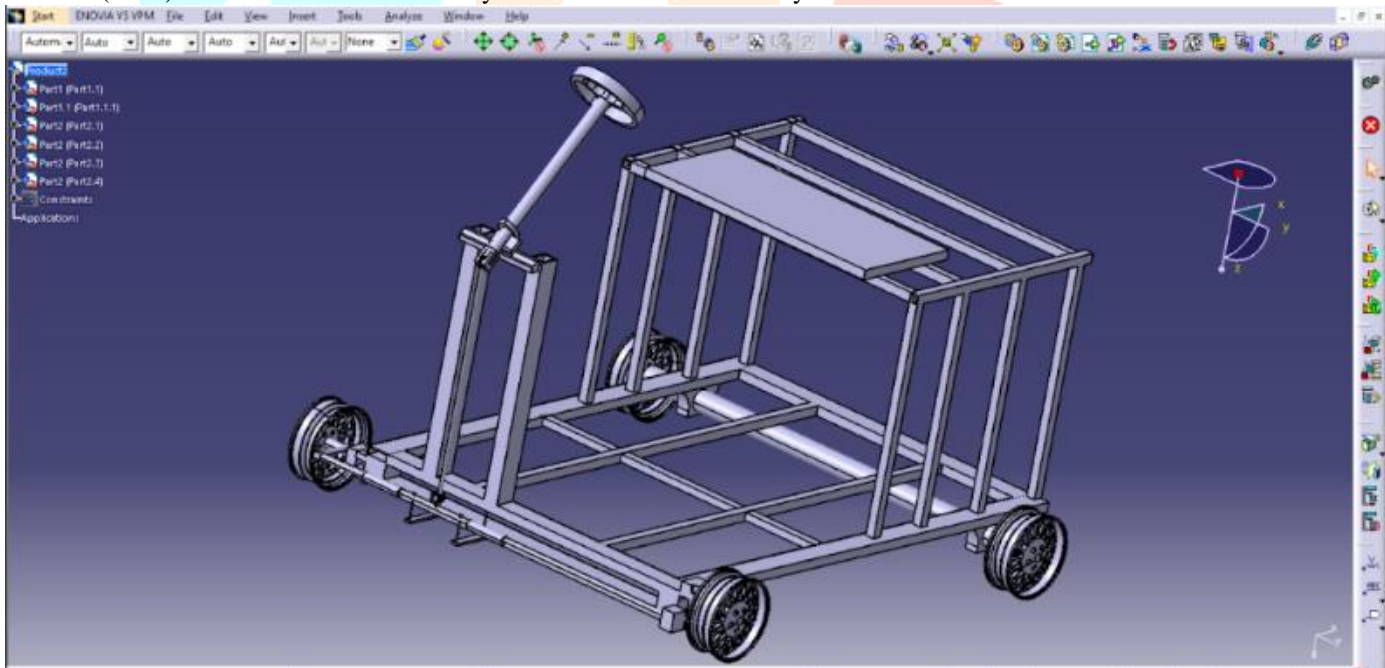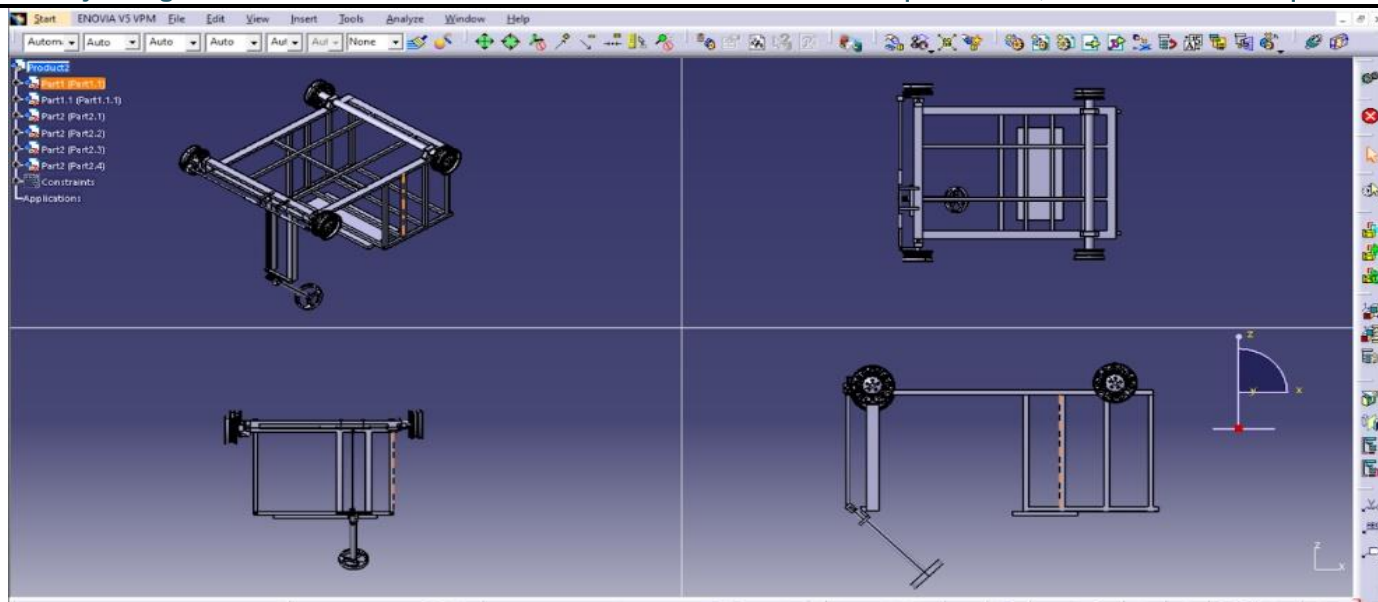

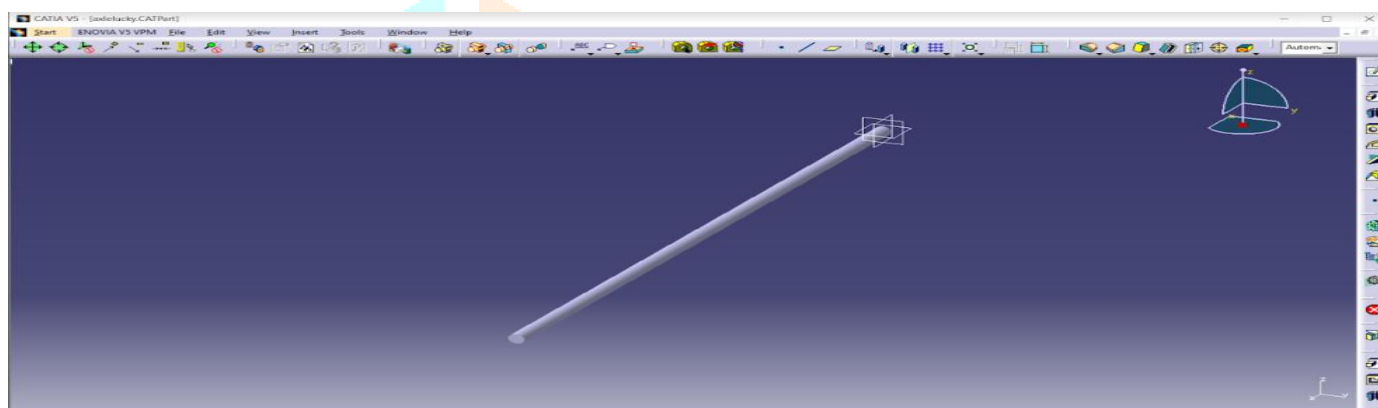Figure (a): 3d design of chassis

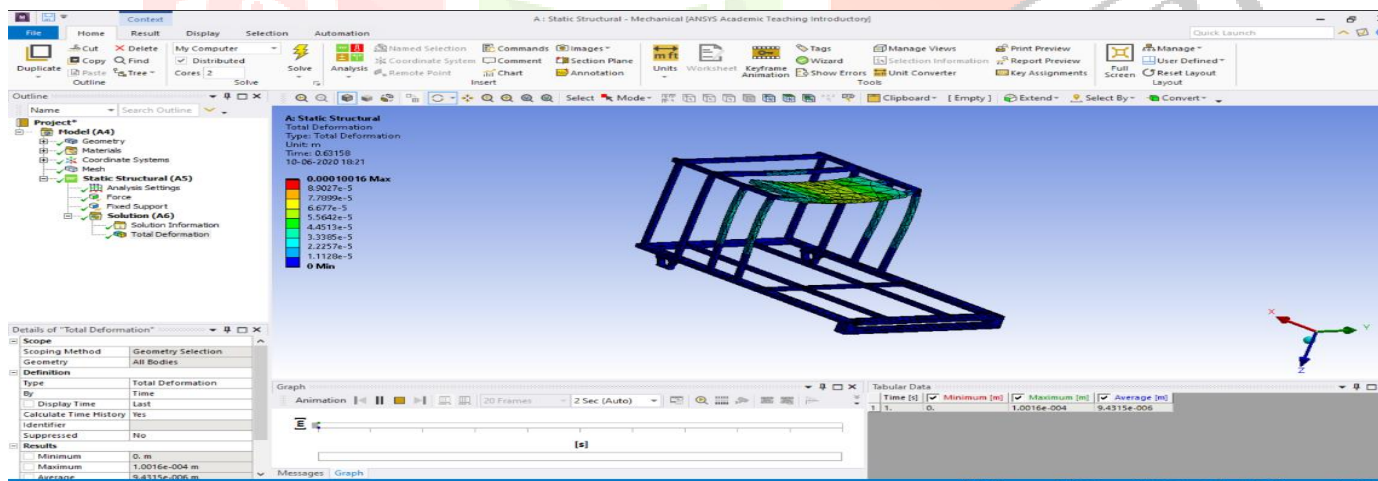Figure (b): design of chassis

Figure (c): design of the axle

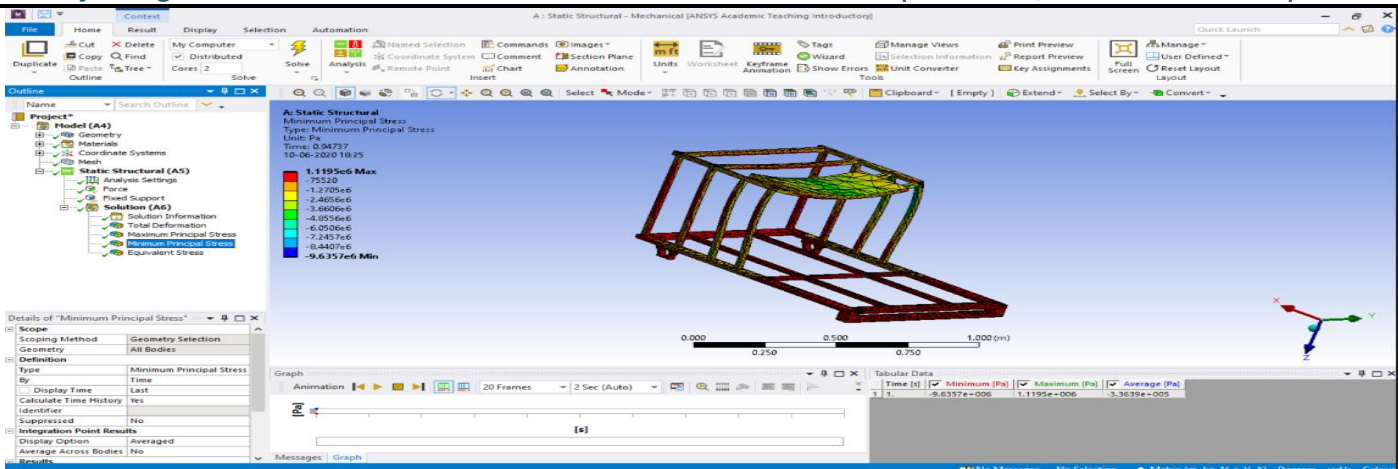Figure (d): total deformation of chassis

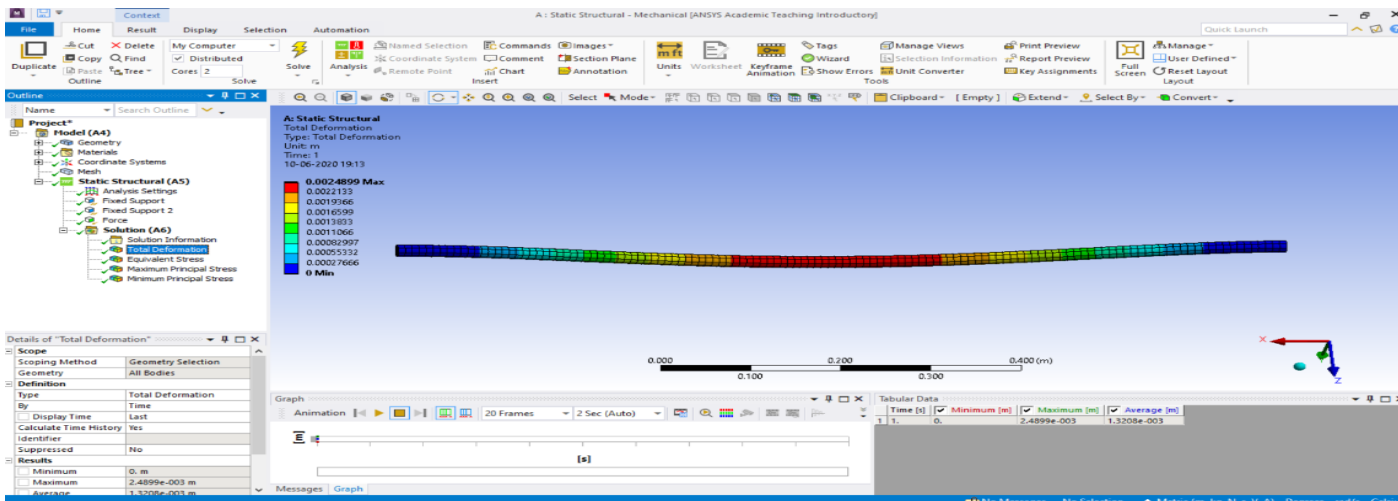Figure (e): stress analysis on chassis
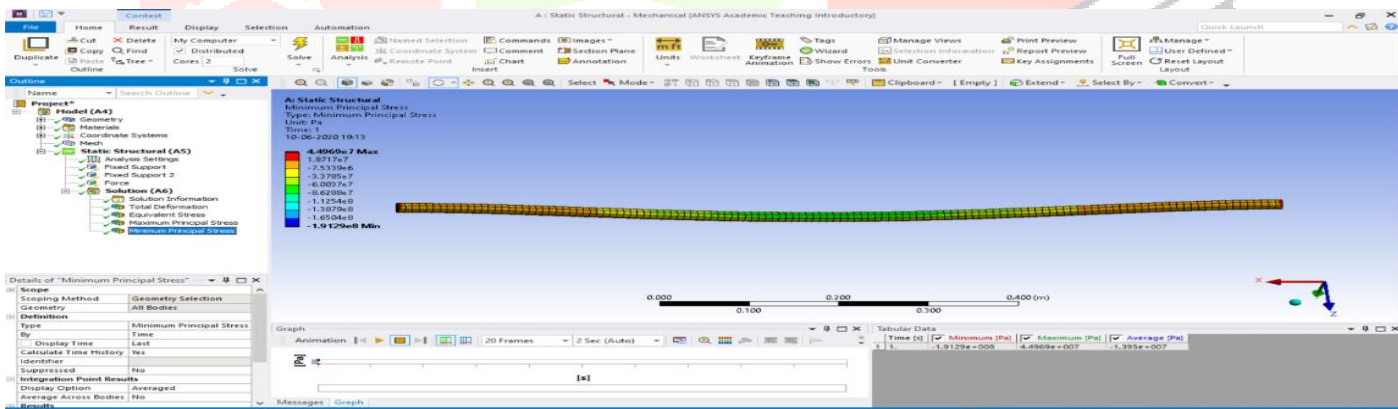

Figure (f): total deformation of the axle

Figure (g): stress analysis on the axle

8. MATERIAL DATA ANALYSIS:-

➤ GEOMETRY:

Object Name	*Geometry*
State	Fully Defined
Definition	
Source	C:\Users\PowerUser\AppData\Local\Temp\WB_LUCKY_PowerUser_6748_2 \unsaved_project_files\dp0\SYS\DM\SYS.scdoc
Type	SpaceClaim
Length Unit	Meters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Length X	1.1211 m

Length Y	0.8 m
Length Z	0.59898 m
Properties	
Volume	8.9057e-003 m³
Mass	69.91 kg
Scale Factor Value	1.
Statistics	
Bodies	1
Active Bodies	1
Nodes	13632
Elements	6252
Mesh Metric	None

➢ Equivalent Stress

Time [s]	Minimum [Pa]	Maximum [Pa]	Average [Pa]
1.	6.7818e-006	8.3521e+006	6.7859e+005

➢ Constants

Density	7850 kg m^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat	434 J kg^-1 C^-1
Thermal Conductivity	60.5 W m^-1 C^-1
Resistivity	1.7e-007 ohm m

➢ Compressive Yield Strength

Compressive Yield Strength Pa
2.5e+008

➢ Tensile Yield Strength

Tensile Yield Strength Pa
2.5e+008

➢ Tensile Ultimate Strength

Tensile Ultimate Strength Pa
4.6e+008

➢ Structural Steel: Strain-Life Parameters

Strength Coefficient Pa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient Pa	Cyclic Strain Hardening Exponent
9.2e+008	-0.106	0.213	-0.47	1.e+009	0.2

➢ Structural Steel: Isotropic Elasticity

Young's Modulus Pa	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa	Temperature C
2.e+011	0.3	1.6667e+011	7.6923e+010	

➢ Structural Steel: Isotropic Relative Permeability

Relative Permeability
10000

9. RESULT AND DISCUSSION

Compressed air technology is a technology from which engines are working easily without producing any type of pollution & it is very economical. Use of non-conventional energy sources we can achieve very good results as it reduces pollution with the use of green technology at the current time this technology is a fortune for us.

There are some results of the test carried out from our project compressed air vehicle.

For a person of 70 kg mass & for plain surface:

1. Tank Pressure: 8 bar
2. Distance achieved: 50 m (164ft)
3. Time Required: 28 second
4. Velocity: 1.78 m/s

For no-load condition:

1. Tank Pressure: 8 bar

2. Distance achieved: 58 m

The main goal of our project is to run the vehicle on compressed air. The result is a low range of short distance traveled. After the modification of the vehicle performance, we can cover the large range and upgrade the conventional vehicle.

10. CONCLUSION:

The use of compressed air as a fuel of vehicle is not very advanced technology in this field of the vehicle is not the very advanced technology in this field we need to research more scope & development. Thus, we will design and fabricate the vehicle model which is Eco-friendly & doesn't cause any type of pollution in our environment. From the use of this problem of global warming and other environmental issues that are generated from the uses of the internal combustion engine. Compressed air vehicle uses non-conventional energy sources as atmospheric air. Nowadays we all will focus on non- conventional energy sources.

The compressed air vehicle can make a very important part of the factor that can prove a solution to the use of natural resources and can be the technology of tomorrow.

In this project, we will make a project on the Design and Fabrication of Compressed Air Vehicles. The capacity of our compressed air vehicle is 120-150 Kg after the arrangement of all the components. We will use the volume of compressor tank of 50 liters and this will be stored at 8 bar. One time filled tank can move the vehicle up to 45-50 m of distance that can be improved by the use of implementing other techniques.

REFERENCES:

[1] Anirudh Addala and Srinivasu Gangada, "FABRICATION AND TESTING OF COMPRESSED AIR CAR" Global Journal Of Researches In Engineering Mechanical And Mechanics Engineering, ISSN: 0975-5861, Volume-13, Issue-1, Year-2013.

[2] Bharat Raj Singh and Onkar Singh, "COMPRESSED AIR ENERGY STORAGE SYSTEM BASED ENGINE FOR RUNNING LIGHT VEHICLE" International Journal of Energy and Environmental Engineering, ISSN: 2008-9163, Volume-2, pp.33-44.

[3] Ruchil A. Patel, "A STUDY ON COMPRESSED AIR ENGINE TECHNOLOGY: A REVIEW" International Journal of Advanced Technology in Engineering and Science, ISSN: 2348-7550, Volume-03, Special Issue No. 01, April-2015.

[4] Viswajeet Singh, "COMPRESSED AIR ENGINE" International Journal of Scientific and Research Publication, ISSN: 2250-3153, Volume-7, Issue-7, July 2017.

[5] A.A. Keste, S.B. Vise, A.N. Adik, and P.R. Borase, "VEHICLE OPERATING ON COMPRESSED AIR BY INVERSION OF SLIDER CRANK MECHANISM" IOSR Journal of Mechanical and Civil Engineering, ISSN: 2278-1684, pp: 50-54.