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S.NO.	Reg No.	Page No.
1	201FA10005	2
2	211LA10004	2
3	211LA10005	2
4	211LA10007	2
5	201FA10003	16
6	211LA10001	16
7	211LA10002	16
8	211LA10006	16
9	201FA10001	42
10	201FA10004	42
11	201LA10003	42
12	211LA10008	42

CAR CRASH TEST SIMULATION ON ANSYS WORKBENCH

A Report

On

FIELD PROJECT

III B. Tech II Semester

Department of APPLIED ENGINEERING

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MAY 2023

CERTIFICATE

This is to certify that Field Project report entitled **“CAR CRASH TEST SIMULATION ON ANSYS WORK TEST BENCH” submitted by the students of 201FA10005-J.AKSHAY, 211LA10004-P.DILEEPRAO, 211LA10005-ABHINAV MANIKANTA, 211LA10007–CH.SESHA SAI** Department of Applied Engineering, Division of Automobile Engineering pursuing III B.TECH in Vignan’s Foundation for Science, Technology & Research, has successfully completed the field project during the academic year 2022-23.

Signature of the guide **Head of the Department**

ABSTRACT

To minimize the damage during car accidents, the solidity of the car body structure must be a priority for the automotive industry. This work aims to analyze the possibility of replacing conventional material used in car bodies by establishing the best suitable composite material in order to provide strength, rigidity, crashworthiness, safety, lightweight, improve the fuel efficiency of cars. In this project, we will design a car body structure and solid concrete wall by using Solid works 2018 software and make suitable composite materials through Ansys ACP (Ansys composite pre-post). Then perform crash analysis on the car body in Ansys workbench software by explicit dynamic module by using different composite materials in car body at different speed of the car. The behaviour of automotive car structure is analyzed by evaluating equivalent stress, strain, total deformation.

TABLE OF CONTENTS

CHAPTER – 01

INTRODUCTION

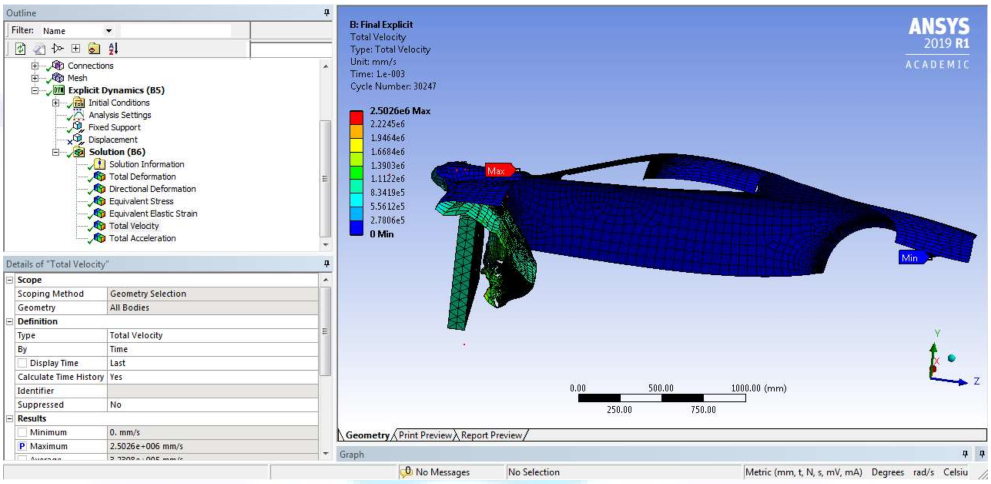
In recent decades the use of composite materials has increased significantly in the automotive industry. Most of the public and private sector companies are focusing on automobiles safety, crashworthiness and lightweight. So that they tend to move towards the application of composite materials by replacing conventional materials like steel and aluminum. In this project, it proposes to analyze and study of crash analysis of car body. So that a car body structure and a concrete wall is modelled by using 3D modelling software Solid works 2018. And then imported these two models to Ansys workbench software for crash analysis. By using ACP, light weight composite material has to be prepared. Here in this project, five different light weight high strength (carbon and glass reinforced) composite materials are selected as a material of a car body.

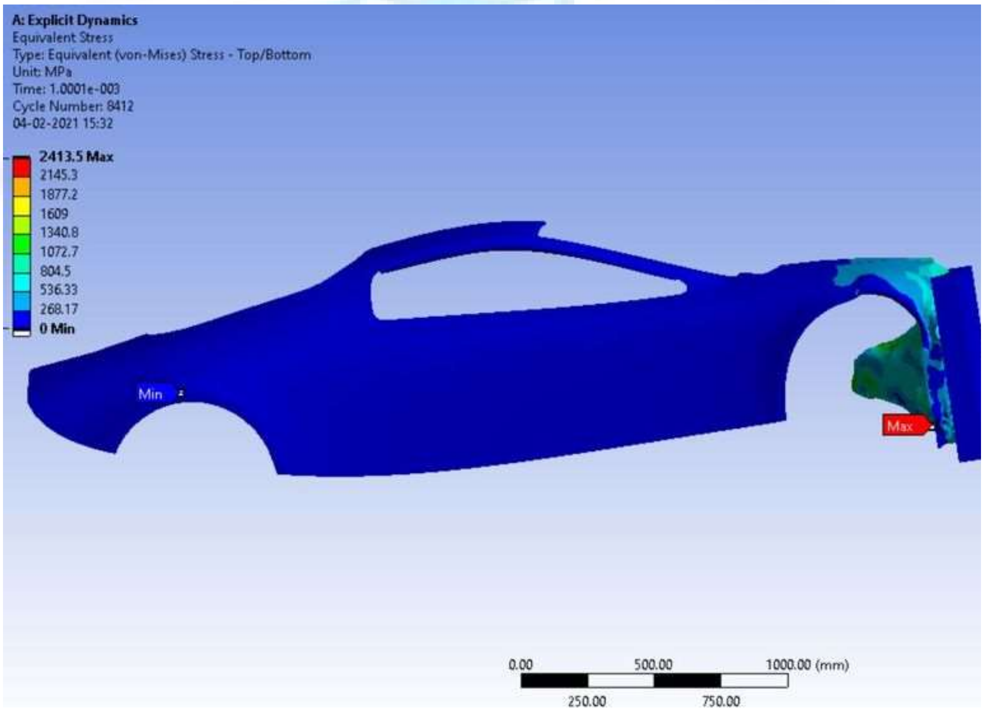
Ansys: Ansys Workbench is the integration and workflow platform that connects Ansys products. The project schematic enables users to configure their simulation processes, optimize exploration through parametric management, submit jobs to solver both locally and remote, and add APIs that allow for third-party software.

CHAPTER – 02

METHODOLOGY

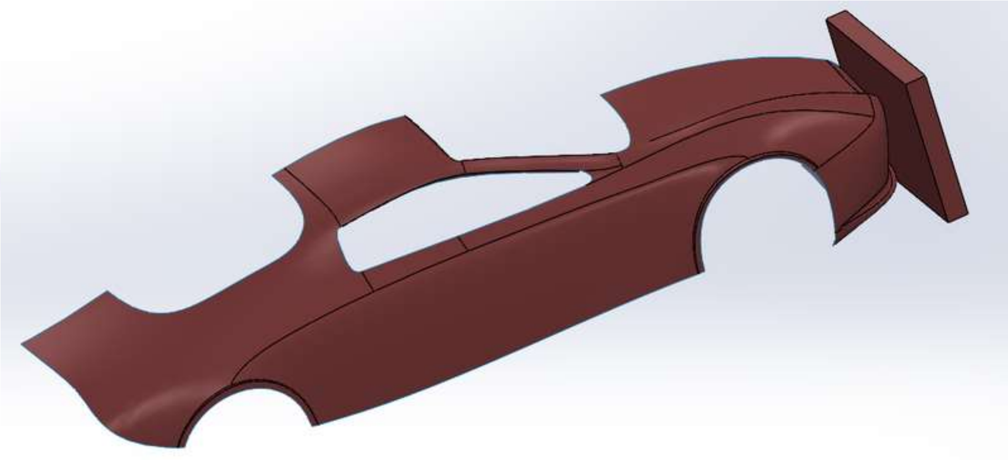
The simulation is aimed at finding the Total Deformation and Equivalent Stresses for each case Geometry : the 3D assembly model of the car Crash model developed in SOLIDWORKS .These model is then imported to Ansys Mechanical explicit dynamics.





Geometry:

The 3D assembly model of the Car Crash model developed in SOLIDWORKS is shown in the figure below:



These model is then imported to Ansys Mechanical explicit dynamics Workbrnch for the analysis.

Material Properties:

The material of the Car is kept to be Stainless Steel NL and for the Wall,the material is be Structural Steel for all the cases . The material properties are given below:

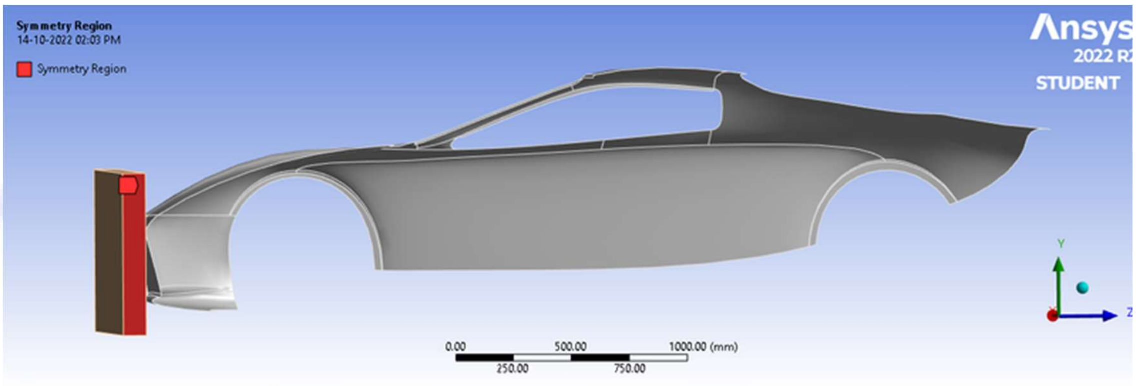
Stainless Steel NL

Density	7.75e-06 kg/mm³
Structural	
Isotropic Elasticity	
Derive from	Young's Modulus and Poisson's Ratio
Young's Modulus	1.93e+05 MPa
Poisson's Ratio	0.31
Bulk Modulus	1.693e+05 MPa
Shear Modulus	73664 MPa

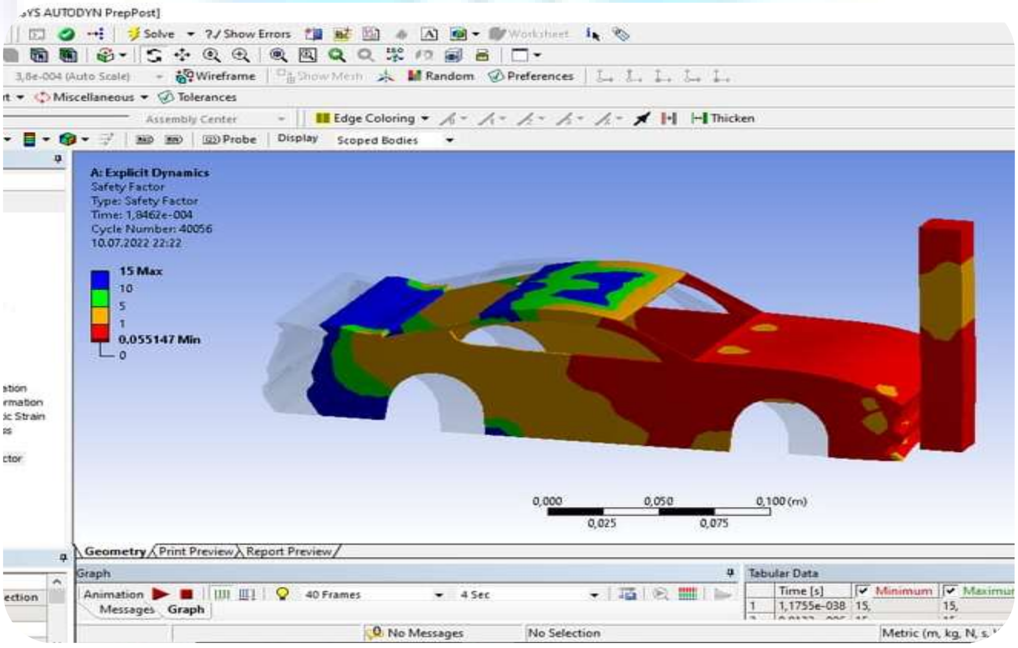
Symmetry

To ensure that the model actually behaves as a Car (since only the one half of the car is present in the module to reduce the computational effort), a symmetry is provided to both the Wall and the Car.

Symmetry for the wall:

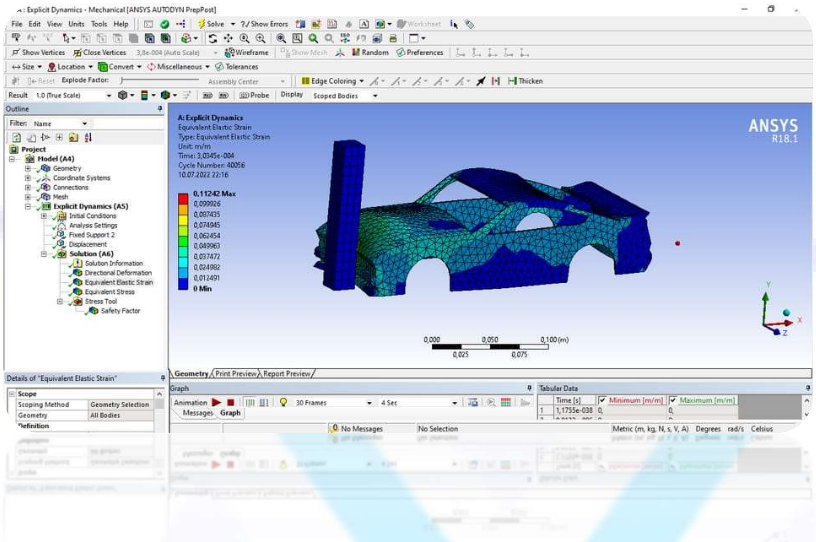


Ansys LS-DYNA is a simulation software used for crash tests, impact and penetration, and occupant safety. It is used in the aerospace industry to simulate bird strikes, jet engine blade containment, and structural failure.



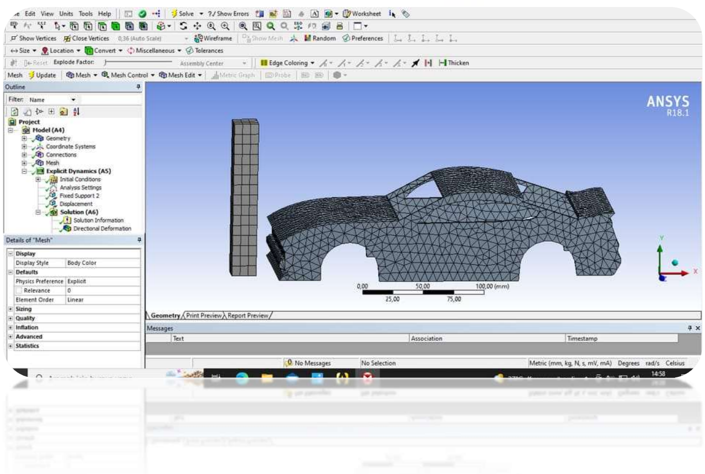
ANSYS Workbench OVERVIEW

- Integrated simulation platform for finite element analysis
- Capabilities for modeling complex structural behavior
- Wide range of applications in automotive engineering



SIMULATION WORKFLOW

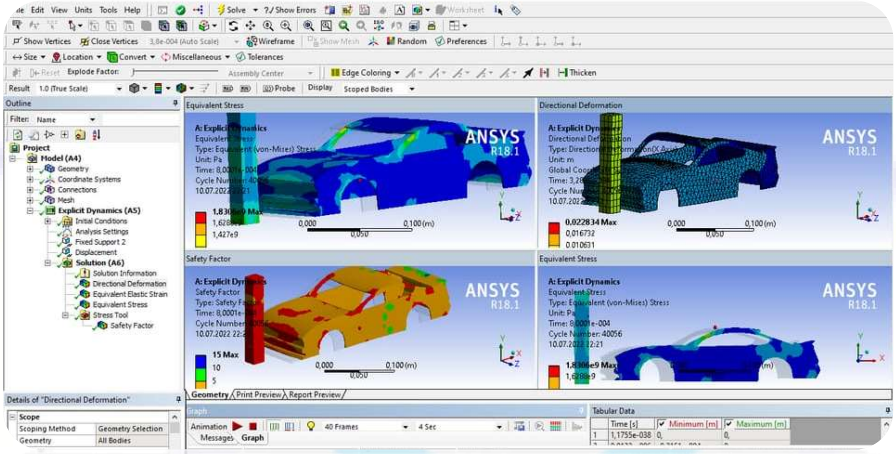
- Geometry Import
- Mesh Generation
- Material Definition
- Boundary Conditions
- Loads Application
- Solver Setup
- Running the Simulation
- Post-Processing & Analysis



POST-PROCESSING RESULTS

Analyzing Simulation Results:

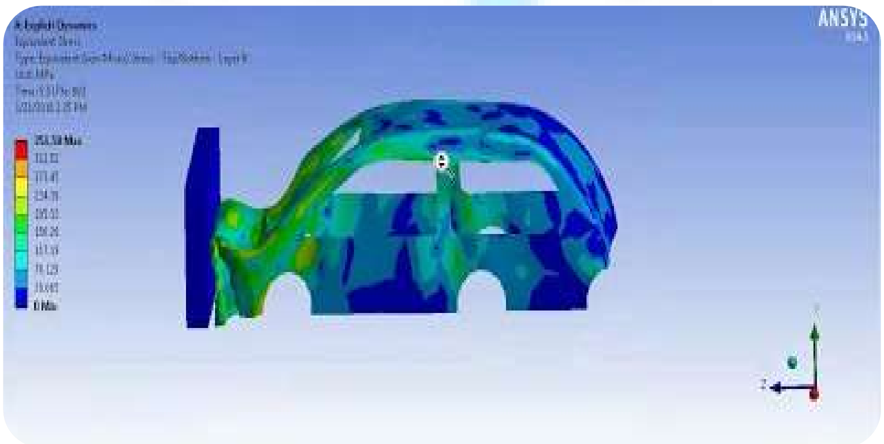
- Visualizing deformation, stress distribution, and strain.
- Extracting critical points of failure.
- Comparison with real-world crash test data.



VALIDATION AND ACCURACY

Validating Simulation Accuracy:

- Comparing simulation results with physical tests.
- Ensuring model fidelity and accuracy.
- Iterative refinement for improved predictions.



SAFETY SYSTEMS IN CAR CRASH TEST SIMULATION

Car crash tests evaluate various safety systems in cars, assessing their effectiveness in mitigating injuries and protecting occupants. Some key safety systems commonly assessed in crash tests

AIRBAGS

- **Frontal Airbags:** Deploy in front-end collisions, cushioning the impact for the driver and front passenger.
- **Side Airbags:** Protect occupants in side-impact collisions, reducing injury risk to the torso and head.
- **Curtain Airbags:** Deploy from the roof to protect occupants' heads in side collisions and rollovers.

CRASH SENSORS

- **Accelerometers:** Detect rapid deceleration, triggering airbag deployment and other safety mechanisms.
- **Crash Severity Sensors:** Assess the force and severity of a collision, influencing safety system response.

CRUMPLE ZONES

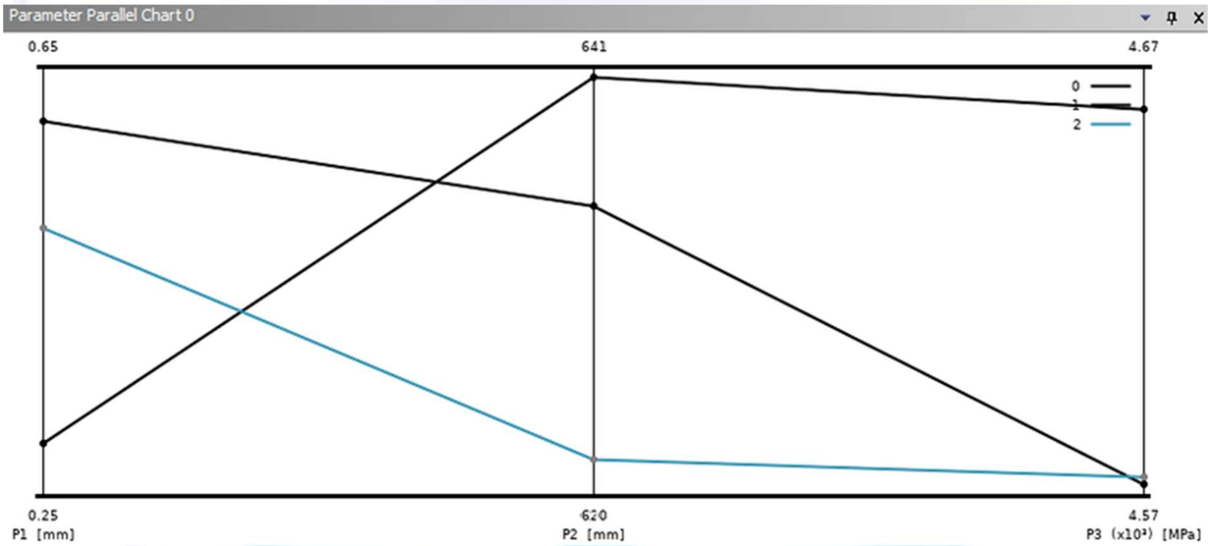
- **Front and Rear Crumple Zones:** Designed to absorb and dissipate energy during impact, reducing force transfer to occupants.

COMPARISON:

The observation from the parametric study are as below:

Table of Design Points

	A	B	C	D
1	Name	P1 - car_body Thickness	P2 - Total Deformation Maximum	P3 - Equivalent Stress Maximum
2	Units	mm	mm	MPa
3	DP 0	0.3	640.54	4660.1
4	DP 1 (Current)	0.6	634.25	4573
5	DP 2	0.5	621.82	4574.6
*				



From the Parametric study table and graph above, it can be seen that with the increase of the thickness, the stress developed is decreasing. That is, the more the thickness of the vehicle body, it provides more safety for the passengers. but this have an adverse effect as well. With the increase in the thickness the mass of the vehicle increases, therby increasing the aerodynamic, acceleration, grading and rolling resistance of the vehicle which in turn reduces the efficiency of the vehicle. So assigning the thickness to the vehicle body is a trade of between the safety and vehicle performance. The parametric study as seen above can be used to find an optmized thickness. The total deformation here refers to the distance travelled by the wall. It doesn't really shows a pattern here. The more the wall moves means the vehicle has less safety as the Wall can pass through the vehicle part. But again, this analysis is done to the outer surface of the vehicle alone. But in actual scenario, there will be a lot other vehicle components as well such as engine, transmission system, etc under the front bonet that also major role identifying the safety of the vehicle during crash analysis. A further study with various other thickness value also need to be done in a parametric study in order to find the actual trend for maximum stress and deformation of the vehice body with thickness.

CHAPTER – 03

CONCLUSION

With Ansys Workbench, a simulation of a vehicle Crash Test was conducted successfully for different vehicle body thickness cases and are compared. According to the analysis, with the increase in the thickness, the maximum stress develped decreases, which would reduce the damage of the vehicle, which in turn provides more safety for the driver and passenger. But increasing thickness would increase the weight of the vehicle which would decrease the performance of the vehicle.

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EXHAUST GAS ANALYZER

A Report

On

FIELD PROJECT

III B. Tech II Semester

Department of APPLIED ENGINEERING

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Signature of the guide **Head of the Department**

ABSTRACT

This paper deals with the design of Exhaust Gas Analyzer for measuring the concentration of contents in exhaust gas emissions from vehicles using MQ135 sensor along with Carbon Monoxide CO using MQ7 sensor. Measuring Exhaust gas emissions from vehicles is an essential element for bringing awareness in the people to take care of increase in pollution caused by vehicle emissions and to safeguard the environment. Based on this, Government of India had already implemented certain NORMS to vehicle emissions to reduce the pollution. We are trying to implement the Exhaust gas analyzer using the Bluetooth device to notify the user about their vehicle emissions, we can bring awareness to every individual about the harm from vehicle emissions causing to our environment by the implementation of our system. We have developed the system as user friendly system for convenient use by every individual .The Exhaust gas analyzer will measure the vehicle emissions or exhaust gases ,the output from sensors will be compare with the current or ongoing issued norms, the concentration of gases will be notified to user to aware the user for vehicle maintenance and flaw detection. Also, the cost of system is economically affordable for everyone.

Keywords– Analyzer, Exhaust Gases, Sensors, Pollution ,Emissions.

TABLE OF CONTENT

1. INTRODUCTION

An exhaust gas analyzer is an instrument for the measurement of carbon monoxide and carbon dioxide among other gases in the exhaust of equipments and motor vehicles , caused by an inaccurate combustion. Due to increase in use of private vehicles the exhaust emission of gases like Co, Co2, HC, PM have increased which gets trapped in atmosphere and rising the global temperature i.e. GLOBAL WARMING which triggers the harmful calamities and has adverse effect on living organisms. Exhaust gas analyzer not only identifies the species but it also gives the content value of the quantity which it displays either in numerical form or shows it graphically.In 1972 at Pierburg in Neuss with the development of the first exhaust gas analyzer. The analyzer employs a monochromatic source of infrared radiation and a multibeam optical comparator system, which is common and shared by all of the measuring channels. The measurement of gases is carried by absorption principle of gases and comparing the light intensity source.

Transportation sector alone utilizes most of the fossil fuels such as petrol, diesel, kerosene and methanol. Considering all major anthropogenic source categories, with exception of agriculture, the transportation sector of our economy releases about one-third of the total emissions of Volatile Organic Compounds (VOCs), nitrogen oxides (NOx), and lead (Pb) and more than twothirds of the carbon monoxide (CO). The CO and the VOCs, (almost all as hydrocarbons) are products of inefficient combustion (Henry and Heinke, 1995). Bailey (1995) and Lilley (2000) have also underscored the significance of carbon monoxide (CO) fumes and spilled oil as major pollutants from vehicle sources that gravely endanger human life and nature.

AUTOMOTIVE EXHAUST GAS ANALYSER
TEMP °C
RPM
I/O

2.VEHICLE EMISSIONS

Thousands of motorized vehicles ply the major roads and streets of Nigerian cities daily. The same is true of many other countries of the world. In doing this, the vehicles consume millions of litres of petrol daily. The combustion of transportation fuels by these vehicles releases several contaminants into the atmosphere, including carbon monoxide, hydrocarbons, oxides of nitrogen, and lead and other particulate matter. Once emitted into the atmosphere, air pollutants undergo mixing or diffusion, the degree of which depends on topographic, climatic, and meteorological conditions (Zannetti, 1992).

Since the 1950"s it has been recognized that transportation engines in developed countries are the major source of air pollution (Milton, 1995), while it is apparent that the proportions to be attributed to various causes vary both in time and from place to place, typical USA, figures are shown in Table 1. It can be seen that transportation is responsible for the biggest share of CO, HC, and NOx in the atmosphere as well as a large proportion of the particulate matter.

2.1 Sources of Pollutants (Emissions) from Vehicles

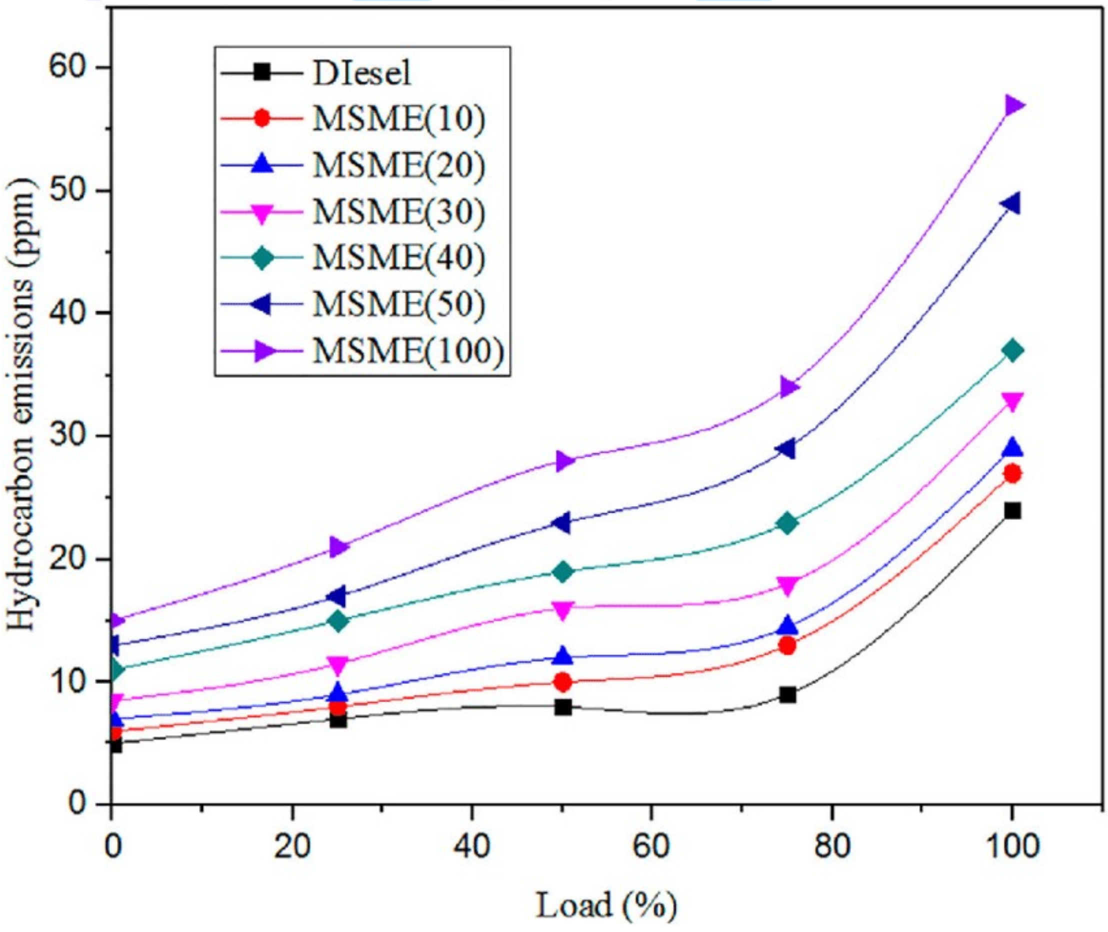
Petrol and diesel engines, both internal combustion engines, are the only engines in wide use in the world"s automotive transportation systems. And they are the major source of urban air pollution (John, 1998). Table 2 gives a list of common engine types, fuels and associated emissions. Petrol is a readily volatilized fuel and in the fuel tank the pressure build up which would result from this evaporation is obviated by introduction of a „breather" vent or pipe into the tank. This still permits evaporation of the fuel.

Evaporation of the raw fuel also occurs in the carburettor at all times except when running at high speed. Some unburned fuel (mixed with air) plus escaping exhaust gases from around ill-fitting pistons leaves the car as crankcase blow by which is a further hydrocarbon loss. Exhaust emissions are more variable in nature and hence more difficult to control. The composition depends on several variables e.g. air/fuel ratio, speed and engine condition. Driving conditions play a major role with exhaust emissions high in CO and HC at low and idling speeds, and NOx high at high engine speeds. At low speeds, especially when cold and the fuel mixture is fuel-rich, incomplete combustion is common resulting in the formulation of more carbon monoxide. Similarly unburned hydrocarbons can be part of the exhaust.

2.2 Types of Emission and Pollutants

2.2.1 Hydrocarbons

Emissions of hydrocarbons indicate low combustion efficiency in internal combustion engines and they arise when vaporised unburned fuel or partially burned fuel products, leave the combustion region and are emitted with the exhaust. Unburned hydrocarbon emissions are independent of air/fuel ratio. They normally arise from shortcomings in the fuel injection system. The level of unburned hydrocarbons in the exhaust gases in generally specified in terms of the total hydrocarbon concentration expressed in parts per million of carbon atoms. The total hydrocarbon emission is a useful measure of combustion inefficiency. Some of these hydrocarbons are nearly inert physiologically and are virtually uncreative from standpoint of photochemical smog. Others are highly reactive in the smog-producing chemistry. Hydrocarbon compounds are divided into non- reactive and reactive based on their potential for oxidant formation in the photochemical smog chemistry. Some hydrocarbons are known carcinogens (Patterson and Henein, 1992). Fuel composition can significantly influence the composition and magnitude of the organic emissions. Fuels containing high proportions of aromatics and olefins produce relatively higher concentrations of reactive hydrocarbons. Oxygenates are present in engine exhaust, and are known to participate in the formation of photochemical smog. Some oxygenates are also irritants and odorants. The oxygenates are generally categorized as carbonyls, phenols, and other non carbonyls. The carbonyls of interest are low molecular weight aldehydes and aliphatic ketones. The volatile aldehydes are eye and also irritants. Carbonyls account for about 10 percent of HC emissions from diesel passenger car engines, but in spark-ignition engine HC emissions are very low. Phenols are odorants and irritants but their levels are much lower than aldehyde levels (Adamczyk et al., 1983; Kaiser et al., 1982).



2.2.2 Oxides of nitrogen (NOx)

Motor vehicles are the principal source of NO and of its oxidation product NO_2. Nitric Oxide (NO) and Nitrogen dioxide (NO_2) are usually grouped together as Nitrogen oxides (NOx) emissions. Nitric oxide is the predominant oxide of nitrogen produced inside the engine cylinder. The principal source of NO is the oxidation of atmospheric (molecular) nitrogen. However, if the fuel contains significant nitrogen the oxidation of the fuel nitrogen – containing compounds is an additional source of NO.

In the combustion of near-stoichiometric fuel-air mixtures, the principal reactions governing the formation of NO from molecular nitrogen are:

$O_2 + 2N_2 = 2NO + N_2$

(1)

$N_2 + 2O_2 = 2NO + O_2$

(2)

$N_2 + 2OH^- = 2NO + H_2$

(3)

Hilliard and Wheeler (1979) worked on chemical equilibrium of burned gases at typical flame temperatures, their studies reveal that NO_2/NO ratio is negligibly small for spark ignition engines. While in diesel engines, NO_2 can be 10 to 30 percent of the total exhaust oxides of nitrogen emissions. NO formed in the flame zone can be rapidly converted to NO_2

$NO + O_2 = NO_2 + ½O_2$

(4)

It is customary to measure total oxides of nitrogen emissions, NO plus NO2, with a chemiluminescence‟s analyzer and call the combination NOx (Lavoie and Blumberg, 1980). It is always important to check carefully whether specific emissions data for NOx are given in terms of mass of NO or mass of NO2, which have molecular weights of 30 and 46 respectively. Oxides of nitrogen are important constituents of photochemical smog. In addition to the greenhouse effect, oxides of nitrogen contribute to environmental pollution in three ways: depletion of the ozone layer, production of acid rain and general air pollution.

Table 4 Average values and % changes in NOx and CO emissions

Types of fuel and mode	NOx (ppm)	CO (%)	% change in NOx	% change in CO
Diesel	295	14.4	-	-
Palm biodiesel	309	13.9	4.7	-3.5
Diesel + EGR	279.2	15.8	-5.4	9.7
Palm biodiesel + EGR	241.02	17.3	-22.0	24.5

2.2.3 Carbon Monoxide (CO)

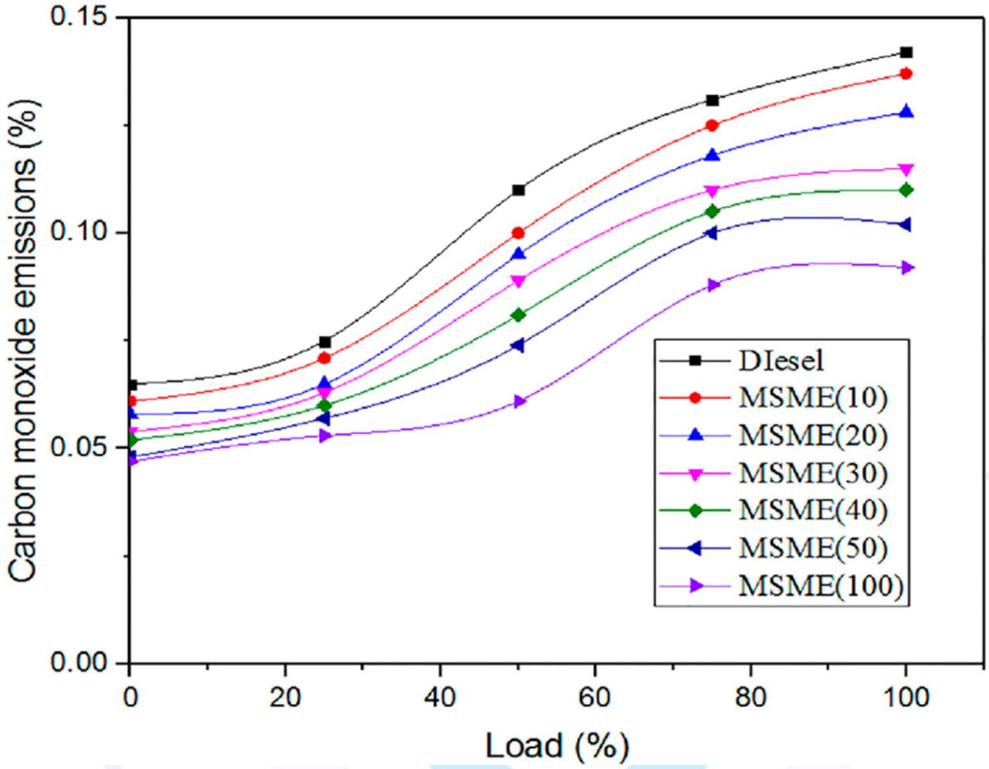
Most of the CO in the ambient air comes from vehicle exhaust. Internal combustion engines do not burn fuel completely to CO_2 and water; some unburned fuel will always be exhausted, with CO as a component. For rich air/fuel mixtures, CO concentration in the exhaust is high, since the amount of excess fuel (unburned fuel) will be high. While for weak air/fuel mixtures, CO emissions are very low, therefore, they are not considered as important. According to John (1998), the levels of CO observed in spark-ignition engine exhaust gases are lower than the value measured within the combustion chamber. Therefore, some of the CO that formed in the combustion process are oxidized to CO_2 before they are discharged into the atmosphere.

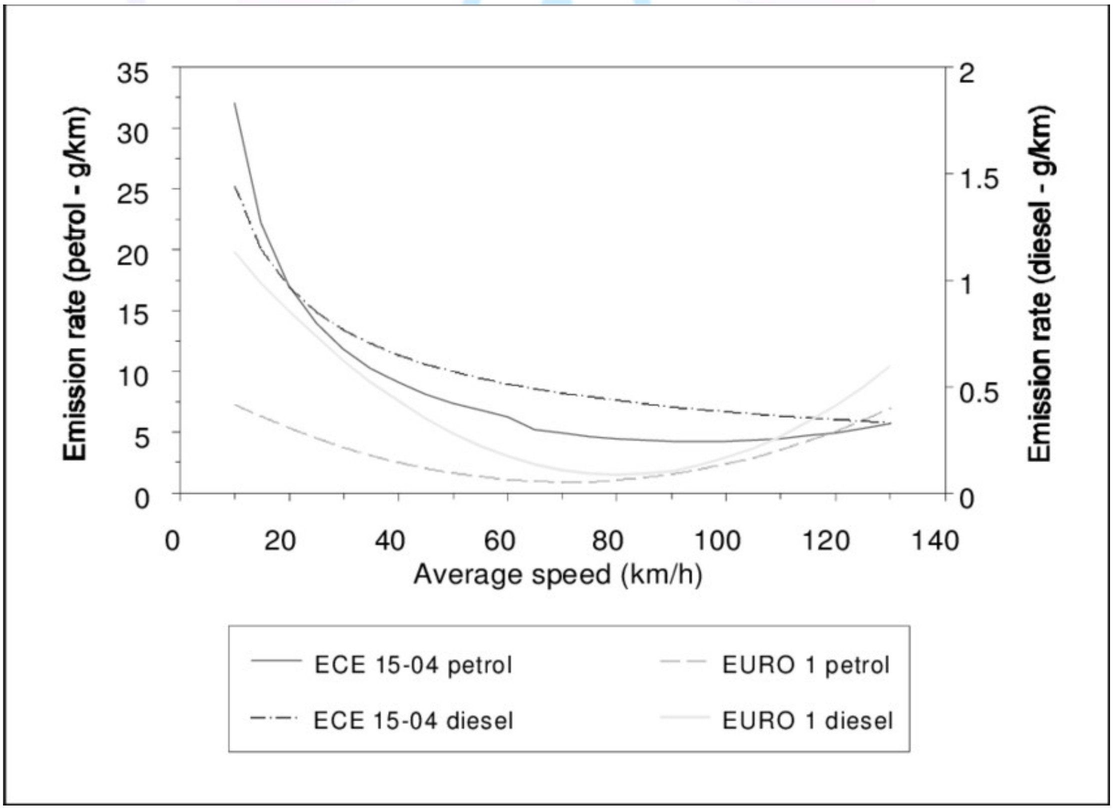
2.2.4 Carbon dioxide (CO_2)

Combustion of petrol takes place in the internal part of the engine of a vehicle. If a typical hydrocarbon octane, is taken to represent petrol, an equation may be written for the combustion occurring in the engine as follows:

$$2C_8H_{18} + 25O_2 = 16CO_2 + 18H_2O \quad (5)$$

The fuel consists of organic molecules, which are mostly hydrocarbon. When such compounds are burnt in automobile engines they yield carbon dioxide and water. Carbon dioxide also contributes to the acidity of rainfall, but more important, CO_2 is transparent to short wavelength radiation from the sun but opaque to longer wavelengths radiated back to space from the earth. Therefore, increased concentrations of CO_2 may result in a heating of the earth‟s atmosphere and global warming.





3. DISTURBANCE OF NATURAL ENVIRONMENT

3.1 Thermal Air Pollution

This type of pollution is applied generally to the discharge of heat into the air environment from the combustion of fuels. The increase in the temperature of any place at a given time above its normal ambient air temperature is evidence that thermal air pollution has occurred in that place. The mean temperature of our planet is fixed by a steady-state balance between the energy received from the sun and the quantity of heat energy radiated back into space by the earth.

Disturbance in either incoming or outgoing energy would upset this balance, and the average temperature of the earth"s surface would drift off to a different steady state value.

The sun"s energy travels to earth surface to warm it and bathe it with light without hindrance. The infrared radiation that sends heat energy back into space cannot travel freely though air as water vapour and CO_2 both absorb infrared. In this way they act like blankets around the earth, hindering the escape of heat into space. As more CO_2 is produced by combustion of fuels, the CO_2 causes hindrance to the escape of the infrared radiated from the earth surface and so the earth warms the more.

3.2 Greenhouse Effect

Unlike the sunlight, the infrared radiation cannot travel freely through the earth mantle of air as it contains H_2O vapour and CO_2, which absorb infrared radiation. In this way, both H_2O vapour and CO_2 act as blankets around the earth and the escape of heat into space. With additional H_2O vapour and CO_2 poured into the atmosphere from other sources, the effect would be that of adding a blanket that hinders the escape of heat the more and so the earth would heat up. This blanketing is the essence of the greenhouse effect. The greenhouse effect takes its name from the warmth of greenhouses, a warmth stemming in part from the ease with which warming sunlight enters through the glass panes, and the difficulty encountered by infrared radiation in escaping off through the same panes with the greenhouse heat.This means that the glass panes act in such the same way as the atmosphere, which allows the free passage of incoming radiation but interferes with outgoing radiant energy. The outgoing radiant energy is absorbed by H_2O and CO_2. With energy escape hindered, the earth becomes warmer than it otherwise would be. Any addition of H_2O and CO_2 would cause additional greenhouse effect.

3.3 Ozone Depletion

The culprits causing ozone depletion are water vapour and nitrogen (II) oxide, NO. The pollutants enter the stratosphere where the ozone layer is. Photochemical reaction occurs in the stratosphere whereby oxygen molecule splits to oxygen atoms. The oxygen atom combines with oxygen molecule leading to the production of ozone

$O_2 + [O] = O_3$

(7)

Oxygen atom reacts with water to give hydroxyl ions and which reduce ozone to oxygen molecule:

$H_2O + [O]$

= 2OH
(8)
OH + O3 = H-O-O + O2
(9)
This step accounts for 11% depletion of ozone. Again, ozone is attacked by NO and is reduced to molecular oxygen.
NO + O3 = NO2 + O2
(10)
Thus we have ozone depletion as given by equations (9) and (10). Unfortunately, eq.(10) is not the end of the story. Further reaction occurs between NO2 and [O] which regenerates NO molecules from NO2 viz:
NO2 + [O] = NO + O2
(11)
NO + O3 = NO2 + O2
(12)
Thus the cycle can proceed over and over again, consuming quantities of O3 with small initial amounts of NO.B.O. Bolaji and S.B. Adejuyigbe
J.GhIE
Vol. 4, No.1, 2006, pp 35–41
39

3.4 EFFECTS ON AGRICULTURE

Optimum plant growth requires adequate light, heat, moisture, nutrients and appropriate soil conditions. An imbalance in any of these results in a stress to the plant, which may result in restricted growth or foliage markings. Pollution provides an extra undesirable stress. If this stress is too high, then the plant will die, despite the relatively complex biological defence mechanisms (e.g. rebuilding of damaged tissue).
Plants absorb gaseous pollutant through their leaves

because one of their major functions is to absorb atmospheric gases. Examination of leaf structure reveals three regions: the epidermis (out layer), the mesophyll and the veins, which transport water and nutrients around the plant. Gases and small particulates enter the leaf through the stomata (leaf pores), to the air spaces of the mesophyll (Posthumus, 1983). Symptoms of damage to the examined leaves are:

(i) necrosis and bleaching of leaf margins;

(ii) glazing and silvering of surfaces, especially the undersides;

(iii) chlorosis (loss of chlorophyll);

(iv) flecking or stippling of upper surfaces.

3.5 Health Effects of Air Pollution

Air pollution has serious economic repercussions. Human health itself has an economic component by virtue of medical costs and work-days lost. Damage to health occurs as pollutant molecules interact unfavourably with the intricate molecules and fluids of the human body. Living systems are so complex that the detailed chemistry of these interactions is unclear in all but a few exceptional cases.

3.5.1 Effects of Carbon (II) Oxides, CO

The one activity of CO in the human body that gives it notoriety is its strong inclination to combine with the haemoglobin of blood. Heamoglobin is an iron containing protein that carries vital oxygen to body tissues, may be represented by the symbol Hb. It picks up oxygen in the lungs thus:

$Hb + O2 = HbO2$

(13)

Where HbO2 is called oxy-haemoglobin

This association is reversible and so the bound oxygen is released once HbO_2 reaches the tissue thus:

$HbO_2 = Hb + O_2$

The free Hb returns to the lungs for fresh supply of oxygen. Now, CO is a good chemical imitation of O_2 because it is diatomic, stable, oxygen containing and having comparable size to O_2. therefore, when CO is present in the lungs through inhalation, it combines with Hb to form carboxy-haemoglobin:

$Hb + CO = HbCO$

This process ties up free Hb in the blood, immobilizing this essential carrier of oxygen. The association can be reversed to yield free Hb again but with difficulty. Research has shown that CO has a much greater affinity for Hb than O_2. So when both are present in equal concentration, CO ties up about 220 times more Hb than does O_2, leading to almost complete O_2 starvation and sure death. With 220-fold advantage, low level of CO in the lungs can immobilize enough Hb to cause dangerous shortage of oxygen. As much as 100 mg/l CO can kill quickly and 250 mg/l CO will cause loss of consciousness (Henderson-Sellers, 1984). The upper limit for industrial exposure to healthy workers is 100 mg/l. At this level, many people experience dizziness, headache and lassitude (Ademoroti, 1996)

3.5.2 Effects of NO and NO_2.

The compound NO is moderately toxic. Like CO, NO can combine with haemoglobin (Hb) forming methemoglobin and thus reducing oxygen transport. In contrast to NO, NO_2 is set at 5 ppm, rabbits exposed to concentrations as low as 1 ppm over a period of one hour have suffered protein changes (Henderson -Sellers, 1984).

3.5.3 Effects Particulate Matter

Inhaled particles greater than 10 µm are lodged in the nostrils. Particles in the size range from 5 µm to 10 µm are captured by the mucous lining in the upper airway; they are carried to the throat and swallowed. Particles less than 2 µm in size are the greatest threat: they penetrate the deeper structures of the lungs, including alveolar sacs, where no protective mucous blanket exists. Some of these particles may be retained in the lungs. It has been suggested that particles enhance the damage to lungs caused by SO2 because they carry SO2 to deep regions of the lung that are not otherwise reached (Waller, 1983).

Particles also catalyze the conversion of SO2 to SO3, which is more corrosive and then to H2SO4. The enhancement of the pollutants effect by another is termed *synergism*. Synergism is common in all areas of environmental pollution. Inhaled particles may be toxic. Soot particles are known to contain benzopyrene, an organic compound which is cancer producing. Lead containing particles from automobile exhausts may transmit toxic lead to the lungs and thence to the bloodstream. Lead is known to damage the brain, center nervous system (CNS), kidneys, liver and reproductive system.B.O. Bolaji and S.B. Adejuyigbe

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Vol. 4, No.1, 2006, pp 35–41

40

4. CONTROL OF VEHICLE EMISSIONS

The carbon monoxide (CO) and volatile organic compounds (VOCs) are products of inefficient combustion, which would be eliminated by burning the fuel to carbon dioxide (CO2) and water (H2O) in the engine of the vehicle to produce power if possible. Most of the VOC emissions are from the tailpipe. These are controlled using catalytic reactors and by injecting air at the exhaust ports of the engine to burn emitted
hydrocarbons in this high-temperature zone. Neither process recovers useful energy, so efforts to modify engine design have been intense. However, more than 20% of the uncontrolled vehicle engine VOC emissions are from the crankcase vent (blow-by and evaporating oil) and from the carburetor vent to the atmosphere. These emissions are controlled using a crankcase vent pipe to the engine intake duct (requiring a pollution control value or PCV) and a “carbon canister” absorption unit for evaporative losses. Fuel injection systems, with their advantage of providing much more precise metering of fuel to the cylinders, significantly reduces pollutant emissions, including further reduction of evaporative losses. Presently, use of oxygenated fuels is encouraged to reduce VOC emissions at the tail pipe (Henry and Heinke, 1996).

Researchers have found that it was necessary to reduce emissions of nitrogen oxides to reduce photochemical smog and rain precursor emissions. One of the most effective ways to reduce these oxides is by introduction of exhaust gas re-circulation (EGR), and by using two stage combustion. High levels of lead emissions have been tackled by the introduction of lead-free gasoline, mandated in developed countries like USA but optional for developing countries like Nigeria. Driving behaviour and route driven (e.g. shifting gears and speedy accelerations) factors contribute to vehicle pollution. Control of emissions depends on several factors such as driver"s experience, type of route used, and in-use factors such as wear, maintenance and malfunction conditions (Vesilind et al., 1993). Vehicle pollution can also be reduced, partially or completely (zero emission) by using:

(i) lean-burn engines, i.e. engines that offer air/fuel ratios in the 22 – 23: 1 range, as opposed to conventional engines, which operate on stoichiometric ratio of 14.5:1;

(ii) intelligent transport systems (ITS) and

(iii) automatic pilot systems.

Also, vehicle emissions can be reduced through better routing of traffic to cut fuel consumption while at the same time reducing pollution and enhancing safety, or using other alternative types of vehicles such as hybrid or electric (Brisley et. al., 1996).

5. CONCLUSION

The dramatic increase in public awareness and concern about the state of the global and local environments, which has occurred in recent decades, has been accompanied and partly prompted by an ever-growing body of evidence on the extent to which pollution has caused severe environmental degradation. Considering all major anthropogenic source categories, with exception of agriculture, the transportation sector of our economy accounts for the major part of atmospheric pollution.

The vehicle exhaust emits volatile organic compounds, nitrogen oxides, leads and carbon monoxides into the atmosphere. These emissions are discussed in this paper. The introduction of vehicle pollutants into the environment has been shown to have many adverse effects on human health, agricultural productivity and natural ecosystems. It has also been shown that highest emissions occur in vehicle deceleration on a volumetric basis, which is due to low air-fuel ratio and low exhaust flow. Thermal air pollution, greenhouse effect, ozone depletion and other pollution resulting in disturbance of natural environment are discussed. Several methods of effective control of automobile emissions to meet current and future environmental demands are also analysed.

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SPRING ANALYSIS

A Report

On

FIELD PROJECT

III B. Tech II Semester

Department of APPLIED ENGINEERING

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MAY 2023

VIGNAN'S
Foundation for Science, Technology & Research
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CERTIFICATE

This is to certify that Field Project report entitled **"SPRING ANALYSIS" submitted by the students of 201FA10001- SHAIK FAROOQ, 201FA10004- G.RAMESH, 211LA10003- J.DEVENDRA SAI, 211LA10008 – P.RAKESH** Department of Applied Engineering, Division of Automobile Engineering pursuing III B.TECH in Vignan's Foundation for Science, Technology & Research, has successfully completed the field project during the academic year 2022-23.

Signature of the guide **Head of the Department**

ABSTRACT

In the realm of computer software development, the efficient management of system dynamics is paramount for achieving optimal performance and responsiveness. This study delves into the intricate analysis of springs within software systems, exploring their dynamic behaviours and impact on overall system functionality.

The research employs advanced techniques in software engineering, utilizing dynamic analysis tools and methodologies to examine the behaviour of springs in real-time. Through a combination of code instrumentation, runtime monitoring, and performance profiling, we aim to uncover the nuances of how springs contribute to the overall responsiveness and stability of software applications.

The investigation focuses on various types of springs employed in software, including event-driven mechanisms, resource allocation strategies, and concurrency control. By dissecting the interactions between these springs and the underlying software architecture, we seek to identify potential bottlenecks, performance anomalies, and areas for optimization.

Additionally, the study explores the adaptability of software springs in different environmental conditions, such as varying workloads and input scenarios. This analysis aims to provide insights into the resilience and scalability of software systems, shedding light on the effectiveness of spring-based components in handling diverse and dynamic computing environments.

Furthermore, the research considers the implications of spring behavior on software security and reliability. By examining potential vulnerabilities and risks associated with the dynamic aspects of software springs, we aim to propose strategies for enhancing the robustness and integrity of software systems.

Ultimately, this comprehensive analysis of springs in computer software contributes to a deeper understanding of their role in shaping system dynamics. The findings of this study can inform software developers, architects, and engineers in making informed design decisions, optimizing performance, and ensuring the overall reliability and responsiveness of modern software applications.

TABLE OF CONTENTS

CHAPTER – 01

INTRODUCTION

In the ever-evolving landscape of computer software development, the quest for optimal performance and responsiveness remains a constant challenge. One crucial aspect contributing to the dynamic nature of software systems is the utilization of springs – metaphorical constructs representing various dynamic components within the codebase. The analysis of these springs is pivotal for understanding and enhancing the overall functionality of software applications.

This study embarks on an exploration of the intricacies involved in the analysis of springs within computer software. Springs in this context encompass a broad range of dynamic elements, including event-driven mechanisms, resource allocation strategies, and concurrency controls. Understanding how these springs operate and interact with the underlying architecture is crucial for developers striving to create robust, efficient, and scalable software systems.

The analysis of springs in computer software involves a multi-faceted approach that integrates advanced techniques from software engineering, dynamic analysis, and performance evaluation. Through the use of sophisticated tools and methodologies, we aim to delve deep into the runtime behaviour of springs, unveiling their impact on system responsiveness and stability.

This investigation utilizes code instrumentation to inject monitoring capabilities into the software, allowing real-time observation of spring-related activities. By employing runtime monitoring, we can capture and analyze the dynamic interactions between different components, providing valuable insights into how springs influence the execution flow of the software.

Performance profiling is another key aspect of our analysis, enabling us to measure the resource utilization and execution times associated with spring-related operations. This quantitative approach helps identify potential bottlenecks and performance anomalies, guiding developers in optimizing critical sections of the code to enhance overall system efficiency.

Furthermore, we explore the adaptability of springs in diverse computing environments, considering variations in workloads and input scenarios. This aspect of the analysis aims to uncover how software springs respond to changing conditions, providing a foundation for building resilient and scalable applications capable of meeting the demands of dynamic real-world usage.

As we delve into the intricate world of spring analysis in computer software, our objective is to not only uncover the nuances of these dynamic components but also to provide actionable insights for software developers and architects. The knowledge gained from this study can inform the design, optimization, and maintenance of software systems, ultimately contributing to the advancement of software engineering practices in the face of ever-evolving computational challenges.

CHAPTER – 02

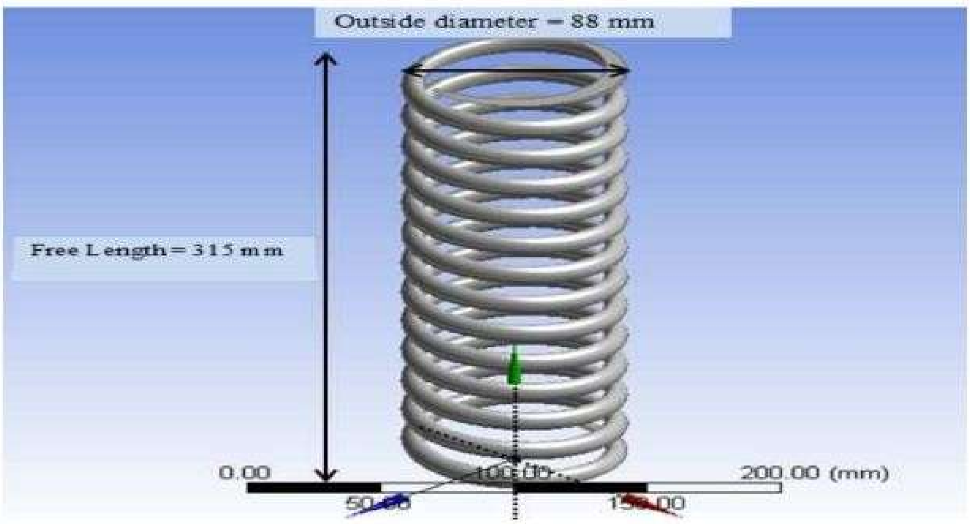
METHODOLOGY

In this study, the simulation and analysis of coil spring were done with different materials. The materials selected were steel structure, copper alloy and carbon composite. The coil spring was simulated with SolidWorks 2018 with specific dimensions which are listed in Table 1.

Table 1 : The Specification of Coil Spring

No.	Specification	Value
1	Outside diameter	88 mm
2	Inside diameter	64 mm
3	Wire diameter	12 mm
4	Free length	315 mm
5	Number of active coil	12
6	Pitch	25mm

Figure 1 : The Coil Spring



The properties of materials used for producing the coil spring in this paper listed in Table 2.

Table 2 : Properties of Materials

Materials	Steel Structure	Copper Alloy	Carbon Composite
Density	7850 kg/m^3	8300 kg/m^3	1600 kg/m^3
Young modulus	2E+11 pa	1.1 E+11 pa	2.28 E+11 pa
Poisson ratio	0.3	0.34	0.28

The numerical analysis was done using finite elements analyzer ANSYS 14. The spring has meshed with the number of nodes was 224030 and number of elements was 138201. The mesh of coil spring shown in Figure 2.

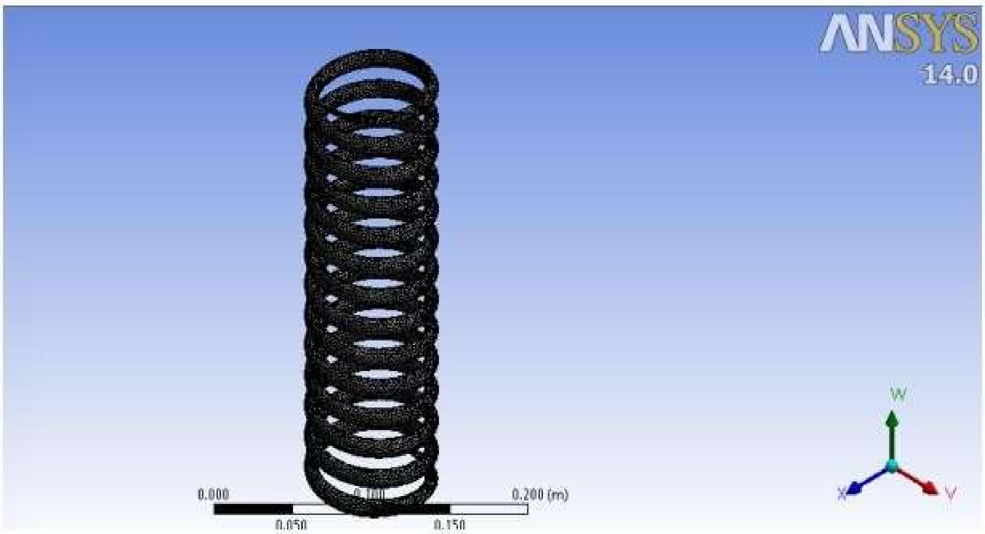


Figure 2 : The Mesh of Coil Spring

The spring was fixed in the bottom end and the load was subjected on the upper end with different values (1500, 2000, 2500) N in order to get the total deformations, stress, strain and shear stress. The analysis was carried out with static analysis in ANSYS 14. The analysis steps could be summarized as the flow chart in Figure 3.

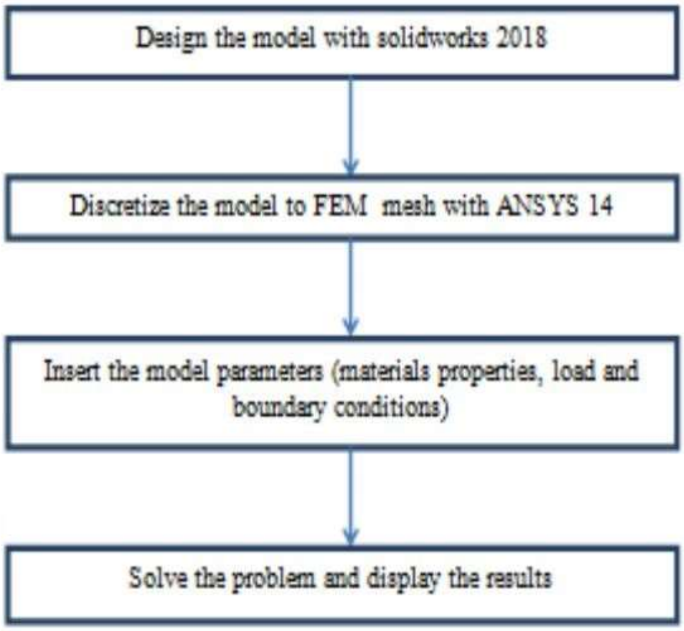


Figure 3 : Flow Chart for Analysis Process

The total deformation, stress according to von-Mises theory, strain and shear stress were obtained numerically for the three materials with various values of the load in order to compare between them and choose the best material that can be used in the production process of the coil or helical spring in modern automobiles.

For the value of load (1500N) the maximum total deformation happened in spring made of copper alloy and it was (448 mm) as shown in Figure 4 below.

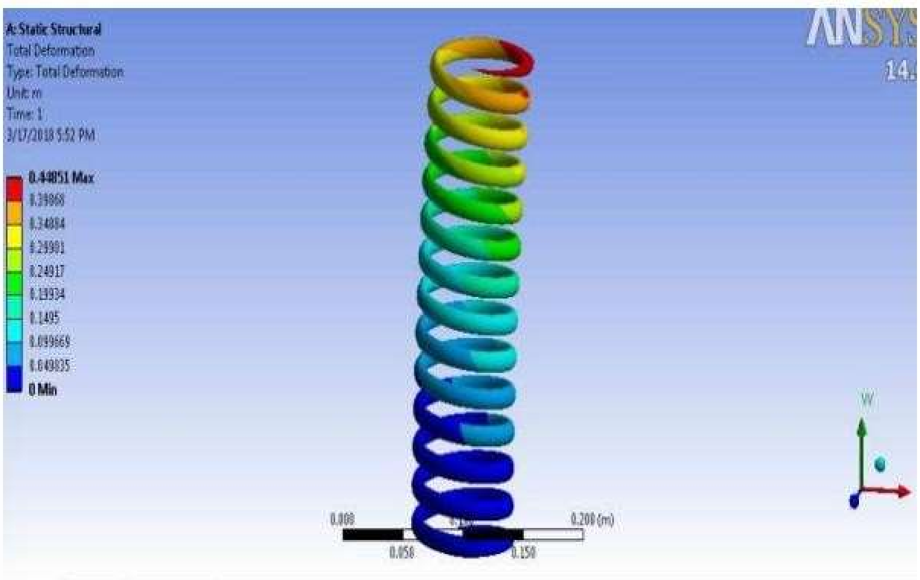


Figure 4 : Total Deformation in Spring Made of Copper Alloy

While the minimum total deformation happened in spring made of carbon composite and the value was (206 mm) as shown in Figure 5 below.

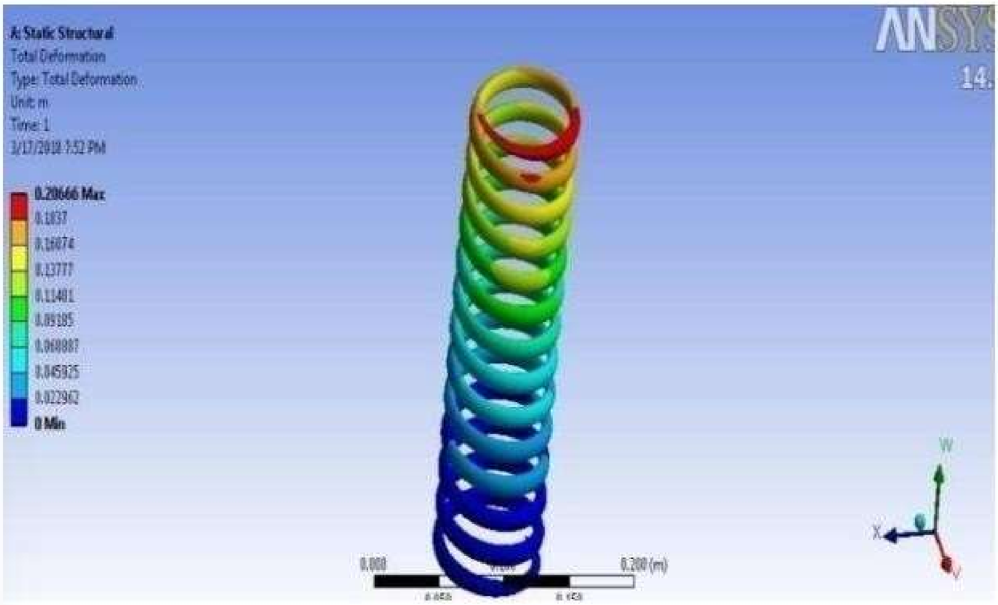


Figure 5 : Total Deformation in Spring Made of Carbon Composite

For the stress, under load (1500 N) the maximum stress according to von-mises theory occurred in spring made of steel structure and the value was (2.825 Gpa) as shown in Figure 6 below.

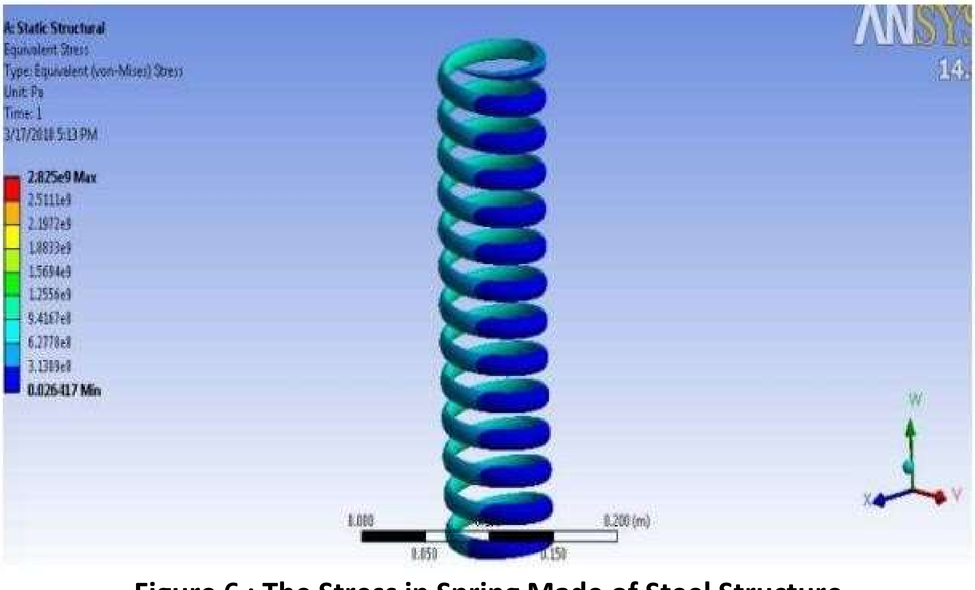


Figure 6 : The Stress in Spring Made of Steel Structure

The minimum value of stress under load (1500) N happened in carbon composites with the value (2.44Gpa) as shown in Figure 7.

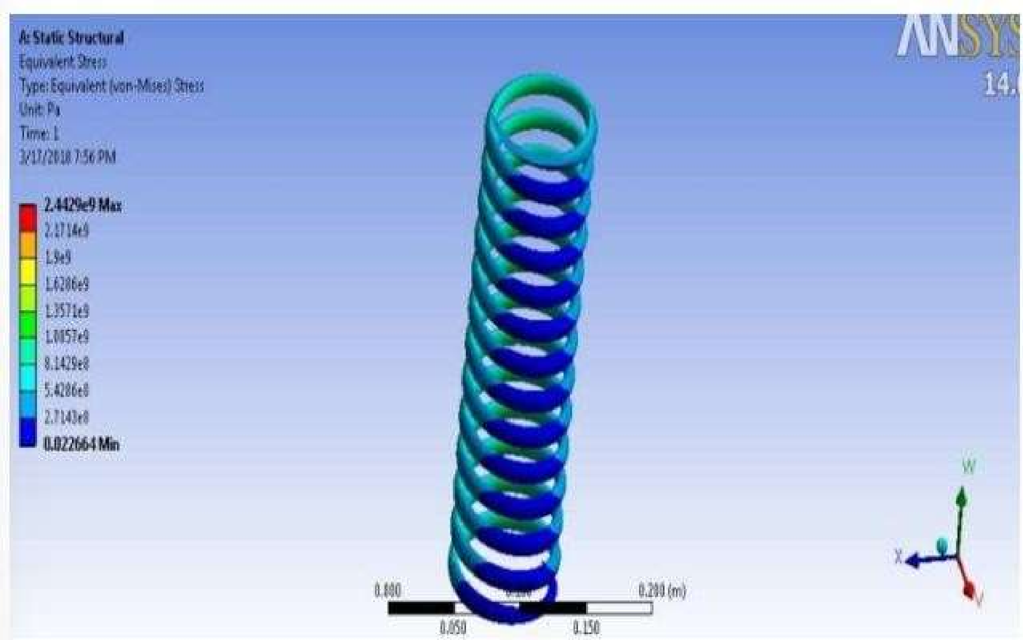


Figure 7 : The Stress in Spring Made of Carbon Composite

For the strain under load (1500N) the maximum strain occurred in spring with copper alloy with value (23.40m m/mm) as shown in Figure 8 below.

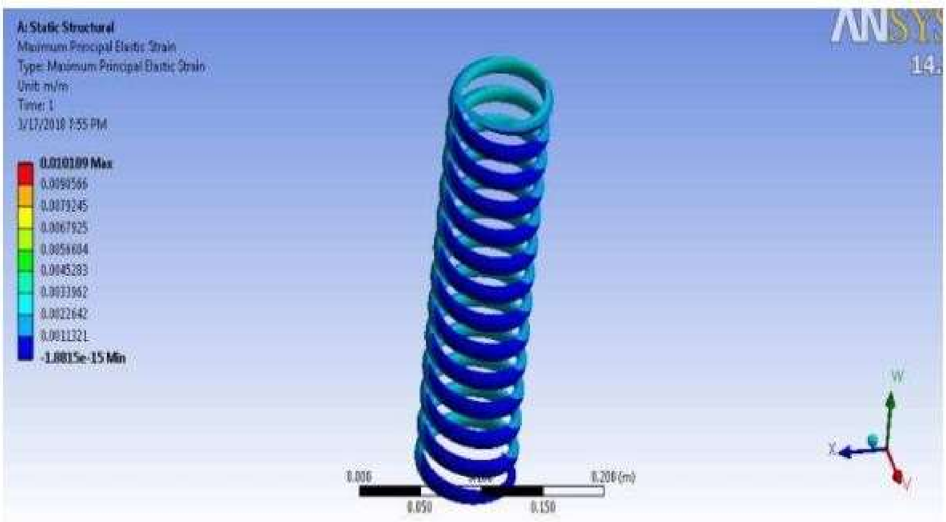


Figure 8 : The Strain in Spring Made of Copper Alloy

The minimum strain occurred in spring made of carbon composite and the value of strain was (10.1 mm/mm) as shown in figure 9 below.

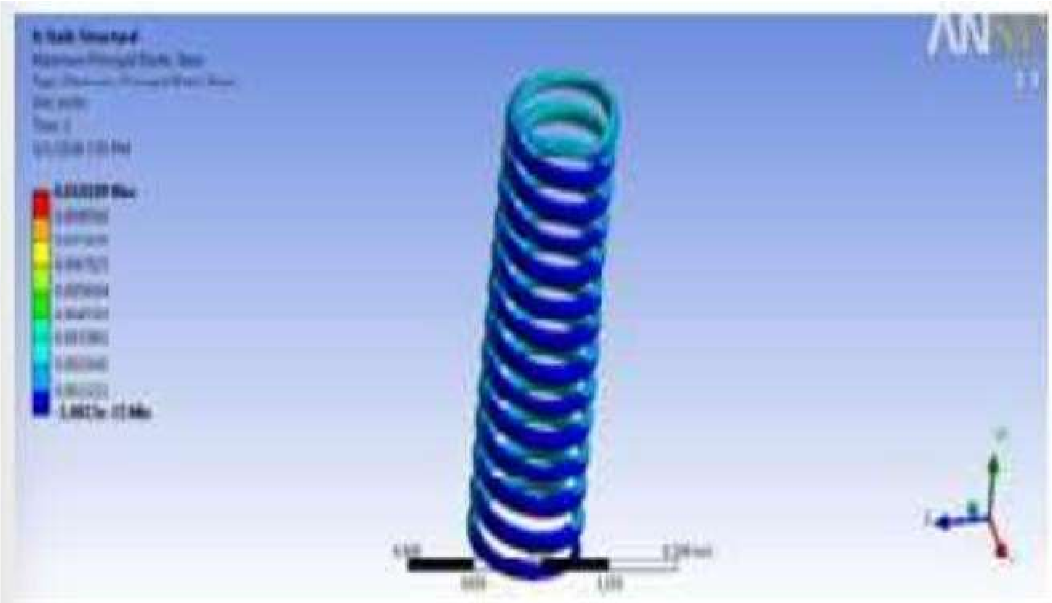


Figure 9 : The Strain in Spring Made of Carbon Composite

For the shear stress under (1500N) approximately was the same for the three materials and the maximum shear stress occurred in spring with carbon composite and the value was (0.453Gpa) as shown in Figure 10 below.

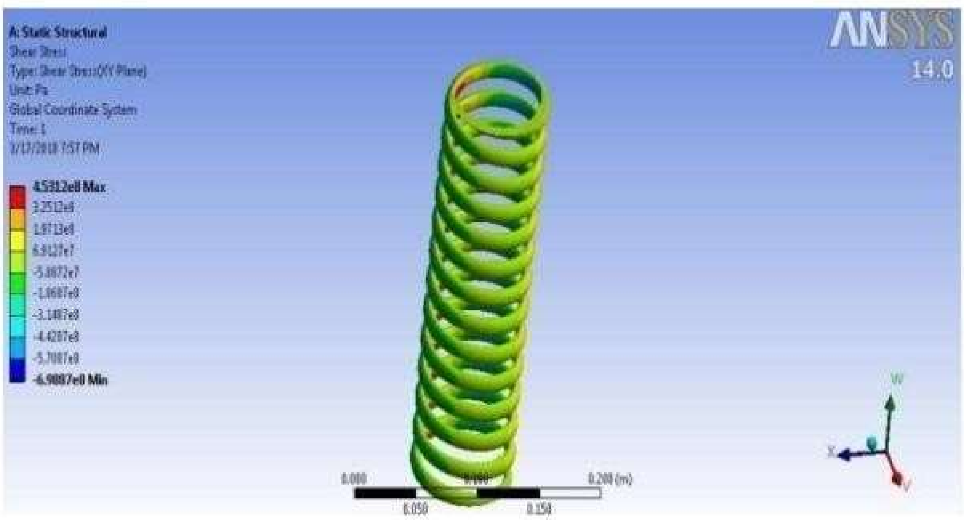


Figure 10 : Shear Stress in Spring Made of Carbon Composite

The minimum shear stress under (1500N) occurred in spring with copper alloy and the value was (0.452Gpa) as shown in Figure 11 below.

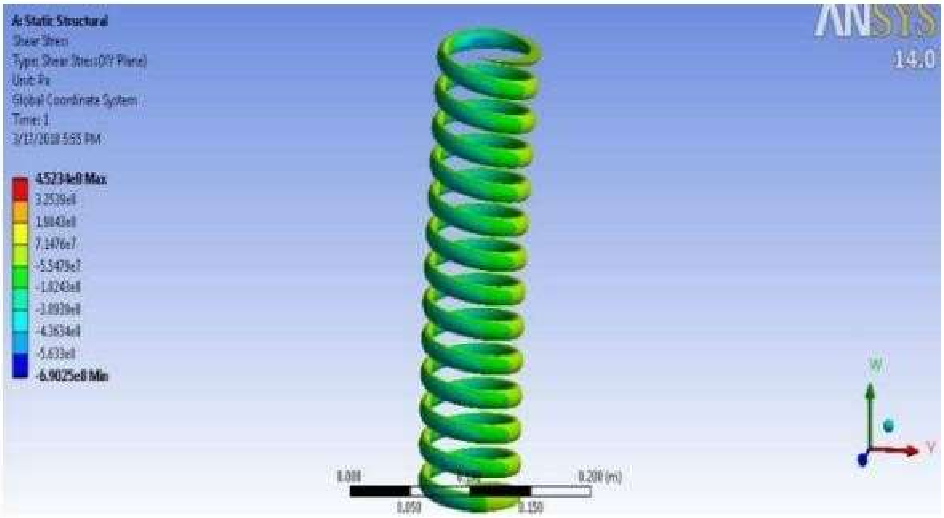


Figure 11 : Shear Stress in Spring Made of Copper Alloy

The results (total deformation, stress, strain and shear stress) for different loads (1500) N for the three materials could be summarized in Table 3 below.

Table 3 : Results for Load (1500) N

Material	Load (N)	Total Deformation (mm)	Stress (Gpa)	Strain (mm/mm)	Shear Stress (Gpa)
Steel Structure	1500	241	2.82	13	0.4525
Copper Alloy	1500	448.1	2.807	23.4	0.4523
Carbon Composite	1500	206.6	2.44	10.1	0.4531

The results (total deformation, stress, strain and shear stress) for different loads (2000) N for three materials could be summarized in Table 4 below.

Table 4 : Results for Load (2000) N

Material	Load (N)	Total Deformation (mm)	Stress (Gpa)	Strain (mm/mm)	Shear Stress (Gpa)
Steel structure	2000	321.5	3.766	17.4	0.603
Copper alloy	2000	598	3.743	31.2	0.6031
Carbon composite	2000	275.5	3.257	13.5	0.641

The results (total deformation, stress, strain and shear stress) for different loads (2500) N for the three materials could be summarized in Table 5 below.

Table 5 : Results for Load (2500) N

Material	Load (N)	Total Deformation (mm)	Stress (Gpa)	Strain (mm/mm)	Shear Stress (Gpa)
Steel structure	2500	401.8	4.708	21.7	0.754
Copper alloy	2500	747.5	4.679	39.1	0.739
Carbon composite	2500	344.4	4.071	17	0.755

The comparison of total deformation at various values of load for the three materials shown in Figure 12.

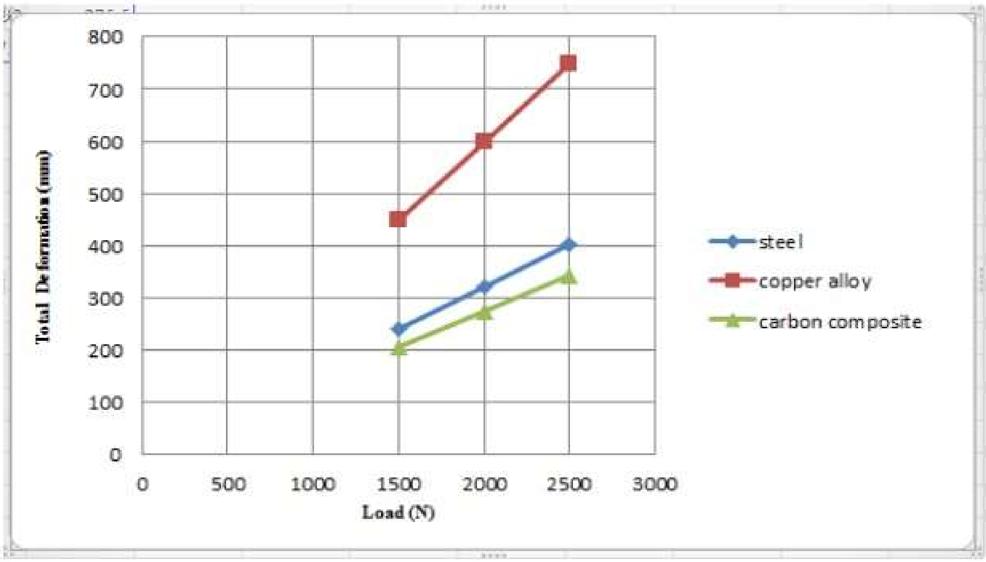


Figure 12 : Total Deformation (mm) vs. Load (N)

The comparison of stress at various values of load for the three materials shown in Figure 13.

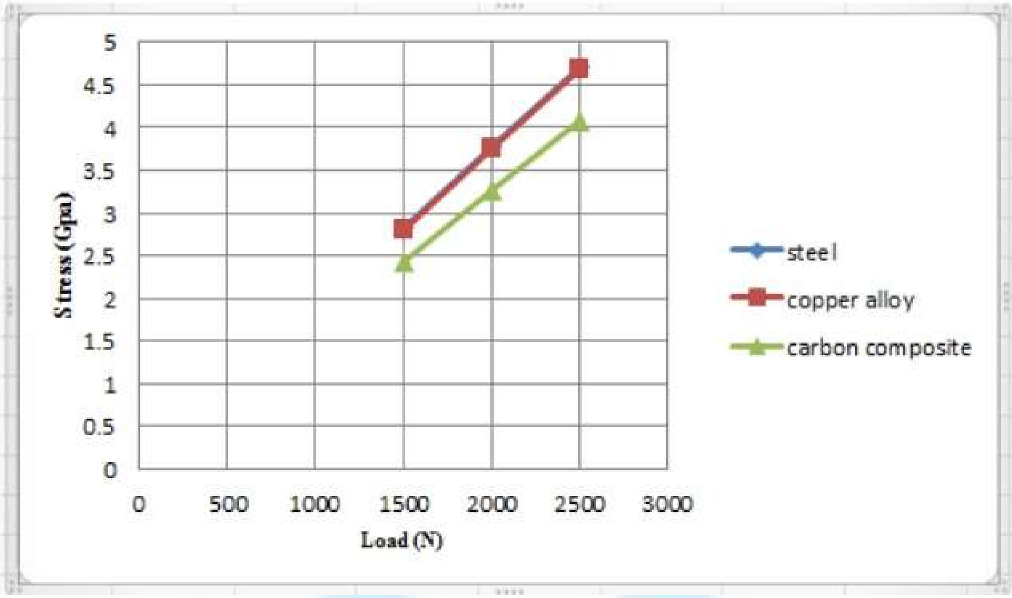


Figure 13 : Stress (Gpa) vs. Load (N)

The comparison of strain at various values of load for the three materials shown in Figure 14.

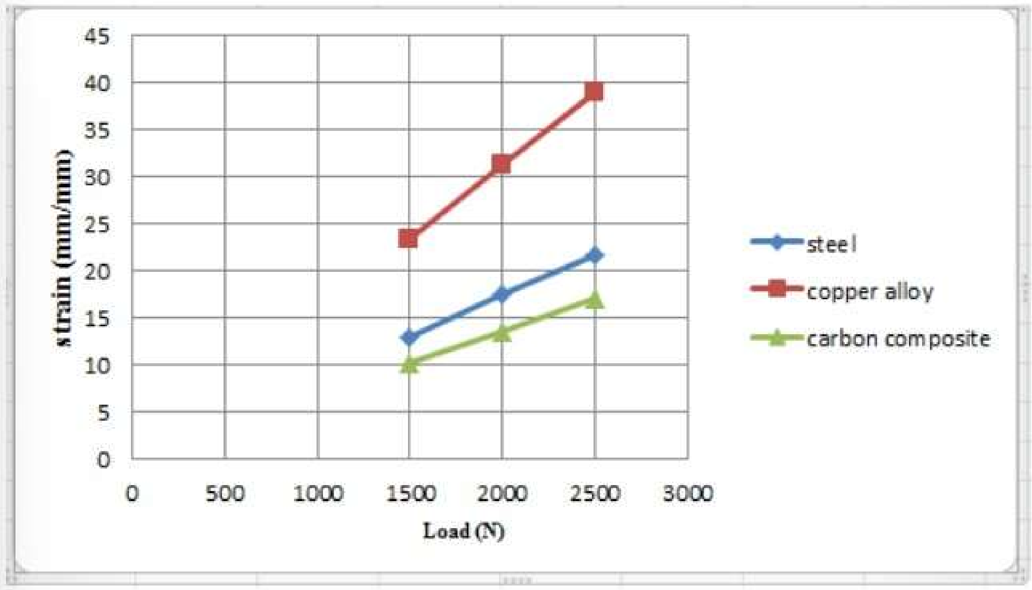


Figure 14 : Strain (mm/mm) vs. Load (N)

The comparison of shear stress at various values of load for the three materials shown in Figure 15.

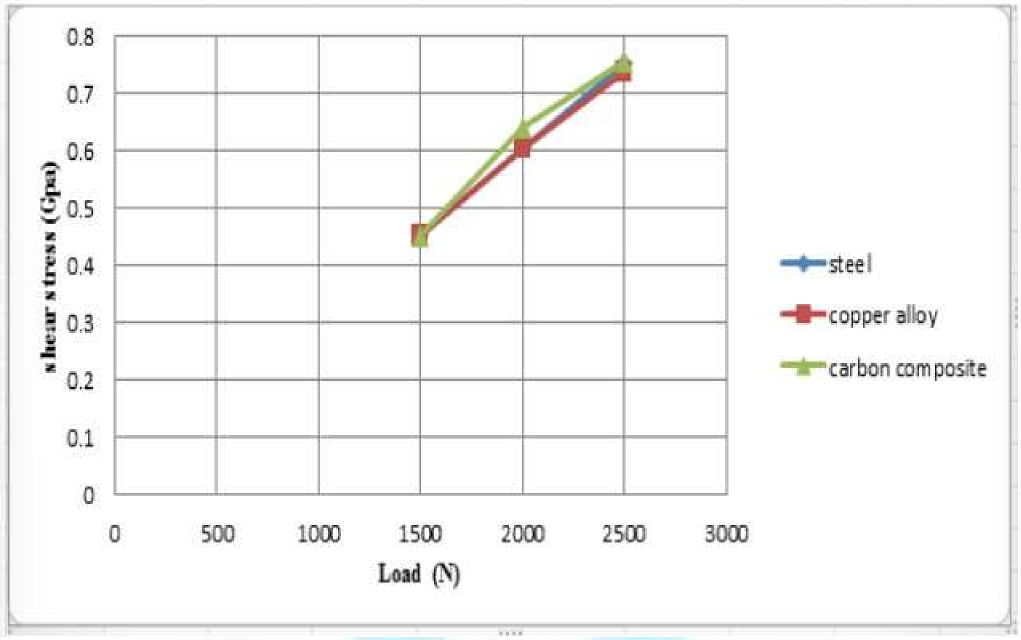


Figure 15 : Shear stress (Gpa) vs. Load (N)

CHAPTER – 03

CONCLUSION

In this study, the simulation and analysis of coil or helical spring which is the main part in the suspension system in modern vehicles were carried out by using Solid works 2018 and ANSYS 14. Three different materials were chosen to manufacture the spring under various values of load. The results showed that the less value of total deformation happened in spring made of carbon composite for all the values of load. The deformation reduced by 15% in carbon composite comparing with the deformation in steel and reduced by about 54% comparing with total deformation in copper alloy. The deformation, strain stress and shear stress increased by increasing the load. The stress and shear stress approximately the same for the three materials under the same load. It could be concluded that the carbon composite is the suitable material to fabricate the coil spring in the suspension system in automobiles. Carbon composite has many advantages for the suspension system such as reduce the weight and strength to the system in spite of its cost. For the future work, it is recommended to simulate the coil spring with different materials and various load and change the type of spring from the coil to leaf spring in addition to change the dimensions of spring such as the outside diameter, free length, pitch etc.

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