CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of study

In a vehicle, a shock absorber is a mechanical component that is installed between the wheel and the body. When a result, it is primarily responsible for absorbing shocks generated by the wheel of the car as it travels over roads with Because of this, the vehicle's body is not subjected to shock, and the rider Hydraulic and pneumatic suspension systems are the most prevalent.

According to the magnetic property principle, when two magnets with similar poles come into contact with one other, a repulsive force is created. Other types of shock absorbers are fitted on cars using this device. In this case, the principle of operation is self-explanatory, as the magnets are fixed in such a manner that one magnet is positioned at the bottom Due to the fact that the poles of this magnet are identical on the inside, they resist each other, causing a gap to be. Due to reduced distance between the two magnetic fields, the vehicle is able to absorb shocks and variations in the road surface via the magnetic flux force. Repulsive force is a dampening force that is utilized as an absorbent medium. This type of shock absorber proves to be more efficient over other types of suspension systems, absorb more number of shocks with high accuracy, has no leakage problem unlike hydraulic and pneumatic system. These are beneficial qualities that makes the magnetic suspension system more effective with less maintenance cost, and hence the automobile.

1.2 Problem statement

As part of an automobile's suspension system, shock absorbers play an important role All four wheels of most automobiles are equipped with a shock-absorb As a result, shock absorbers are primarily used to limit the total movement of a vehicle's body, stabilize the vehicle's journey as well as its tires.

The most common types of shock absorbers are the hydraulic and pneumatic types which require regular maintenance thereby adding up to vehicle expenditure and the possibility of fluid leakage as a result of damaged or worn out damper. Unlike the hydraulic and pneumatic types of shock absorbers, the magnetic shock absorber uses the repulsive force generated from the magnetic property of like poles repelling each other rather than fluids, it has an advantage over the other types due to the possibility of zero fluid leakage. Permanent magnets retain its magnetic properties for a very long time, therefore no need for constant maintenance or frequent replacement of shock absorber as the case may be for hydraulic and pneumatic types. These and many more are useful qualities that make the magnetic shock absorber more efficient and effective with less maintenance cost.

Cushions and springs are combined with pneumatic and hydraulic shock absorbers. There are check valves and orifices in a car shock absorber that use spring-loaded check valves to control the flow of oil When developing or selecting a shock absorber, it's important to examine where the energy will travel. It turns out that the viscous fluid inside most shock absorbers is capable of converting energy Fluid warms up in hydraulic cylinders, but hot air is generally expelled from air cylinders into the environment in order to cool them down. For example, with electromagnetic shock absorbers, the dissipated energy can be stored and re-used at a later time Shock absorbers, in general, let cars ride more comfortably over rough roads.

As part of this research, we're developing a novel suspension system based on magnetic power that may be employed In order to suspend the cylinder, magnets with like poles facing each other are allowed to move inside the cylinder These magnets are placed on the ends of the shock absorber's piston rods. One piston rod is linked to the vehicle's wheel, so it moves with the wheel, while the second piston rod is attached to the vehicle's body, so it is permanently fixed In order to get the spring action, the magnetic poles must resist each other as they move closer to each other. Between them, a magnetic repelling flux force is created since both magnets are pointing at the same magnetic pole Using this repulsion force as a shock absorber is an excellent idea However, as the vehicle's wheels move over a rough or bumpy road surface during the suspension system's operation the wheel will move up and down, causing its piston rod to rotate linearly within the shock absorber during operation. Magnet on it therefore travels closer to another piston rod magnet. To prevent the piston rod from moving, a repulsive magnetic flux force is created, which forces the moveable magnetic field away from the fixed field. Thereby preventing displacement forces from reaching car body. As a result, the rider is able to enjoy a As well as the magnetic suspension, the shock absorber also has a helical steel spring inside it. As an extra suspension support, this spring helps to dampen shocks and prevent direct magnet collisions under extreme shock loads. Because of its numerous benefits over other systems, magnetic suspensions systems are widely utilized today. In the shock absorber, a stainless steel spring allows the piston rod's magnets to gently return to their original position. As soon as the coil spring is released, it returns It is for this reason that the magnetic shock absorber is used to dampen the shocks and vibrations that are created when a vehicle

1.3 Aim and Objectives

The objectives of the study are:

i. To carryout design analysis of the magnetic shock absorber.

ii. To carryout parametric design analysis based on three conceptual designs of the magnetic shock absorber using simulation software.

iii. To simulate performance evaluation of the proposed magnetic shock absorber.

1.4 Scope and limitation

1.4.1 Scope of study

In a car, hydraulic and pneumatic shock absorbers use springs and fluid to absorb shock. As a result of its enormous size and high cost, A neodymium magnetic shock absorber is used to prevent fluid leaks and spring failure. In addition, it prevents shock absorber damage, resulting in less deflection, wheel hop, and tire wear.

This project shows the development of Neodymium magnetic shock absorber, its design, functions and working principles.

This project is limited to the properties of Neodymium magnets

1.5 Justification of Study

It has been brought to our notice the defects of hydraulic and pneumatic shock absorber which requires frequent maintenance, of which as a result the running cost becomes very expensive.

Neodymium magnets are employed because they retain their magnetic properties for a lengthy span of time, thereby making irrelevant the issue of regular maintenance unlike the hydraulic and pneumatic shock absorber, magnetic shock absorber uses the repulsive force

gotten from the magnetic property which states that like poles repel each other as an absorbing media to absorb the forces caused when vehicle drives over uneven ground.

1.6 Report Organization

Introduction, Literature Review, Research Methodology Discussion of Results and Conclusion and Recommendations would be the five chapters of this paper.

Chapter one provides a general overview of the project's history (including the issue statement), goals and objectives, and scope of It is the primary purpose of this chapter to provide the reader with a thorough knowledge of the project

Chapter two explains the basic idea of the project, defines words connected with the project, and examines the strengths and limits of techniques taken in comparable works in order to gain a comprehensive knowledge of the project's constraints and build a strategy for overcoming them.

The third chapter describes the many materials and units that make up the system, as well as the conceptual designs of the project, as well as visual aids of the various components of the designs, as well as the In order to do this, you must be familiar with the many components that will be To demonstrate its strengths, it details the system's testing and performance evaluation of its components.

on chapter four, you'll find the finalized design that will be utilized in fabrication, as well as a discussion of the results obtained from the design analysis

The report's fifth chapter summarizes the work's goals, development methods, results, and improvements made, as well as recommendations for improving the system's strength.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview (Magnet, Shock absorber)

An item or material that generates a magnetic field is called a magnet. Despite its invisibility, this magnetic field is responsible for a magnet's most notable property: the ability to attract and repel other ferromagnetic elements such as iron and steel. An item that attracts and repels oppositely polarized objects may also be described as having the following fundamental properties:

i. Magnetic poles always exist in pairs.
ii. Like poles repel each other, whereas unlike poles attract
iii. Lesser distances increase the magnetic force between two magnets.

A magnet may be classified into three categories, namely temporary, permanent, and electromagnets. Permanent magnets, on the other hand, are widely It is because of this that they are called permanent magnets, as they do not lose their magnetic properties once they

Permanent magnets come in four forms:

i. Ceramic or ferrite
ii. Alnico
iii. Samarium Cobalt (SmCo)
iv. Neodymium Iron Boron (NIB)

2.2 Historic Background of Shock Absorbers

Pinjarla and Lakshmana (2012) state that shock absorbers smooth out or dampen rapid shock impulses and disperse kinetic energy, and that they are made of metal. Absorbers must be able to either absorb or dissipate. The majority of early vehicles, as well as carriage and railway trains, employed leaf springs. When the leaves rubbed together, they dampened the sound a J.M.M. Truffault, a Frenchman in the 19th century, invented the first genuine shock absorber. Although originally suspended by springs, the bike's front fork was equipped with an anti-oscillation friction mechanism. While visiting Versailles in 1899, Edward V Hartford witnessed one of Truffault's bicycles win a The friction device's potential in the automobile industry was quickly recognized By the following year, Hartford had outfitted an Oldsmobile with a version of Truffault's design. For its first set of shock absorbers, engineers used a pair of levers with a rubber pad attached to the pivot point. Shock absorbers have come a long way since the invention of the shock absorber During the 20th century, Lincoln Ballyhooed modeled air suspension and Cowey Motor Works of Great Britain implemented it. Shock absorbers have changed since then in order to provide a more pleasant ride. If you are constructing or picking a shock absorber, you should take into account where the energy will be Automobile and motorbike suspensions, airplane landing gear, as well as numerous industrial machinery, all rely on shock absorbers. To minimize the vulnerability of structures to earthquake damage and resonance, structural engineers have utilized large shock absorbers. Dashpots are devices meant to absorb stress and offer smooth deceleration in linear motion applications, such as shock absorbers, linear dampers, and dashpot. Standard shock absorbers bring the piston rod back to its unloaded position by using a spring. It is common for shock absorbers to have either a fluid or mechanical dampening system, as well as a mechanism for returning to the In order to maintain optimum traction, the shock absorber keeps the car's tires

in constant contact with the road. This is due to the fact that shock absorbers are part of the car's suspension, thus if they're worn out, the vehicle'

2.3 Types of Shock Absorbers

It took a long time for the automobile shock absorber to grow into what it is today

Shock absorbers come in a variety of shapes and

i. *Hydraulic shock absorbers* are the most prevalent form of shock absorber. The shock absorber's body transfers heat away from the tube since the fluid cannot escape.
ii. *Pneumatic or air shock absorbers* which disperse the energy of suspension spring movement by releasing heated

Parts of a Shock Absorber

In spite of the fact that shock absorbers differ in terms of design and operation, their These are the components that go into making a shock absorber's exterior and interior portions.

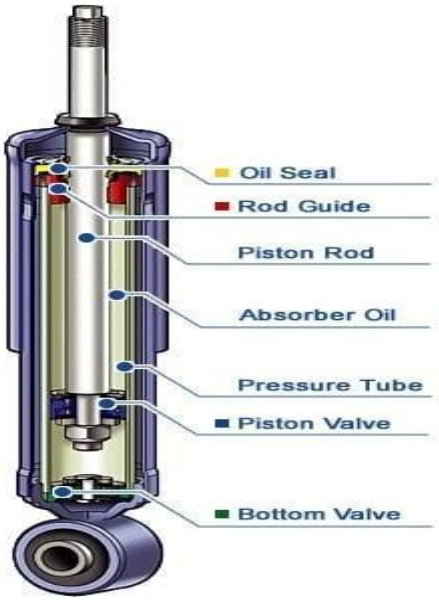


Plate I: Part Diagram of a Shock Absorber

Source; Machinery's Handbook (2012)

Shock Absorber Parts and Function

Shock Absorber Mounts

To keep shock absorbers in place, shock absorber mounting components must be installed to the vehicle's Mounts may be found on the top and bottom Both can have the same "eye" into which a bushing and bolt are placed. In certain designs, the lower mount has a "eye" while the higher mount has a "pin."

Shock Absorber Bush

In the mountings, you'll find them Bushings absorb vibrations and isolate metal elements to avoid noise and wear. As part of a shock absorber's rebuildable components, bushings



Plate II: Shock Absorber Bushing

Source; Machinery's Handbook (2012)

Shock Absorber Coil Spring

In some shock absorber types, the shock absorber assembly includes a coil spring. Coil-over shock absorbers and spring coil shock absorbers are two popular names for these Even though it seems like a suspension strut, it is not one.

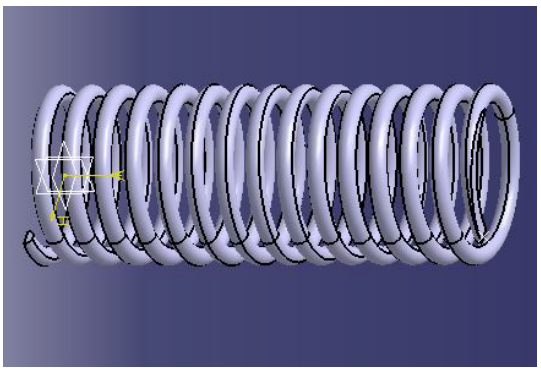


Plate III: Shock Absorber Coil Spring

Source; Johnson, Davis & Anthony (2016).

Shock Absorber Piston and Piston rod

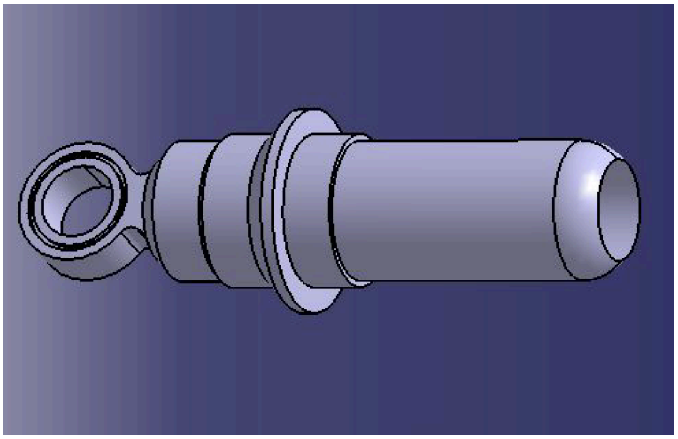
In the piston of the shock absorber there are valves or opening For a shock to operate well, it must be able to transport oil via these route In the shock absorber cylinder, it directs the piston with the help of the

Shock Absorber Cylinder

The shock absorber's body is made up of this tube. As well as containing the compression oil, it also creates the tube inside which the shock absorber.

PLATE IV: Shock absorber cylinder

Source; Johnson, Davis & Anthony (2016).



Shock absorber bolts

Shocks and suspension are held in place by these fasteners, which are located at opposite ends of a vehicle's body Torque them to the correct torque values. Shocks that are not properly torqued might become loose and not perform as intended.



Plate V: Shock Absorber Bolts

Source; Machinery's Handbook (2012)

Other significant shock absorber elements for automobiles include:

Rod guide-This allows the piston rod to travel smoothly.

Nitrogen gas and gas chamber- in a compression chamber or cylinder a gas that is confined in a chamber It keeps the oil from creating bubbles.

Washers and plates- In the shock absorber, they're known as spacers.

2.4 Neodymium Magnets

Neodymium iron boron magnets (also known as Neo, NdFeB or NIB magnets) are the most powerful permanent magnets commercially available today, having magnetic characteristics that considerably exceed alnico and ceramic(ferrite) magnet materials. Due to the strong magnetic remanence and high coercivity of these sintered magnets, they have an extraordinarily high energy product for their small size; nonetheless, they are more expensive than other permanent magnets. You may get them in a variety of forms, sizes, and grades.

Commercial, industrial, and technical applications needing powerful permanent magnets most often employ neodymium magnets. Smaller, lighter components may now be used in magnetic assemblies and components, resulting in significant cost reductions.

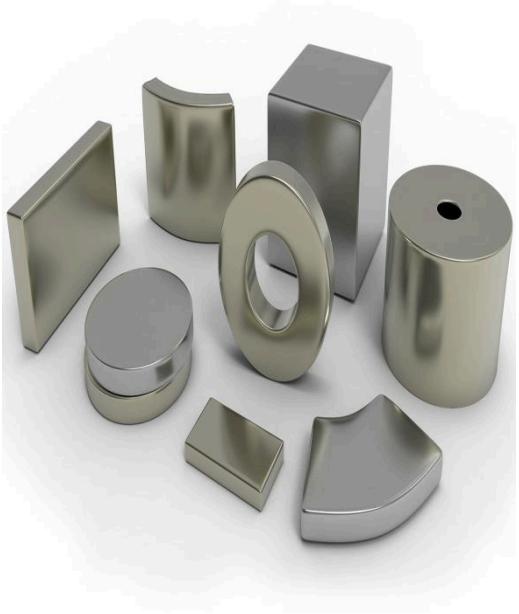


Plate VI: Neodymium magnets

Source: Arnold Magnetic Technologies

2.4.1 History of Neodymium

Karl Auer discovered neodymium in Vienna, Austria, in 1885 In 1839, Carl Gustav Mosander discovered cerium, from which he derived didymium. Dodymium was found to be composed of lanthanoid elements, and samarium was recovered from it in 1879, followed by gadolinium a year later. When Auer extracted neodymium and praseodymium from didymium in 1885 with the use of nuclear spectroscopy, their existence was confirmed. The mineral didymium was first investigated by Bohuslav Brauner in Prague in 1882. Didymium specialist Robert Bunsen was Auer's mentor when he made his discovery, but Bunsen accepted Auer's findings instantly, while other scientists remained suspicious for several years. General Motors and Sumitomo Special Metals developed the Nd2Fe14B compound in 1982 as a result of the growing price of SmCo permanent magnets' raw material. Molycorp acquired Magnequench in 1986, which became part of Neo Materials Technology, Inc. when GM developed melt-spun nanocrystalline isotropic Neo powder. Sumitomo Special Metals, a subsidiary of Hitachi Corporation, develops and manufactured full-density sintered Nd2Fe14B magnets and licenses them to other firms. More than 600 patents on Neodymium magnets are held by Hitachi. China has become the world's largest producer of Neodymium magnets due to its vast availability of rare earth ores. Globally, 129,000 metric tons of rare earth elements were produced in 2010, with non-Chinese production making up a small Neodymium is a silvery-yellow metal with a Greek name meaning "new twin." Air, water, and most acids react with it. A strong permanent magnet and lasers are made from neodymium alloy. It is also used to color ceramic wares In addition to coloring glass in various colours of red and purple, didymium glass is used to make welder's goggles. In Mischmetal, neodymium makes up 18 percent Also, neodymium is used in tanning beds to block infrared radiation while enabling UV tanning rays to pass through.

2.4.2 Uses of Neodymium

The most important use for neodymium is in an alloy with iron and boron to make very strong permanent magnets. This discovery, in 1983, made it possible to miniaturise many electronic devices, including mobile phones, microphones, loudspeakers and electronic musical instruments. These magnets are also used in car windscreen wipers and wind turbines.

Neodymium is a component, along with praseodymium, of didymium glass. This is a special glass for goggles used during glass blowing and welding. The element colours glass delicate shades of violet, wine-red and grey. Neodymium is also used in the glass for tanning booths, since it transmits the tanning UV rays but not the heating infrared rays.

Neodymium glass is used to make lasers. These are used as laser pointers, as well as in eye surgery, cosmetic surgery and for the treatment of skin cancers.

Neodymium oxide and nitrate are used as catalysts in polymerisation reactions.

2.4.3 Sources of Neodymium

A large majority of lanthanide elements are found in the minerals monazite and bastnaesite Ion exchange and solvent extraction can be used to recover neodymium from these minerals. Anhydrous neodymium chloride or fluoride can also be reduced with calcium to get the element. As an impurity in monazite and bastnasite, neodymium is the most common source of the metal USA, China, Russia and Australia are among the places where it is mined, as well.

2.4.4 Applications of Neodymium Magnets

Magnesium neodymium ferroboron (NdFeB) magnets are frequently employed in radar technology, satellite communications, remote Magnesium can also be found in cathode ray tubes, magnetrons tubes, and circulators.

In addition to electric bicycle motors, neodymium magnets are utilized in elevator traction machines, refrigerator air conditioner motors, wind-driven motors, and more

It is utilized in the production of speakers, hearing aids, stereo headphones (MP3, MP4 format), telephone receivers, electro-acoustic sensors, and other products.

In addition, permanent magnets are utilized to manufacture a wide range of magnet-related equipment such as magnetized gears and brakes, magnetized fittings, magnetized salvage devices and magnetized seal doors.

Aside from transportation, neodymium magnets are also commonly utilized in luxury vehicles as windshield wiper motors and oil pump motors.

There are a variety of uses for neodymium magnets in the medical field. NdFeB magnets are also utilized in MRI, which is a medical equipment that has grown significantly in recent years.

Utilized in the field of magnetic separation technology, which is extensively utilized in the fields of beneficiation (coal preparation), raw material processing (raw materials), water treatment (water treatment), trash treatment (gar

2.5 Two wheelers vehicles

When a vehicle has two wheels, it is referred to as a One behind the other, as with single-track vehicles, or side-by-side on a single axle. When a vehicle has two wheels, it is referred to as a One behind the other, as with single-track vehicles, or side-by-side on a single axle.

2.5.1 Types of two wheelers vehicles

i. **Segway:** This two-wheeled, self-balancing personal transporter has two wheels attached to a frame, one on each side of the frame.

ii. **Bicycle:** Pedal-driven, single-track, human-powered or motor-powered, with two wheels linked to a frame, one behind the other, it is also known as a bicycle

iii. **Motorized bicycle:** When a bicycle has a motor or engine connected, the motor or engine and transmission can be used to either power the vehicle without assistance, or to help with

iv. **Recumbent bicycle:** This is a bicycle that allows the user to recline in a relaxed manner while riding. Back and buttocks support the rider's weight equally.

v. **Motorcycle:** Depending on where you are in the world, you may hear it called a bike, a cycle, or It is a motorized two-wheeled vehicle.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Material Selection

(i) Neodymium Magnets

(ii) Stainless Steel Piston rod

(iii)Coil Spring

(iv)PVC Pipe



Plate VII: Components of the Neodymium magnetic shock absorber

Source: Khurmi& Gupta.,2005

Material for this research includes neodymium-iron-boron alloys with a tetragonal Nd2Fe14B crystal structure. As a result, both magnets face the same direction and a significant air space is permitted between them. In a shock absorber, they're placed separately on the ends of two piston One piston rod is linked to the vehicle's wheel, so it moves with the wheel, while the other piston rod is connected to the vehicle's body, so it is stationary. Due to the fact that both magnets are facing the same pole, a magnetic repelling flux force is created between When employed as a shock absorption medium, this repulsive force If the vehicle's wheel travels up

and down across road surface imperfections, the piston rod that is linked to it will reciprocate linearly within the shock absorber. Defined by this, if a magnet on one piston rod travels closer to a magnet This creates a magnetic flux force that pushes the moveable magnet away from the fixed one, preventing the piston rod from moving. A result of this is that the tire's displacement force is avoided from affecting the car' As a result, the rider is able to enjoy A helical steel spring is also used in the shock absorber, in addition to magnetic suspension. As an extra suspension support, this spring helps to dampen shocks and prevent direct magnet collisions under extreme shock loads.

3.2 METHODS

3.2.0 Conceptual design phase

This basically covers the conceptual designs and simulation procedures of the magnetic shock absorber. Here three conceptual designs are presented and analyzed to determine the most efficient one among them for use. Based on a simple engineering concept, this machine will fulfill the purpose for which it was built, according to its design. The strength of the machine must be higher than the stress in order to assure its safety and dependability.

3.2.1 First conceptual design of magnetic shock absorber

This shows the first conceptual design of the neodymium magnetic shock absorber created using Solid Works design software along with geometrical specifications of the various components comprising the design.

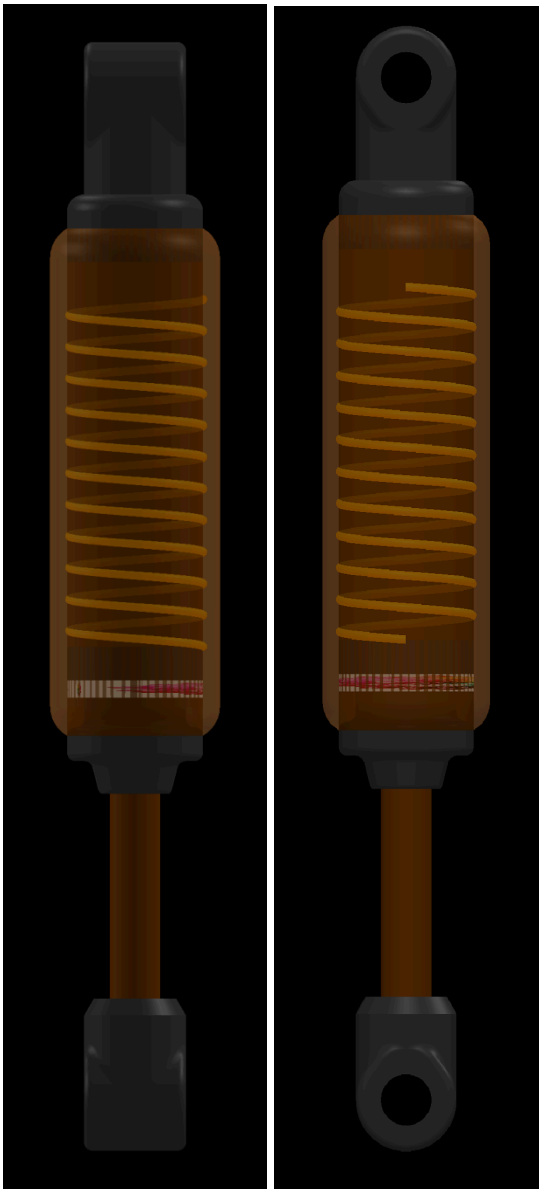


Plate VIII: First conceptual design of magnetic shock absorber



Plate IX: Front-end view of shock absorber bushing

3.2.2 Second conceptual design of magnetic shock absorber

This shows the second conceptual design of neodymium magnetic shock absorber developed using Solid Works design software as well as geometrical specifications of various components comprising the system.

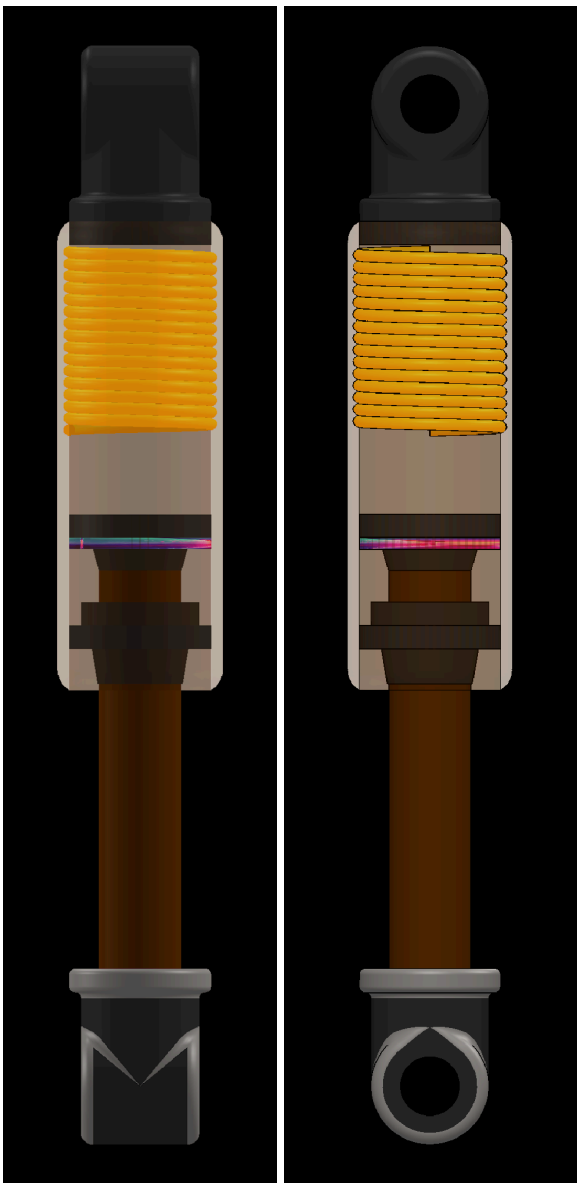


Plate X: Second conceptual design of magnetic shock absorber

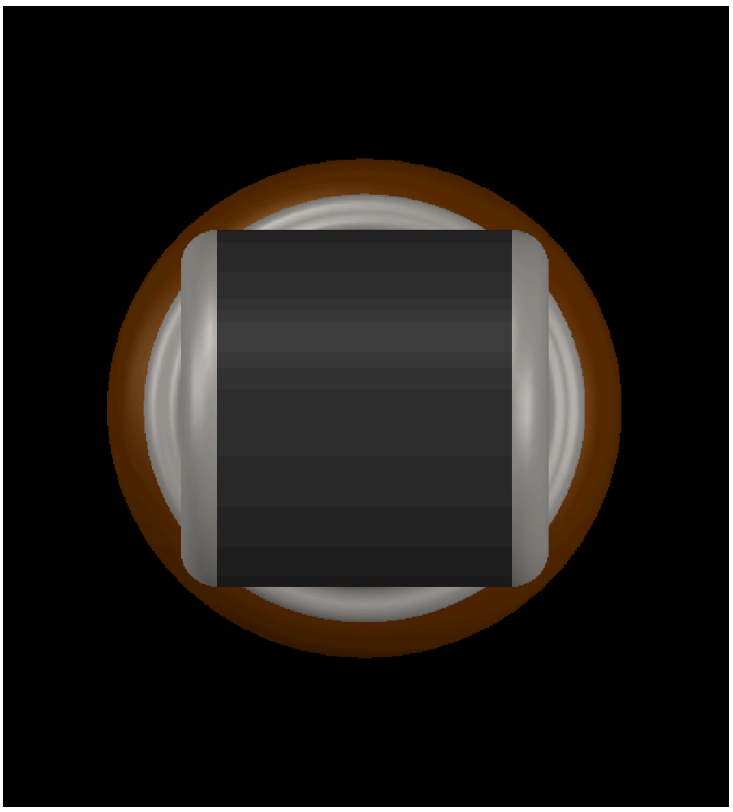


Plate XI: Top view of second conceptual design of magnetic shock absorber

3.2.3 Third conceptual design of magnetic shock absorber

This shows the third conceptual design of neodymium magnetic shock absorber developed using Solid Works design and simulation software application along with geometrical specifications of various components comprising the system.



Plate XII: Third conceptual design of magnetic shock absorber

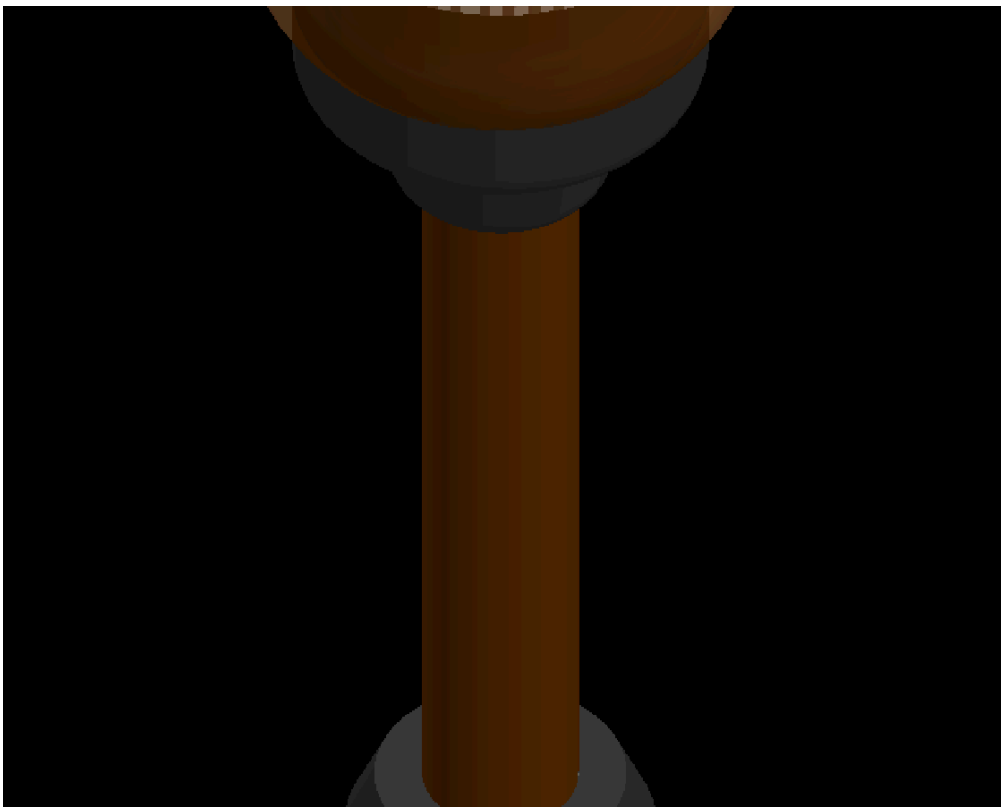


Plate XIII: Piston rod of third conceptual design of magnetic shock absorber

DESIGN PARAMETERS FOR THREE CONCEPTUAL DESIGNS OF NEODYMIUM MAGNETIC SHOCK ABSORBER

S/N	Parameters	First Conceptual Design (mm)	Second Conceptual Design (mm)	Third Conceptual Design (mm)
1	Length of spring	102.52	103.88	102.52
2	Outer diameter of spring	25	25	17
3	Inner diameter of spring	20	20	12

4	Diameter of neodymium magnet	35	24.5	12
5	Length of absorber casing	150	200	150
6	Maximum distance between magnets	115	120	115
7	Minimum distance between magnets	50	20	50
8	Diameter of shaft	40	35	9
9	Diameter of top and bottom bushings	7.5	7.5	3
10	Thickness of wire spring	2.5	5	2.5
11	Piston Length	95	95	90
12	Inner diameter of absorber casing	40	65	20
13	Outer diameter of absorber casing	50	70	25
14	Thickness of bushings	30	50	15

Table 3.1: Design parameters for three conceptual designs of neodymium magnetic shock absorber

After simulation of the three conceptual designs using Solidworks software, it was determined that the third conceptual design was the most suitable for the project in terms of efficiency and cost-effectiveness and was therefore implemented for fabrication.

3.2.4 Design Specifications of Cylinder

Outer diameter of cylinder $\emptyset_0$=25mm

Thickness of the cylinder t =2mm

Inner diameter of the cylinder $\emptyset_i$= 20 mm

Allowance to spring and magnet= 2mm on each side

Length of the cylinder h = 150mm

3.2.4 Design Specifications of Piston and Piston rod

Piston length = 90 mm

Piston head hole outer diameter = 40mm

Piston head thickness = 5mm

Piston head hole inner diameter = 40-(5x2) =30mm

Piston head length = 35mm

Piston head curve radius = 7.5mm

Piston ring diameter= 35mm

3.3.0 Design analysis and calculation of adopted conceptual design

3.3.1 Design analysis and calculationof spring used in third conceptual design

The length and outer diameter of spring are selected based on geometrical requirements or specifications of the shock absorber.

Length of spring = 102.52mm

Number of turns= 11

Outer diameter of spring, D_o = 17mm

As per design data book for cold drawn wire steel the wire diameter, d = 2.5mm

Inner diameter of spring, D_i = 12mm

Calculating the load bearing capacity of spring:

For any service life,

Shear stress,τ= 364 N/mm^2

Since spring is made up of steel

Spring index, C= $\frac{D_o}{d}$(3.1)

=$\frac{15}{2}$

C = 7.5

Then, Wahl factor of spring, K=$\frac{4C-1}{4C-4}$ + $\frac{0.615}{C}$ (Khurmi & Gupta.,2005) (3.2)

For C =7.5, k= 1.197

Now to find load holding by spring W,

We know that k = $\frac{8W.D}{\pi d^3}$ (Khurmi & Gupta.,2005) (3.3)

W=63.6569N

Thus, spring holds the load of63.6569N

The remaining load is absorbed by magnet.

3.3.2 Design analysis of load to be carried by shock absorber

Weight Vehicle Body =5Kg = 49N

Weight of Person Sitting on Vehicle =30Kg = 294N

Total Load = Weight Vehicle Body + Weight of Person Sitting onVehicle

Total Load = 196N

Load on front SuspensionR_f = 35% of Total load = 0.35× 294 = 102N

Considering Dynamic Loads Double (W_s) = R_S×2 =102 x 2 = 204N

Single Shock Absorber Weight $\frac{W_s}{2}$=102N (3.4)

Taking Factor of Safety = 1.2

So, Design Load = $\frac{W_s}{2}$× 1.2 =122N. (Jha*et al., 2017*)

3.4 Calculation of magnetic repulsion force

The Gilbert model of magnetic theory is used to determine the repelling force between two magnets. For two identical cylindrical magnets there is a force F between them that may be calculated using the following equation

According to (Nandish*et al.*, 2019), $F= [B_o^2 A^2 (L^2+r^2) / (\pi\mu 0 / L^2)] X [1 /d^2+ 1/ (1+2L)^2 -2 / (d + L)^2]$

B_o is flux density at each pole of magnet in tesla.

In physics, magnetic flux density is the quantity of flux per unit area of a segment that is perpendicular to the flux's If you've heard of it, you've probably heard of it by other names, such as " As a result, the magnetic flux density increases with the density of magnetic field lines.

A is the surface area of magnet poles in m^2.

L is the magnet's length in m.

Magnets have a radius of r in m,

μo is permeability of free space=4π*10-7 T-M /A,

d is the separation distance between two magnets in m, and it is much greater than the magnet's radius r. (Nandish et al 2019)

CHAPTER FOUR

4.0 DISCUSSION OF RESULTS

During testing, it was discovered that the farther the magnets are from each other, the weaker the repulsive force with corresponding less load carrying capacity, while the closer the magnet the stronger the repulsive force with attendant higher load carrying capacity.

Table 4.1 Bill of Engineering Measurement and Evaluation (BEME)

The proposed budget cost of developing the magnetic shock absorber mainly consists of material cost, labor cost and overhead cost.

S/N	Components	Material	Quantity	Unit Price	Total Cost (₦)
1.	Spring	High Carbon steel	1	500	500
2.	Magnet	Neodymium	2	8000	16,000
3.	Cylinder	PVC Pipe	1	1000	1,000
4.	Piston	Stainless steel	2	500	1,000
5.	Software Cost	_____	___	5000	15,000
TOTAL					33,500

4.1.0 Cost of the Project

Here's how much this project will cost you.

4.1.1 Cost Analysis

Here's how a system calculates the fair and correct cost of production for its component elements. Among other things, these costs include:

1. Material cost
2. Labour cost
3. Over headed Cost

4.1.2 Material Cost

Cost of raw resources per unit multiplied by the number of units produced.

4.1.3 Labour Cost

The cost of labor includes the pay paid to construction workers. Only the manufacturing of important pieces may be estimated or accounted for in full.

It is advised that the labor cost is 15 percent of the material cost and the overhead is 10%, according to Tyler and Esup (1991).

Labour cost = $\frac{15}{100} \times 33{,}500$ = ₦ 5,025

Labour cost = ₦ 5,025

4.1.4 Over-Head Cost

Overhead costs include transportation costs, which are computed as follows:

Over headed cost = $\frac{10}{100} \times 33{,}500$ = ₦ 3,350

Over headed cost = ₦ 3,350

4.1.5 Total Cost

Cost is the sum of material cost plus labor costs plus overhead costs (overhead).

Therefore, Total Cost = 33,500 + 5,025 + 3,350 = ₦ 41,875

4.2 EXPECTED RESULTS

r = 6 mm is the magnet's radius in the present work.

Length of magnet is L=12 mm

During normal driving circumstances, the distance between the magnets in the shock absorber is 115 mm, and the distance between the magnets when they come near is 50 mm. So, force of repulsion will be maximum F_{max}, when x =50mm

When x = 50 mm,

Repulsive force will be minimum F_{min}.

There is a difference between the maximum repulsive force (Fmax) = 441N and the load to be carried by the suspensions

This innovative magnetic suspension system can withstand and carry operational loads.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Neodymium Magnetic Shock Absorber for two wheelers was designed utilizing widely available materials.

The fabricated Shock Absorber can be mounted on a two-wheeler vehicle for use.

Lastly, in tests, shock absorbers proved to be capable of carrying the weight for which they were intended.

5.2 Recommendations

Each of the following areas might be improved by completing this project by any student who is interested in it:

(i) Fabrication of a Neodymium magnetic shock absorber for different vehicles.

(ii) Design of Neodymium magnetic shock absorber for two wheelers with more efficiency.