EXPERIMENTAL ANALYSIS OF PERMANENT MAGNET TYPE SUSPENSION SYSTEM

A report submitted to the Department of Mechanical, Sonargaon University of Bangladesh in Partial fulfillment of the requirement for the Award of Degree of Bachelor of Science in Mechanical Engineering.

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ABSTRACT

Suspension is a mechanical arrangement contributing to vehicle's road handling behavior. If roads were perfectly flat with no irregularities, suspensions wouldn't be necessary. It's these imperfections that apply force to the wheels. There are many types of suspensions such as double wishbone, trailing arm and air shocks. But these suspensions possess some disadvantages such as vibration, mechanical failure and stiffness variation. So in this paper we have introduced the idea of “MAGNETIC SUSPENSION” which will enhance the driving pleasure and control over road. Magnetic suspension will allow us to get variable stiffness and much higher comfort just by playing with magnetic field. It will also allow us to reduce wear and tear along with less maintenance. The arrangement will be in such a way that same poles will be facing each other resulting in repulsion of the magnets. That is either (+) positive - (+) positive or vice versa. Reducing vehicle’s vibrations while travelling on irregular roads, the magnets will act as dampers and damping effect will be produced due to repulsion between them. Moreover, stiffness can also be controlled by varying magnetic field according to the requirement.

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CHAPTER 1

INTRODUCTION

1.1 General

The idea for a magnetic shock absorber, makes use of the magnetic repulsion between dipoles to achieve shock absorption. Often when riding on her two-wheeler we used to face some problems while moving on the bumpy road due to its unevenness.it observed that the like pole of two magnets of the same properties and strength repulse each other and they keep constant distance between each other because of their magnetic fields this made her think that if the shock absorber are made of magnets with similar poles facing each other, it may give better performance and no maintenance would be required for the same. In this project two magnets are placed in a piston. One magnet is fixed with piston. Another one is movable, which is connected with rod. With magnets are replaced by air.

Our magnetic shock absorber works on the basic principle of magnet that "opposite poles attract each other and same poles repels each other". In this both magnets are facing same poles (both magnets are placed facing north and north or south and south). Both magnets are same pole. When the rod moves inside the piston movable magnet move towards the fixed magnet. Since both magnets are of same pole repulsion force is created between the magnets. So the movable magnet opposes the rod action and moves the rod up. Magnetic suspension system is mainly based on the property magnets that like poles of magnets repel each other. This characteristic of magnets is used for suspension work of system. This system also contains spring in between these two magnets to avoid direct contact of two magnets due to overloading. This system finds large number of applications in automobile industry.

In today's world automobile sector has reached its peak. In two wheeler suspensions system used in coil spring is that after some time it becomes not only harder but also reduces cushioning effect. This limitation has overcome by magnetic suspension. The cushioning effect is provided by magnetic suspension is existing for long time. There is one magnet fixed at the top of the inner portion of the cylinder. The second magnet placed at bottom of t inner portion of cylinder that reciprocates up and down due to repulsion. The two mange fight against each other to achieve the aspect of suspension.

Causing the formation of suspension to the vibrations formed in vehicle, which are caused due the road irregularities in order to offer the comfort to both the vehicle assembly and passengers on the vehicle. This system is having the tendency to eliminate the use of conventional suspension system due to its low cost and less maintenance capacity. Fossil fuels are being consumed with very fast rate. Also the cost of fuel is increasing with a very fast rate. So somebody has to work on saving of the fuel consumption. Our aim is to demonstrate how the kinetic energy from the suspension of a car can be utilized to achieve our goal of obtaining maximum energy that would otherwise have gone waste. We propose a design plan that converts the mechanical energy in cars to electrical energy much more efficiently than it has been done before.

The electricity generated will then be used to recharge the car battery for further use for functioning of the car. There is a wide scope for regeneration of energy like regeneration of breaking systematic. We have decided to work on utilization of suspending mass of a vehicle through regeneration system with the help of shock absorber. Shock absorbers are having reciprocating motion in it. Although the reciprocating distance is very low the suspending mass is very high i.e. the mass of total vehicle. When vehicle is on a normal road then also shock absorbers are working due to uneven roads, sudden breaking or sudden acceleration.

So this reciprocating motion of shock absorbers can be converted into rotary motion and through small gearbox attached to alternator of automobile, electricity will be generated when shock absorbers will be reciprocating. In the case of brakes or suspensions, kinetic energy is often released as heat. Friction brakes, which convert kinetic energy to heat, are used in the majority of automobiles. This basically means that when you apply the brakes, a lot of energy is released as heat. Regenerative braking is the conversion of kinetic energy generated during braking into a form that can be used right away or stored till later. For most convectional vehicles, the majority of the Kinetic energy converted during friction braking,

between the brake pads & wheels turns into heat which then gets emitted unused into the environment as waste but not when driving a hybrid model or electrical vehicle. Using electric motors, a portion of Kinetic energy can be recovered for reuse. This means using a regenerative braking system, all the Kinetic energy that would have been lost can partially be put right back into the battery. Every automotive suspension has two goals: passenger comfort and vehicle control. Electromagnetic suspension is a system that converts vehicle bump into electrical energy. Its primary function is to reduce effects of vibration irregularities on roads. This is achieved with the help of shock absorbers that emit vibrational energy in the form of heat. This heat is the one that this project aims to harvest and convert into electrical power that can then charge the battery. This research proposes a design of a system where the heat lost in the suspension system and brakes combined is extracted, converted into a usable form of electrical energy which can charge batteries. In 1967, the American Motor Car Company (AMC) created an electrical energy regeneration brake for their concept electric car, the AMC Amitron.

Toyota was the first car manufacturer to commercialize RBS technology in their Prius series hybrid cars (Clark, et al, 2011). Since then there has been an evolution in the regenerative braking systems. Modern hybrid cars and EVs make use of an electrical engine to power the car which makes applying regenerative braking very simple and efficient. ZERA launched the first electric car to accelerate adoption of clean energy, it is in sync with Zimbabwe's aspirations of a modernized and mechanized country by 2030. The intent to adopt more electric cars in the country means the need to charge those cars grows. This is a great opportunity to invest in the design of the electromagnetic suspension.

The automobile chassis is mounted on the axles not direct but through form of springs. This is done to isolate the vehicle body from the road shock which may be in the form of bounce pitch, roll or sway. These tendencies give rise to on the uncomfortable ride and also cause additional stress in the automobile frame & body. All the part which performs the function of isolating the automobile from the road shocks are collectively called a Suspension System. It includes the springing device used & various mounting for the same. Broadly speaking, suspension system consist of a spring & damper. The energy of road shock cause the spring to oscillate. The oscillations are restricted to a reasonable level by the damper, which more commonly called a Shock Absorber.

1.2 Objective

The objectives of this project are:

- To Design and Fabrication of Magnetic Suspension System.
- To test the Performance of Fabricated Magnetic Suspension System.

1.3 Organization Of Book

This project book consists of Six chapter. The first chapter contains the statement of the introduction, our motivation for the project, objectives of the study, our used methodologies and the project organization. Chapter two contains literature review and Suspension System in details. Chapter three describes the proposed system architecture with component details which we have used for our work. Chapter four contains result and discussion in details about our work. Chapter five we have discussed the advantages of the project and also about some aspects we had to overcome while doing the project.
In the final chapter, and lastly we gave the reference.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Review

A motorcycle's suspension serves a dual purpose: contributing to the vehicle's handling and braking, and providing safety and comfort by keeping the vehicle's passengers comfortably isolated from road noise, bumps and vibrations. The typical motorcycle has a pair of fork tubes for the front suspension, and a swing arm with one or two shock absorbers for the rear suspension.

A shock absorber (in reality, a shock "damper") is a mechanical or hydraulic device designed to absorb and damp shock impulses. It does this by converting the kinetic energy of the shock into another form of energy (typically heat) which is then dissipated. Most shock absorbers are a form of dashpot.

Pneumatic and hydraulic shock absorbers are used in conjunction with cushions and springs. An automobile shock absorber contains spring-loaded check valves and orifices to control the flow of oil through an internal piston. One design consideration, when designing or choosing a shock absorber, is where that energy will go. In most shock absorbers, energy is converted to heat inside the viscous fluid. In hydraulic cylinders, the hydraulic fluid heats up, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of shock absorbers, such as electromagnetic types, the dissipated energy can be stored and used later. In general terms, shock absorbers help cushion vehicles on uneven roads.

Difference between Magnetic Shock Absorber and Spring Shock Absorber

Table 1: Difference between two shock absorbers

Sr. No.	*Magnetic Shock Absorber*	*Spring Shock Absorber*
1	It has more life	It has less life
2	Life is nearly about approximately 20 years	Life is nearly about approximately 10 years
3	The weight of magnet is more	The weight of spring is low as compared to magnets
4	If the power of magnets decreases then it is possible to recharge and it able to use again and again	Its strength at spring is decreased or loss it is necessary to replace it new one
5	It has very low maintenance	It has more maintenance

2.2 Suspension System

The automobile chassis is mounted on the axles, not direct but through some form of springs. This is done to isolate the vehicle body from the road shocks which may be in the form of bounce, pitch, roll or frame and body. All the parts which perform the function of isolating the automobile from the road shocks sway. These tendencies give rise to an uncomfortable ride and also cause additional stress in the automobile are collectively called a suspension system. It includes the springing device used and various mountings for the same. Broadly speaking, suspension system consists of a spring and a damper. The energy of road shock causes the spring to oscillate. These oscillations are restricted to a reasonable level by the damper, which is more commonly called a shock absorber.

Shock Absorber

A Shock Absorber is a mechanical device designed to smooth out or damp shock impulse, and convert kinetic energy to another form of energy (usually thermal energy, which can be easily dissipated). It is a type of dashpot. A shock absorber is a device which convert mechanical energy into thermal energy. The energy transformation occurs as the shock absorbers fluid medium is forced through orifice at high velocity. Pneumatic and hydraulic shock absorbers are used in conjunction with cushions and springs.

An automobile shock absorber contains spring-loaded check valves and orifices to control the flow of oil through an internal piston. One design consideration, when designing or choosing a shock absorber, is where that energy will go. In most shock absorbers, energy is converted to heat inside the viscous fluid. In hydraulic cylinders, the hydraulic fluid heats up, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of shock absorbers, such as electromagnetic types, the dissipated energy can be stored and used later. In general terms, shock absorbers help cushion vehicles on uneven roads In a vehicle, shock absorbers reduce the effect of travelling over rough ground, leading to improved ride quality and vehicle handling.

While shock absorbers serve the purpose of limiting excessive suspension movement, their intended sole purpose is to damp spring oscillations. Shock absorbers use valving of oil and gasses to absorb excess energy from the springs. Spring rates are chosen by the manufacturer based on the weight of the vehicle, loaded and unloaded.

Some people use shocks to modify spring rates but this is not the correct use. Along with hysteresis in the tire itself, they damp the energy stored in the motion of the unspring weight up and down. Effective wheel bounce damping may require tuning shocks to an optimal resistance. Spring-based shock absorbers commonly use coil springs or leaf springs, though torsion bars are used in torsional shocks as well. Ideal springs alone, however, are not shock absorbers, as springs only store and do not dissipate or absorb energy. Vehicles typically employ both hydraulic shock absorbers and springs or torsion bars. In this combination, "shock absorber" refers specifically to the hydraulic piston that absorbs and dissipates vibration.

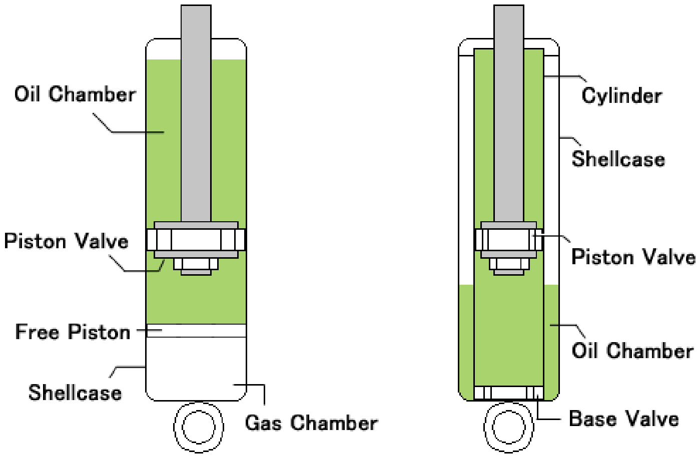

Figure 2.1: Mono Tube and Twin Tube Shock Absorber

Type of Shock Absorber

There are two types of shock absorber are given below:

A) Air Shock Absorber.

Air shock absorber consists of an air chamber, an iron piston and a fluid.

B) Damper Shock Absorber.

A damper shock absorber consists of a single chamber or two chamber, it may be fluid field or filled with air. It is commonly used to absorb the shock during the linear motion of a vehicle.

Mono Shock Absorber

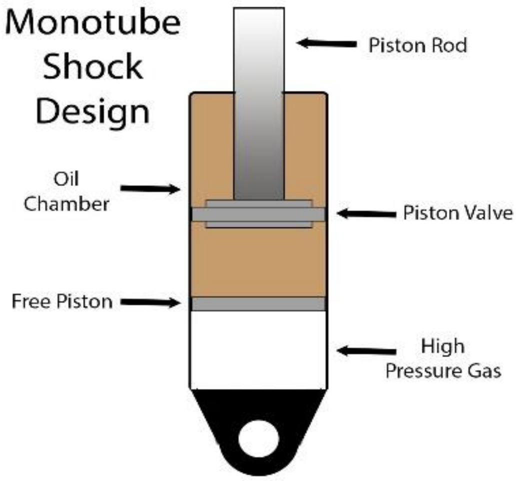

Figure 2.2: Mono Shock Absorber

The mono tube damper consists of single tube with two valves. It is mostly oil filled and used in larger vehicles. When the damper compresses when of the valve gets opened and when it extends the other valve gets open and the first one closes. The amount of the fluid released depends on the speed of the bumps it gets while moving. If it receives low speed small bumps the larger vents get opened and there is large amount of fluid is released. On the other hand, if gets high speed strong bumps the smaller vent gets opened and a small amount of oil is released.

Twin Tube Shock Absorber:

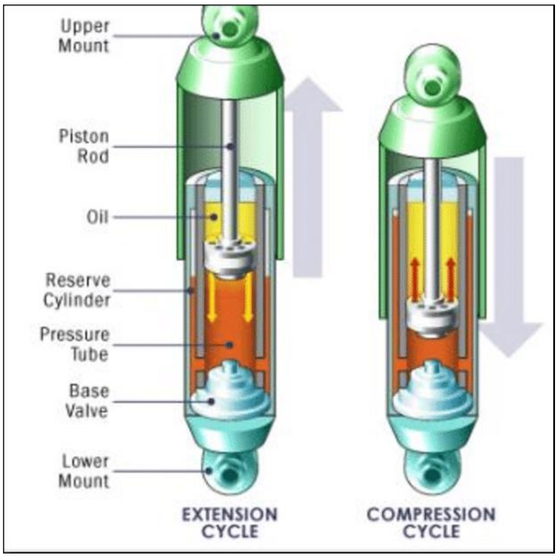

Figure 2.3: Twin Tube Shock Absorber

Also known as a "two-tube" shock absorber, this device consists of two nested cylindrical tubes, an inner tube that is called the "working tube" or the "pressure tube", and an outer tube called the "reserve tube". At the bottom of the device on the inside is a compression valve or base valve. When the piston is forced up or down by bumps in the road, hydraulic fluid moves between different chambers via small holes or "orifices" in the piston and via the valve, converting the "shock" energy into heat which must then be dissipated.

CHAPTER 3
CONSTRUCTION

3.1 Construction

In this project two magnets are placed in a piston. One magnet is fixed with piston. Another one is movable, which is connected with rod. With magnets are replaced by air. Our magnetic shock absorber works on the basic principle of magnet that “opposite poles attract each other and same poles repels each other”. In this both magnets are facing same poles (both magnets are placed facing north and north or south and south). Both magnets are same pole. When the rod moves inside the piston movable magnet move towards the fixed magnet. Since both magnets are of same pole repulsion force is created between the magnets. So the movable magnet opposes the rod action and moves the rod up. The piston or cylinder is made up of non-magnetic material. The non-magnetic material will hold the magnet in both the sides. By using this type of shock absorbers the suspension will be more and the impact of vibration is very less compared with the spring loaded shock absorbers. Thus the magnetic shock absorber works. When the weight of the vehicle increases or vehicle climbs irregular surface, the wheel goes upwards and shock absorber is compressed, at this time the piston moves downwards. The magnets are made closer to each other, due to the increase of weight, the piston rod containing magnet is made to compress to certain extent. At the same time, the stainless steel spring provided is freely inside the shock absorber. The additional support for magnetic shock absorber is provided by a helical coil spring, which was compressed at this stage. So the shocks and vibrations are prevented. When the weight of the vehicle is decreased or it returns to its original position, the shock absorber gets expanded. In this position the piston moves from the bottom to top due to the magnetic flux power of the magnet. The stainless steel spring provided inside the shock absorber made the magnets inside the piston rod to return to its original position slowly. The coil spring return to its original position. Thus the magnetic shock absorber absorbs the shock and vibrations produced while running a vehicle on a irregular road surface.

Component details:

Magnet:

Outer diameter = 52 mm

Inner diameter = 24 mm

Thickness = 11 mm

Stainless steel spring:

Outer diameter = 30 mm

Inner diameter = 25 mm

Thickness = 3 mm

No of coil = 14

Length = 120 mm

PVC pipe 1:

Length = 270 mm

Diameter = 62 mm

PVC pipe 2:

Length = 220 mm

Diameter = 40 mm

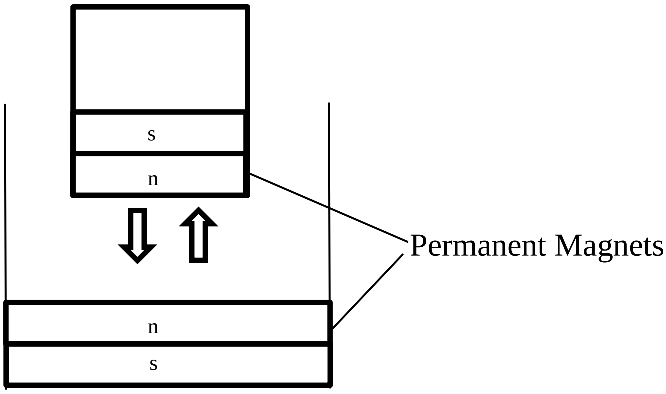

Figure 3.1: Schematic View Of Magnetic Shock Absorber

3.2 Feature of Magnetic Suspension

Some of the main features of electromagnetic suspensions are:

1) It prevents the road shocks from being transmitted to the vehicle parts, thereby providing suitable riding and cushioning effect to the occupants.

2) Keeps the vehicle stable while in motion by providing good road holding during

driving, cornering and braking.

3) Provides safe vehicle control and free of irritating vibrations and reduce wear and tear.

4) Easy to design and modify the design (if according to any automobile's specifications.

5) It provides you the maximum safety and comfort ability when compared to the other conventional suspension systems

3.3 Overview Modern Suspension System.

When people think of automobile performance, they normally think of horse power, torque and zero-to- 60 acceleration. But all of the power generated by a piston engine is useless if the driver can't control the car. That's why automobile engineers turned their attention to the suspension system almost as soon as they had mastered the four-stroke internal combustion engine. The job of a car suspension is to maximize the friction between the tires and the road surface, to provide steering stability with good handling and to ensure the comfort of the passengers. If a road were perfectly flat, with no regularities, suspensions wouldn't be necessary. But roads are far from flat's these imperfections that apply forces to the wheels. According to Newton's laws of motion, all forces have both magnitude and direction. A bump in the road causes the wheel to move up and down perpendicular to the road surface. The magnitude, of course, depends on whether the wheel is striking a giant bump or a tiny speck. Either way, the car wheel experiences a vertical acceleration as it passes over an imperfection.

3.4 Methodology

Magnetic suspension is a methodology used in various fields such as engineering, transportation, and materials science. It involves suspending an object using magnetic fields, which can be useful for levitation, stabilization, or precise positioning without physical contact. It's often employed in applications like high-speed trains, magnetic bearings in rotating machinery, and even in laboratory experiments for studying materials under near-zero gravity conditions.

3.5 Block Diagram

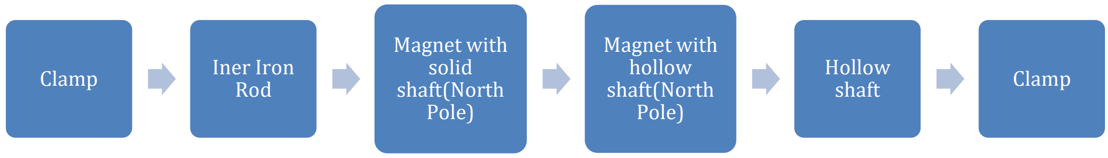

Figure: Block Diagram of Magnetic Suspension Systems

3.6 Suspension

The suspension in magnetic suspension systems is achieved by opposing magnetic forces. Typically, there are two main components: magnets in the object being suspended and magnets in a fixed structure or base. These magnets create repulsive forces, counteracting gravity and allowing the object to float or be suspended in the desired position. The strength and orientation of the magnetic fields are carefully controlled to achieve stability and control over the suspended object. Sophisticated control algorithms are often used to adjust the magnetic fields in real-time to maintain stability and desired positioning.

3.7 Inner Rod

An inner rod could refer to various things depending on the context:

1. In engineering or mechanics, an inner rod might be a component within a mechanical assembly, such as a connecting rod inside an engine.

2. In the context of fishing, an inner rod could refer to the smaller rod contained within a telescopic fishing rod, which extends outwards when assembling the rod for use.

3. In the context of science or laboratory equipment, an inner rod might be a part of a larger apparatus used for stirring, mixing, or supporting other equipment

Spring (Device)

A spring is an elastic object that stores mechanical energy. Springs are typically made of spring steel. There are many spring designs. In everyday use, the term often refers to coil springs.

When a conventional spring, without stiffness variability features, is compressed or stretched from its resting position, it exerts an opposing force approximately proportional to its change in length (this approximation breaks down for larger deflections). The rate or spring constant of a spring is the change in the force it exerts, divided by the change in deflection of the spring. That is, it is the gradient of the force versus deflection curve. An extension or compression spring's rate is expressed in units of force divided by distance, for example or N/m or lbf/in. A torsion spring is a spring that works by twisting; when it is twisted about its axis by an angle, it produces a torque proportional to the angle. A torsion spring's rate is in units of torque divided by angle, such as N-m/rad or ft-lbf/degree. The inverse of spring rate is compliance, that is: if a spring has a rate of 10 N/mm, it has a compliance of 0.1 mm/N. The stiffness (or rate) of springs in parallel is additive, as is the compliance of springs in series.

Types:

Springs can be classified depending on how the load force is applied to them:

- **Tension/extension spring-**the spring is designed to operate with a tension load, so the spring stretches as the load is applied to it.
- **Compression spring** - is designed to operate with a compression load, so the spring gets shorter as the load is applied to it.
- **Torsion spring-**unlike the above types in which the load is an axial force, the load applied to a torsion spring is a torque or twisting force, and the end of the spring rotates through an angle as the load is applied.
- **Constant spring-**supported load remains the same throughout deflection cycle
- **Variable spring-**resistance of the coil to load varies during compression
- **Variable stiffness spring-**resistance of the coil to load can be dynamically varied

for example by the control system, some types of these springs also vary their length thereby providing actuation capability as well.

They can also be classified based on their shape:

- **Flat spring-**This type is made of a flat spring steel.
- **Machined spring-** This type of spring is manufactured by machining bar stock with a lathe and/or milling operation rather than a coiling operation. Since it is machined, the spring may incorporate features in addition to the elastic element. Machined springs can be made in the typical load cases of compression/extension, torsion, etc.
- **Serpentine spring-**A zig-zag of thick wire upholstery/furniture. often used in modem.
- **Garter spring-** A coiled steel spring that is connected at each end to create a circular shap

3.8 Magnet

A magnet is a material or object that produces a magnetic field. It attracts ferromagnetic materials like iron, nickel, and cobalt and can also exert force on other magnets. Magnets have two poles, called the north and south poles, where the magnetic field lines enter and exit, respectively. These poles have opposite magnetic orientations, meaning that like poles repel each other, while opposite poles attract. Magnets can be natural, such as lodestone, or artificial, like the magnets commonly used in everyday objects such as fridge magnets or magnetic compasses.

Figure 3.2: Magnet

There are several types of magnets, each with unique properties and applications:

1. Permanent Magnets: These retain their magnetic properties once magnetized and are

commonly made from materials like iron, nickel, cobalt, or certain alloys like neodymium-iron-boron .

2. Temporary Magnets: These are materials that become magnetic when in the presence of a magnetic field but lose their magnetism when the field is removed. Soft iron is a common example.

3. Electromagnets: These are magnets created by electric current flowing through a coil of wire. The magnetic field is temporary and can be controlled by varying the current.

4. Neodymium Magnets: A type of rare.

Magnetic field

A magnetic field is a region around a magnet or a moving electric charge where magnetic forces are experienced. It's represented by lines of force, often depicted as magnetic field lines, which indicate the direction and strength of the magnetic field. The strength of a magnetic field is measured in units called teslas (T) or gauss (G), depending on the system of measurement.

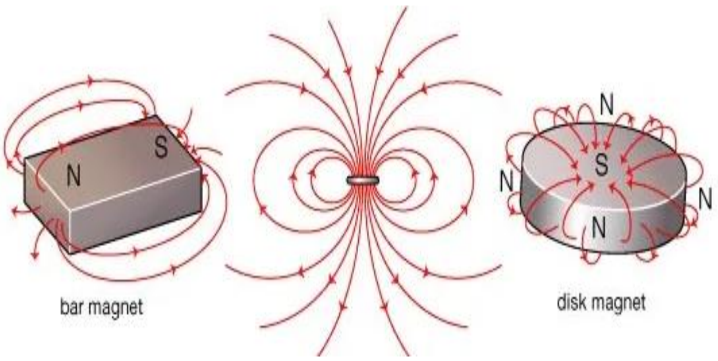

Figure 3.3: Magnetic Field

Magnetic fields are produced by the motion of electric charges, such as electrons moving through a wire, or by the intrinsic magnetic properties of certain materials, such as iron. They exert forces on other magnetic materials and on moving electric charges, causing them to either attract or repel each other.

In addition to the static magnetic fields produced by permanent magnets or stationary electric charges, magnetic fields can also be dynamic, changing over time, as seen in electromagnets or inductors where electric currents flow through wires or coils. These dynamic magnetic fields can induce electric currents in nearby conductors, a phenomenon known as electromagnetic induction, which is the principle behind devices like generators and transformers.

Magnetization:

The magnetization of a magnetized material is the local value of its magnetic moment per unit volume, usually denoted M, with units A/m. It is a vector field, rather than just a vector (like the magnetic moment), because different areas in a magnet can be magnetized with different directions and strengths (for example, because of domains, see below). A good bar magnet may have a magnetic moment of magnitude 0.1 A m^2 and a volume of 1 cm^3, or 1x10 m^3, and therefore an average magnetization magnitude is 100,000 A/m. Iron can have a magnetization of around a million amperes per meter. Such a large value explains why iron magnets are so effective at producing magnetic fields.

Electromagnets:

An electromagnet, in its simplest form, is a wire that has been coiled into one or more loops, known as a solenoid. When electric current flows through the wire, a magnetic field is generated. It is concentrated near (and especially inside) the coil, and its field lines are very similar to those of a magnet. The orientation of this effective magnet is determined by the right-hand rule. The magnetic moment and the magnetic field of the electromagnet are proportional to the number of loops of wire, to the cross-section of each loop, and to the current passing through the wire. If the coil of wire is wrapped around a material with no special magnetic properties (e.g., cardboard), it will tend to generate a very weak field. However, if it is wrapped around a soft ferromagnetic material, such as an iron nail, then the net field produced can result in a several hundred- to thousand-fold increase of field strength.

Field of Magnet:

Far away from a magnet, the magnetic field created by that magnet is almost always described (to a good approximation) by a dipole field characterized by its total magnetic moment. This is true regardless of the shape of the magnet, so long as the magnetic moment is non-zero. One characteristic of a dipole field is that the strength of the field falls off inversely with the cube of the distance from the magnet's center. Closer to the magnet, the magnetic field becomes more complicated and more dependent on the detailed shape and magnetization of the magnet. Formally, the field can be expressed as a multi pole expansion: A dipole field, plus a quadrupole field, plus an octupole field, etc.

At close range, many different fields are possible. For example, for a long, skinny bar magnet with its north pole at one end and south pole at the other, the magnetic field near either end falls off inversely with the square of the distance from that pole.

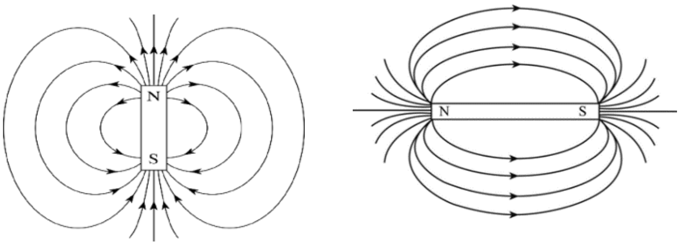

Figure 3.4: Field Line of Cylindrical Magnet

Magnetic Flux:
Magnetic flux is a measurement of the total magnetic field which passes through a given area. It is a useful tool for helping describe the effects of the magnetic force on something occupying a given area. The measurement of magnetic flux is tied to the particular area chosen.

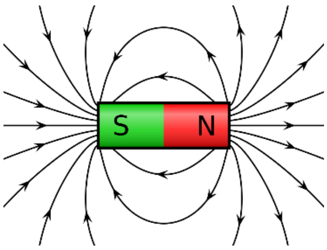

Figure 3.5: Magnetic Flux

Description:
The magnetic interaction is described in terms of a vector field, where each point in space is associated with a vector that determines what force a moving charge would experience at that point (see Lorentz force). Since a vector field is quite difficult to visualize at first, in elementary physics one may instead visualize this field with field lines. The magnetic flux through some surface, in this simplified picture, is proportional to the number of field lines passing through that surface (in some contexts, the flux may be defined to be precisely the number of field lines passing through that surface; although technically misleading, this distinction is not important). The magnetic flux is the net number of field lines passing through that surface, that is, the number passing through in one direction minus the number passing through in the other direction (see below for deciding in which direction the field lines carry a positive sign and in which they carry a negative sign). In more advanced physics, the field line analogy is dropped and the magnetic flux is properly defined as the surface integral of the normal component of the magnetic field passing through a surface.

3.9 Permanent Magnet Shock Absorber

A Permanent Magnetic suspension apparatus for maintaining a spaced relationship between a first movable member and a second fixed member, wherein the motion of the movable member requires dampening, cushioning, stabilizing, harmonic balancing, and/or reflexive re-centering.

The suspension apparatus includes a plurality of sets of permanent magnets located within a case, which is coupled to one of the members. The sets of permanent magnets are coupled to an elongated support member, which is couple to the second member. The support member extends within the case, with the support member and the case being adapted for relative axial movement.

The sets of permanent magnets are arranged in bidirectional repulsion configuration with additional magnet fixed within the case. the sets of permanent magnets are being moved relative to the fixed permanent magnets, such that the magnetic forces of repulsion produced by the permanent magnets are increased in response to relative movement between the support member and the case, creating dampening, cushioning, stabilizing, harmonic balancing, and/or re-centering forces.

3.10 Design of Magnetic Suspension System

The design parameters used in this process are the standard values for motorcycles. The spring is mounted in between two magnets to avoid impact of magnets. The outer diameter of spring can be selected considering the clearance between casing diameter and spring which avoid jam of spring.

Vehicle body weight =1500kg
Passenger weight =500kg (approximately)
Total weight =2000kg
=2000*9.81N
=19620N
Rear Suspension =65%
=12753N
Each wheel = 12753/2
= 6376.5N
Considering Dynamic Load Double = 6375.5*2
=12753N
Taking factor of safety 3

So that, 12753*3 = 38259N

Magnetic Power 2N/mm^2
Area need = 38259/2
= 19129.5 mm^2
So,
$\frac{\pi}{4}$ d.d = 19129.5
d = 108.63mm
= 10.86cm
Magnet dia = 11cm

Let,
Design force, F = 38259 N
Bending Length, L =165mm
Bending moment, FL
=38259*165
=6312735 Nmm
M=$\frac{\sigma\pi}{32}d^3$
D=48.85
=49mm or 50mm
= 5cm
Solid Shaft=5cm

3.11 Working Principal

Magnetic Suspension or magnetic ride control is a type of suspension system where the shock absorbers reacts to the road and adjusts much faster than regular absorbers. Magnetic suspension can adapt to uneven road surfaces several hundred times per second, in fact it takes only a few milliseconds to adjust any one of the shock absorbers. Magnetic suspension is described as the fastest reacting suspension in the world as sensors monitor the road surface up to 1000 times per second and an ECU can make variations within a few milliseconds resulting in the possibility of multiple damping variations being made in a second. Magnetic ride control uses a system known as magneto rheological technology for suspension damping. Each absorber is filled with a polymer liquid containing many

small magnetic particles. An electrical charge is sent to the liquid in the absorber which immediately changes the position of the particles in the liquid and its viscosity. The viscosity of the polymer liquid can be changed to an almost solid state similar to plastic or rubber in composition. As the viscosity of the liquid changes, it offers a difference in the damping. Each of the four dampers are adjusted individually and independently even when it seems that all of them are doing the same thing. This ensures a comfortable ride along various road surfaces.

Magnetic suspension reduces vibrations, bouncing, noise and body roll very effectively on all road surfaces and at any speed that the vehicle could travel. The reduction of body roll may reduce the need for anti- roll bars. Another benefit is that these dampers easily offers the best of both worlds in the ride comfort/handling compromise that many other suspension systems are subjected to. Although this type of suspension offers a very comfortable ride, sport settings can be applied or tuned into the system to cater for performance vehicles.

3.12 Component List

1. Metal Shaft
2. PVC pipe
3. Spring
4. Inner rod
5. Magnet
6. Screw and joint
7. Clam
8. Frame base
9. Frame car

i. Motor
ii. Battery
iii. Switch
iv. Wheel
v. Pin
vi. Scale
vii. Plastic Shite
viii. Board
ix. Battery Connector
x. Electric wire
xi. Pipe and injection

3.13 Complete Project Image

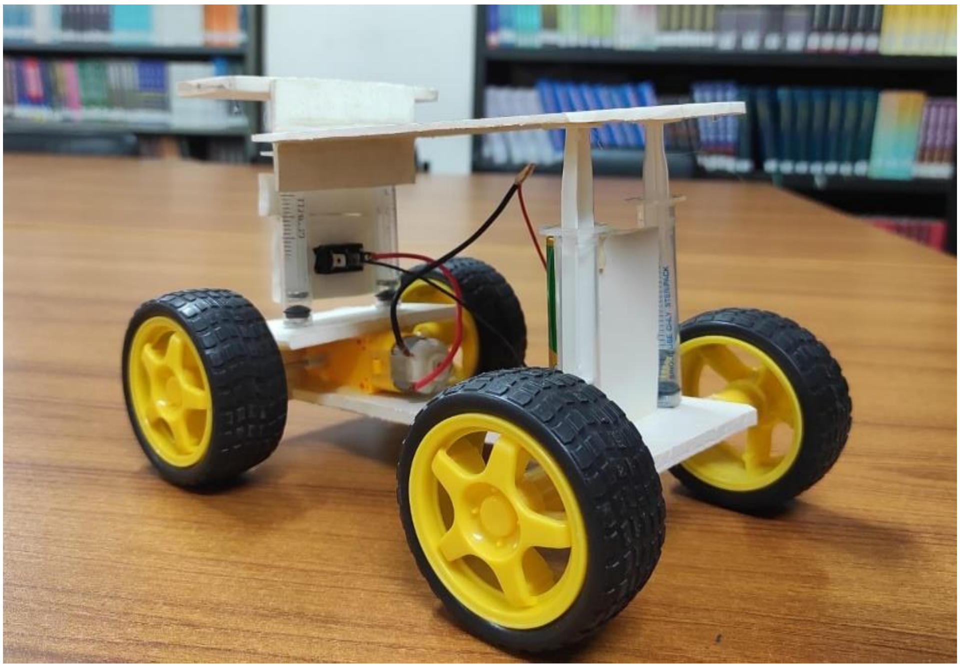

Figure 3.6: Complete Project Image

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Calculation

Minimum and Maximum mass determination of magnetism**:**

We know that,

Magnet diameter, d =5mm

=0.5 cm

Magnet height = 2 mm

=0.2 cm

Now,

Let, total weight =x

Rear suspension = 65%

=65%x

Considering Dynamic Load Double =65%x*2

For single shock absorber weight, W =(65%x*2)/2

=65%x

Factor of safety 2

Design load= w*2

Magnet power =550 g

=0.55 kg

Need area, w*2/0.55

We know, Area= π/4*d*d

= (π/4)*(0.5*0.5)

=0.196 cm

So, (65%x *2) /0.55= 0.196

X= (0.196*0.55) / (0.65*2)

=0.083kg

= 83g

Magnet power =550 g
=0.55 kg

Need area, w*2/5.395

So, Maximum load =83 g
And Minimum load (without chassis) =0g
Chassis weight = 26g

Data Table:

No	Magnat Power	Load
1	550g	83g
2	1000g	150g
3	2000g	301g

4.2 Discussion:

Magnetic Shock Absorber which is mainly based on the principle of magnetic property like when the same poles of two magnets come in contact with each other then they are repulsed from each other. This unit is mounted in vehicle such as other type of shock absorber. The working of this absorber is very simple. Two magnets are mounted in this way that one is mounted below and other is on upper side. Poles of these magnets are same at inner side so that they are repulsed from each other and space is made between them due to this. When the vehicle is running on the bump or the muddy road then the space between two magnets is reduced and then shocks and variations present in the vehicle absorbed by repulsion property of the magnet. By using this type of absorber we can absorb the more number of shocks and variations are absorbed with the more accuracy. This shock absorber has no problem of leakage of oil like hydraulic shock absorber. Also this has less maintenance than other types of shock absorber. So that we can made this type of shock absorber for the efficient work of vehicle and for reducing the maintained cost of vehicle.

4.3 Advantage:

a) It has more life, Life is nearly about approximately 20 years

b) The weight of magnet is more but It has very low maintenance

c) Magnetic shock absorber will reduce the problems associated in the spring shock absorb due to friction and other factors.

d) This will also reduce the maintenance cost as it does not need repairing.

e) Load carrying capacity of magnetic shock absorber is more.

f) Improving no. of magnets that to make these magnetic shock absorbers even better, a chain of more than two magnets can be used to tolerate the shocks or weight and make the vehicle comfortable.

g) Noiseless operation during functioning.

h) Magnet can be re-magnetized to its originally strength.

i) It improves the ride quality.

4.4 Application:

In one embodiment, the control mechanism is coupled between the frame of a vehicle and a wheel support assembly. The permanent magnetic suspension apparatus, however, is for use with any type of equipment or machinery having a movable and non-movable, or fixed, member. this includes, but is not limited to, cars, trucks, motorcycles, scooters, all-terrain vehicles, semi-tractors, semi-trailers, and the like, as well as, but not limited to, industrial equipment and machinery, hospital and office machinery and equipment, such as being coupled between the frame of an office chair and the chair seat.

4.5 Limitation:

i. When both the magnets are in contact will reduce its magnetic strength.

ii. The magnetic power varies according to the earth magnetic field. So, it cannot be used in Polar Regions.

iii. The primary disadvantages of existing systems are their relatively high cost and the oil can thicken after continuous use and requires periodic replacement.

iv. The lift force depends on the speed, mechanical support must be used at rest and at low speeds until the lift-off speed where the magnetic suspension force exceeds the force of gravity is reached.

CHAPTER-5

CONCLUSION AND FUTURE WORK

5.1 CONCLUSION

This project has provided us an excellent opportunity and experience to use our limited knowledge. We gained a lot of practical knowledge regarding planning, purchasing assembling and machining while doing our project work. We feel that the project work is a good solution to bridge the gate between institution and industries. We are proud that we have completed the work with the limited time successfully. The MAGNETIC SHOCK ABSORBER is working well. We are also able to understand the difficulties in maintaining the tolerances and also quality. We have done to our ability and skill making maximum use of available facilities. In conclusion remarks of our project work, let us add a few more lines about our impression on project work. Thus, we have developed a "MAGNETIC SHOCK ABSORBER" which helps to know how to achieve low cost and minimize the size.

5.2 FUTURE WORK

It is possible to do make this modification in the magnetic shock absorber, some of them are explained below:

- If the coils are fitted at the outer side of magnet, then it is possible to generate electricity which could be used for charging purposes.
- Maglev technology could be incorporated in the motorcycles along with electromagnetic suspension system to provide for better ride on the irregular surfaces as well as on well paved roads
- Better control of the damping could be provided by using an independent control unit for magnetic suspension.
- Efficiency improvement can be carried out by making use of lightweight materials for the production of the suspension.

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