MAGNETIC SUSPENSION SYSTEM

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ABSTRACT

This project is based on suspension system of two wheelers which were formally depending upon spring type, hydraulic and pneumatic suspension systems. This report gives information about magnetic suspension system and the magnetic suspension system is turning out to be the new option to these conventional suspension systems. The aim of this project is to study and investigate the response of system, when it is subjected to road surface irregularities with the hope that it would help automobile industry. This project presents design, construction and working of magnetic suspension system. This system uses magnets and spring as passive dampers, which are used to reduce displacement and acceleration of sprung mass in order to improve ride comfort. By using this type of absorber we can absorb the more number of shocks and variations are absorbed with more accuracy. This type of Suspension has no problem of leakage of oil like hydraulic shock absorber. Also this has less maintenance than other types of shock absorber that we can made this type of shock absorber for the efficient work of vehicle and for reducing the maintained cost of vehicle.

Keyword: - *Magnetic Shock Absorber, Magnet, Spring, etc….*

1. INTRODUCTION

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 the inner portion of cylinder that reciprocates up and down due to repulsion. The two magnets 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.

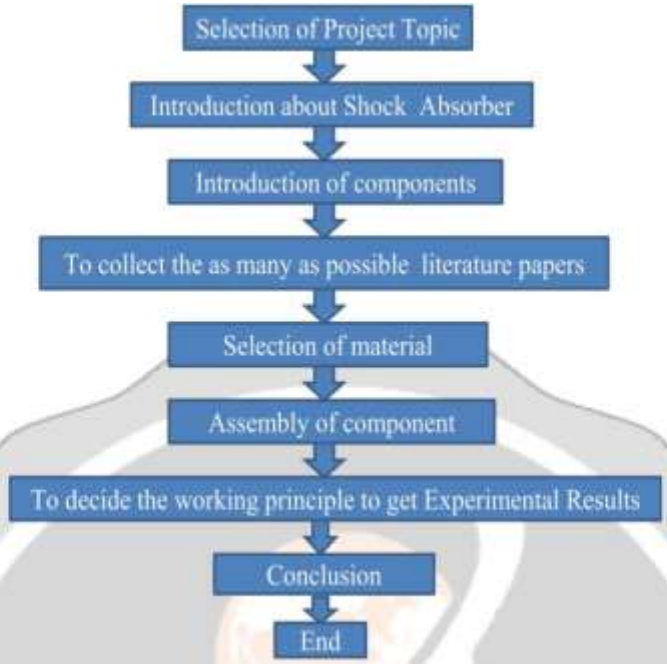
1.1 Problem Statement

As we know the disadvantages of our conventional suspension system in order to overcome the disadvantages the magnetic suspension system can be a option to the same. Therefore the magnetic suspension system can be used in many applications of the suspension in Automobile industries and in other industries. The mechanical magnetic suspension system using permanent magnet also has some disadvantages of slow responsibility and difficult control. Here we will focus on developing the actively control mechanical magnetic suspension systems using a permanent magnet.

1.2 Objectives

- To eliminate the road shocks from being transmitted to the vehicle and its Components.
- To safeguard the occupants of vehicle from road bumps.
- To maintain the stability of vehicles.
- To control the maintenance as well as initial cost.
- To give the good road holding while driving, cornering and braking.
- To maintain good cushioning effect.
- To validate the design by testing prototype model.

1.3 Methodology



2. LITERATURE REVIEW

Milica B. Naumovic&Boban R. Veseli [3] described that the 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 repel 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 moves 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.

V.V.Borole and prof. K. K. Chaudhari [1] studied and described the Electromagnetic suspension system for automobile and studied different ways to recover energy from suspension system by using piezoelectric material to increase the efficiency of the automobile. Vehicle during running condition vibrate by means suspension operate by using motion of the shock absorber produce energy. Due to this tried to generate electricity from this system they proposed to use this electricity for headlamps and indicators etc. They also proposed to use these electro-magnets for preventing the tyres of vehicles from puncturing due to nails by attracting them to the magnets.

Prof N.Vivekanand etc. all [5] described about the analysis of suspension spring to determine and its fatigue life using finite element methodology. One of the most important part of the suspension system is the coiled spring which are helical in shape steel bar that absorb the shock. They also stated the advantages and disadvantages of conventional suspension systems, which helped us in designing a magnetic shock absorber in order to overcome the disadvantages of conventional suspension systems. They also stated design considerations of spring and due to this it helped in designing the spring in between the magnets.

B. V. Jayawant [2] described about the design and fabrication of magnetic suspension system. According to authors of these papers the coil spring suspension system have imitation that after some period of time coils become not only harder but also reducing cushioning effect and these limitation overcome by the new concept of ―magnetic suspension system‖ the cushioning effect provided by these system existing long life. They select material by considering Mechanical properties. This selection of materials also helped in selecting materials for the shafts, cylinder and spring.

Ayman A. Aly, and Farhan A. Salem [4] studied and described the disadvantages of other types of suspension system with magnetic suspension the material properties used for the magnet, coil spring, shaft according to author the magnetic system have more and more advantages than the air, hydraulic suspension. The hydraulic and air suspension have leakage problem and which is dangerous for any suspension system because of that big reason

magnetic suspension system were used. Also, they discussed the all suspension system by comparing them with respect to their cost, material, maintenance, service life of the system etc. causing us to select proper suspension system in order to avoid maintenance and to improve the life of the system.

Feng Sun advisor Koichi OKA [6] focused on the magnetic suspension systems and the control systems using permanent magnets. First, an overview of the research background was introduced in a classification way, and the structure of this thesis was shown in chapter 1. Second, the research contents about the magnetic suspension systems using permanent magnets were exposited in three parts.

Part I proposed a zero power control method using a spring and an integral feedback loop, and examined the zero power control method on two kinds of magnetic suspension systems with permanent magnets and linear actuators. They examined the zero power control method on a hanging type magnetic suspension system which can be applied as a noncontact conveyance vehicle. In chapter 2, the hanging type suspension principle was explained, and an experimental prototype was set up. A mathematical model was created. The suspension feasibility of the system was examined theoretically. The realization of zero power control was analysed in device, mathematical model, and control system. The numerical simulations and experiments were carried out in five cases. All the simulation and experimental results indicated that this hanging type magnetic suspension system could be suspended stably. Moreover, comparing the results in the five cases, the validity of the zero power control was examined.

Therefore, using this two proposed magnetic suspension systems, the miniature transmission device and the noncontact manipulation mechanism can be developed; and combining the proposed zero power control method, the zero power noncontact supporting also can be realized. The developed systems can be applied in some special places, e.g. the constant temperature plant.

Moreover, many control methods can realize the zero power control, but this thesis just discussed the method using the current integral feedback loop. The load observer control method may be regarded as the next step of the research. For the hanging type magnetic suspension system, this thesis just investigated the stable suspension in one dimension, and the controllable movement of the device has not been touched. The controllable movement of the hanging type magnetic suspension device in the horizontal plane may be the next step of this research.

3. Working Principle

Shock absorber device was used for reducing the effect of sudden shock by the dissipation at the shock's energy on an automobile springs & shock absorber are mounted between the wheels and the frame. When the wheel of vehicle comes across the surface irregularities on road, springs absorb the resultant shock by expanding & contracting. To prevent the spring from shocking the frame excessively, their motion is restrained by shock absorber, which are also known by the more descriptive term dumpers. The main types of suspension systems are Pneumatic suspension system, Hydraulic suspension system, spring type (Conventional suspension system) and Magnetic suspension system. The shock absorbers are used in two wheeler system.

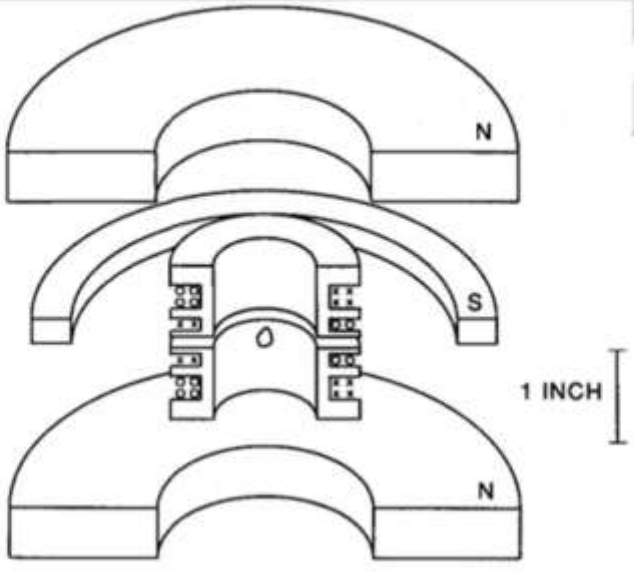


Fig -1 Principle of magnetic shock absorber

3.1 SELECTION OF MATERIAL

Material used for spring: - Mild steel

Reasons:

- Mild steel is readily available in market
- It is of low cost to use.
- Available in standard sizes.
- Good mechanical properties i.e. it is easily machine able.
- Moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection.
- Low factor of safety results in unnecessary risk of failure.
- High tensile strength.
- Low co-efficient of thermal expansion.

4.3 Magnetic Material Properties:
Neodymium magnet:-It also called NIB magnet or rare-earth magnet. Neodymium magnet is a powerful magnet made of neodymium, iron, and boron — Nd2Fe14B.

4.4 Material for Hollow Shaft:
Mild steel is used for hollow shaft as it covers the whole system and protects the magnets & spring from dust, dirt and foreign small particles which would cause problem in system.

4. DESIGN

4.1 Design of Main Spring

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.
Outer diameter of spring, = 40 mm
For cold drawn wire steel,
Wire diameter d = 5 mm…… (Design data book)
Inner diameter of spring

= 40-10
= 30 mm,

Calculating the load bearing capacity of spring For any service life, Shear stress = 0.5

=0.5×1190
=595 N/mm2

Spring index,

C= /d =
40/5 C
= 8

Now, Wahl's correction factor of spring,

= —— ——

= 1.18

Now to find load holding by spring P,

Shear stress = —

595 = ——

= 618.79N

Deflection of spring (δ) can calculate by,

δ = ——

Assuming

G=81000

=————

$$\delta = 56.32mm$$

Spring rate = –

$$=11N/mm$$

Spring stiffness

$$K = 11N/mm$$

Number of turns

$$N = 9$$

As spring has square and ground ends number of Inactive turns = 2 Total number of turn,

$$NT = N +$$
$$2 = 9 + 2$$
$$NT= 11$$

Solid length of spring,

$$= NT\ d$$
$$= 115$$
$$= 55mm$$

Free length of spring,

$$= \text{solid length} + \text{deflection} + \text{axial gap}$$
$$= 55 + 56 + 0.15(56)$$
$$= 55 + 56 + 0.15(56)$$
$$= 120mm$$

Pitch of spring

$$=PN+d$$

Pitch of spring

$$p = 12.77mm$$

4.2 Design of Magnet:

Power Magnet Pair =10,000GP (Gauss Power)
Weight Vehicle Body =110kg = 1080N
Weight of Person Sitting On Vehicle = 140kg =1374N
Total Load = Weight of Vehicle Body + Weight of Person Sitting On Vehicle

$$=1080+1374$$

Total Load

$$=1080+1374$$
$$=2454\ N$$

Rear Suspension

$$= 65\text{percentage of } 2454$$
$$N =1595.1\ N$$

Considering Dynamic Loads Double (W) 1595.12 N

$$=3190.2\ N$$

For Single Shock Absorber Weight(W/2)

$$=\frac{\quad}{\quad}$$
$$= 1595.1\ N$$

Taking Factor of Safety = 1.2 So
Design Load=1914.92N Magnetic
Power per Unit Area =2
So Area Required for Suspension Of 300kg load

$$2 = 1914.12/A$$
$$A = 957.06$$
$$A = –$$
$$957.06 = –$$
$$d = 34.90mm=35mm\ d$$
$$= 35mm$$

Diameter of magnet (d) = 35mm

4.3 Design of shaft

The shaft is subjected to pure bending stress
Design force = 1914.12 N
Bending length = 165 mm
Bending moment

$$M = F \quad L$$
$$= 1914.12 \quad 165$$
$$= 315829.8 N.mm$$
$$M = \text{——}$$
$$315829.8 = 32599.13 d3$$
$$d = 18mm$$

4.4 Design of hollow shaft:

$$M =$$
$$M = 1914.12 \quad 200$$
$$M = 382824 N/mm$$

Assuming

$$M = \text{————————}$$
$$382824 = \text{————————}$$
$$= 17.04 N/mm2$$
$$= 20 < 35 N/mm2$$

As induced stress is less than allowable stress the design of hollow cylinder is safe.

5. CONCLUSIONS

Magnetic suspension system mainly summarised on the use of permanent magnets in order to overcome the disadvantages of conventional suspension systems like –less life, frequent maintenance and less durability. More importantly magnetic suspension system can be used as an option to conventional suspension system with no doubt. Here in our project we designed a magnetic suspension system for a two wheeler well known as shock absorbers. The design of this magnetic system mainly included few steps like selecting proper materials for the components of the system then designing the dimensions of component and system by stress and load.

This project mainly started with the literature review of magnetic suspension system which mainly discussed with the drawbacks of conventional suspension system and advantages of using magnetic suspension system at the same place. The project introduction included the working principle of shock absorbers, objectives for the same, The project also contains the classification of suspension system. Then the project concentrated on the construction, working principle of magnetic suspension system. The material selection was also included in order to design the system. This project included the design calculations afterwards.

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