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MAGNETIC SUSPENSION SYSTEM

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Abstract - This his research paper presents the design, development, and performance evaluation of a magnetic suspension system for modern engineering applications. The system employs magnetic levitation technology to suspend objects, reducing friction and wear while enhancing system efficiency. The design incorporates a combination of permanent magnets and electromagnets to achieve stable levitation and precise control.

Through a series of simulations and experiments, the study investigates key parameters such as load capacity, stability, and response time. The results demonstrate that the magnetic suspension system offers superior performance compared to traditional mechanical suspension systems, providing smoother motion and reduced noise levels. Additionally, the system's adaptability makes it suitable for various applications, including transportation, industrial machinery, and vibration isolation.

Further research is proposed to optimize the system's control algorithms and explore potential integration with other advanced technologies such as active noise control and energy recovery systems. The study concludes that magnetic suspension systems have the potential to revolutionize multiple industries, offering a more sustainable and efficient alternative to conventional methods.

***Key Words*:** *Magnets, Coil Spring, Design Parameter, Magnetic Shock Absorber, Magnet, Spring*

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.[1]

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.

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.

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. [2]

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 consists of a spring & damper. The energy of road shock causes the spring to oscillate. The oscillations are restricted to a reasonable level by the damper, which more commonly called a Shock Absorber.

2. LITERATURE REVIEW

Linear electrical devices are used to generate electricity, where the prime mover moves through reciprocating motion within few centimeters (Ping et al., 2006, Kou et al., 2008, Szabo et al., 2007). However, since last two decades researchers are investigating its application as a pertinent alternative to fluid damper in conventional shock absorbers

Permanent magnet linear devices are preferred in regenerative electromagnetic shock absorber to provide damping and regeneration. Moreover, these can also be used to apply active force in the suspension system. Ability to manipulate their damping force with low-cost electronics control gives it advantage for implementing semi-active suspension, in comparison to the conventional fluid solution (Mirzaei et al., 2001).[4]

Liu and Lin (2013) investigated feasibility of developing a suspension(regeneration) unit consisting of tubular permanent magnet linear generator. Authors have designed an electromagnetic device which can generate maximum power of 12 W and 400 N damping force, when fitted in a car shock absorber. Gupta et al. (2011) concludes that large magnetic field in the air gap of linear generator ensures efficient energy recovery.[5]

Oprea et al. (2012) explained analytical framework for using linear generator as a damper in vehicle shock absorber. Finite element simulations are used to determine the generator dimensions for maximum flux density in the air gap. Authors have observed that damping force is not exactly proportional to the excitation velocity and few harmonics are present in the force. Design and analytical simulation of linear generator consisting of rare earth magnets has been discussed by Zuo et al. (2010).

Goldner and Zerigian (2005) superimposed magnetic field by two concentric columns of magnets to achieve higher flux density in the generator air gap. Authors have used analytical calculations and estimated maximum theoretical efficiency of the device to be 44%.[7]

3. DESIGN OF MAGNET

Power Magnet Pair =10,000GP (Gauss Power) Weight Vehicle Body =110kg = 1080N
Weight Of Person Setting On Vehicle = 140kg =1374N
Total Load = Weight Vehicle Body + Weight Of Person Setting On Vehicle
=1080+1374
Total Load =1080+1374
=2454 N
Rear Suspension = 65percentage2454
=1595.1 N
Considering Dynamic Loads Double(W)= 1595.12
=3190.2 N
For Single Shock Absorber Weight(W/2)= 3190.1/2 = 1595.1 N
Taking Factor Of Safety = 1.2
So Design Load=1914.92N
Magnetic Power Per Unit Area =2N/mm2
So Area Required For Suspension Of 300kg load
2 = 1914:12=A
A = 957:06mm2
A = 4d2
957:06 =4d2

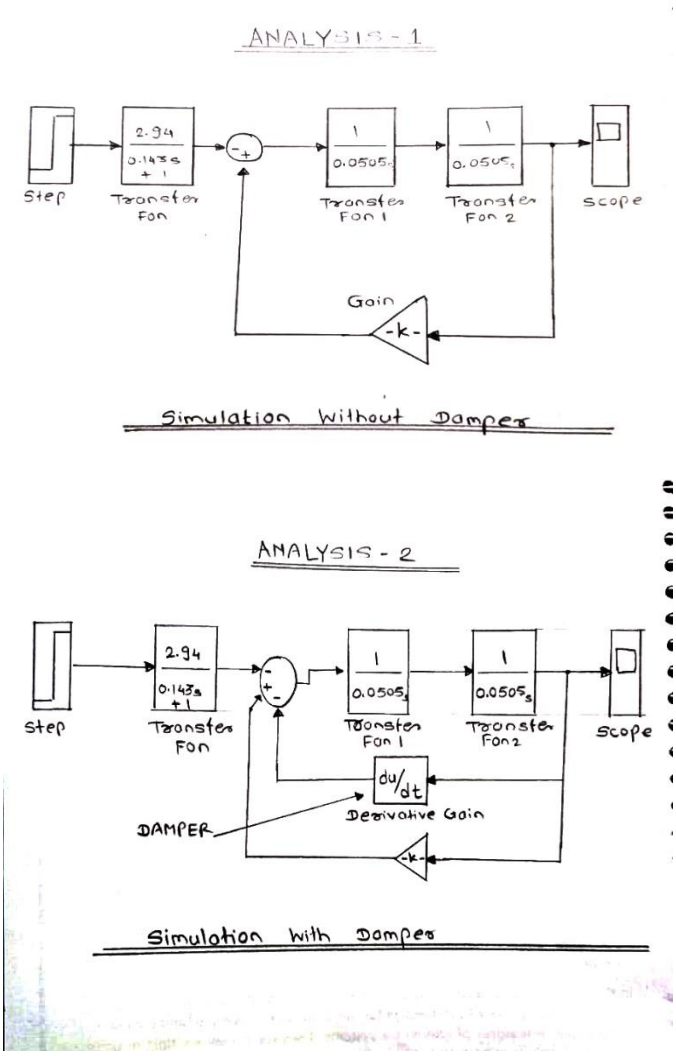

Fig 1:- Simulation with Damper

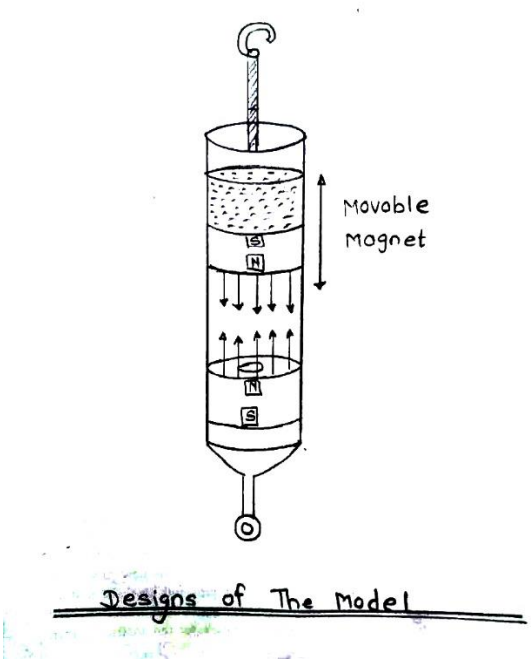

Fig2:-Design of model

4. PROCESS OF PROJECT

1. **Conceptualization and Design:**
- Requirements Gathering: Define the requirements of the magnetic suspension system, including the desired performance, load capacity, stability, and application (e.g., trains, vehicles, or industrial applications).
- System Design: Design the overall system, including the levitation mechanism, control system, power supply, and safety features.
- Magnet Selection: Choose appropriate magnets (permanent or electromagnets) for levitation and propulsion based on the requirements and application.[8]

2. **Modeling and Simulation:**
- Mathematical Modeling: Create a mathematical model of the system to understand its behavior and dynamics.
- Computer Simulations: Use simulation tools to model the system and assess its performance, stability, and efficiency. This can help identify potential issues and optimize the design.

3. **Prototype Development:**
- Prototyping: Build a small-scale prototype of the magnetic suspension system to test the design and functionality.
- Component Testing: Test individual components such as magnets, coils, sensors, and control systems to ensure they meet specifications and perform as expected.

4. **Control System Design:**
- Control Strategy: Design a control strategy to manage the magnetic fields for stable levitation and propulsion.
- Feedback Control: Implement sensors and feedback mechanisms to monitor and adjust the system's performance in real-time.[10]

5. **Integration and Testing:**
- System Integration: Integrate all components (magnets, coils, sensors, control systems) into the complete magnetic suspension system.
- Testing: Conduct extensive testing to ensure the system operates safely and effectively. This includes levitation, guidance, and propulsion tests.

6. **Safety and Reliability:**
- Safety Features: Implement safety features such as emergency braking systems and fail-safe mechanisms.
- Reliability Analysis: Assess the reliability and robustness of the system and its components.

7. **Optimization:**
- Performance Optimization: Optimize the system's performance in terms of energy consumption, speed, stability, and load capacity.
- Cost Optimization: Optimize the design and materials to reduce costs while maintaining quality and performance.

8. **Deployment and Maintenance:**
- Deployment: Once the system is fully tested and optimized, it can be deployed for its intended application.
- Maintenance Plan: Develop a maintenance plan to ensure the system remains in good working condition over time.[11]

9. **Evaluation and Feedback:**
- Performance Evaluation: Continuously evaluate the performance of the system and gather feedback for improvements.
- Iterative Improvements: Use the feedback and performance data to make iterative improvements to the system.

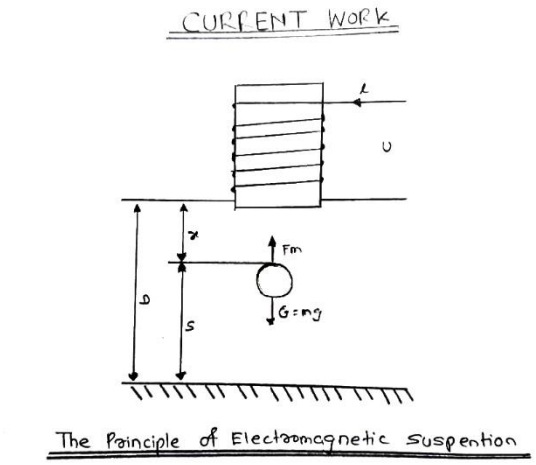

Fig3:- Current Flow

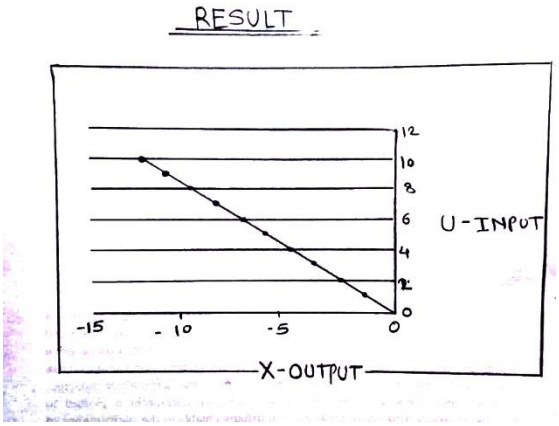

Fig 4:- Analysiz of Result

5. FINAL MODEL

The final model for a magnetic suspension system typically consists of several key components and consideration. Magnetic Actuators: These are the components that generate the magnetic fields necessary for levitation and control Levitation and Guidance Control: The system needs to levitate and guide the object in a stable and controlled manner. This involves precise control of the magnetic fields to counteract gravity and other forces such as air resistance.[12]
Feedback Control: Sensors monitor the position and motion of the levitated object and provide feedback to the control system. Stability Control: The magnetic suspension system must be able to maintain stability in all three axes (x, y, z) to prevent tipping, oscillation, or drifting.

Power Supply and Control Electronics: A stable power supply and efficient control electronics are necessary to power the magnetic actuators and process sensor data. Safety Mechanisms: Safety measures, such as backup power supplies and fail-safe systems, are critical for ensuring the system operates safely in case of a failure. Structural Design: The design should minimize interference with the magnetic fields and provide structural support while maintaining light weight. Environmental Considerations: Factors such as temperature, humidity, and other environmental conditions can affect performance, so these should be considered in the design. Integration with Other Systems: The magnetic suspension system may need to interact with other systems such as control and monitoring, propulsion, or communication systems.

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.

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 SUSPENSION SYSTEM 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 SUSPENSION SYSTEM which helps to know how to achieve low cost and minimize the size

REFERENCES

[1] Design and fabrication of magnetic shock absorber: S.Gopinath , R.J. Golden Renjith , J.Dineshkumar.
[2] A Review On Magnetic Shock Absorber : mr.V.V.Borole,prof. K.K.Chaudhari. E-Issn: 2348-0831 Volume 2,
[3] Issue 3 (Mar-Apr 2015) Pp 104-109.
[4] Analysis For Suspension Spring To Determine And Improve Its Fatigue Life Using Finite Element Methodology:
[5] Chandrakant Chavan, G.M.Kakandikar, Swapnil S.Kulkarni.
[6] Design and Fabrication of Magnetic Suspension: Sushant Tandel1, Bhagyesh Desai2.
[7] Magnetic Suspension In Automobiles: Suvriti Dhawan1, Ravi Nandu2.
[8] Automobile Engineering: Kripal Singh
[9] Mr. V. V. Borole, prof. K.K.Chaudhari.―A Review On Magnetic Shock Absorber‖ Mar-Apr 2015, pp 104-109.
[10] B V Jayawant, Rep. Prog. Phys.―Electro-magnetic Suspension and Levitation‖, 1981.
[11] Milica B. Naumovic, BobanR.Veselic, Automatic Control and Robotics, ―Magnetic Levitations Systems in Control Engineering Education‖, 2008 pp.151-160.
[12] Ayman A. Aly, and Farhan A. Salem, IJCAS, ―Vehicle Suspension System Control: A Review‖ July 2013.
[13] Assistant Prof N. Vivekanand, AbhilashMunaki, ChinmayAcharya, IIJME, ―Design analysis and simulation of double wishbone suspension system‖, June 2014.
[14] Feng Sun advisor Koichi OKA (Special Course for International Students) Department of Intelligent Mechanical Engineering, Graduate School of Engineering ,Kochi University of Technology, Kochi, Japan ―Magnetic Suspension Systems Using Permanent Magnet‖ August 2010.
[15] V. B. Bhandari, Book of ―Elements of Machine Design‖