Electromagnetic And Magnetic Suspension

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Abstract- Electromagnetic suspension works where two or more electromagnets of the same polarity absorb all the bumps. The main problem is making the magnets strong sufficiently when running off cars electrical system. This work describes techniques for the design & analysis of a prototype magnetic suspension system. The viability of future high temperature super conducting magnet. A design for MAGLEV has been investigated with regard to their application to active secondary suspension. It has also analysed and compared the functions and performances of the magnetic suspension system with the hydraulic, and air suspension structures.

Keywords- Suspension, Automotive, Electromagnetic, Magnetic, Mechanical, Advance Engineering, Vehicle Technology, Magnetic Levitation, Suspension Bearing.

1. INTRODUCTION

As the joints are the important part of the human body because of which he can walk, run, sit and jump properly, the suspension system is a knee of a vehicle, with which the vehicle can give us a comfortable ride. The suspension scheme connecting a vehicle body to the wheels and its tyres allows the wheels to move in an essentially vertical direction in response to road surface irregularities, a spring temporarily stores energy, thus insulating the vehicle body from acceleration peaks.
A shock absorber or damper ensures that oscillations induced by the road inequality or aerodynamic forces (or by accelerating, braking or lateral forces), which would impair ride comfort and road holding.

2. PROGRESS & BACKGROUND

Basically, suspensions are multipurpose in engineering field. There are a lot of aspects in progress of suspension technology in nearest future. Some of are currently using by many of engineering assets by various purposes like shock absorbing, fast transmission, comfortable ride and safety. There are some conventional suspensions are widely used in automobile section. By using the technology of magnet and electromagnet we can increase the stability and efficiency. And for fast transportation this technology can make the fortune. By simply applying magnetic and electromagnetic suspension in SUV cars we can get better stability and joy of riding. By applying same technology in sports cars the speed and braking ability may increase. So by applying this technology in production of automobile engineering may change the future.

If all is well, the suspension dampers on a vehicle, and does their work quietly and without any fuss. Like punctuating or acting, dampers at their best when they are not noticed. Drivers and passengers simply want the damper to be trouble free. For the designers, however, there is a satisfaction in creating a good, new damper for a racing car or rally car, and perhaps making some contribution to competition success. Less exiting but economically more important, there is also satisfaction in seeing everyday vehicle travelling safety, with comfortable occupants, at speed that could be quite impractical without good dampers. The current worldwide production of dampers is difficult to estimate with accuracy, but it is probably around 50 to 100 million units per year with retail value well in excess of one billion dollars per year. The fitting of damping devices to the vehicle suspensions followed rapidly on the heels of the arrival of the motor car itself. Since those early days, the damper has passed through a century of evaluation, the basic stages of which may be considered as:

1. Dry friction (snubbers)
2. Blow-off hydraulics
3. Progressive hydraulics
4. Adjustable (manual alternation)
5. Adaptive (slow automatic alternation)
6. Semi active (fast automatic alternation)

The zeitgeist regarding dampers has changed considerably over the years, in roughly the following periods:
1. Up to 1910, dampers were hardly used at all. In 1913, Rolls Royce actually discontinued rear dampers on a Silver Ghost, illustrating just how different the situation was in the early years.
2. From 1910 to 1925, mostly dry snubbers were used.
3. From 1925 to 1980, there was a long period of dominance by simple hydraulics, initially simply constant force blow-off, and then proportional characteristics, then adjustable, leading to mature product.
4. From 1980 to 1985, there was excitement about the possibilities for the active suspension, which could effectively eliminate the ordinary dampers.
5. From 1985, it became increasingly apparent that good deal benefit of active suspension could be obtain much more cheaply by fast auto-adjusting dampers, and the damper suddenly became an interesting, developing component again.

Damper types which are explained fully later can be initially classified in two ways:

a) Dry friction with solid elements.
b) Hydraulic with fluid elements.

In 1966, Danby and Powell proposed an EDS system for high-speed transportation using super conducting magnets with a "null flux" suspension. Other designs were later proposed using continues sheet guide ways. Subsequent researchers in the U.S., Japan, Germany, UK and Canada have developed further innovations (such as ladder type guide way for increased lift efficiency), but there are still a number of technical problems that needed resolution.

Current Details of Electromagnetic Suspension (Maglev):
There are three primary types of Maglev technologies:
1. Superconducting magnets (electrodynamics suspension)
2. Feedback controlled electromagnets (electromagnetic suspension)
3. Newer potentially more economical system using permanent magnets Induct act.
The several approaches and designs have been produced by Japan and Germany. These two countries are very active in maglev research. The design used for trains in which the train levitates by the repulsive force of the same poles of the magnets. To levitate the train a very strong magnetic field is required but large electromagnet is also a big issue for the design, so instead of using the large magnets, they used superconductor for an efficient electromagnet.
Induct rack is a new and less expensive system. The system depends on the current induced in the passive electromagnetic array by permanent magnets, so that it provides the better load carrying capacity related to the speed. Induct rack was developed by physicist William Post at Lawrence Livermore National Laboratory. For stabilization Induct rack uses Hal Bach arrays. Currently, some space agencies, such as NASA, are researching the use of maglev systems to launch spacecraft. In order to do so, the space agency would have to get a maglev-launched spacecraft up to escape velocity, a task which would otherwise require elaborate timing of magnetic pulses or a very fast, very powerful electric current.

3. PRINCIPAL & CONCEPT

The basic principle is to develop a contact less spring; the uncertainty will be corrected with electromagnetic actuators. Electromagnetic suspension works where two or more electromagnets of the same polarity absorb all the bumps. The main problem is making the magnets strong enough so they can run on car's electrical system. Electrodynamics magnetic suspension called EDS maglev and referred to as repulsive Maglev because it relies on repulsive magnetic Forces, has the capability of allowing high speed transportation with a relatively large breaking power between the vehicle and guide way. Have a set of shock with magnet inside them that are used as the fork setup. There is one magnet at the upper of the inner portion of the cylindrical shock sleeve with the north polarity facing down towards the ground. The second magnet sits on the top of the inner shock that pivots up and down. This magnet has the north polarity upwards so it's parallel with the other magnet. The dual magnet fights against each other giving the forks travel. There is also an adjustment at the top of the shock, which allow the magnet to become closer .together for a stiffer travel or further apart for softer travel.

Dynamics of the magnetic suspension system:
The magnetic force applied by the electromagnet is opposite to magnitude and maintains the suspended steel ball in a levitated position. The magnetic force FM depends on the electromagnet current I, electromagnet appearances, and the air gap X between the steel ball and the electromagnet. The motion of the steel ball in the magnetic field is expressed as Where m is the mass of the suspended steel ball, G = mg is the gravity force, and X is the air gap amongst the steel ball and the electromagnet. The magnetic force FM is a nonlinear function of the current I and the air gap X. The linearization of the static characteristic near the set point

(F0, X0, I0) is given as The voltage calculation of the electromagnetic coil is articulated as Where U is the controlled voltage applied to the electromagnet, R is the coil resistance, and
L is the inductance of the electromagnet. Inductance L=f (X, t) is a function of the air gap, the coil, the core, and the steel ball. The steady state of the operating point air gap between the mass and the electromagnet is maintained by creating the magnetic force which is adjusted so that the gravitational force of the steel ball is balanced. The small differences from the operating point are normalized over operating spaces (G, D, IMAX, and Umax) and they are defined as follows:
Where f is the normalized resultant force, x is the normalized air gap, it is the normalized current, and u is the normalized voltage. X0, I0, and U0, are the steady-state values. Substituting Eq.4 into Eqs.1, 2, and 3 the dynamics of the system can be presented as follows.
The linear system is unstable and controllable.

4. AIMS & OBJECTIVES

Aim: To design and analyse a prototype Magnetic Suspension System.

Objectives: 1. Literature Review
2. Research the principles of the various types of suspension systems and analysing their functions and performances.
3. Investigate the application of the magnetic suspension system.
4. Design a prototype Magnetic Suspension System.
5. Analyse the designed Magnetic Suspension System.
6. Compare with the other type of Suspension Systems.
7. Assumption.

The main objectives of the suspension system are:

a) To prevent the road shocks from being transmitted to the vehicle parts, thereby providing suitable riding and cushioning effect to the occupants.
b) To keep the vehicle stable while in motion by providing good road holding during driving cornering and braking.
c) Provides safe vehicle control and free of irritating vibrations and reduce wear and tear.

The different types of suspension system which are available are mentioned below.

1. Front Suspension:
Solid I-Beam: It’s a non-independent design .These is used on trucks and other large vehicles. Its economical and simple .It has low maintenance but poor handling.
Twin I-Beam: Found on many Ford trucks. Its Forged, cast, or stamped axles. Has excellent load capacity. It requires special equipment for alignment adjustments.
Mac Pierson Strut: One of the most popular systems .It has one Control Arm. Ideal for front wheel drive. Light weight and economical. Good ride quality and handling characteristics. It’s used for both front and rear suspensions.
Short-Long Arm: Independent design uses an upper and a lower control arm uses either torsion bars or coil springs Good ride quality and handling appearances Heavy and complex design requires a lot of space.

2. Rear Suspension:
Non Independent Rear Leaf Springs: It’s a non-independent design Similar to front solid I-beam axle. Used for large load carrying ability.
Non-Independent Rear Coil Springs: It’s a non-independent design .Uses coils and control arms instead of leaf springs. Has good load carrying capacity.
Trailing Arm: It’s an Independent Design Uses individual lower control arms. Uses coil springs and shocks for good ride quality.
Beam: Non-independent design Stamped beam axles. Uses coil springs and trailing arms. Used for light and simple design.

Bose system for suspension & it’s working module:
In 1980, Bose founder and CEO Dr.Amar Bose conducted a mathematical study to determine the optimum possible performance of an automotive suspension, ignoring the confines of any existing suspension hardware. The result of this 5-year study indicated that it was possible to achieve performance that was a large step above anything available. After evaluating conventional and variable spring/damper systems as well as hydraulic approaches, it was determined that none had the combination of speed, strength, and efficiency that is necessary to provide the desired results. The study led to electromagnetics as the one approach that could realize the desired suspension characteristics.
The Bose system uses a linear electromagnetic motor (L.E.M.) at each wheel, in lieu of a conventional shock and spring setup. The L.E.M. has the ability to extend (as if into a pothole) and retract (as if over a bump) with much greater speed than a fluid damper (taking just milliseconds). These lightning-fast reflexes and precise movement allows the wheel's motion to be so finely controlled that the body of the car remains on level, regardless of the goings-on at the wheel level. The L.E.M. can also counteract the body motion of a car while accelerating, braking and cornering, giving the motorist a greater sense of control and passengers less of a need for Dramamine. To further the smooth ride goal, wheel dampers inside each wheel hub smooth out small road inadequacies, isolating even those nuances from the passenger compartment. Torsion bars take care of supporting the vehicle,

allowing the Bose system to concentrate on optimizing handling and ride dynamics. A power amplifier supplies the juice to the L.E.M.s. The amplifier is a regenerative design that uses the compression force to send power back through the amplifier. Thanks to this efficient layout, the Bose suspension uses only about a third of the power of a vehicle's air conditioning system. There are a few other key components in the system, such as control algorithms that Bose and his fellow brainiacs developed over a few decades of crunching numbers. The target total weight for the system is 200 pounds, a goal Bose is confident of attaining. The Bose suspension system installs easily into the front of the vehicle. A new engine cradle connects the front suspension to the car body using the original factory mounting hardware, creating a drop-in replacement module.

Research vehicle:
In many of today's production vehicles, the suspension system comprised of front and rear suspension modules that bolt to the underside of the vehicle. The Bose suspension takes advantage of this pattern by creating replacement front and rear suspension modules. Using this approach, the research team has been able to retrofit the Bose suspension into existing production vehicles with minimal modifications. Bose's front suspension segments use a modified McPherson strut layout and the rear suspension modules use a double-wishbone linkage to attach a linear electromagnetic motor between the vehicle body and each wheel. Torsion springs are used to support the weight of the vehicle. In addition, the Bose suspension includes a wheel damper at each wheel to keep the tire from bouncing as it rolls down the road. Unlike conventional dampers, which transmit vibrations to the vehicle occupants and sacrifice comfort, the wheel damper in the Bose suspension system operates without pushing against the car body, keeping passenger comfort. But, the truth is many people can't afford to install this system because of its price.

5. Magnetic materials

Magnets are attracted to, or repelled by, other materials. A material that is strongly attracted to a magnet is said to have permeability. Iron and steel are two examples of materials with very high permeability, and they are strongly attracted to magnets. Liquid oxygen is an example of something with a low permeability that it is actually slightly repelled by magnetic fields. Everything has a measurable permeability like people, gases and even the vacuum of outer space. The SI unit of magnetic field strength is the tesla, and SI unit of total magnetic flux is the Weber. 1 Weber = 1 tesla following through 1 square meter, and is a very large amount of magnetic flux. Material can be classified according to their permittivity and conductivity. Materials with a large amount of loss inhibit the propagation of electromagnetic waves. In this case, generally when/ (e)>> 1, we consider the material to be a good conductor. Dielectrics are associated with lossless or low-loss materials, where/ (e) << 1. Those that do not fall under either limit are considered to be general media. Perfect dielectrics a material that has no conductivity, thus exhibiting only a displacement current. Therefore it stores and returns electrical energy as if it were an ideal capacitor. In the case of lousy medium, i.e. when the conduction current is not negligible, the total current density flowing is:
Measurement:
The dielectric constant of material can be found by a variety of static electrical measurement. The complex permittivity is evaluated over a wide range of frequencies by using different variants of dielectric spectroscopy, covering 21 orders of magnitude from 10- 6to 1015Hz. Also, by using cryostats and ovens, the dielectric properties of a medium can be characterized over an array of temperatures. In order to study systems for such diverse exciting fields, a number of measurement setups are used, each adequate for a special frequency range.

1. Low-frequency time domain measurements (10-6-103Hz)
2. Low-frequency frequency domain measurements (10-5-106Hz)
3. Reflective coaxial methods (106-1010Hz)
4. Transmission coaxial method (108-1011Hz)
5. Quasi-optical methods (109-1010Hz)
6. Fourier-transform methods (1011-1015Hz)

Magnet used for Induct rack:
Induct rack is a completely passive, fail-safe magnetic levitation system, using only unpowered loops of wires in the track and permanent magnets (arranged into Hal Bach Arrays) on the vehicle to achieve magnetic levitation. The track can be in one of two configurations, a "ladder track" and a "laminated track". The ladder track is made of unpowered Litz-wire cables, and the laminated track is made out of stacked copper or aluminium sheets.
Description: Induct rack was invented by a team of scientists at Lawrence Livermore National Laboratory, headed by physicist Richard F. Post, for use in maglev trains. The only power required is to push the train forward against air and electromagnetic drag, with increasing levitation force generated as the velocity of the train increases over the loops of wire. Its name comes from the word inductance or inductor; an electrical device made from loops of wire. As the magnet array (with alternating magnetic field orientations) passes over the loops of wire, it induces a current in them. The current creates its own magnetic field which repels the permanent magnets. When neodymium-iron-boron permanent magnets are used, levitation is achieved at low speeds, allowing it to lift 50 times the magnet weight. The test model levitated at speeds above 22 mph, but Richard Post believes that on real tracks, levitation could be achieved at "as little as 1 to 2 mph". Below the transition speed, the magnetic drag increases as the vehicle's speed increases and approaches the transition speed, but above this transition speed, the magnetic drag decreases as the vehicle's speed increases. The induct rack II variation uses two Hal Bach arrays, one above and one below the track to double the levitating magnetic field without substantially increasing the weight or footprint area of the Hal Bach arrays, while having lower drag forces at low speeds. Several maglev railroad proposals are based upon induct rack technology. The U.S.National Aeronautics and Space Administration (NASA) are also considering induct rack technology for launching rockets. Stationary

cars: For use at embarkation/ debarkation areas, an implementation using a moving track would continue levitating the car while stationary. With a loop construction similar to a flat escalator by stationary track there would be no moving parts friction. Also, the elimination of the need for wheels during starting/ stopping of the cars simplify car construction and maintenance.

Neodymium magnet:

A neodymium magnet or NIB magnet (also, but less specifically, called a rare earth magnet) is a powerful magnet made of a combination of a combination of neodymium, iron and boron -$Nd_2Fe_{14}B$. Neodymium magnet on a bracket from a hard drive they have replaced marginally weaker and significantly more heat-resistant samarium cobalt magnets in most applications, due mainly to their lower cost. These magnets are very strong in comparison to their mass, but are also mechanically fragile and the most powerful grades lose their magnetism at temperatures above 176 degrees Fahrenheit or 80 degrees Celsius. High-temperature grades will operate at up to 200 and even 230 C but their strength is only marginally.

Maglev design: Electromagnetic Suspension System: - (Concept)

The design of the electromagnetic suspension system can be done with two types: 1) By using a Hydraulic Damper or 2) By using Linear Motor as a Damper. The concept is to design the magnetic suspension system on the front shock absorber of the motor bike to have a better performance with ease of handling and comfort ride. There are two cylinders installed on two separate arms of the front shock absorbing rods. The cylinder contains the pair of the cylindrical magnets having same pole facing each other to create the required repulsive force to have required levitation effect. The two cylindrical magnets having "S" (South Pole) on the outer surface concentric with the inner circle having "N" (North Pole).

1) Working for the Hydraulic Damper:

The two disc magnets in a tube or two ring magnets on a shaft, as seen in above figure comprise our required magnet for a motor bike front suspension system. With unlike poles facing, the magnets repel each other & generate an air gap between them. The repulsive force restores displacement towards each other, and displacement away is restored by gravity. A hydraulic damper is fixed on the top of the cylinder and connected with the upper magnet with a shaft. The set of shocks used with magnets inside them that are used as the fork setup. One magnet is at the top of the inner portion of the shock with north polarity facing down towards the ground. The second magnet sits on the top of the inner shock that pivots up and down. This magnet has the north polarity upwards so it is parallel with the other magnet. The two magnets fight against each other giving the forks travel. There is also an adjustment at the top of the shock, which allows the magnets to become closer, together for a stiffer travel or further apart for softer travel. The force from gravity, the force from repelling magnet & the radial instability is restrained by shaft. If the shaft is removed from the simple spring, it will be unstable naturally. The magnet will tend towards vertical motion, resulting in instability in two orthogonal vertical axes. A more controlled (but no less unstable) way of arranging two magnets arrangement is known as a thrust bearing, and has the advantage in that if instability does occur, the unstable magnet will not fly unpredictably away from the fixed magnet (because the former will be constrained by the latter). The vibrations and the instability will be absorbed by the hydraulic damper. It is stated for completeness that the magnet has two poles North & South. Two magnets placed with opposite poles facing will attract each other. Conversely, two magnets placed with like poles facing will repel each other. That these forces occur is very well known, but the mechanisms that create these forces are beyond the scope of this document. There are several materials of which permanent magnets may be made.

2) Working of Linear Motor as a Damper:

Linear electromagnetic motor (L.E.M.) can be used at each wheel, in lieu of a conventional shock and spring setup. The L.E.M. has the ability to extend (as if into a pothole) and retract (as if over a bump) with much greater speed than a fluid damper (taking just milliseconds). These lightning-fast reflexes and precise movement allow the wheel's motion to be so finely controlled that the body of the car remains level, regardless of the goings-on at the wheel level. Inside the linear electromagnetic motor are magnets and coils of wire. When electrical power is applied to the coils, the motor retracts and extends, creating motion between the wheel and car body. One of the key advantages of an electromagnetic approach is speed. The linear electromagnetic motor responds quickly enough to counter the effects of bumps and potholes, maintaining a comfortable ride. Additionally, the motor has been designed for maximum strength in a small package, allowing it to put out enough force to prevent the car from rolling and pitching during aggressive driving manoeuvres. The L.E.M. can also counteract the body motion of a car while accelerating, braking and cornering, giving the driver a greater sense of control and passengers less of a need for Dramamine. To further the smooth ride goal, wheel dampers inside each wheel hub smooth out small road imperfections, isolating even those nuances from the passenger compartment. Torsion bars take care of supporting the vehicle, allowing the system to concentrate on optimizing handling and ride dynamics. A power amplifier supplies the juice to the L.E.M.s. The amplifier is a regenerative design that uses the compression force to send power back through the amplifier.

The design of the magnetic spring has the following requirements:

One degree of freedom instability:

A quasi-steady, non-linear analysis of single-degree-of-freedom motion for a single flexible cylinder in an array of rigid cylinders subject to a fluid cross-flow is presented. Then, by using the so-called first approximation of Krylov and Bogoliubov the stability and existence of limit cycle amplitudes are investigated. It is shown that, in general, the stability behavior predicted by the non-linear analysis is in agreement with that obtained from the previously developed linearized analysis. Every unstable axis requires actuators for stability control. Therefore, it is desired to minimize the number of unstable degrees of freedom. Furthermore, the unstable direction must be in the horizontal direction for efficient passive vertical load bearing.

1. Ability to support large loads:

It is desired for the entire weight of the table plus equipment is supported by the permanent magnets. Weight supported by the electromagnets consumes large amount of power, which is undesirable for cost and heat reasons.

2. Effective electromagnet actuator placing:

Actuators, which apply forces unsymmetrically, will apply a moment to the levitating table, which would be undesirable. Electromagnet actuators must be used for stabilizing the unstable axis as well as for rejecting vertical disturbances.

Permanent Magnet Design:

It is the purpose of this section to ignore the reasons for the magnetic field or any complex equations relating to magnetic, but rather develop an informal understanding of magnetic behavior.

Short attention will be placed on the cheaper, legacy magnetic materials. These, such as ferrite magnets and alnico magnets, have weak magnetization such that they may be demagnetized by strong magnetic fields. Rear earth magnets have been available for the last twenty years, which have more desirable properties than these old fashioned magnets. This section describes the design and modelling of the multiple loop guide way and development of circuit model to predict behavior of a novel Maglev system based on high temperature super conducting coils. This so called "Flux Cancelling" EDS Maglev suspension achieves high efficiency for suspension and guidance in addition to rapid attenuation of magnetic flux with distance by utilizing an iron core super conducting octuplets (Anything having eight poles or electrodes, but especially a combination of two quadruples used for controlling beams of charged particles). In order to test these concepts, a 1/5 scale suspension magnet using copper coils and guide way embedded in a high speed rotating test wheel can be constructed. Magnetic field strength, in gauss can be calculated at any distance at the end of magnet. Results are for field strength on-axis, at a distance 'Z' from a pole of the magnet. These calculations are only appropriate for "Square Loop" or "Straight Line" magnetic materials such as ferrites, neodymium-iron-boron and samarium cobalt magnets. They should not be used for alnico materials.

Flux Cancelling Geometry:

The guide way is composed of multiple conductive copper coils arranged vertically, and the train magnets are arranged in a duel row N-S-N-S arrangement (Fig.1). When the train is in the vertical null position at z = z0 and travelling in +y direction, there is no net flux through the levitating coils, and no net current induced around the loop. However, if the train's vertical position deviates from equilibrium, the net changing flux through the loop induced current in the loop. This creates a restoring force, with the magnetic suspension acting as a linear spring with spring constant kz. The suspension has a resulting resonant frequency where kz is magnetic spring constant and M is a total suspended mass. There is no inherent damping mechanism intrinsic to EDS suspensions other than aerodynamic drag.

Suspension Magnet Design:

The suspension magnet in the test facility should has a pole pitch p = 0.126 meter. The magnet core is constructed with laser-cut laminations of 0.9-millimeter thick M19 transformer steel. Eight copper coils were wound with 18 gauge copper magnet wire on an arbour with same geometry as the magnet pole faces. The final copper coil design had 550 turns in a winding window of 5 cm x 2 cm. The design limit of the copper coils is 8 amps in still air (with current density J = 1000 A/cm2) and 20 Amps when operating in the liquid nitrogen bath (J = 2500 A/cm2). The measured resistance of each coil is 3.4 Ohms at 300K and 0.442 Ohms when cooled to 77K, corresponding to maximum copper power dissipation per coil of 200 Watts. The magnet is mounted to a multi-axis force sensor, which allows real-time measurement of forces and moments. The core laminations were sized by considering the power dissipation per unit length in a section of the core made up of NL laminations.

Technology:

There are three primary types of MAGLEV Technologies:

1. One that relies on feedback controlled electromagnets (Electromagnetic Suspension or EMS). Ex.: Trans rapid
2. The another one relies on the superconducting magnets (Electrodynamics Suspension or EDS) Ex.: JR-Maglev
3. And the last one and newer , potentially more economical system that uses paramagnets i.e. Induct rack

- Induct rack:

A newer, perhaps less expensive system is called "Induct rack". The technique has a load carrying ability related to the speed of the vehicle, because it depends on the current induced in a passive electromagnetic array by permanent magnets. In the prototype, the permanent magnets are in the cart; horizontally to provide lift, and vertically to provide stability. The array of wire loops is in the track. The magnets and cart are unpowered, except by the speed of the cart. Induct rack was originally developed as a magnetic motor and bearing for a flywheel to store a power with only slight design changes, the bearings were unrolled into a linear track. Induct rack was developed by the physicist Mr Richard

Post at Lawrence Livermore National Laboratory. Induct rack uses Hal Bach arrays for stabilization. Hal Bach arrays are arrangement of permanent magnets that stabilize moving loops of wires without electronic stabilization. Hal Bach arrays were originally developed for beam guidance of particle accelerators. They also have a magnetic field on the track side only, thus reducing any potential effects on the passengers.

- Lift and Propulsion:

Japan and Germany are active in Maglev research, producing several difference approaches and designs. In one design, the train can be levitated by the repulsive of like poles or the attractive force of opposite poles of magnets. The train can be propelled by a linear motor on the track or on the train, or both. Massive electrical induction coils are placed along the track in order to produce the magnetic field necessary to propel the train.

- Stability:

Static magnetic bearing using only electromagnets and paramagnets are unstable because of Earns haw's theorem; on the other hand diamagnetic and superconducting magnets can support a Maglev stably. Some conventional Maglev systems are stabilized with electromagnets that have electronic stabilization. This works by constantly measuring the bearing distance and adjusting the electromagnets accordingly.

6. LITRATURE REVIEWS

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7. APPLICATION OF ELECTROMAGNETIC & MAGNETIC SYSTEM

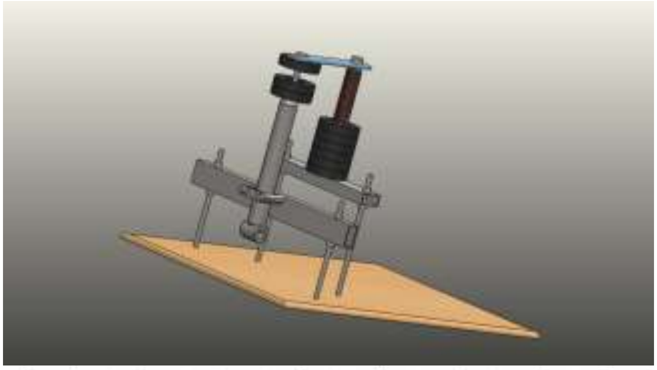
- To improve the stability of the vehicle by using electromagnets.
- It should improve the vehicles running performance.
- It could be reduce the roll and pitch.
- To reduce overall body motion and jarring vibrations results in increased comfort and control.

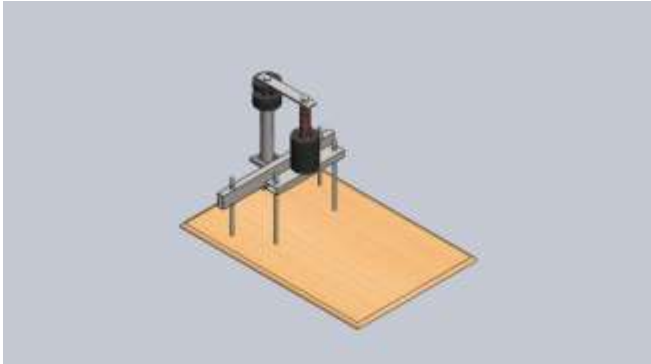
8. ADVANTAGES & DISADVANTAGES

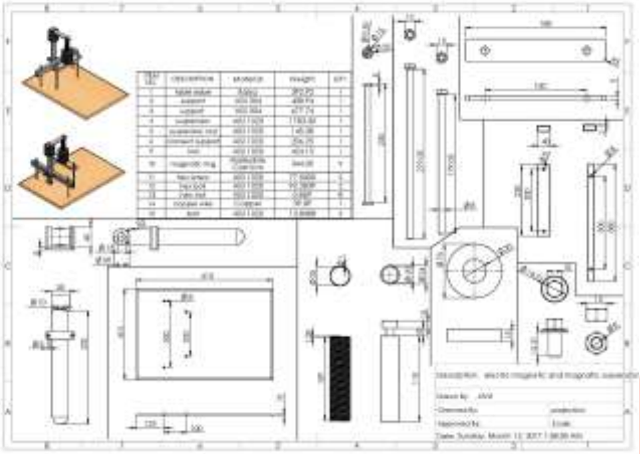
Advantages:
- Better stability while performing vehicle operation.
- High sock absorbing performance.
- More and powerful transmission.
- Incriminations in breaking ability.
- More comfort.
- Safer ride.

Disadvantages:
Every system has some disadvantages attached to it. Some of the drawbacks can be grouped as below
- The second drawback is, when this system breakdowns it's very difficult and costly affair to repair it .The other system available can be easily be repaired.
- The system is very complex and requires high precision machinery and skilled workers to manufacture.

9. CONCLUSION







On the basis of our deep research in this segment we happly conclude with our prospected prototype and its component structure. The design and modelling process of a 1/5-scale "flux-cancelling" Maglev suspension has been described in this paper. Using approximate techniques, this design can be used to predict the analysis. With comparison to other types of suspension system, electromagnetic suspension system provides totally comfortable ride.

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