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Design and analysis of electromagnetic suspension system in automobiles

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Abstract -An electromagnetic suspension system is designed with increased comfortness and reduced annoying sounds in automobiles. It also prevents the floor damages from automobiles due to vibration. Now a days the automobiles and machines use incompressible fluids in shock absorbers to absorb sudden shocks and vibrations that arise under motion. In our project, electromagnetic coil is used to absorb the shocks experienced by the vehicle. The shock absorber is fabricated for the equipment like automobiles and movers which are suitable for AC & DC supplies up to 12V to 220V. In our project, electro-magnetic coil is operated at 12V D.C battery supply.

Index words - Electromagnetic suspension , MR Fluid , Ball Bearing , Neodium Magnet and Copper coil .

I. INTRODUCTION

The sole purpose of this project is to improvise the existing suspension system by replacing the present shock absorbers with electromagnets. The present shock absorbers consist of incompressible fluid which converts the kinetic energy in to heat energy and dissipated. As all the parts are in contact with each other even though it is damping sudden shocks, due to direct contact these vibrations are transferred. Some of the disadvantages of the present shock absorbers are:

1) Damage of the vehicle components due to vibrations
2) Failure of parts due to sudden shocks.
3) Discomfort for passengers due to vibrations.
4) Floor damage in case of machines due to Vibrations

If we analyze the drawbacks of the present shock absorbers, all the above problems can be solved by simply eliminating the contact between the wheels and chassis of the vehicle. Therefore as a student of the mechanical engineering this project will expose me to the field of designing and allows me to study to the detailed properties of electromagnets. In this project in order to raise the upper part of the body from the lower one, electromagnets are used. These electro magnets are placed in such a way that similar poles are placed on the same side so that the repel each other and as the moment in horizontal direction is constrained it starts moving up lifting up the body of the vehicle. This is done to damp to road shocks transmitted to the frame by the wheels as they roll over the road. All these parts which perform this function are collectively called a suspension system. Thus, the suspension system in the includes springs, shock absorbers and their mountings. The suspension system of a motor vehicle is divided into the rear end suspension and front-end suspension

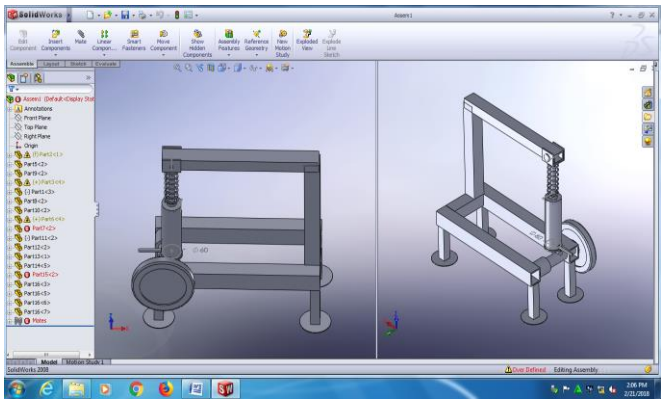


Fig.1 Electromagnetic suspension system Diagram

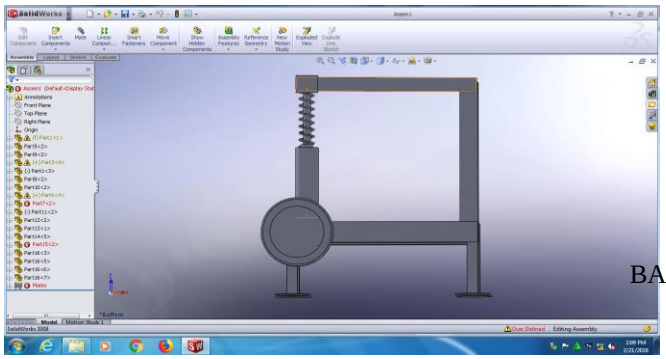


Fig.2 Electromagnetic suspension in 3D diagram

II. LITERATURE SURVEY

[1] Houtman P. Siregar et al. discuss about the material of the magnet for core of electromagnetic fuel saver are made of plain carbon steel and copper. Diameters of the wire winding, which is used in the research, are 0.25 mm and 0.35 mm. Speed of the engine, and number of coil which is coiled in the winding core of the fuel saver are chosen as the testing variables. From this work is obtained that the performance of the electromagnetic fuel saver which use copper core is better than the electromagnetic fuel saver.

[2] Y.Yojana Reddy describe about design and simulation of a magnetic suspension system for the quarter car. Here in the designed suspension system, the damping value can be varied by changing the electric current supply in the electromagnet. Basically, this system works on Levitation technology, in which pre-defined air gap is maintained due to magnetic repulsion. Here two types of the controller are designed that is look-up table and fuzzy rules to maintain the predefined air gap.

[3] Zutao Zhang et al. discuss about the suspension vibration induced by the road roughness acts as the system excitation to the energy regenerative shock absorber. The vibration is then transmitted through the mechanical transmission module, which changes bidirectional vibration into unidirectional rotation based on gears and a rack to drive the generator module

III. COMPONENTS AND DESCRIPTION

The major components of the Electro-Magnetic suspensions" are follows

- Battery
- Electromagnetic Coil
- Suspension arrangement
- Spring
- Frame Stand
- Bearing
- Wheel arrangement
- Piston
- MR Fluid

BATTERY

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. To be economically attractive the storage of solar electricity requires battery with a particular components

- Long life
- High reliability
- High overall efficiency
- Low discharge

We use lead acid battery for storing the electrical energy from the solar panel for lighting the street and so about the lead acid cells are explained below.

ELECTROMAGNETIC COIL

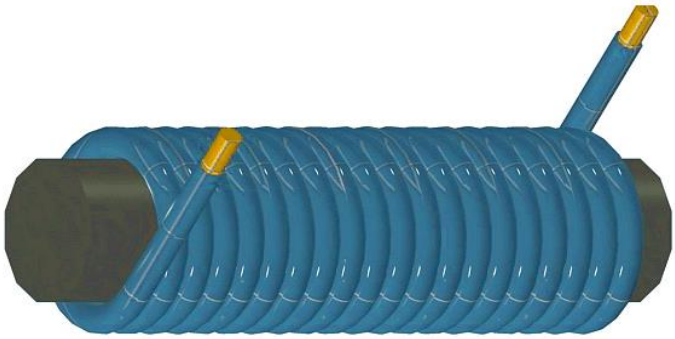


Fig.3 Electromagnetic coil

An electromagnetic coil is an electrical conductor such as a wire in the shape of a coil, spiral or helix. Electromagnetic coils are used in electrical engineering, in applications where electric currents interact with magnetic fields, in devices such as inductors, electromagnets, transformers, and sensor coils. Either an electric current is passed through the wire of the coil to generate a magnetic field, or conversely an external *time-varying* magnetic field through the interior of the coil generates an EMF (voltage) in the conductor.

SUSPENSION ARRANGEMENT

In our project, air operated suspension system. This suspension system consist of the following items

- Piston
- Piston Rod
- Cylinder Cover Plates
- Cylinder Mounting Plates

SPRING

Springs are elastic bodies (generally metal) that can be twisted, pulled, or stretched by some force. They can return to their original shape when the fore is released. In other words it is also termed as a resilient member.

FRAME STAND

Frame stand is made up of mild steel materials. The whole above mentioned parts are fixed in to this frame stand with suitable arrangement.

BEARING

The bearings are pressed smoothly to fit into the shafts because if hammered the bearing may develop cracks. Bearing is made up of steel material and bearing cap is mild steel. Ball and roller bearings are used widely in instruments and machines in order to minimize friction and power loss.

WHEEL ARRANGEMENT

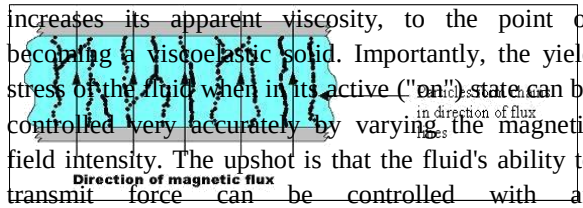
The simple wheel arrangement is fixed to the frame stand. Near the wheels, the hydraulic jack is fixed. This wheel arrangement setup is for showing the successful working of our project. But the real implementation can be done in the automobile and the lifting can be applied to all the four wheel.

PISTON

A piston is a component of reciprocating engines, reciprocating pumps, gas compressors and pneumatic cylinders, among other similar mechanisms. It is the moving component that is contained by a cylinder and is made gas-tight by piston rings. In an engine, its purpose is to transfer force from expanding gas in the cylinder to the crankshaft via a piston rod and/or connecting. In a pump, the function is reversed and force is transferred from the crankshaft to the piston for the purpose of compressing or ejecting the fluid in the cylinder. In some engines, the piston also acts as a valve by covering and uncovering ports in the cylinder wall.

MR FLUID

A magneto rheological fluid (MR fluid) is a type of smart fluid in a carrier fluid, usually a type of oil. When subjected to a magnetic, the fluid greatly increases its apparent viscosity, to the point of becoming a viscoelastic solid. Importantly, the yield stress of the fluid when in its active ("on") state can be controlled very accurately by varying the magnetic field intensity. The upshot is that the fluid's ability to transmit force can be controlled with an electromagnet, which gives rise to its many possible control-based applications.



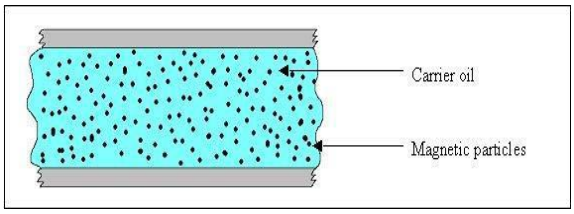


Fig.4 MR Fluid

IV.OPERATION REQUIRED

1. Metal cutting
2. Sawing
3. Drilling
4. Welding
5. Assembling

1.METAL CUTTING

Metal cutting or machining is the process of by removing unwanted material from a block of metal in the form of chips.

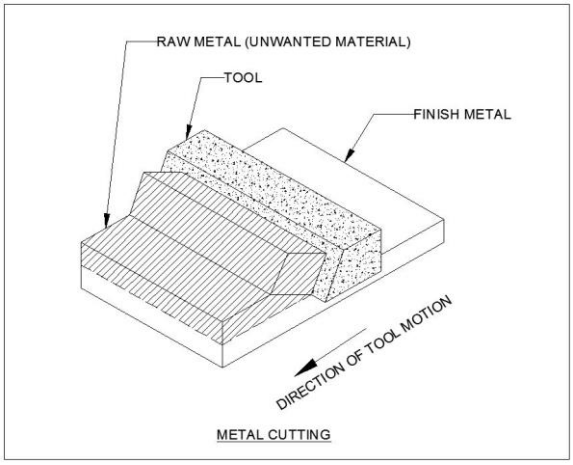


Fig.5 Metal cutting process

2.SAWING

Cold saws are saws that make use of a circular saw blade to cut through various types of metal including, sheet metal. The name of the saw has to do with the action that takes place during the cutting process, which manages to keep both the metal and the blade from becoming too hot.

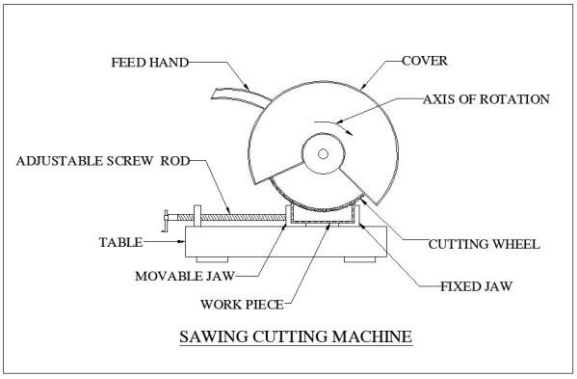


Fig.6 Sawing process

3.DRILLING

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. The drill bit is a rotary cutting tool, often multi point. The bit is pressed against the work piece and rotated at rates from hundreds to thousands of revolutions per minute.

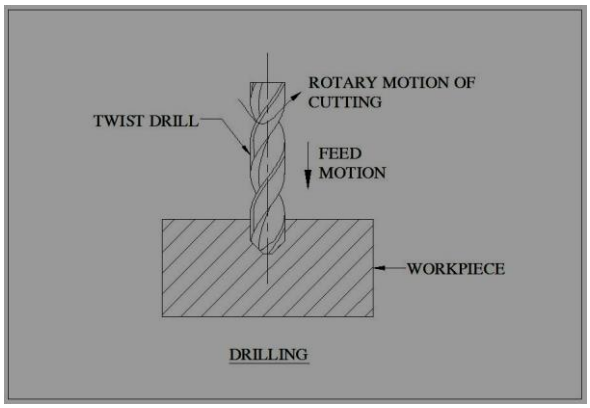


Fig.7 Drilling process

4.WELDING

Welding is a process for joining similar metals. Most welding involves ferrous-based metals such as steel and stainless steel. Welding is used for making permanent joints. It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames.

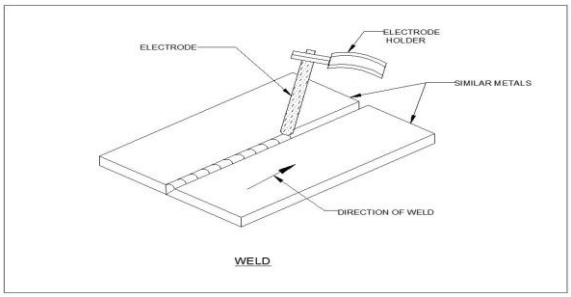


Fig.8 welding process

V.WORKING PRINCIPLE

Electromagnetic suspension system works in the principle that the attractive force of the opposite pole is used for performing the braking system. When an electric current is passed through a solenoid switch, the electric field is converted into the magnetic field. The plunger reciprocates and this reciprocating motion is connected to the suspension system.

This electromagnetic shock absorber arrangement is the additional suspension arrangement for the existing shock absorber arrangement. This electromagnetic shock absorber arrangement will be activated automatically when the weight of the vehicle is exceeded for the particular load.

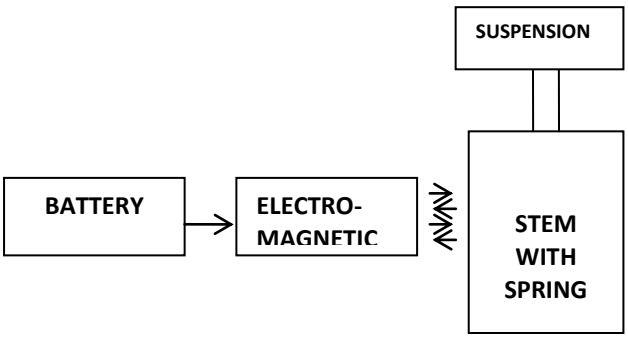


Fig.9 Layout of electromagnetic suspension system

When solenoid switch receives power, electromagnet is magnetized, which attracts plunger. This attractive force causes the plunger to reciprocate. This reciprocating motion is converted to the liner motion of the suspension system and the shock absorber works effectively.

VI.ANALYSIS RESULT FOR SUSPENSION

MESHING USING ANSYS

In preparing the model for analysis, Ansys subdivides the model into many small tetrahedral pieces called elements that share common points called nodes.

- Red dots represent the element's nodes.
- Elements can have straight or curved edges.
- Each node has three unknowns, namely, the translations in the three global directions.
- The process of subdividing the part into small pieces (elements) is called meshing. In general, smaller elements give more accurate results but require more computer resources and time.
- Ansys suggests a global element size and tolerance for meshing. The size is only an average value, actual element sizes may vary from one location to another depending on geometry.
- It is recommended to use the default settings of meshing for the initial run. For a more accurate solution, use a smaller element size.

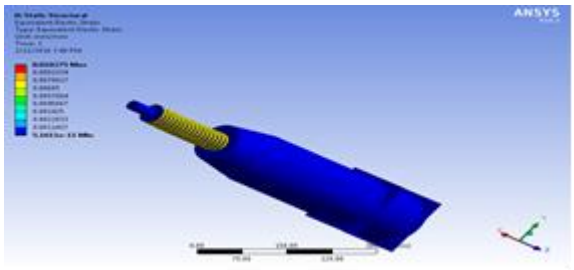


Fig.11 Maximum principal stress

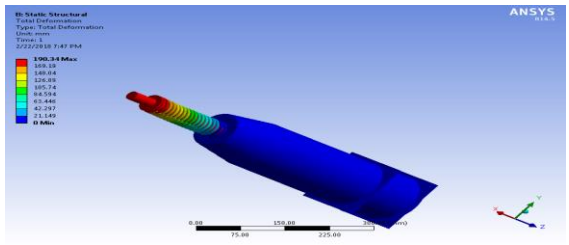


Fig.10 Equivalent elastic strain

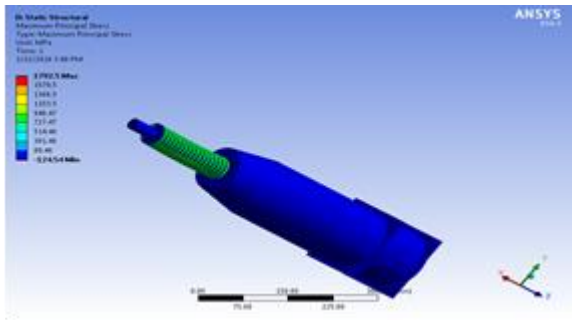


Fig.12 Equivalent (von-mises) stress

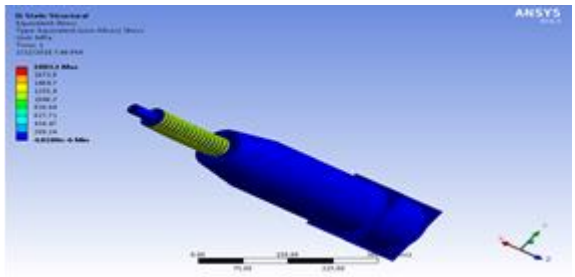


Fig.13 Total deformation

CONCLUSION

Thus we have done an Fabrication and Analysis on "ELECTRO-MAGNETIC SUSPENSION SYSTEM" which helps to know how to achieve smooth suspension system. This suspension will prevent the damages that can be caused due to the bottoming and lifting of the wheel as it is free from vibrations. Hence bringinging in the use of electro-magnetic suspension will give you an easy and a comfortable drive.

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