IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 3, March 2016.
www.ijiset.com
ISSN 2348 – 7968

Electromagnetic Suspension System-A Review

Prof. Sagar S. Khatavkar, Mr. Dinesh Anchan , Mr. Prathamesh Deo, Mr. Samruddha Kale, Mr. Krushna Umate.

[1]Asst. Prof., Automobile Engineering Department, SCOE Kharghar, Maharashtra, India
[2] Student Automobile Engineering Department, SCOE Kharghar, Maharashtra, India
[3]Student Automobile Engineering Department, SCOE Kharghar, Maharashtra, India
[4]Student Automobile Engineering Department, SCOE Kharghar, Maharashtra, India
[5]Student Automobile Engineering Department, SCOE Kharghar, Maharashtra, India

Abstract- This paper is a review on design and modification of electromagnetic suspension , rear suspension, magnetic suspension, uses of shock absorber etc.These are important aspects consider in below review done by various writers on a no. Of suspension systems developed by them.The function of suspension in any vehicle is to prevent shock during rough road condition and to enhance traction force between road surfaces. Any notable invention when taken into account,it can be perceived that it has evolved greatly to reach such height by addressing their limitations.

I. INTRODUCTION

I.

]The first question for an ordinary person when reading a paper based on any suspension system is "What is suspension ?","What does it actually means with respect to vehicles ?". A mechanical system of springs or shock absorbers connecting the wheels and axles to the chassis of a wheeled vehicle. It can also be understood as the system of tires, tire air, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two. Suspension systems serve a dual purpose — contributing to the vehicle's roadholding/handling and braking for good active safety and driving pleasure, and keeping vehicle occupants comfortable and a ride quality reasonably well isolated from road noise, bumps, vibrations,etc. Obadiah Elliott registered the first patent for a spring-suspension vehicle; - each wheel had two durable steel leaf springs on each side and the body of the carriage was fixed directly to the springs attached to the axles. Suspension has become one of the key elements of modern motorcycles as safety and comfort are influenced by it. Suspension systems have direct responsibility of safety during anti-squat and anti-dive."What is anti-dive and anti-squat ?". Anti-dive and anti-squat are percentages that indicate the degree to which the front dives under braking and the rear squats ie.;suspension will extend under acceleration. Now coming back to the primary fucntion of suspension, What happens when you hit a huge bump of speed breaker at 60kmph, eventually it will lead to an accident if there was no suspension system rather leading to a severe vibration, Moreover when you apply a brake on front wheel some part of braking force gets used up by front suspension, when maximum energy is absorbed by the front suspension and the remaining excess breaking force it will lead to pivoting about the point of contact of the front wheel.And similarly effect is observed during acceleration. Hence suspension systems are of great importance to vehicles handling and braking, and to providing better traction, safety and comfort.

II. SUSPENSION ANALYSIS

Andrzej Milecki , Miko" Aj Hauke, 2012,[1]Application Of Magnetorheological fluid In Industrial Shock Absorbers, discussed: Magnetorheological (MR) fluid, which is capable of controlling the stopping process of moving objects, e.g. on transportation lines. The proposed solution makes it possible to adjust the braking force (by electronic controller) to the kinetic energy of the moving object . The paper presents an overview of passive shock absorbers. Next, the design concept of a semi- active shock absorber with the MR fluid is proposed. Theoretically the optimal breaking process occurs when the breaking force is constant on the whole stroke of the absorber

Babak Ebrahimi , Mir Behrad Khamesee , M. Farid Golnaraghi, 2008,[2]Design And Modeling Of A Magnetic Shock Absorber Based On Eddy Current Damping Effect, studied: Eddy currents are generated in a conductor in a time-varying magnetic field. They are induced either by the movement of the conductor in the static field or by changing the strength of the magnetic field, initiating motional and transformer electromotive forces (emfs), respectively. Since the generated eddy currents create a repulsive force that is proportional to the velocity of the conductor, the moving magnet and conductor behave like a viscous damper. Graves et al have derived a mathematical representation for eddy current dampers, based on the motional and transformer emf, and have developed an analytical approach to compare the efficiency of the dampers in terms of these two sources. For more than two decades, the application of eddy currents for damping purposes has been investigated, including magnetic braking systems , vibration. Control of rotary machinery, structural vibration suppression , and vibration isolation enhancement in levitation systems. The newly developed analytical model is used to design high-performance dampers for a variety of applications.

Alberdi-Muniain , N. Gil-Negrete , L. Kari, 2012,[3]Direct Energy flow Measurement In Magneto-Sensitive Vibration Isolator Systems, learned: The effectiveness of highly non-linear, frequency, amplitude and magnetic field dependent magneto-sensitive natural rubber components applied in a vibration isolation system is experimentally investigated by measuring the energy flow into the foundation. The energy flow, including both force and velocity of the foundation, is a suitable measure of the effectiveness of a real vibration isolation system where the foundation is not perfectly rigid. The vibration isolation system in this study consist s of a solid aluminium mass supported on four magnetosensitive rubber components and is excited by an electro-dynamic shaker while applying various excitation signals, amplitudes and positions in the frequency range of 20–200 Hz and using magneto sensitive components at zero-field and at magnetic saturation. The energy flow through th e magneto-sensitive rubber isolators is directly measured by inserting a force transducer below each isolator and an accelerometer on the foundation close to each isolator.

Bart.L.J.Gysen, Johannes.J.H.Paulides, Jeroen.L.G.Janssen, 2010,[4] Active Electromagnetic Suspension System For Improved Vehicle Dynamics studied: Due to the change in vehicle concepts to the more electric car, the suspension system becomes ever more important due to changes in the sprung and unsprung masses. Active electromagnetic suspension systems can maintain the required stability and comfort due to the ability of adaptation in correspondence with the state of the vehicle. Specifications are drawn from on-and off road measurements on a passive suspension system, and it can be concluded that, for ARC, a peak force of 4kN and an RMS force of 2kN (dutycycleof100%) are necessary for th front actuators. Furthermore, the necessary peak damping power is around 2kW; however, the RMS damping power is only 16W during normal city driving. The maximum bound and rebound strokes are 80 and 58mm, respectively. The on road measurements, which are mimicked on a quarter car setup by means of electromagnetic actuation, a good tracking response, and measurement of the frequency response of the tubular actuator, prove the dynamic performance of the electromagnetic suspension system**.**

Georgios Tsampardoukas, Charles W.Stammers, Emanuele Guglielmino, 2008,[5] Hybrid Balance Control Of A Magnetorheological Truck Suspension, discussed: The paper concerns an investigation into the use of controlled magnetorheological dampers for a semi active truck suspension. A control strategy targeted to reduce road damage without penalizing driver comfort is presented. A half truck model is employed and system performance investigated via numerical simulation. A balance control algorithm (variable structure type algorithm) based on dynamic tyre force tracking has been devised. Algorithm robustness to parametric variations as well as to real life implementation issues such as feedback signals noises are investigated as well. The magnitude of total road damage reduction (over three axles)on a simulated random road varies with vehicle speed. The reduction was found to be 6% at 7.5m/s, 19% at 17.5m/s and 9% at 25m/s.

Kirk T. McDonald, Joseph Henry Laboratories, Princeton University, Princeton, NJ08544 (April14,2012),[6]Magnetic Damping discussed: When a conductor moves through a non uniform, external magnetic field, the magnetic flux varies through loops fixed inside the conductor, so an electromotive force is induced around the loops, according to Faraday’s law (in the rest frame of the conductor), and eddy currents flow. The Lorentz force on these eddy currents, due to the external magnetic field, opposes the motion, and one speaks of magnetic braking/damping. This effect is (ultra) relativistic, being of order v2/c2, where v is the speed of the conductor and c is the speed of light in vacuum. While such relativistic effects are generally small for “ordinary” velocities, the eddy current density obeys J=σE, where the conductivity σf or good conductors approaches c2/v2 when measured in Gaussian units, such that eddy current braking is a rare example of an important (ultra) relativistic correction at low velocities. In the present problem the magnetic field is spatially uniform, so the magnetic flux through a moving loop does not change, and no eddy currents develop. Yet, there exists a very weak magnetic damping effect.

Zekeriya Parlak, Tahsin Engin, Ismail Çallı, 2012,[7] Optimal Design Of MR Damper Via Finite Element Analyses Of Fluid Dynamic And Magnetic Field, studied: The purpose of the study was to optimize MR damper geometrically in accordance with two objectives, target damper force as 1000N and maximum magnetic flux density. The optimization studies were carried out by finite element method using electromagnetic and CFD tools of ANSYSv12.1. The FEM analyses were employed to get desired optimal values in ANSYS Goal Driven Optimization tool. Values of optimal of the design parameters of the MR damper were searched between lower and upper boundaries in both electromagnetic and CFD analyses. The parameters were geometrical magnitudes, current excitation and yield stress. In the electromagnetic analysis gap width, flange length, gap length, piston head housing thickness, radius of piston core, the number of coil turns and the applied current were selected as design parameters to be able to get maximum magnetic flux density. The values were used in CFD analysis to obtain damper force under optimal conditions **.**

R. Zalewski , J. Nachman , M. Shillor , J. Bajkowski, 2013,[8] Dynamic Model For A Magnetorheological Damper, discussed: Lumped mass thermo-mechanical model for the dynamics of a damper filled with a magnetorheological fluid is described, analyzed, and numerically simulated. The model includes friction and temperature effects, and consists of a differential inclusion for the piston displacements coupled with the energy balance equation for the temperature. The fluid viscosity is assumed to be a function the temperature and electrical current, which in practice may be used as the control variable. Numerical simulations of the system behaviour are presented. In particular, the simulations of an initial impact show how the subsequent oscillations can be effectively damped.

Ammar A. Aldair and Weiji J. Wang, [9]discussed: To improve the vehicle performance such as ride comfort and road handling, the active suspension system should be used. However, the current active suspension system has a high energy consumption therefore reducing the fuel economy. In this paper the vibration excited by road unevenness is treated as a source of mechanical energy. It is being converted into electrical energy to compensate for the energy consumption by the active suspension. To achieve this task, an electromagnetic active suspension system has been introduced. The power generated from this device has been used as input power of the pump of the hydraulic actuators. Adaptive neuro-fuzzy controllers have been designed to generate a signal to control the valves of the hydraulic actuators.

Aniket Thosar, [10]discussed:- All Terrain Vehicle (ATV) is defined by ANSI as a vehicle that travels on low pressure tires, which is used to handle any kind of terrain it faces. The paper focuses on design of rear suspension system for an ATV. The paper covers simulation, modeling and analysis of suspension geometry. Suspension is designed such that it provides better handling and better comfort for an ATV

Arindam Pal, Sumit Sharma, Abhinav Jain, C.D.Naiju,[11],discussed: Suspension system is the term that defines the transmissibility of an off-road vehicle. In order to resist the bumps and jerks that usually occur in an off-road track, an integrated approach of design is developed to obtain an optimized geometry which can give the drivers a ‗fun-to-drive' experience. This paper describes the development of this suspension and steering geometry design that is fast enough to be used at off-road circuit giving us appropriate camber and caster variations , toe angles , Ackermann geometry , proper flow of forces from chassis to ground and shock absorber characteristics when running on the challenges posed by a rugged off-road track. The geometry design discussed here was achieved through the thorough study of its dimensions, position of installation and application. This vehicle was a Baja off-road prototype which is used in international competitions among universities with its top speed as 45- 65km/hour and its turning radius being 10.5 ft. The car is rear wheel driven.

III. Conclusion

After studying all these papers we have come up with some conclusion which have been noted down as follows:

- For a suspension to work properly the adjustment of braking force to kinetic energy of a moving object is important.

- It is can be concluded that the driver does experience vibration during normal operations under passive suspension system that may not be as much as with respect to the sprung mass or unsprung mass,(sprung mass is the portion of the vehicle's total mass that is supported above the suspension, including in most applications approximately half of the weight of the suspension itself.The unsprung mass is the mass of the suspension, wheels or tracks, and other components directly connected to them, rather than supported by the suspension.) but significant to cause an effect on driver's health.

- It is observed that the Semi-active suspension system has better performance capabilities over passive suspension system.

-Considering electromagnetic suspension, it has high bandwidth and efficient solutions for improving handling and comfort.

IV. Reference

[1] Andrzej Milecki , Miko Aj Hauke,2012, Application Of Magnetorheological fluid In Industrial Shock Absorbers, Mechanical Systems And Signal Processing 28,528–541.

[2] Babak Ebrahimi , Mir Behrad Khamesee , M. Farid Golnaraghi,2008, Design And Modeling Of A Magnetic Shock Absorber Based On Eddy Current Damping Effect, Journal Of Sound And Vibration 315, 875–889.

[3] Alberdi-Muniain , N. Gil-Negrete , L. Kari, 2012,Direct Energy flow Measurement In Magneto-Sensitive Vibration Isolator Systems, Journal Of Sound And Vibration 331,1994–2006

[4] Bart.L.J.Gysen, Johannes.J.H.Paulides, Jeroen.L.G.Janssen, 2010, Active Electromagnetic Suspension System For Improved Vehicle Dynamics, IEEE Transactions On Vehicular Technology, Vol.59.No.3

[5] Georgios Tsampardoukas, Charles W.Stammers, Emanuele Guglielmino, 2008,Hybrid Balance Control Of A Magnetorheological Truck Suspension, Journal Of Sound And Vibration31.7 ,514-536

[6] Kirk T. Mcdonald, Joseph Henry Laboratories, Princeton University, Princeton, NJ08544,2012, Magnetic Damping

[7] Zekeriya Parlak, Tahsin Engin, Ismail Çallı, 2012,Optimal Design Of MR Damper Via Finite Element Analyses Of Fluid Dynamic And Magnetic Field, Mechatronics 22, 890–903

[8] R. Zalewski , J. Nachman , M. Shillor , J. Bajkowski,2013, Dynamic Model For A Magnetorheological Damper, Applied Mathematical Modelling

[9] Ammar A. Aldair and Weiji J. Wang School of Engineering and Design, University of Sussex, Falmer, East Sussex, UK ,THE ENERGY REGENERATION OF ELECTROMAGNETIC ENERGY SAVING ACTIVE SUSPENSION IN FULL VEHICLE WITH NEUROFUZZY CONTROLLER

[10] Aniket Thosar, Design, Analysis and Fabrication of Rear Suspension System for an All Terrain Vehicle, International Journal of Scientific & Engineering Research, Volume 5, Issue 11, November-2014 258 ISSN 2229-5518

[11] Arindam Pal, Sumit Sharma, Abhinav Jain, C.D.Naiju, Optimized Suspension Design of an Off-Road Vehicle,The International Journal Of Engineering And Science (IJES) ||Volume||2 ||Issue|| 6 ||Pages|| 57-62||2013|| ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805.

V. Authors

Mr. Sagar Suryakant Khatavkar obtained his Masters of engineering from Mumbai University in Manufacturing System Engineering. He is currently working as Asst. Prof. in Automobile Department of Saraswati College of engineering. His research areas are Dynamics of Machinery, Mechanical Vibration and Automotive design.

Mr. Dinesh Anchan , Mr. Prathamesh Deo, Mr. Samruddha Kale, Mr. Krushna Umate are presently pursuing their bachelor of Engineering in Automobile Engineering. Their topic of research are automotive design and Suspension.