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Electromagnetic Suspension System-A Review

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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 the. 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.

1. Introduction

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 road holding/ 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 antisquat ?". Anti-dive and anti-squat are percentages that indicate the degree to which the front dives under braking and the rear squats i.e.; suspension will extend under acceleration. Now coming back to the primary function 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.

2. 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 Khamese, M. Farid Golnaraghi, 2008,
[2] Design and modelling 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 have 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 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 have 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.

Kirk T. McDonald, Joseph Henry Laboratories, Princeton University, Princeton, NJ08544 (April14,2012)
[3] 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 conductor 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.

Ammar A. Aldair and Weiji J. Wang,
[4] 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, [5] 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, modelling 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,[6],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.

4. Conclusions

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.

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