An Overview on Suspension System

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ABSTRACT: ***Suspension systems don't receive a lot of attention, yet they're arguably the most important element in how much fun you have driving your vehicle on a daily basis. Automobile designers are always modifying and improving their designs in the pursuit of that elusive ideal: a flawless ride with race-worthy handling. We're not quite there yet, but the most recent systems are doing a better job than ever at balancing the conflicting objectives of comfort and performance. When it comes to suspension design, manufacturers have tried a variety of methods, just as they have with most other components on a vehicle. Luxury vehicles are designed to provide a smooth ride, while sports cars must corner at high speeds. Trucks, on the other hand, must transport large loads and may go off-road.***

KEYWORDS: ***Active Suspensions, Adaptive Control System, Intelligent Control, Modernization of Suspensions, Vehicle System.***

1. INTRODUCTION

Suspension is a system that links a vehicle to its wheels and enables relative motion between them. It consists of tires, tire air, springs, shock absorbers, and linkages. Suspension systems must accommodate both road handling and ride quality, which are incompatible. Suspension adjustment requires a thorough knowledge of the situation. Because all ground forces acting on the vehicle pass via the contact patches of the tires, it is critical for the suspension to maintain the road wheel in touch with the road surface as much as possible. The suspension also protects the car and any personal property from damage and wear[1]–[4].

1.1 History of Suspension System:

Horse-drawn carriages dominated the streetscape until the turn of the century, but the introduction of the automobile, which Gottlieb Daimler and Carl Benz developed independently in 1886, established a completely new set of requirements in comparison to those associated with horse-drawn carriages, especially in terms of suspension: it was necessary to c Gottlieb Daimler and Carl Benz took different methods to this: whereas Benz's Patent Motor Car was based on a carriage with a steering system and utilized a steering head and wire wheels, Daimler's vehicle was based on a carriage with a steering system. Technology advanced quickly. The "wire-wheel vehicle" was invented by Wilhelm Maybach, Daimler's genius design engineer, in 1889. This vehicle, like the Benz, now had a chassis that was totally separated from the realm of carriage construction. There was also significant advancement in the development of engines, which grew more powerful, making vehicles quicker but also heavier, putting new demands on the suspension. As a result, the design engineers came up with more complex solutions. Coil springs were gradually used, for example, on the back axle of the Daimler belt-driven vehicle of 1895. However, it was Carl Benz, not Gottlieb Daimler, who developed the "double pivot" steering mechanism, which addressed the issue of how to drive a four-wheeled vehicle. In 1893, Benz submitted a patent for this innovative form of steering, which was initially utilized in the Victoria model[5].

1.2 the suspension system work:

Wheel movement is independent of the body thanks to the suspension control arms or links. This creates a barrier between the body and the road bumps. The springs attempt to bring the frequency of road disturbances into a more tolerable range. They also dampen vibrations through friction (spring ends and seat) and their own hysteresis. The energy of the dynamic load transmitted via the road bumps is dissipated by the damper. They work together to reduce the impact of road undulations on the vehicle's ride and stability[6]–[9].

1.3 Different Types of Suspensions used in Automobile Industries:

i. Dependent Suspension System:

This kind of suspension system works as a solid connection between two wheels, transferring any movement from one to the other. The force is also transferred from one wheel to the next. ATVs with a built-in suspension system are not appropriate for self-reliant mobility of the two wheels. The examples of dependent suspension systems are as follows:

- Composite Leaf Suspension: Heavy-duty cars use this kind of suspension (trucks, bus, etc.).
- Rod for pushing and pulling Suspension is a kind of suspension used in racing vehicles.
- Suspension with an anti-roll bar. Used in high-end automobiles.

ii. Independent Suspension System:

The wheel may move without influencing the motion of the opposing wheel using this kind of suspension. Because of its benefits over dependent suspension systems, this suspension system is extensively employed in passenger vehicles, luxury automobiles, and ATVs. The examples of independent suspension systems are as follows:

- Macpherson Suspension: Found in most commercial vehicles' front suspension.
- ATVs use a double wishbone suspension.
- Suspension for the trailing arm.

Most business vehicles have this kind of rear suspension.

1.4 Active Suspension System:

An active suspension system has the capacity to constantly decrease sprung mass acceleration as well as limit suspension deflection, resulting in progressive tire traction with the road surface and enhanced braking, grip control, and vehicle agility. The automobile industry is now engaged in a ruthless competition to create highly evolved vehicles. Advanced suspension systems are one of the performance concerns, as they prevent road disturbances from affecting passenger comfort while improving riding capabilities and ensuring a smooth drive. While the suspension system's goal is to offer a smooth ride in the automobile and aid in vehicle control over difficult terrain or in the event of an abrupt halt, boosting ride comfort results in a longer suspension stroke and less dampening in wheel hop mode. To address these suspension issues, a variety of control techniques have been advocated. Many active suspension control approaches, including as Linear Quadratic Gaussian (LQG) control, adaptive control, and non-linear control, have been developed and suggested to address the issues that have arisen.

i. Semi Active:

The damping coefficient of a semi-active damper may be inflected, but the direction of damping force is determined by the relative velocity between the sprung and unsprung masses. The system combines a damper with a variable dampening coefficient. Semi-active systems are those in which the properties may be quickly altered (typically in less than 100 milliseconds). The advancement of electro rheological (ER) and magneto rheological (MR) fluids has accelerated semi-active suspension research. Passive suspension systems can no longer meet the above-mentioned competing criteria; consequently, active and semi-active suspensions must be used. Active vehicle suspension systems were created in the early 1970s with the goal of optimizing the trade-off between ride comfort and road handling. Semi-active suspension allows for smooth damper coefficient adjustments. In terms of increasing ride quality, it may be almost as effective as completely active suspension. Semi-active control devices have the potential to provide the same level of dependability as passive control devices while maintaining the flexibility and adaptability of a fully active system. A excellent example of a device for semi-active suspension is a magneto rheological damper. The power controlled actuator, such as a linear electric motor or a hydraulic servomechanism, is placed between the wheels and the vehicle body in active suspension.

ii. Passive Suspensions:

The total orifice area (number of holes) in the piston head determines the damping value (Cs) of a passive damper.

iii. MR Fluid:

Oil with various percentages of ferrous particles (20-50 microns in diameter) covered with an anti-coagulant substance make up magneto-rheological fluid. The viscosity of the magneto rheological fluid is affected by altering the magnetic field intensity. The Semi-Active Suspension based on MR fluid is shown in Figure 1.

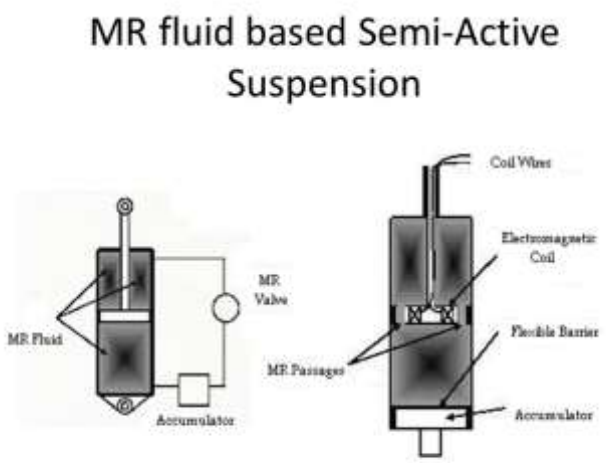

Figure 1: Illustrates the MR fluid based Semi-Active Suspension[10]

1.5 Objective of Suspension:

The suspension system's goals are as follows:

- To prevent road shocks from transferring to the vehicle's components.
- To protect the occupants from road shocks.
- To keep the vehicle stable while it is pitching or rolling while in motion.

i. Shock Absorber:

Shock absorbers are hydraulic pump-like devices that aid in the management of the vehicle's springs and suspension's impact and rebound movement. Along with dampening shocks and vibrations, the shock absorbers primary function is to guarantee that the vehicle's tyres stay in contact with the road surface at all times, resulting in the car's safest control and braking reaction.

1.6 Applications of Shock Absorbers:

Automobile and motorbike suspensions, airplane landing gear, and the supports for many industrial equipment all use shock absorbers. In structural engineering, large shock absorbers have been employed to decrease the vulnerability of structures to earthquake damage and resonance. A yaw damper is a transversely mounted shock absorber that helps prevents railcars from swinging too far from side to side. They're useful in passenger railways, commuter rail, and rapid transit systems since they protect railcars from destroying station platforms.

1.7 Benefits of Shock Absorber:

- *Safety:*

Shock absorbers are the most important part of the suspension system. As a result, their primary function in vehicle safety is to provide steering stability and whole vehicle security. Shock absorbers that are worn out lack the ability to regulate the vehicle and increase the stopping distance by approximately 20%. This puts the vehicle's safety and the safety of all passengers at jeopardy.

- *Stability:*

Stability is another key function of shock absorbers. They enhance the friction between the automobile tyres and the road, allowing the vehicle to maintain its stability on the road. Shock absorbers would be unnecessary if streets, highways, and rural roads were completely level. Even freshly resurfaced roads, however, contain minor imperfections that cause the wheel to wobble up and down. Without shock absorbers, all vertical energy from the wheels is transferred to the vehicle's structure. As a result, the wheels may lose contact with the road surface for a brief time before slamming back into the road due to Newton's gravity.

- *Comfort:*

Shock absorbers are most often linked with comfort. The issue of improving passenger comfort has been a significant element of the manufacturing process since the creation of the first vehicle. It was for this reason that absorbers were created. Their duty is to keep the car stable and guarantee that all passengers are comfortable. To offer a smooth and pleasant ride, they decrease the amplitude of vibratory movements caused by different road flaws.

2. DISCUSSION

A vehicle's suspension system is responsible for isolating the vehicle's chassis from road disturbances. It is necessary to keep a vehicle's tyres in constant contact with the road. The damper is the most essential component of a suspension system. It smooths out the shock of an unexpected bump on the road, reducing the effects. Vibration energy is transformed to heat in most shock absorbers and dissipated into the environment. Suspension systems are divided into three categories based on their controllability: passive, active, and semi-active. Despite the fact that each kind of suspension system has its own set of benefits and drawbacks, they all use spring and damper components. The car suspension system has been classified and briefly described in this article.

3. CONCLUSION

Suspension is a system that links a vehicle to its wheels and enables relative motion between them. It consists of tires, tire air, springs, shock absorbers, and linkages. Because the suspension bears the vehicle body and transfers all of the force between the body and the road, it is responsible for driving comfort and safety. The suspension system serves as a safety component for the vehicle by providing the appropriate height and cushioning against bumps and imperfections on the road surface. The car suspension system has been classified and briefly described in this article. The semi-active suspension system has been described as the most appropriate for road vehicles. Because all ground forces acting on the vehicle pass via the contact patches of the tires, it is critical for the suspension to maintain the road wheel in touch with the road surface as much as possible.

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