
Advancement in Suspension System for Automobile Industry: A Review

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ABSTRACT

In this paper we have discussed the suspension system for automobile industry and why there is a need of efficient suspension system. Also various types of suspension systems and their advantages. Then we have discussed modern suspension systems in various automobile companies and vehicles. This study of modern suspension system gives a brief idea about various advanced suspensions that exist currently. In order to bring comfort and stability in driving, a suspension system can play an important role. Right from the evolution of conventional suspensions to their advancements in today's modern world, everything is discussed in this paper. This paper is not only about a review on advances in suspension system but also about the requirement of upgrading various old components in suspension system in order to obtain an upgraded version of it. The comparative analysis of various type of suspensions gives the brief idea about their usage and advancements. When we compare some popular suspensions with each other, we got some interesting results, which are mentioned in the paper.

KEYWORDS

Suspension system, Advancement, Review, Comparative analysis, Automobile, Modern type of suspensions.

INTRODUCTION

Suspension is the term given to the system of springs, shock absorbers and linking that connects a vehicle to its wheels [1]. Suspension systems serve a dual purpose, contributing to the car's road handlings and breaking for good active safety and driving pleasure. It keeps vehicle occupants comfortable and reasonably well isolated from road noise, bumps, and vibrations. It is important for the suspension to keep the road wheel in contact with the road surface as much as possible, because all the forces acting on the vehicle do so through the contact patches of the tires [1]. The suspension also protects the vehicle itself and any cargo or luggage from damage and wear. The arrangement of springs and damper are made in such a way that it forms a system which protects vehicle chassis from various shocks and vibrations. Since from so many years various types of suspensions are being used. Their manufacturing and modification are done on the basis of road conditions and demand from market. But Now-a-days there is a high demand of superior suspensions that provides high performance and comfortable ride. So in this condition the conventional types of suspensions like Leaf Springs, Coil Springs, Mac Pherson strut, Wishbone type suspension, etc. are not used because they are unable to fulfill the requirement.

Hence a term called as "Advanced Suspension" is used for those type of suspension which are able to give maximum performance and comfortable ride in any road conditions. Advanced suspensions provides excellent resistibility towards the shocks received from roads. They provides override systems, good efficiency, low failure rate, superior design and mobility, maximum strength and durability. They also provides some smart technological features like driverless ride, personalized marketing based on your driving, health monitoring and remote vehicle shutdown, etc.

When we compare some popular suspensions with each other, we get some interesting results about it. WE came to know that according to the conditions of surrounding, the suspensions should be self-adjusting to get more comfort.

OBJECTIVES OF SUSPENSION SYSTEM

- Protection of passengers and goods from road shocks and vibrations.
- Provides good control over the vehicle while braking and cornering.
- It reduce wheel wobbling and providing riding comfort.
- Provides stability and gives cushioning effect [2].

DIFFERENT TYPES OF SUSPENSION SYSTEM

- Conventional suspension system
- Independent suspension system
 1. Independent front suspension system
 - A. Wishbone type suspension
 - B. Mac Pherson strut type suspension
 - C. Vertical guide type suspension
 - D. Trailing link type suspension
 2. Independent rear suspension system
- Air suspension system
- Telescopic shock absorbers

Wishbone and Mac Pherson type suspensions are well known and commonly used everywhere. Role of independent front and rear suspensions are very important for a vehicles safety.

1. WISHBONE TYPE SUSPENSION

This type of suspension is widely used in most of the economy automobile. The use of coil springs in the front axle suspension of cars is now almost universal. This type of suspension consist of upper and lower wishbone arms which are fixed to the frame member. The spring is placed in between the lower wishbone and the underside of cross-member. This arrangement are made in such a way that the vehicle weight is transmitted from the body and the cross-member to the coil spring through which it goes to the lower wishbone member. A shock absorber is fitted inside the coil spring which sustains the shocks received from the road. The lower wishbone has sufficient length thus it gives the more constant track when the wheels are lifted. The arms of the lower wishbone are designed in such a way that they may resist the breaking torque [4]. In such a way this type of suspension has more advantages and hence it is used widely in most of the cars.

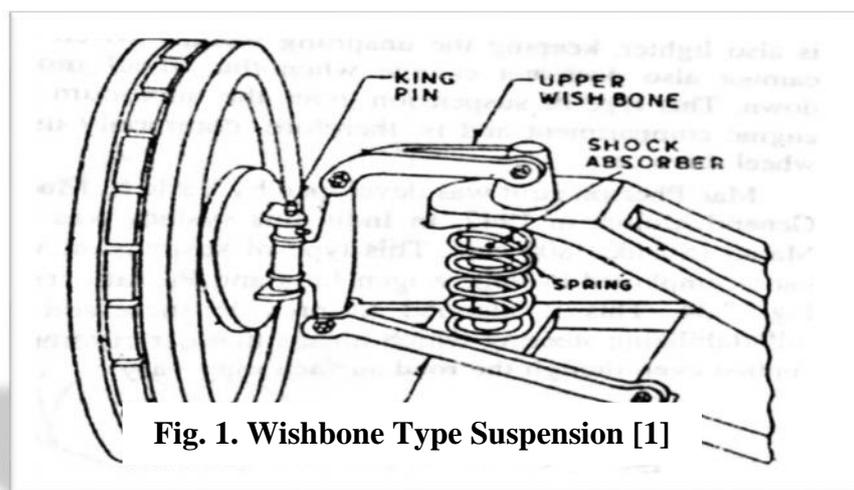


Fig. 1. Wishbone Type Suspension [1]

2. MAC PHERSON TYPE SUSPENSION

Wishbone type suspension is modified to get Mac Pherson type suspension. In this system, only lower wishbone is used which is hinged to the cross member. The wishbone positions the wheels and wheel resists acceleration, braking and side forces. A strut contains shock absorber and spring, and carries stub axle on which wheel is mounted [2]. Main advantages of this type of suspension system is, it is very light in weight, which reduces unnecessary weight on springs. The chassis of the vehicle does not moves when wheel goes up and down direction. Due to its light weight and small size, it provides maximum space for engine. This type of suspension system is used in Maruti 800, Swift, etc. Fig.2. Gives the brief idea about Mac Pherson strut.

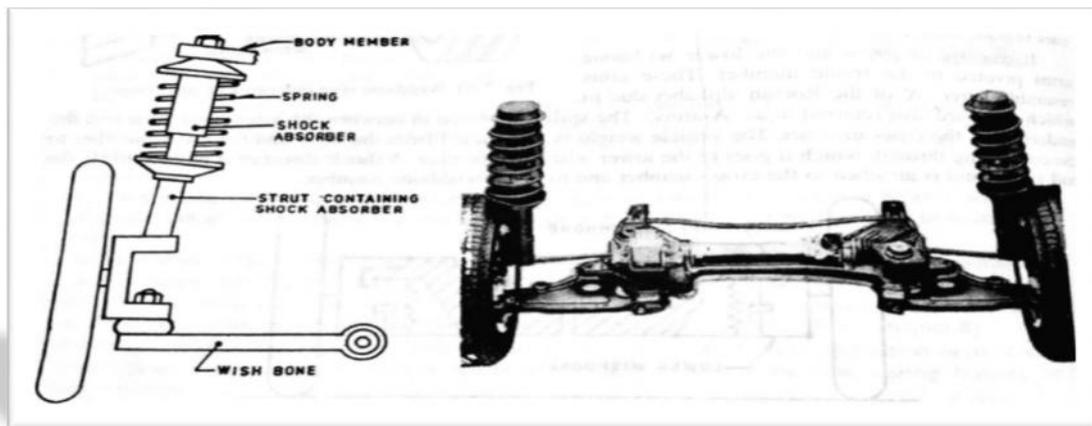


Fig. 2. Mac Pherson Type Suspension [1]

3. AIR SUSPENSIONS

Air suspension is a type of vehicle suspension powered by an electric or engine driven air pump or compressor. This pump pressurizes the air, using compressed air as a spring. Air suspension is often used in place of conventional steel springs, and in heavy vehicle applications such as buses and trucks. If the engine is left off for an extended period, the vehicle will gradually settle to the ground. The purpose of air suspension is to provide a smooth, constant ride quality and in most cases it is self-leveling. Generally there are two types of air springs (a) Bellow type & (b) Piston type [1]. Both the types of air springs are used in vehicles. But however some advancements are takes place in both the models, which increases their efficiency and durability. The main advantage of air suspensions is that, they have improved the standard of ride comfort & noise reduction is attained. Air suspensions brings dynamic ride for user, which is a big advantage of it, because no other conventional type of suspension is able to do that.



Fig. 3. Air Suspensions [3]

4. TELESCOPIC SHOCK ABSORBER

A springing device must be a compromise between flexibility and stiffness [1]. If it is more rigid, it will not absorb road shocks efficiently & if it is more flexible it will continue to vibrate even after the bump has passed. So the springing device should neither be rigid nor so flexible. Telescopic shock absorbers are used in wide range for bikes, mopeds, etc. The spring which is used in this absorber has the high capacity to sustain heavy load in any adverse situation. It is of a tabular shape and a liquid of specified viscosity is filled in it. The liquid is in the composition of 60% Transformer oil and 40% Turbine oil. However just similar to the air suspensions some modifications are take place in this type of suspensions, to increase its efficiency. Fig.4. gives the brief idea about telescopic shock absorbers.

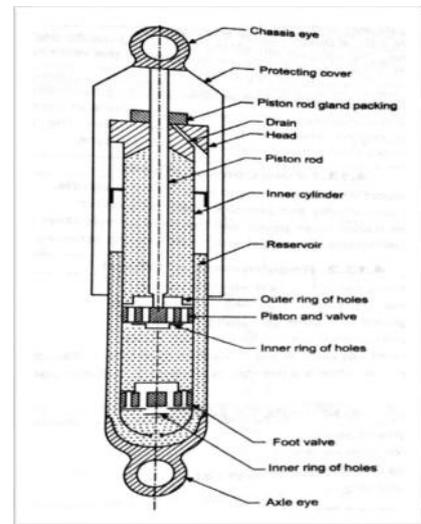


Fig. 4. Telescopic Shock Absorber [2]

ADVANCEMENT IN SUSPENSION SYSTEMS

As we have seen some important and widely used suspensions, which are having their own importance in their field of use. But as we discussed earlier this type of old suspensions are not able to satisfy the requirements of modern luxury vehicle production companies. So to satisfy them and to bring comfortable and safe ride, lot many modifications are made, this modifications are explained further.

1. NITROX SUSPENSIONS

The rear shock absorbers on current Bajaj Pulsar series bikes are also popularly known as NITROX shock absorbers. These types of shock absorbers are actually called as ‘Gas Filled Shock Absorbers’. The small canister (box) which is attached is filled with the nitrogen gas. Therefore it is called as ‘Gas filled shock absorbers [4].’ The main purpose for using nitrogen is to improve the efficiency of shock absorbers. The dampers have a tendency for the oil to form foam (form bubbles) under heavy use and riding conditions. The foaming is usually caused by air bubbles inside oil during suspension action. In order to solve this, a secondary cylinder is connected to the shock absorber which acts as a reservoir for the oil and pressurized gas (nitrogen). The pressurized nitrogen gas inside the canister prevents foaming of hydraulic oil inside the damper due to heavy usage or damping action. Due to this, the performance of the suspension remains constant [4].



Fig. 5. Nitrox Suspension [4]

2. AIRMATIC AIR SUSPENSION SYSTEM

This is one of the most advanced suspension system owned by a well-known company Mercedes-Benz. The innovators of Mercedes-Benz introduced air suspensions in car. Air suspensions are designed and used over a wide range in heavy vehicles like buses, trucks, etc. But introduction of air suspensions in cars was one of the

biggest revolution in automobile industry. The damping of each wheel self-adjusts according to the current driving situation and the condition of the road. This adjustment happens within the friction of seconds. The pneumatic self-levelling suspension fully automatically adapts the ride height independent of the load. In order to minimise aerodynamic drag, the system lowers the ride height automatically from a speed of 100 km/h [5]. All the advanced options can be selected through AGILITY SELECT which is a console provided at the dashboard. So it is very comfortable and luxurious as all the desirable mode of driving can be selected from dashboard itself. This is similar to BOSE SUSPENSION SYSTEM.

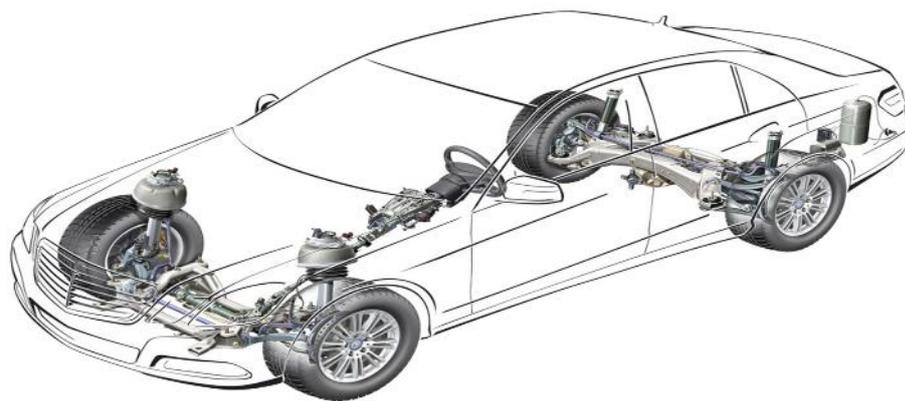


Fig. 6. AIRMATIC Air Suspensions in Mercedes-Benz [5]

3. DRC SYSTEM

"Dynamic Ride Control". The system is a mainly mechanical suspension, and uses a pump to keep pressure in the shock absorbers during cornering to avoid rolling and pitching. The system can adjust the stiffness at each shock absorber constantly to maintain both a comfortable ride and high grip. The shocks are connected in two diagonal circuits each with a separate central valve [6]. However, DRC's main advantage is that it operates without the need of the complicated electronics required in similar systems used in Mercedes-Benz and other companies. In this DRC system the spring and dampers have excellent tunings, which optimizes the contact with the road. Sports suspensions can be adjusted in such a way that, they can be lower 10-20 mm than normal suspensions [7]. Whatever the situation will arise the suspensions are self-adaptive. They don't need much power or complicated electrical circuits to perform their operation. Hence they are also called as Adaptive Air Suspensions. The self-adaptive Dynamic Ride Control in Audi RS 7 Sport back is shown in fig. 7.

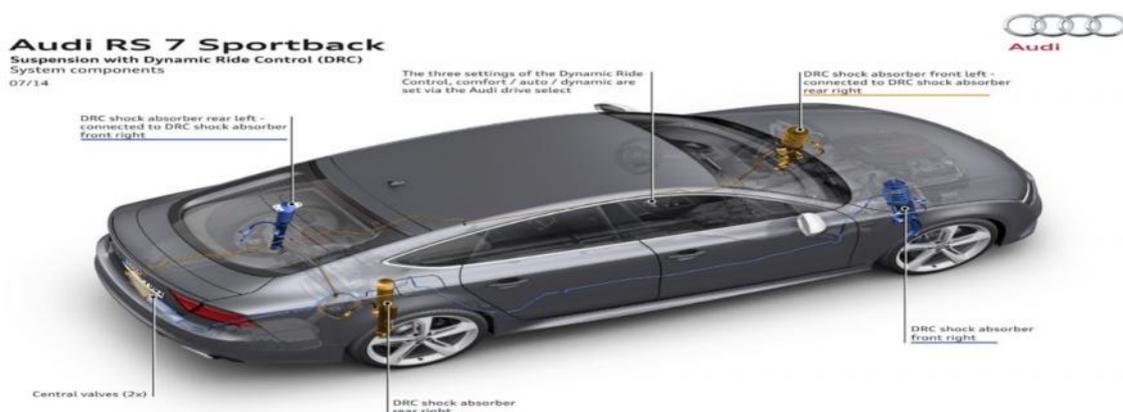


Fig. 7. Dynamic Ride Control System in Audi RS 7 Sportback [7]

4. MILITARY REQUIREMENTS

Defense sector of any country plays very important role in security. Working situations and conditions of military personals are much more different than common man. They have to work in adverse weather conditions with full load on their vehicles. They need powerful engines with high performance 4×4 transmission systems, High breaking strengths and most importantly a strong & heavy duty suspension system. An advanced and fully upgraded suspension system plays very effective role in military sector. The suspensions should be enough capable to sustain shocks and vibrations from hill and war fields. For such a heavy duty suspension the combination of two suspensions are made and then they are introduced in the heavy trucks and jeeps.



Fig. 9. Independent Military Suspensions [8]

LEADING COMPANIES

To manufacture this advanced suspensions some companies are offering excellent & advanced shocker technology.

1. Delphi Automotive PLC

Delphi Automotive PLC is an automotive parts manufacturing company headquartered in Gillingham, Kent, UK. It is one of the world's largest automotive parts manufacturers and has approximately 161,000 employees. 'Magna Ride' shock absorbers are fitted to high-end cars in USA & Europe, e.g., Audi (TT & R8) and Ferrari [1].

2. Tenneco Automotive Pvt. Ltd.

It is one of the arising electronic suspension manufacturer. Their 'Computerized Electronic Suspensions (CES)' is being used in some models of Volvo, Mercedes-Benz, Ford and Audi [1].

3. ZE Sachs

Their computerized Damping Control (CDC) shockers are being supplied to Audi, Porsche, Bentley and BMW to be employed in selected models. Its main advantage is that, driver who just have to push a button on the dashboard, it makes the car safer and easier to drive [1].

RESULT & DISCUSSION

With the reference to the above information we came to know that different types of suspensions can be used in suitable conditions. Referring to their properties and abilities a comparative table can be obtained.

Table 1. Comparative Analysis

Type of Suspension	Comfort	Load Bearing Capacity	Safety Factor	Construction	Cost	Applications
Wishbone Type	Moderate	Moderate - High	Good	Heavy in weight & less efficient	Economical	In cars and mini trucks
Mac Pherson Strut	Moderate	Moderate - High	Good	Light in weight & good efficient	Economical	In cars like swift, Spark, Alto, etc.
Telescopic Shock Absorbers	Moderate	High	Good	Light in weight & moderate efficient	Economical	Bikes & Mopeds
Nitrox	High	Moderate - High	Good	Light in weight with maximum efficiency	Economical in some cases	Sport bikes and economical bikes
DRC	High	Moderate	High	Simple and advanced	Costly	Audi & Lamborghini (Sports Car)
AIRMATIC	High	High	High	Complicated with high efficiency and advancement	Costly	Mercedes-Benz

CONCLUSION

As we discussed earlier that various advancement has been takes place in automobile industry to make it more and more effective, safe & comfortable. However for creating anything new which is beyond imagination, needs great innovation power and today's world is full of innovators. New innovations held in Mercedes-Benz, Audi and other well-known companies, which are beneficial for their position in market. But as the generations are changing, life styles are changing, it has a great effect on automobile industry. Different cars with aerodynamic models are introduced in market. Now-a-days supersonic cars and bikes are in trends. Right from the Maruti 800 to Bugatti Veyron 16.4, we can observe the tremendous change in the designing of cars. As the designing of car interior and exterior is developed, in the same way there is a high demand for improvement in the conventional type of suspension system. In order to match up with the high profile designing of car, suspensions must have some dynamic designs, so that it can increase car's efficiency & safety.

The designing of suspension system must be in such a way that, it must sustain instant impact and withstand in the emergency or high speed conditions. When we are talking on safety, maximum weightage goes to suspension design. By comparing some properties of suspensions, we came to know that all of them are

cannot be used in any condition, however DRC and AIRMATIC can be used in adverse conditions. So advancement in suspension system is very important for automobile industry because safety, comfort & luxury are directly related to it. In future also there is a much more scope in the advancement of automobile industry, because it is the backbone of today's world.

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