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Review on shock absorbers & suspension system

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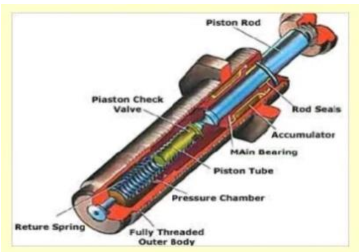
Abstract – Shock absorber is an essential part of suspension system in vehicles. There are different types of springs used in shock absorbers such as helical, leaf, coil, etc. Shock absorbers used in auto mobiles, industries in machines, robots, etc. A spring in shock absorbers absorbs or store energy so that it called mechanical devices. Shock absorbers design in such a way to give comfortable ride with smooth out damp shock impulse and dissipate kinetic energy. The aim of this review paper is to analyses and minor study on shock absorbers.

1.INTRODUCTION

Shock absorber consist of two parts first is spring and second is damper, where spring is a elastic member or device which store mechanical energy is to made by spring steel when a spring stretched or compressed it exerts a apposing force . There are different types of spring used in automobile discussed below mostly springs are obey hooks law. Mainly, shock absorbers are also known as oil pumps, a piston is installed at the end of piston rod and it runs hydraulically . when a vehicle run on worst road it move or roll up and down motion due jerks or damps condition of road so hydraulic fluid forced through some orifices holes consist in piston these orifices allows worst only little amount of fluid as a oil enters through the piston due to this a restriction cause to piston or slow down spring and suspension movement.



<u>(1.1) MAIN COMPONENT OF SHOCK ABSORBERS ARE:</u>
(a) PISTON ROD,(b) MAIN BEARING,(c) PISTON RINGS,(d) PRESSURE CHAMBER,(e) OUTER BODY

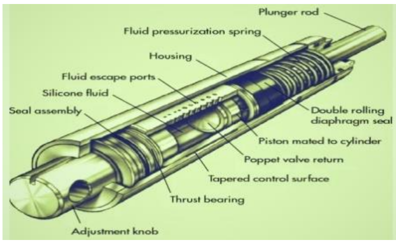
(a) Piston and piston rod is most necessary part of whole mechanical device mainly made up of high tensile steel has long life .piston rod attached one end of piston rod .

(b) The function of main bearing is provide lubrication to whole shock absorber .

(c) Main function of rings are seal the lubrication oil or maintain pressure .mainly two types of piston rings are pressure ring and lubrication ring .pressure ring maintain pressure and other ring restricts lubrication oil.

(d) It is made by hard alloy steel and can with stand up to internal pressure about 1000 bar.

(e)Outer body covers whole components and protect them from dust and foreign material like dust particles .



1.2 <u>Selection of material :</u>
Material and its allowable stress table given below of spring material used in shock absorbers .

Material and its allowable stress

Sr No.	Material	Allowable Shear Stress (N/mm²)			Modulus of Rigidity(G) KN/mm²	Modulus of Elasticity(E) KN/mm²
		Light	Average	Severe		
1	Carbon steel					
	Diameter 2.125mm	651	525	420	80	210
	Diameter 2.125 to 4.625mm	595	483	385	80	210
	Diameter 4.625 to 8.00 mm	525	420	336	80	210
	Diameter 8.00 to 13.25mm	455	364	294	80	210
	Diameter 13.25 to 24.25mm	392	315	252	80	210
	Diameter 24.25 to 38.00 mm	350	280	224	80	210
2	Music wire	612	490	392	80	210
3	Oil tempered wire	525	420	336	80	210
4	Hard drawn spring wire	437.5	350	280	80	210
5	Stainless steel wire	437.5	350	280	70	196

1.3 <u>SHOCK ABSORBER TYPES ARE:</u>

There are many types of shock absorbers available in market /industry different kinds of techniques are there to reduce shocking effect on running vehicles and to make a ride comfortable.

(a) Metal springs,(b) Elastomeric shock absorber (rubber butter),(c) Hydraulic dash pot,(d) Collapsing safety shock absorber (e) Pneumatic cylinder,(f). Self compensating hydraulic .

(a) METAL SPRING : Metal spring type shock absorber more and more used in industries because if its lower of its lower cost has better cushioning effect . it reducing the collision speed and reducing shock loading .they are able to operate in every hard condition under large range of temperature . metal spring store or absorb more and more energy rather than dissipating it . metal spring provide cushioning effect with help of damper . there are differ type of metal spring ,helical spring , bevel washes ,leaf spring , ring spring , mesh spring etc.

(b) ELASTOMATIC SHOCK ABSORBERS: These are low cost option for reducing the collision speed and shock loading providing damping system. These devices have high stopping force at end of strokes with internal damping .Elastomeric dampers are more used because of its advantage its low cost. The inherent damping of elastomers is useful in preventing excessive vibrations amplitude resonance much reduced metal spring .

(c) HYDAULIC DASHPOT : This type is based on simply hydraulic cylinder as a piston rod is moved hydraulic fluid is forced through an orifices which restricts flow and consequently provided a controlled resistance to movement at the piston rod with anyone metering orifice the moving load is abruptly slowed down at the start of stroke . The breaking force rise to a very peak at the start of the stroke and then fall away rapidly on completion of the stroke system being stable the energy being dissipate in the hydraulic fluid as heat , hydraulic fluid as heat hydraulic dash pot provide with spring return actuator after impacting load is removed.

(d) COLLAPSING SAFETY SHOCK ABSORBERS : This type of shock absorber single type used for or designed in such a way they collapse and impart energy is absorbed or material distord in their yield range or elastic range .

(e) PNEUMATIC SPRING : These shock absorbers use air as the re strict medium . air has a high energy storage capacity compared metals and elastomeric material for heavy duties with high loads and deflection the air spring is generally for more compact that equivalent metal or elastomeric devices . due to compressed of air . these have a sharply rising force characteristics towards the end of stroke the majority of energy is absorbed near the end of stroke. air spring required more maintenance than elastomers and spring .force on air cylinder can be determined by pv =constant.

(f) SELF COMPENSATING HYDUAULIC :These shock absorbers are similar to the hydraulic dash pot type except an of orifices are provided allowing different degree of restriction throughout the stroke .these devices are constructed or designed to bring moving load is smoothly a constant resisting force throughout entire shock absorber stroke . This type provided with return the actuator to its original position after impacting load removed.

2. Literature review

An exhaustive literature review is carried out to know the recent practices and theories in shock absorber design. It will also help to obtain a superior understanding of internal components and internal flows had been designed and modeled in the past.

Reybrouck introduced one of the first brief parametric models of a mono tube damper reference[3]. Flow restriction forces were found using experimental relationships that included leak restriction, port restriction and spring stiffness correction factors. Once individual internal forces were found, another experimental relationship was used to calculate the total damping force. Pressure fall across the specific flow restrictions could also be found. These correction factors had some physical meaning, but their values were found through experimentation. Reybrouck later completed his model to a twin tube damper and included a more physical representation of hysteresis [3]. It was shown that hysteresis was caused not only by oil compressibility, but the compressibility of gas bubbles transferred from the reserve chamber. It was also shown that reserve chamber pressure greatly affects the solubility of nitrogen.

Kim [4] also performed an study on a twin tube damper with focus on a vehicle suspension system. Kim's model [4] included chamber compliance and fluid compressibility which yielded a differential equation for the chamber pressures that was solved using the Runga Kutta Method. Discharge coefficients were experimentally found and applied to the model. Incorporated damping data into a car model, the frequency response of the sprung mass and tire deflection were calculated numerically.

On the other hand Lang was one of the first examiner who was first examine the internal physics of the fluid and the valves in an attempt to model their behavior.In 1977, Lang published his Ph.D. studying the behavior of automotive dampers at high stroking frequencies [5]. The work included creation of one of the first parametric models of a twin tube automotive damper with good performance on experimental data. This paper is the milestone paper in understanding

performance behavior of new techenology dampers. The concepts behind Lang's model "The development of a mathematical model of shock absorber performance based upon dynamic pressure flow characteristics of the shock absorber fluid and the dynamic action of the valves" [5].Lang's model included the efficient compressibility. This aided in correctly modeling one influence on hysteresis. Chamber pressures were also examined. The model used equations for standard steady orifice flow based upon pressure fall across the flow orifice. The dynamic discharge coefficients and the valve notch forces were found experimentally. A limitation of Lang's model was computing power; his work was completed on an analog computer. For this reason, dynamic discharge coefficients were assumed constant.

S K Mangal et al . [6] Mathematical research on Math lab. His experimental analysis on Electro dynamic vibration shaker s comparative analysis can predict the damp force of MR Damper. Variable Flux intensity can varies density of alignment. Damping force depends upon induced magnetic field. Its piston and cylinder are made of EN!A Low carbon steel .Magnetic flux can found out with help of Reluctance and Permeability Finding For each and every section as shown in Figure

Magnetic Force F= Rϕ=NI ...(3)

N= no of magnetic coil turn

I = Input current Passed through coil

Φ= Magnetic Flux =BA ....(4) B= Megnetic Flux Density A= Cross Section Area

Magnetic Reluctance R = L/μA ... (5)

L = length of Component μ= Magnetic Permeablity

Variable damping is produced by varying current in MR damper .mat lab developed Equation (4 & 8) Yield Stress

Γ= (6.9*102)+(4*104)B- (1*105)B2+(9.1*104)B3 ......(6)

FΓD=FΓ+Fή+Ff.. ... (7) Where

FΓD=Total damping Force

FΓ = Force Component Due to induced Yield stress Fή= Viscous Force Of Component Ff.. =Frictional force Component

By increasing Magnetic field increase in damping force.

Talbott's M.S. thesis in 2002 introduced a objective model for an Ohlins NASCAR type mono tube racing damper [7]. One major goal of this model was to correlate the model to the real physics of the damper to avoid experimental correction factors used in past models. Talbott and Starkey also published these findings in SAE paper [7]et.al. Total flow is comprised of valve orifice flow, bleed orifice flow, and piston leakage flow. Flow resistance models were created for each separate flow based on the pressure drop across the orifice, path per Lang's work. Pressure in the gas chamber, Pg, was correlated to the pressure in the compression chamber, Pc using force balance on the gas piston. Talbott assumed the oil and gas in the damper was incompressible.

Sanjeev Chaudhary [8] also modeled spring loaded hydro-pneumatic suspension, consistent in roll plane as a four-degree-of-freedom dynamical system focus to excitations arise from worst condition of road and roll moment caused by directional maneuvers, is analytically investigated for its ride and handling performance. The static and dynamic properties of the interconnected suspension are resulting and discussed in terms of its suspension rate, roll stiffness, and damping forces. The results show that the proposed interconnected hydro-pneumatic suspension can provide comparatively improved performance in both bounce and roll modes. Large spring rate leads to reduce interconnection effect whereas; s..maller rate leads to large stmt size and pressure. In general, the results show that the proposed interconnected hydro-pneumatic suspension can provide comparatively improved performance in both bounce and roll modes.

Adrian Simms et al. [9] introduced damper for the output characteristics of attention were pretend for sinusoidal excitations of 1, 3 and 12 Hz. In order to select the optimum damper modeling strategy for a 'virtual damper tuning environment', the suitability of the differing approaches were determined with respect to the different criterion like ability to capture damper non-linearity and dynamic behavior, flexibility to model different shock absorber types, ease of model generation (Experiment/Parameter identification), suitability for use in vehicle simulations and usefulness as a predictive tool. All of the sine wave amplitudes were 0.05m with exception of the 12 Hz signal which was 0.005m.These pretend results were then compared to those obtained from researches for identical excitation signals.

3. VEHICAL SUSPENSION:

In a vehicle, it reduces the effect of traveling over rough ground, leading to improved ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. Without shock absorbers, the vehicle would have a bouncing ride, as energy is stored in the spring and then released to the vehicle, possibly exceeding the allowed range of suspension movement. Control of excessive suspension movement without shock absorption requires stiffer (higher rate) springs, which would in turn give a harsh ride. Shock absorbers allow the use of soft (lower rate) springs while controlling the rate of suspension movement in response to bumps. They also, along with hysteresis in the tire itself, damp the motion of the unspring weight up and down on the springiness of the tire. Since the tire is not as soft as the springs, effective wheel bounce damping may require stiffer shocks than would be ideal for the vehicle motion alone. Spring-based shock absorbers

commonly use coil springs or leaf springs, though torsion bars can be used in tensional shocks as well. Ideal springs alone, however, are not shock absorbers as springs only store and do not dissipate or absorb energy. Vehicles typically employ springs and torsion bars as well as hydraulic shock absorbers. In this combination, "shock absorber" is reserved specifically for the hydraulic piston that absorbs and dissipates vibration.

(3.1)*REGENERATIVE SUSPENSION: According to the working principle, the regenerative suspension can be divided into two types: mechanical and electromagnetic regenerative suspension.

[A]. Mechanical Regenerative Suspensions: The mechanical regenerative suspension is reformed from the traditional hydraulic or pneumatic suspension. It absorbs the kinetic energy of suspension and converts into potential hydraulic or pneumatic energy to be stored in accumulator. However, these hydraulic or pneumatic systems characterize some disadvantages. One, the complex pipeline system has considerable weight and need more installation room. Two, hose leaks and ruptures may disable the whole system. Three, the responding bandwidth of hydraulic or pneumatic systems is narrow, which confines the suspension performance. Four, the reuse of the regenerated hydraulic or pneumatic energy are limited, especially when the automotive industry is toward commercializing hybrid electric vehicles and full electric vehicles. Hence, the researches on hydraulic or pneumatic regenerative suspension are relative rare. Jolly et al. [10] proposed an energy regenerative system based on hydraulic device to control the vertical vibration of vehicle seat using the regenerated energy. Nissan [11] developed a fully active suspension system with hydraulic actuators, which suppresses the suspension vibration by accumulating or releasing the energy in the accumulator under the control of valves. Noritsugu [12] investigated an active air suspension via reclaiming the exhaust to control suspension vibration for improving suspension performance and decreasing energy consumption.

[B]. Electromagnetic Regenerative Suspensions: Electromagnetic regenerative suspension transforms the shock energy into electric energy that is more convenient to store and reuse, and has high performance, develop efficiency, little space requirements, reference [13]. Permanent magnates motor is favored in to Electromagnetic Regenerative Suspensions exerts active force in actuator mode or damping force. The damping force can be easily changed by tuning the shunt resistances. There are six types of electromagnetic regenerative suspension based upon structure configuration, and relating researches discussed below.

[B.1] Direct-Drive Electromagnetic Suspension

In direct-drive electromagnetic suspension, linear permanent magnets motor is used which eliminates the shock absorber. It changes the mechanical energy of relatively motion between vehicle chassis and wheel into electric energy and no need of transmission devices.

Okada et al. [14] conclude that the active and regenerative vibration control suspension using linear actuator, and its performances of vibration isolation and energy regeneration were analyzed. Suda et al. [15] also conclude that investigated a self-powered active vibration control system with two linear motors for truck cabins. In this system, an electric generator that is installed in the suspension of the chassis reproduces vibration energy and stores it in the condenser. An actuator in the cab suspension achieves active vibration control using the energy stored in the condenser. Since the weight of the chassis of a typical heavy duty truck is greater than that of the cabin, vibration energy in suspension of a chassis is expected to be greater than that in the cab suspension. So this system is self-powered. Further more, they proposed self-powered active vibration control using a single electric actuator. Goldner [16] invented an electromagnetic linear generator to capture the suspension vibration energy. Zuo et al. [17] designed a linear energy harvester to test the amount of energy which can be regenerated. Gysen et al. [14] utilized direct-drive electromagnetic motor to improve the suspension performance, and proved its efficiency for harvesting vibration energy. Bose Company [18] applied the linear motor in vehicle suspension. The system ends up consuming one-third of the energy used by a car's air conditioner.

[B.2] Ball Screw Electromagnetic Suspension:

Ball screw is also transmission device which converts linear motion into rotary motion. Arsem [19] constructed a electric shock absorber with ball screw to harvest vibration energy. Murty [20] also proposed a ball screw electric damper whose damping force can be adjusted by changing the shunt resistance. Suda et al. [16] invented a ball screw harvester and analyzed its dynamic and regenerative characteristics. F. Yu et al. [21] constructed a ball screw damper.fig.2 given below..

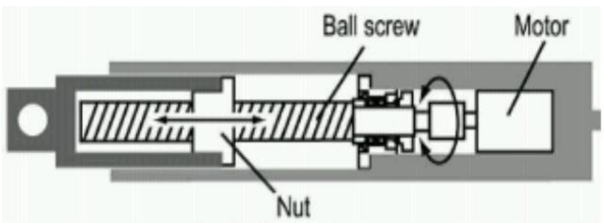


Fig.2 Ball screw harvester

[B.3} Rack-Pinion Electromagnetic Suspension:

Rack-pinion gear mechanism can also convert linear motion into rotary motion. Suda et al. [16] studied a regenerative active suspension combining rack-pinion and rotary motor. Beno et al. [22] invented electronically controlled active suspension system which adopted the rack and pinion mechanism. The invention results show that the limit speed and handling performance of vehicle had been raised.fig.3 given below…

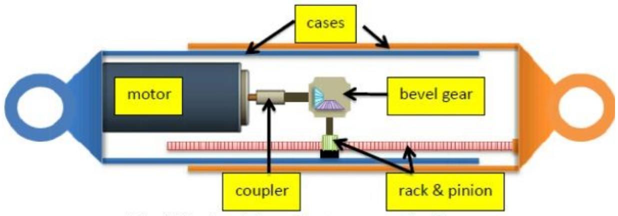


Fig.3 Rack-pinion electromagnetic damper

[B.4]Planetary Gear Electromagnetic Suspension:

Planetary gear is always used to reduce or increase rotate speed. Introducing the planetary gear is helpful for boosting motor efficiency and active force. In order to improve the regenerative efficiency, Suda et al. [16] add a planetary gear to ball screw damper. Horstman incorporating with L-3 and Texas University is developing ECASS for tracked combat vehicle. This system has a sufficient active force, compact structure and good safety property that the combat vehicles require.

[B.5] Hydraulic Transmission Electromagnetic Suspension:

Levant Power Corp. [23] is inventing a regenerative damper, called GenShock, combining hydraulic transmission and electric motor. In which the hydraulic motor driven by fluid rotates by a consistent direction whatever the piston runs up or down. Because the rotation direction of electric motor doesn't alternate frequently, the regenerative efficiency is improved. Levant Power Corp. claims that Genshock enhancing fuel economy of by up to 6% for military vehicles as well as improves ride quality via adaptable, variable-damping suspension. On the other hand, reduced heat dissipation in the damper through energy recovery helps to reduce maintenance requirements. Xu et al. [24] designed a hydraulic transmission electromagnetic energy-regenerative suspension, introduced its working principle, and the imitation results revealed that its complete functioning is greater to that of the passive suspension.

[B.6] Self-Powered Magnetorheological Suspension:

In recent days, magnetorheological (MR) damper has mechanical simplicity, high dynamic range, low power requirements, large force capacity and robustness. Aims to save energy extend more, many researcher have been studying self-powered MR damper. Jung et al. [25]

proposed a self-powered elegant damping system that consists of an MR damper and an electromagnetic induction (EMI) device to reduce vibrations. The EMI device absorbs vibration energy to generate electrical energy and power the MR damper. Although the EMI device is separated from the MR damper, it offers a new technology scheme for self-powered vibration control system. Choi [26] and Bogdan [27] exerted some similar researches.

4. CONCLUSIONS

In this study shock absorbers are discussed above and their types some diagrams are given above to clear concept of component of shock absorber .Also some researches on shock absorbers and suspension system are discussed above which are used in shock absorbers to modify and to resist the shocks obtained from bumping action from road and studied selection of material of spring.

REFERENCES

{1}. Machine design by RS.KHURMI.

{2}. Strength of material by SADHU SINGH .

{3}. Reybrouck K.G A non linear parametric model of an Automotive shock Absorber, SAE Technical paper series 940869, 1994.

[4]. Kim D, Analysis of Hydraulic shock absorbers and Implementation on the vehicle suspension system , M.s. Thesis, Seoul National University, S.korea, 1993.

[5]. Lang H.H A study of the characteristics of automotive hydraulic dampers at stroking frequencies, Ph.d. Dissertation, University of Michigan, Ann Arbor , 1997.

[6].S.K Mangal, Ashwin Kumar, KD chattopadhya, Development of MR damper Modeling and its Experimental vibration , The UIP Journal of mechanical Engineering , Vol 7th, NO 3, 2014.

[7]. Tallbott M.S, An Experimentally Validated Physical Model of high performance damper, M.S Thesis, Purdue University, Laffayette , 2002.

[8]. Sanjeev choudhary, A Thesis on Ride A Roll performance analysis of a vehicle with Spring Loaded Interconnected hydo-pnematic suspension , Concordia University,Montreal,Canada,1998.

[9]. Adrian simms nad David Crolla , The Influence of damper Properties on vehicle Dynamic Behavior, SAE Technical Paper series ,2002-01-0319.

[10]. jolly M margolis D, regenerative system for Vibration Control, Journal of vibration and Acoustic, 1997,119(2),pp.208-205.

[11]. AoyamaY, Kawabette K, Hasegawa S, Dovelopment of fully active suspension by Nissan, SAE paper 901747.

[12]. Norisugu T, Energy saving of pneumatic system. Energy regenerative of pneumatic drive system application of air suspension, Hydraulic and pneumatic, 1999,38(4),pp.1-4.

[13]. B.L.J Gysen Tom PJ, J.J.H Paulides et al, Efficiency of a regenerative direct drive active suspension IEEE Trans on vehicular Technology, vol.60, no.4, May 2011.

[14]. Okada Yohi ji , lim Sang-Soo, Ozawa keisuke, Energy regenerative active control suspension, proceeding of the ASME design, Engineering Technical conference, 2003, pp.2135-2142.

[15]. Nakano K, Suda Y, Combined type self powered active vibration control of truck cabin, vehicle system dynamics, 2004,41[6],pp.

[16]. R.B Goldener, P zerigan, electromagnetic linear generator and shock absorber, US Patent No 6952060,2005.

[17]. Lei Zuo, Scully, Sheshtani et al, Desighn and characterization of an electromagnetic energy harvester for vehicle suspension, Smart material and structure, 19(2010).

[18]. Jones W, Easy ride Boss Corporation. Uses speacker Technology to ear adaptive suspension, IEEE Spectrum,2005, 42(5); 12-14.

[19]. H.B Arsum electric shock absorber, US Patent NO 3559027.

[20]. B.V Murty Electric Variable damping vehicle suspension, US Patent NO 4815575, 1989.

[21]. Y.C Zhang, F Yu, Y.H. GU, et al, Isolation and energy regenerative performance Experimental verification of Automotive Electric Suspension, Journal of ShangHai Tong University, 2008, 42(6), pp. 874-877.

[22]. J.H Beno, D.A Bracie, et al. study on electromagnetic comparison losses for conventional passive and energy efficient active suspension system, SAE, 2002.

[23]. http://www.levantpower.com

[24]. Xu lin, Yung Bo, Guo Xuexun, et al, Simulation and performance Evaluation of Hydraulic Transmission Electromagnetic regenerative Active Suspension, 2010 Second WRI Global Congress on Intelligent system.

[25]. Choi Y.T, Wereley NM, Self power magnetorheological dampers, Journal of Vibration and Acoustics 2009, 131,pp. 44-55.

[26]. Bogdan Sapi naski, Vibration power generator for a linear MR damper,. Smart material and structure. 2010,19:105012.

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