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EXPERIMENTAL VERIFICATION OF ELECTRICALLY POWERED HYBRID SUSPENSION FOR AUTOMOBILES

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ABSTRACT

Passenger vehicle comfort is the target of every big OEM. Ride and handling need to be optimised very cleverly. Hybrid suspension using electrical power is one of the solution for today's customer demand of variable damping. The design of hybrid suspension system is done by 12 V DC motor coupled to power screw arrangement.The system works in two modes by varying the damping coefficient. A motor coupled to power screw varies the annulus of damper in 2 modes. This paper presents an experimental verification of ther design of hybrid suspension.

KEYWORDS: **Hybrid, Two mode damping, screw arrrangement, ride comfort.**

INTRODUCTION

The automobile suspension is a flexible link between the sprung and un-sprung mass of vehicle. Shock absorbers are a part of this system which dampens the vibrations of the system caused due to road excitations. The function of suspension system is to provide passenger comfort and vehicle handling characteristics.
The semi-active suspension systems are one step ahead of passive systems as they can vary the damping forces of shock absorber. In this electrically powered hybrid suspension system same is done by use of 12V DC motor. The semi-active damper is fail safe in principle. Even if controller signal is disconnected, it behaves as passive damper.

RIDE-HANDLING COMPROMISE IN AUTOMOBILE SUSPENSION SYSTEMS

An automobile suspension system is mainly designed for best quality of ride and handling. Many factors influence these two parameters. Damping value being focussed in this study refer Figure-1.Considering Q_r and Q_H as quality rating for ride and handling some facts have been studied. Plotting Q_r and Q_H for various damping values the polar curve gives us the idea about the effect of increasing the ride level on handling.Optimum values for best ride is around damping ratio 0.2 and best handling may require a ratio of 0.8. The practical range chosen is 0.25-0.75. Theoretically a damping ratio of 0.17 is considered ride optimumand ratio of 0.45 the optimum for road holding.Also a value of 0.44 for road holding of rough road[6]. This shows a need for variable damper which can be used comfortably by driver on different rioad conditions.

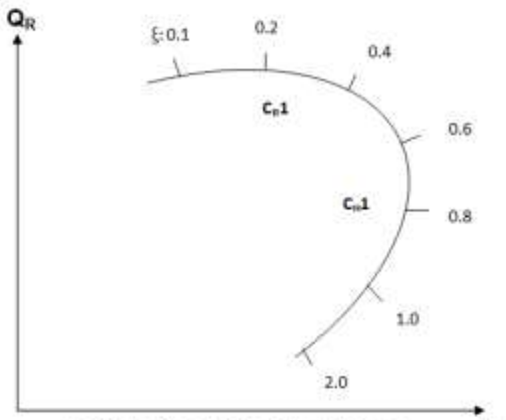

Fig-1 Ride handling quality loop with variable damping

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ELECTRICALLY POWERED HYBRID SUSPENSION SYSTEM

The design of hybrid suspension system involves 12 V DC motor coupled to ball screw arrangement. A helical spring is used with both ends ground. The free length of the spring is adjustable. The free length adjustment will adjust the ground clearance of the vehicle. The free length adjustment is done using precision linear actuator in the form of 12 V DC motor coupled to ball screw arrangement. It has precise displacement and accuracy of motion. The motor drives the screw and thereby the nut displaces to adjust the free length of spring. This also adjusts the displacement of the piston of the damper. The second part of design is hydraulic damper which is coupled to the screw arrangement and it adapts itself as per the motion of the screw and nut arrangement, thereby adjusting the damping coefficient

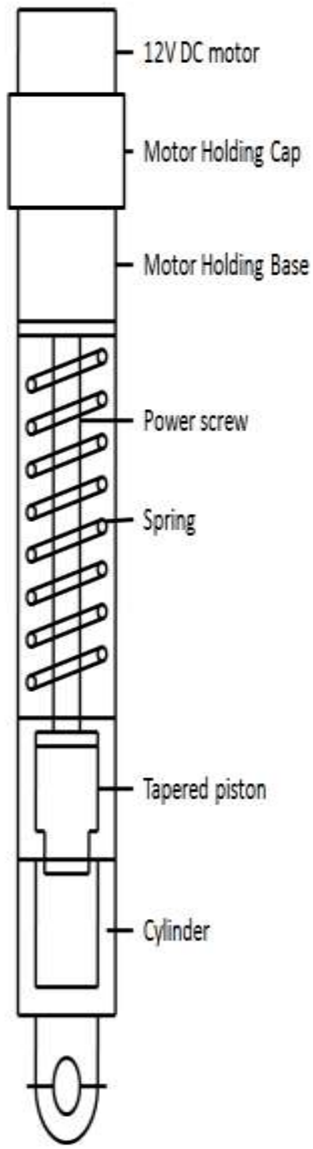

FIG-2 ELECTRICALLY POWERED HYBRID SUSPENSION SYSTEMS

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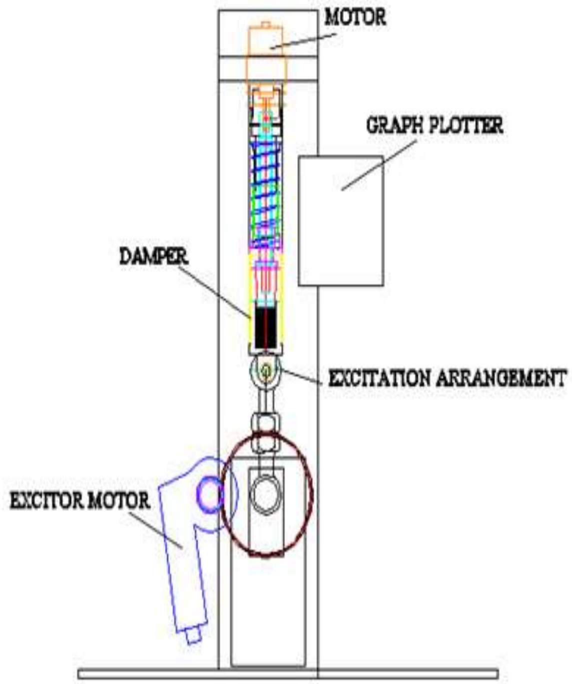
TEST SET-UP

The experimentation setup is as shown in Figure below.



RESULTS

Experimental tests were conducted for smooth and rough road condition damping. Displacement were measured for differentfrequencies from 1.15 rad/s to 5.77 rad/s. Mode-1 and mode -2 were given different simple harmonic excitation of 2mm and 3.5mm respective for smooth and rough road conditions.
The results are tabulated as below.

<u>Mode-1: Smooth Road Condition</u>

Damping factor : 0.08

Excitation Amplitude (mm): 2

S.No	Excitation Frequency (rad/sec)	Theoretical Displacement(mm)	Experimental displacement(mm)
1	1.15	3.74	3.6
2	1.26	3.44	3.5
3	1.36	3.18	3.1
4	1.47	2.95	3
5	1.57	2.76	2.8
6	3.15	1.43	1.5
7	5.77	0.89	1.1

Mode-2: Rough Road Condition	
Damping factor:	0.48
Excitation Amplitude (mm):	3.5

S.No	Excitation Frequency (rad/sec)	Theoretical Displacement (mm)	Experimental displacement (mm)
1	1.15	3.495306152	3.5
2	1.26	3.206195836	3.4
3	1.36	2.961737072	3.3
4	1.47	2.752361474	3.2
5	1.57	2.571052204	2.8
6	3.15	1.310746051	1.5
7	5.77	0.756162553	0.9

Magnification factor

S NO	SMOOTH ROAD	ROUGH ROAD
	0.08	**0.48**
1	1.007	1.004
2	1.008	1.004
3	1.009	1.005
4	1.011	1.006
5	1.012	1.007
6	1.051	1.026
7	1.194	1.086

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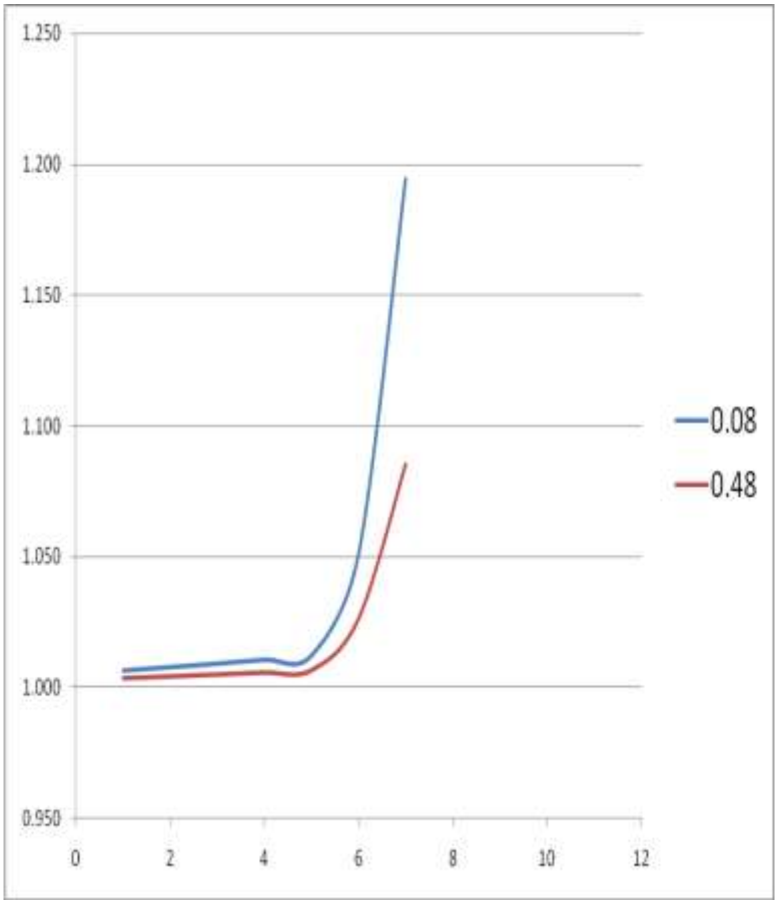

Figure 3- Magnification factor for both damping modes

CONCLUSION

- The damping ratio is below 1 which proves the system will be under damped.
- Damping ratio for both smooth and rough modes is achieved different 0.08 and 0.48 resp.
- Thus, The existing hybrid suspension design can achieve variable damping factor for smooth and rough road conditions.The hybrid suspensions using electrical power can be a good semiactive suspension for passenger vehicle segment.

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REFERENCES

[1] N. B. Kate, T. A. Jadhav, "Mathematical modelling of an automobile damper," International Journal of Engineering Research, Volume No.2, Issue No.7, pp. 467-471, Nov. 2013.
[2] Pinjarlal. Poornamohan, Lakshamana Kishore, "Design and analysis of shock absorber," International Journal of Engineering Sciences and Research Technology, volume 1, Issue 4, ISSN. 2319-1163, Dec.2012.
[3] Kalyan Raj, et.al, "Engineering a passive non-linear automobile suspension," International Conference on Compute Aided Engineering, IIT Madras.
[4] Prince Jerome Christopher, R. Pavedhan, "Design and analysis of two wheeler shock absorber coil spring," International Journal of Modern Engineering Research, pp. 133-140, 2010.

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

[5] Suresh Raddy, Thontaraj Urs, "Comparative study of static structural analysis of shock absorber for different material," International Journal of Engineering Science and Innovative Technology, Volume 3, Issue 6, November 2014.
[6] John. C. Dixon, Shock Absorber Handbook, Second edition, John and Wiley Sons Ltd. 2007.
[7] G. K. Grover, Mechanical Vibrations, Eight edition, Nem Chand & Bros, Roorkee, 2009.
[8] Helical Compression spring, Indian Standard IS 7906 (Part 1), 1997.
[9] JASO C 602-92 Telescopic shock absorbers for automobiles.
[10] H Nozaki, "Technology for measuring the Damping force", SAE-2004-01-2068.
[11] S Subramanian, "Development of Non linear shock absorber model", SAE-2003-01-0860