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"An over view of Design and Experimental Testing of a Two-Terminal Mass Device with a Variable Moment of Inertia Flywheel."

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ABSTRACT

A twoterminal mass (TTM) based vibration absorber with the variable moment of inertia(VMI) for passive vehicle suspension is proposed. The VMI of the system is achieved by themotion of sliders which are embedded in theflywheel driven by hydraulically. The moment of inertiaincreases for strong vertical vehicle oscillations and decreases for lower verticaloscillations. The hydraulic mechanism of system converts the relative linear motion between the two terminals of the suspension into rotary motion of flywheel. For larger vehicle vertical oscillation, the sliders inside flywheel move away from center of flywheel because ofcentrifugal force, thus yielding highermoment of inertia. The opposite is true in case of lower vehicle oscillation. In this way the moment of inertia gets adjusted itself adaptively in response to road conditions.

Keywords- variable moment of inertia, two terminal mass device, shock absorber.

I.INTRODUCTION

When a wheel hits a bump which compresses the suspension this part of the vibration energy generated by hitting bump is stored in suspension. After bump, the stored energy needs to flow back. If the vehicle is not equipped with a shock absorber, the suspension would continue to go up and down because of hitting the bump. In other words, this part of the energy leads to vehicle oscillations, which is obviously undesirable. The shock absorber dissipates or absorbs the energy generated because of vehicle oscillation and prevents the suspension system oscillations for prolonged time.

Most of existing shock absorbers are hydraulic type dampers which damp the oscillation by dissipating vibration energy into heat. Thus, the energy is wasted. So this study is directed towards the development of a new mass based shock absorber to minimize the oscillation without energy waste and in the meanwhile improve the performance of suspension. The aim of this study is to design a passive two terminal (TT) variable moment of inertia (VMI) hydraulic flywheel system which may be used in a conventional vehicle suspension to improve the performance namely low displacement, fast response and low vehicle oscillations.

II.PERFORMANCE ANALYSIS OF NONLINEAR VIBRATION ISOLATOR WITH MAGNETO-RHEOLOGICAL DAMPER

S. Dutta, et al. [1], studied Performance analysis of Nonlinear Vibration Isolator with Magneto-Rheological Damper. Their study involves nonlinear vibration isolator which was considered for studying the effectiveness of isolation against harmonic force and displacement excitations. The nonlinearity in the magnetorheological fluid based damper as well as in elastic member was taken into account. The MR-damper has been modeled and the spring was taken to have cubic nonlinearity. Analytical expression for the energy dissipation characteristics of damper has been derived.

III.ENERGY HARVESTING, RIDE COMFORT AND ROAD HANDLING OF REGENERATIVE VEHICLE SUSPENSIONS

L. Zuo, et al. [2], published the paper on Energy harvesting, ride comfort, and road handling of regenerative vehicle suspensions. They has addressed that a comprehensive assessment of the power is available for harvesting in the vehicle suspension system and the tradeoff among energy harvesting, ride comfort, road handing with analysis, simulations and experiments. The excitation from road irregularity was modeled as a stationary random process with road roughness suggested in the ISO standard. The norms were used to obtain mean value of power generation and the root mean square values of the vehicle body acceleration and dynamic tireground contact force. For the quarter car model, analytical solution of the mean power was obtained. The influence of road roughness, vehicle speed, suspension stiffness, shock absorber damping, tire stiffness, wheel and chasses masses to the vehicle performances and harvestable power was studied.

IV.INTEGRATION OF SHOCK ABSORPTION AND ENERGY HARVESTING USING A HYDRAULIC RECTIFIER

C. Li, et al. [3], studied Integration of shock absorption and energy harvesting using a Hydraulic Rectifier. Authors has addressed that the hydraulic shock absorbers have been widely used to dissipate kinetic energy of the shocks into surrounding environment. By utilising oscillatory motion to drive power generator, the shock energy can be converted into electricity for harvesting. Since, the frequent bidirectional oscillation of the generator causes a large impact force. This further leads to deteriorated energy harvesting performance, moving parts fatigue, and even system failure. Hence, this study introduces four check values to form a hydraulic rectifier to integrate the shock absorption and energy harvesting functionalities. The bidirectional oscillation of the shock and the vibration was converted into unidirectional rotation to drive the generator. They proposed a prototype energyharvesting shock absorber which has been designed and fabricated. An electromechanical model has also been developed to examine the response behavior of the prototype device. The performance of prototype has been characterized based on the experimental results from three test setups. Both mechanical and electrical parameters of the electromechanical model have been identified based on cyclic loading experiments.

The results have shown that the developed energy harvesting shock absorber is capable of harvesting the energy and absorbing the shock simultaneously.

V.ZERO-ENERGY ACTIVE SUSPENSION SYSTEM FOR AUTOMOBILES WITH ADAPTIVE SKY-HOOK DAMPING

K. Singal, et al. [4], studied on Zero-energy active suspension system for automobiles with adaptive sky-hook damping. They has discussed that the advantage of the semiactive system over an active system is that it consumes almost zero energy by utilizing a variable damper whose damping coefficient is changed in real time, while a fully active suspension system consumes significant power for its operation. Authors explored a new zero-energy active suspension system which combines the advantages of semiactive and active suspensions by providing the performance of the active system at zero energy cost. Unlike a semiactive system in which the energy is always dissipated, the proposed system harvests and recycles energy to achieve active operation. An electrical motorgenerator is used as the zeroenergy actuator the controller and energy management system are developed.

VI.PERFORMANCE LIMITATIONS AND CONSTRAINTS FOR ACTIVE AND PASSIVE SUSPENSIONS: A MECHANICAL MULTI-PORT APPROACH

M.C. Smith, et al. [5], published the paper on Performance limitations and constraints for active and passive suspensions: A mechanical multi-port approach. The authors had proposed a framework using mechanical multi-port networks to study the performance capabilities and constraints in vehicle suspensions. To understand the set of dynamic responses which are achievable for both passive and active systems, to this end, to view a suspension system as a mechanical multi-port network and draw on concepts from electrical circuits such as passivity and reciprocity. Authors identified necessary conditions on the external behaviour of a quarter-car model for the suspension to be capable of passive realization and they established force laws which cannot be implemented without an internal power source. They study the number of available degrees of freedom i.e., independently specifiable impedances in the quarter, half and full car cases.

VII.PERFORMANCE BENEFITS IN PASSIVE VEHICLE SUSPENSIONS EMPLOYING INERTERS

M.C. Smith, et al. [6], studied on Performance benefits in passive vehicle suspensions employinginerters. They has proposed a new ideal mechanical oneport network element named the inerter which was recently introduced and shown to be realizable, with the property that the applied force is proportional to the relative acceleration across the element. A comparative study was done of several simple passive suspensions struts each containing at most one damper and inerter as a preliminary investigation into the potential performance advantages of the element. Improved performance for several different measures in a quarter-car model was demonstrated here in comparison with a conventional passive suspension strut. A study of a full-car model was also undertaken where performance improvements are also shown in comparison to conventional passive suspension struts.

VIII.TWO-TERMINAL MANIPULATION OF MASSES: APPLICATION TO VIBRATION ISOLATION OF PASSIVE SUSPENSIONS

C. Li, et al. [7], published the paper on Two-terminal manipulation of masses: Application to vibration isolation of passive suspensions. They has addressed that a typical mass has only one genuine terminal, through which the mass interacts a position and a force vector with the environment. They proposed an innovative two terminal manipulation approach for typical masses, such as mass blocks and flywheels, so as to upgrade its topology. A prototype device of the two-terminal mass was developed for testing. The experimental result validates its free two-terminal inertial dynamic characteristics. The twoterminal mass was then applied to vibration isolation of the passive suspension. The simulation result shows that, due to the presence of the second genuine terminal, the two-terminal mass contributes the suspension better isolation performance. The presented approach provides masses more extensive applications to vibration systems.

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