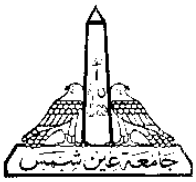

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Automotive Engineering

PERFORMANCE OF AUTOMOTIVE AIR SUSPENSION CONTROL SYSTEM

A Thesis submitted in partial fulfillment of the requirements of the degree of Master of Science in Mechanical Engineering (Automotive Engineering)

by

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Bachelor of Science in Mechanical Engineering

(Automotive Engineering)

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Statement

This thesis is submitted as a partial fulfilment of Master of Science in Mechanical Engineering (Automotive Engineering), Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Thesis Summary

This thesis is concerned with the evaluation of the automotive air suspension system performance experimentally and theoretically and its effect on ride comfort behaviour.

A mathematical model was introduced that simulate conventional suspension system performance as a datum and studies the effect of changing the mass ratio, the stiffness ratio and damping ratio on its performance

An existing test rig was modified in which the required experimental work was carried out. An excitation input was developed in terms of frequency and amplitude by using an adjustable eccentric cam assembly to obtain variable excitation input amplitudes. The cam rotational speed was changed using an inverter to control the excitation frequency. An air suspension assembly was installed in which the air spring is connected to two separate air reservoirs through two On/Off valves from which the air pressure can be adjusted to control the initial stiffness value. A steel structure was also added to guide the vertical movement of the sprung mass. The acceleration of the mass and the pressure of the air spring have been measured at the different operating conditions in terms of excitation amplitudes and frequencies values and including the different air volumes.

The experimental results were measured and stored in computer files for further analysis.

A simple mathematical model is proposed that simulates the air spring behaviour which is connected to two additional air reservoirs through two

On/Off valves. The effect of changing the additional volumes through switching on or off the valves is also investigated.

Curves showing variations of air spring stiffness and transmissibility ratio with the input frequency are plotted. Comparison between conventional suspension and air suspension is presented.

The theoretical model is validated using the experimental results. Good correlation between experimental and theoretical results is evident, which indicates the possibility of using the proposed model for further parametric studies.

It is concluded that the air suspension improves the comfort behaviour more than the conventional one through reducing the system natural frequency and amplitude ratio. It was also found that increasing the additional volume reduces the system natural frequency.

Key words: Ride comfort, active suspension, air spring.

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Contents

List of Figures & Photos

List of Abbreviations

1-DOF Single Degree of Freedom

2-DOF Two-Degree of Freedom

7-DOF Seven-Degree of Freedom

DAQ Data Acquisition

DLC Dynamic Load Coefficient

FE Finite Element

FFT Fast Fourier Transform

IWM In-Wheel Motor

LQR Linear Quadratic Regulator

MR MagnetoRheological

RMS Root Mean Square

WFE Wave and Finite Element