Vibration Behaviour Control of a Fabricated One-Passenger Electric Vehicle with Either Mechanical or Air Suspension

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Vehicle vibration transmission associated with the dynamic system depends on the frequency and direction of the input motion and the characteristics of vehicle suspension system and the seat from which the vibration exposure is received. A fabricated one-passenger electric vehicle equipped by a coil spring (mechanical) suspension system is introduced in this study. An air suspension system is used to replace the coil spring suspension system to improve ride comfort performance and intelligent classical adaptive neuro-fuzzy inference system controller is used to control the vehicle seat performance parameters. Accelerometers are mounted on the seat pan and seat base (floor) when measuring vertical acceleration. Data is frequently weighted according to standard BS 6841 in order to model the human response to vibration in terms of location and direction. The Simulink model is developed in Matlab software with the adaptive neuro-fuzzy inference system controller for the vehicle seat weighted vibration acceleration control. The results indicate that the predicted vibration acceleration can track the target vibration acceleration very well. Moreover, the values of the crest factor and kurtosis for the vehicle equipped by air suspension system are lower than those for the vehicle equipped by mechanical suspension system. Furthermore, the seat effective amplitude transmissibility for the fabricated vehicle with air suspension behaves lower value than that for mechanical suspension.

1. INTRODUCTION

A comfortable ride is essential for a vehicle to obtain passenger satisfaction. In this view, vehicle manufacturers are constantly seeking to improve vibration comfort. Many factors influence the transmission of vibration to and through the body. Transmission associated with the dynamic system depends on the frequency and direction of the input motion and the characteristics of the vehicle suspension system and the seat from which the vibration exposure is received. Oscillatory responses are analysed by means of a bus oscillatory model with linear characteristics and three degrees of freedom, with excitation by the Power Spectral Density (PSD) of the roughness of asphalt-concrete pavement in good condition. This analysis is conducted through a simulation, in frequency domain, using statistical dynamics equations. A program created in the software pack MATLAB is used to analyse the transfer functions, spectral density and RMS of oscillatory parameters. The results of the analysis show that the parameters, which ensured good oscillatory comfort for the driver, were conflicting with the parameters which ensured the greatest stability of the bus and the corresponding wheel travel. In terms of the driver’s oscillatory comfort, the bus suspension system should have a spring of small stiffness and a shock absorber with a low damping coefficient. In terms of active safety, it should have a spring of small stiffness and a shock absorber with a high damping coefficient, while minimum wheel motion requests for springs of great stiffness and shock absorbers with a high damping coefficient.

A new pneumatic spring that allows for tuning the stiffness and ride height independently and continuously is pre-