

Energy dissipation and the dynamic response of a vehicle on deformable pavement with stochastic roughness

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ABSTRACT

Within dynamics of a vehicle, various mechanisms such as pavement-related rolling resistance result in fuel consumption. This paper examines the energy dissipation of a vehicle focusing on the mechanisms in suspension systems and tire sidewall in the presence of pavement deflection. Especially, a pavement-vehicle interaction model is developed to accommodate road roughness and the deflection of pavement. A half-car model is considered to represent the vehicle, a filtered white noise model is used to characterize the road roughness, and a layered foundation is developed to represent the deformable pavement. To introduce a delayed road profile at the rear tire, a Padé approximation is implemented to the model as well. The resulting system is expressed in an augmented state-space format, with white noise being the primary input to the system. To obtain the vertical response and the energy dissipation of a vehicle, the Lyapunov equation governing the covariance of the response is solved. Parametric studies are performed to examine the effect of the elasticity of the pavement and roughness on the vehicle. Due to the efficacy and flexibility in the calculation, the proposed approach has been implemented in a field test. The calculated vehicle dynamics are then compared with field measured vehicle response for validation.

REFERENCES

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