# The Effect of Suspension Damping on Vehicle Response to Transient Road Inputs

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This thesis considers the transient response of suspension models of a vehicle traversing a versed-sine shaped bump. In the first instance, the damper is assumed to be linear which enables analytical solutions to be obtained for the displacement and acceleration shock spectra. Numerical solutions are also obtained using the Runge-Kutta method. The analysis differs from much of the general shock and transient vibration literature in that the acceleration response is considered for a displacement input. By considering bump traversal time of short and long durations relative to the natural period of the system, a simple expression has been determined for the peak acceleration in terms of the system's parameters, bump length and vehicle speed.

Using a two degree-of freedom (DOF) quarter car model, the effect of the unsprung mass on the peak acceleration is investigated by numerical simulations. The acceleration shock response spectrum of the two DOF system is compared with that of the SDOF system. Experimental work involving the measurement of accelerations of the sprung mass and unsprung mass of a passenger car has also been carried out to test the validity and limitations of the approximate relationship derived for the single degree-of-freedom (SDOF) system. A practical hydraulic automotive damper is considered and the principle of operation is discussed. Using experimental data from an automotive non-linear damper, a piece-wise linear damping model is established.

Two types of bi-state damping are introduced to model a non-linear automotive damper in terms of shock isolation. One is piece-wise linear to represent different damping coefficients in the jounce and rebound directions. Another is switching damping coefficients so that the damper is switched off whilst the vehicle is traversing the bump and on again once the vehicle has traversed the bump. Numerical simulations are presented for the transient response of a SDOF model with a versed-sine base displa cement input. The results of the piece-wise linear damper are compared with that of the switchable damper. The maximum benefit of the switchable damper in reducing the peak acceleration is investigated analytically using the approximate equations. A significant reduction in acceleration is observed when the switchable damper is considered in the SDOF model. This study of non-linear passive damping models in transient shock vibration may be used in a new strategy for semi-active damping control.