

Motorcycle Steering Oscillations Due to Road Profiling

A study of the effects of regular road undulations on the dynamics of a cornering motorcycle is presented. This work is based on a detailed motorcycle-rider-tyre model that was developed in the multibody simulation code AUTOSIM.

We make use of root-locus and frequency response plots that were derived from a linearized version of this model; the linearization is for small perturbations from a general steady-cornering equilibrium state. The root-locus plots provide information about the damping and resonant frequencies of the key motorcycle modes at different machine speeds, while the frequency response plots are used to study the propagation of road forcing signals to the motorcycle steering system.

Our work is expanded to include a study of the possible onset of nonlinear oscillations. In this part of the study the main analysis tools are the nonlinear simulation model and a time-frequency analysis of the results.

The results show that at various critical cornering conditions, regular road undulations of a particular wavelength can cause severe steering oscillations. At low speeds the machine is susceptible to road forcing signals that excite the lightly damped wobble and front suspension pitch modes. At higher speeds it is the weave and front wheel hop modes that become vulnerable to road forcing. We believe that the results and theory presented explain many of the stability related road accidents that have been reported in the popular literature and are therefore of practical import.

The models used in this research are available at the web site <http://www.ee.ic.ac.uk/control/motorcycles/>.