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Impulsive Laboratory Tests to Predict On-Road Comfort of a Bicycle

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ABSTRACT

A method for the prediction of on-road comfort of city bicycles from laboratory tests is presented. Experimental tests are performed by exciting the wheels of the bicycle with impulsive vibrations and measuring the frequency response functions (FRFs) between different sensitive points of the bicycle (*i.e.*, seatpost and stem) and the wheels. Laboratory tests are carried out with the rider on the bicycle and the posture is carefully checked. A mathematical model is developed to predict the accelerations experienced by the rider considering tyre and wheelbase filtering. Comfort predictions obtained with the experimental-numerical method are compared with reference values obtained from road tests. A general agreement in terms of root mean square values and power spectral densities is found.

Keywords: bicycle, comfort, vibrations, impulsive testing.

1 INTRODUCTION

The study of bicycle comfort is an interesting research topic closely related to sustainable mobility because the problem of low-emission urban and sub-urban mobility is often solved by means of a widespread use of bicycles and bicycle lanes. City bicycles are used by a wide range of people, which includes kids, elders and workers that use the bicycle throughout the day. For some of these users riding comfort may be an important issue and the continuous use of a non-comfortable bicycle may lead to back pain or other disorders.

Bicycle comfort depends on many mechanical, biomechanical and environmental factors [1], including the level of vibrations transmitted to the rider, the posture, the distribution and amplitude of contact forces between the rider and the vehicle, traffic and weather conditions. Nevertheless, most of the researchers recognize the vibrations transmitted to the cyclist as one of the main causes of discomfort [2-4]. For this reason, some studies dealing with bicycle vibrations have been already carried out.

Some researchers performed specific road tests installing a data logger or a computer on the bicycle and measuring the vibrations of the handlebar, saddle and other relevant points by means of accelerometers [2, 5, 6]. The analysis of road tests results in the frequency domain [2, 5] showed that most of the vibrations caused by road excitation belong to the band 0-60 Hz and that in this band the spectra are very irregular, with a large number of close peaks.

Even if road tests are the most direct method for measuring bicycle comfort, some researchers highlighted that the repeatability of results is sometimes poor owing to variations in rider posture, bicycle speed and road conditions [7]. Consequently, some laboratories developed indoor testing