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Experimental investigation on the road transmitted vibration on a mountain bicycle

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ABSTRACT – This paper presents an experimental investigation on the road transmitted vibration on a mountain bicycle through a field test. It is purposely to determine the cycling comfort which is commonly represented by the vibration magnitude of the bike. The result shows that the cycling comfort is significantly affected by the roughness condition of the road but on the other hand only small effect is obtained from different tire size.

1. INTRODUCTION

Over decades, bicycle has been become one of the most favorite vehicles in the world. Besides fuel price issue, it is also because people can increase their body health by cycling. Since its presence in eighteen centuries, bicycle technology has been rapidly developed by researchers including the design, materials and also the dimension. One of the most important aspects for the cyclist is comfort issue, represented by the bike vibration. Many researchers have been conducting research concerning on this particular topics. Wenhua *et.al* [1] studies the comfort level of bicycle rider under different surface condition using software simulation. Petrone and Giubilato [2] develop a test method to evaluate the radial structural behavior of a bicycle wheel with respect to the rider's comfort. Holzel *et.al* [3] investigates the effect of surface road condition on the racing bicycle comfort. Similarly, Vanwalleghem [4] studies the dynamic behavior of an instrumented bicycle to see its relation to the comfort level. Currently, Liu *et.al*. conducts a simulation study of a full suspension bicycle to analyze the pedaling force and comfort [5]. Nevertheless, most of the conducted researches are only limited on a road bicycle scope.

This paper, therefore, presents a study on the effect of road transmitted vibration on the mountain bike comfort through field experimental test. The tire size and surface roughness are varied in order to give more comprehensive information.

2. METHODOLOGY

2.1 Experimental Setup

Figure 1 and 2 shows the experimental setup for the bicycle field test. Two accelerometers are placed at the front fork and at the seat post and are connected to the VibPlot dynamic signal analyzer through BNC cables.

Figure 1 Experimental setup.

Figure 2 Accelerometer placement: Seat post (left) and front fork (right).

Three different sizes of tire are investigated as depicted in Figure 3. The technical specification of each tire is given in Table 1.

Table 1 Tire specification

Brand	Maxxis Cross Mark	Michelin Wild Racer	Maxxis Larsen TT Exeption
Material	Natural Rubber	Natural Rubber	Natural Rubber
Width (in)	2.1	2.0	1.9
Diameter (in)	26	26	26

Figure 3 Different sizes of tire.

Three different road surface conditions are also investigated as depicted in Figure 4 : cement pavement, soil and soil with uneven rocks.

Figure 4 Different road surface condition:
a). cement, b). soil, c). soil with uneven rocks.

2.2 *Measurement Procedure*

The measurement is conducted in three different cycling speeds i.e. 5, 6 and 7 km/h. The effect of different tire size and road surface condition is investigated for every speed. Data is taken within 3 seconds on a 6 m track after steady cycling is reached. This is purposely to avoid noise reading data and unwanted shock. The logarithmic value of vibration acceleration is presented against frequency from 0 – 10,000 Hz in order to obtain wide and adequate information of vibrational response from the bicycle.

3. RESULTS AND DISCUSSION

3.1 *Effect of Speed*

Figure 5 shows the effect of speed on the bicycle vibration. It can be seen that the cycling speed is proportional to the bicycle vibration. As the cycling speed increases, the excitation force form the contact between road and tire is also significantly increased which apparently produce higher vibration to the bike. Apart from this, higher vibration is also produced when the pedaling force of the cyclist is increased during speed increment.

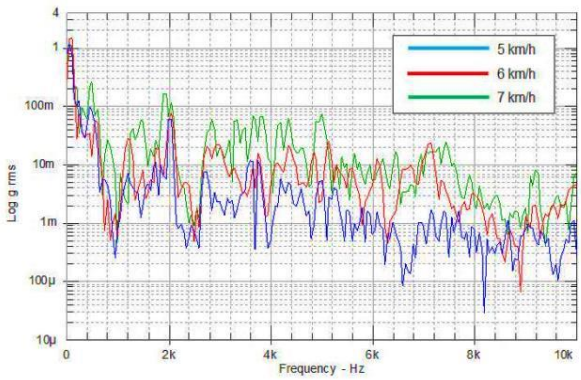

Figure 5 Effect of Speed (2.0”, cement pavement)

3.2 *Effect of Road Surface Condition and Tire Size*

Figure 6 shows the effect of road surface condition on the bicycle vibration. Smooth road apparently produces the lowest vibration and conversely, rougher surface gives higher vibration. The road roughness affects the force excitation to the bike considerably. The rougher the road, the higher excitation force is produced. While the effect of tire size apparently does not give significant effect to the bicycle vibration. This might be due to the small differences of the size, the force excitation produced by the contact between the road and different tire size is then quite similar.

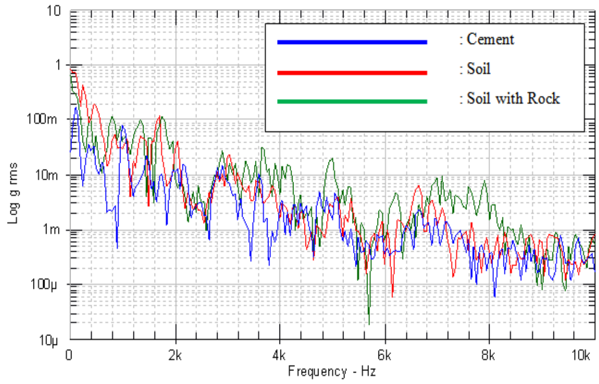

Figure 6 Effect of Surface condition (2.0”, 5 km/h)

4. SUMMARY

The effect of the road transmitted vibration on the bicycle comfort has been studied experimentally. As a conclusion, vibration of a mountain bicycle depends on the road surface condition considerably. On the other hand, different tire size does not give significant effect on the bike vibration.

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