Evaluation of comfort: Acceleration transmissibility of different road bikes
William Bertucci, Frédéric Puel, Benoit Jarlot, Frédéric Grappe, Sebastien Duc

To cite this version:

HAL Id: hal-03124485
https://hal.univ-reims.fr/hal-03124485
Submitted on 28 Jan 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Evaluation of comfort: Acceleration transmissibility of different road bikes

Conference Paper - July 2015

5 authors, including:

William Bertucci
University of Champagne-Ardenne (France)
162 PUBLICATIONS 1,217 CITATIONS

Frédéric Puel
Université de Reims Champagne-Ardenne
37 PUBLICATIONS 58 CITATIONS

Benoit Jarlot
Université de Reims Champagne-Ardenne
10 PUBLICATIONS 16 CITATIONS

Sébastien Duc
Université de Reims Champagne-Ardenne
70 PUBLICATIONS 512 CITATIONS

Some of the authors of this publication are also working on these related projects:

- Finite elements models of bones View project
- Proposition de thèse CircaPerf View project
Evaluation of comfort: Acceleration transmissibility of different road bikes

W Bertucci1*, F Puel1, B Jarlot1, F Grappe2,3, S Duc1

Abstract

**Background:** Cycling training volume is very important for professional cyclists. According to Pinot and Grappe (2014), a top-10 cycling Grand Tour finisher rides ~30,000 km and 950 h during one complete season. In this condition several factors can induce muscular injuries or fatigue such as training load, number of competitions, quality of the recovery, and posture adopted on bike. One possible additional factor for increasing this risk is related to the vibration exposure encountered during cycling on cobblestones. According to the norms and guidelines used in the world of work (e.g. EN-ISO-5349-1, 2001), this vibratory exposure could theoretically only be tolerable for seven minutes (Chiementin and al., 2011; 2013), which is very low compared to the total time spent on cobblestones during a classic cycle race like Paris-Roubaix (~1.5 h). It has been shown also that settings (tyre pressure) and bike components (frame, wheels and fork) play a key role in the transmissibility of the mechanical vibrations to the cyclists’ hands and buttock (Lepine et al., 2014). Thus to reduce the vibratory dose suffered by the cyclists, it seems interesting to choose the most appropriate settings and bike components in order to prevent muscular injuries or fatigue and, potentially, to increase cycling performance.

**Purpose:** The aim of this study was to assess acceleration transmissibility from the tyres to the handlebar and the seatpost on different road bikes designed or not with damping systems against vibration exposure encountered on cobblestones.

**Methods:** Five different carbon bikes (Table 1) have been tested on a vertical vibration plate (Physioplate Fit, Globus, Domino Srl, Codognè, Italia). The vibration (from 15.8 to 56.7 Hz) was applied successively under the front and the rear wheel. All the tests were performed by the same cyclist in the same body position and with wheels inflated to 7 bars. Three triaxle accelerometers (1350 Hz, Hikob Fox, Hikob, Villeurbanne, France) were firmly mounted on the vibration plate, the stem and the seat post (Figure 1). Transmissibility has been computed from the ratio between the root mean square (RMS) measured on the stem (output) to the RMS measured on the vibration plate (input).

**Results and Discussion:** Figure 2 shows that the sensitivity of the protocol proposed in the present study was able to determine differences between bikes, even if the bikes were built in the same material (carbon) or made by the same manufacturer (Table 1). Therefore, it would be used by manufacturers to optimize the comfort and the performance of their bikes, and also by cyclists to choose the “best” bike configuration to minimize the vibration exposure. Nevertheless, this choice should be confirmed by tests in actual conditions in order to evaluate the comfort and the sensation the cyclist experiences according to the racing configuration. Moreover it is quite surprising that bikes designed with damping systems (bike 1 to 3) did not always present the lowest transmissibility values, especially for low frequency vibrations (< 32 Hz). Further studies should be conducted in order to explain these differences.

<table>
<thead>
<tr>
<th>Bike</th>
<th>Damping system in the frame/bike</th>
<th>Road cycling usage</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>On the top tube</td>
<td>Classic race</td>
<td>A</td>
</tr>
<tr>
<td>2</td>
<td>In the fork, the seat tube and the seat stays</td>
<td>Classic race</td>
<td>B</td>
</tr>
<tr>
<td>3</td>
<td>At the junction between the top and seat tubes</td>
<td>Classic race</td>
<td>C</td>
</tr>
<tr>
<td>4</td>
<td>Without damping system</td>
<td>Mountain race</td>
<td>B</td>
</tr>
<tr>
<td>5</td>
<td>Without damping system</td>
<td>Mountain race</td>
<td>A</td>
</tr>
</tbody>
</table>
**Figure 1.** Experimental set-up (bike 1, without the cyclist)

![Experimental set-up](image)

**Figure 2.** Transmissibility stem/platform assessed on the five bikes

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Bike 1</th>
<th>Bike 2</th>
<th>Bike 3</th>
<th>Bike 4</th>
<th>Bike 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.8</td>
<td>0.4</td>
<td>0.6</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>24.3</td>
<td>0.6</td>
<td>0.8</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>32.5</td>
<td>0.8</td>
<td>1.0</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>40.7</td>
<td>1.0</td>
<td>1.2</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>48.9</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56.7</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Contact email:** william.bertucci@univ-reims.fr (W. Bertucci)

1 GRESPI EA 4696 / UFR STAPS, University of Reims Champagne Ardenne, France
2 Health & Sport Department, University of Franche-Comte, EA 4660, Culture – Sport – Society (C3S), Besancon, France
3 FDJ.fr Professional Cycling Team, Moussy le Vieux, France