講演番号 275　　文献番号 20226275

Study on motorcycle rider characteristics in a vibration field

- On the measurement of mechanical characteristics of rider body -

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KEY WORDS: motorcycle, vibration, body vibration while driving, biomechanics

‘Introduction’

The rider's body is flexible and capable of complex movements when handling a motorcycle. The behavior of a rider handing a motorcycle is not limited to the rider's active driving behavior such as steering bar operation and body leaning. The rider's body acts like a flexible damper against the motorcycle's vibratory behavior caused by vibrations and disturbances during riding. This has a passive effect on vehicle dynamics. The rider operating the motorcycle changes the position of the force balancing with the ground surface by shifting the position of the composite center of gravity. Tire characteristics have a significant effect on vehicle dynamics, influenced by changes in the rider's composite center of gravity position with the rider. If passive characteristics by the rider are not taken into consideration, there will be a gap between the vehicle dynamics analysis simulation and the actual driving of the motorcycle. The passive characteristics of the rider's arms and body have been studied previously. However, few past studies have focused on the movement of the rider's head. The head may have a big impact because its degree of freedom differs from that of the upper body due to its connection with the cervical spine. The objective of this study is to understand the mechanical characteristics of riders on motorcycles, including their heads. Future modeling and utilization of the results of this study is expected to improve the accuracy of simulation and development efficiency of vehicle dynamics, including both riders and motorcycles.

‘Experimental Method’

Vertical excitation was applied to reproduce the vibration during running, and the passive vibration characteristics of the rider were collected. The vibration conditions applied to the rider are based on accelerations in the angular frequency range for each direction of motion in each vibration as specified in ISO 2631-1. The vibration generator shown in Figure 1 was used to subject the experimental participants to vibration for approximately 15 seconds at reference frequencies of 0.5 Hz to 5.0 Hz. The experiment participants were instructed to assume their usual driving situation on a straight road. Participants were asked to wear the same clothing and shoes as they normally wear when riding a motorcycle. During the vibration measurement section, the participants were instructed to minimize unnecessary movements such as re-gripping the steering handle or re-sitting on the seat.

‘Experimental Result’

Figure 2 shows the vertical acceleration-frequency characteristics of the rider's head and chest during vertical excitation, obtained from the Fourier series expansion based on the measurement results. The experimental results show that there are resonance points around 3.0 Hz in the head and chest. The phase response of the accelerometers in the chest started almost in-phase and a phase delay was observed as the frequency increased. This is because the rider's body responds to the vertical movement of the vehicle body in opposite phases, extending during upward excitation and contracting during downward excitation.

‘Conclusion’

In this report, we used a vibration generator and a vehicle mockup to measure the passive characteristics of a rider when subjected to the vertical vibration that motorcycle riders are subjected to on a daily basis. The frequency response was checked and the conclusions obtained are as follows.

(1) The vertical resonance point during vertical excitation of the rider is around 3.0 Hz at the head or chest, and the secondary resonance point is after 5 Hz.

(2) Comparing the head and chest, the head DOF should be taken into consideration because the number of resonance points and phase characteristics are different.

Fig.1 Experiment landscape

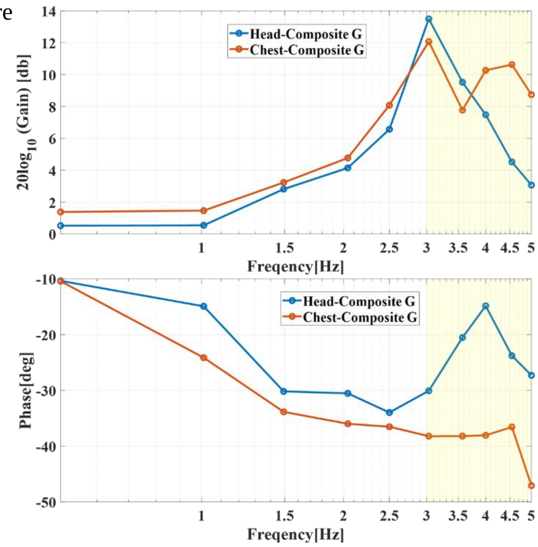

Fig.2 Frequency response (Heave)

2022 JSAE Congress (Autumn) - Summarized Paper
Issued on October 7, 2022