STIFFNESS AND DAMPING OF RUBBER IN SLIDING CONTACT DETERMINED BY RESONANCE CURVES

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ABSTRACT
Elastomers such as rubbers are important in many technical applications, especially those requiring high friction. A typical property of rubber friction is bell-shaped velocity dependence, and two origins exist. One is due to the material response, originating from the bell-shaped rheology of elastomers [1]. The other is due to the mechanical response, originating from the vertical lift of the counter surface with asperities [2]. At the same time, wear resistance is also required for rubber products. One of the remarkable features of rubber wear is the formation of the abrasion pattern. Several studies have indicated the effect of the viscoelasticity of rubbers on the pitch of abrasion patterns [3].

To clarify the tribological and viscoelastic properties of rubbers, a unique apparatus that measures the dynamic response of rubbers in sliding contact was developed [4]. **Figure 1** shows an overview of the apparatus. The rubber roller rotated by a motor was brought into contact with the rough rigid surfaces excited with the PZT actuator. The excitation frequency was swept from 50 to 100 Hz, and resonance curves were obtained. **Figure 2** shows typical resonance curves obtained. The resonance frequency and amplitude are different between the non-contact state (black line), stationary contact (blue line), and sliding contact (red line). The contact stiffness and damping of rubbers can be determined by focusing on these transition of resonance curves.

In this study, the effects of material properties (stored modulus: E', loss modulus: E'' and $\tan\delta = E''/E'$) and mechanical properties (vertical load and sliding speed) on contact stiffness and damping were experimentally investigated. In addition, the influence of contact stiffness and damping on rubber wear, especially on abrasion patterns, will also be reported.

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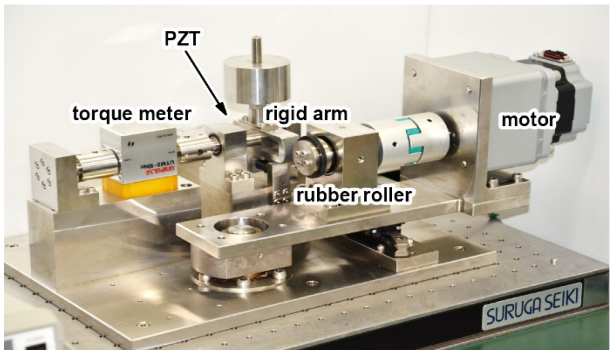

Figure 1. Overview of the apparatus.

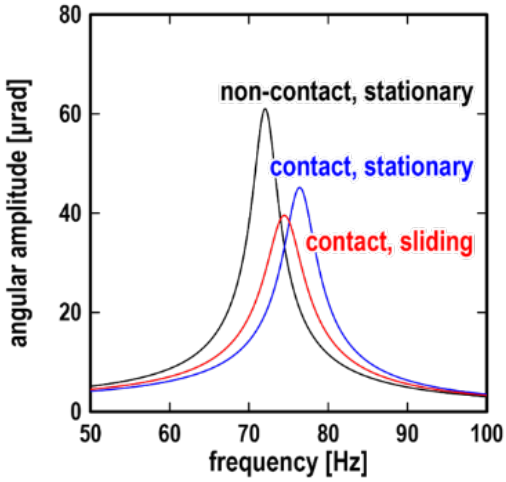

Figure 2. Resonance curves (black line: non-contact, blue line: stationary contact, red line: sliding contact).