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Measurement of strain distribution, acceleration, and sound pressure in tread blocks of rotating tires

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The part of the tire surface that comes in direct contact with the road surface is called the tread. The tread has a pattern that consists of grooves, blocks, and sipes. Recently, several studies have been conducted in response to the increasing demand for noise-reducing tires. To achieve tire/road noise reduction, it is important to understand the mechanism of tire/road noise generation. However, the details of the mechanism of tire/road noise generation remain unclear as it is caused by various mechanical phenomena that occur between the tire tread block and road surface.

This study focuses on the deformation behavior of tread blocks and investigates its effect on tire/road noise. Specifically, the strain distribution, acceleration, and sound pressure in individual tread blocks were measured and compared with the frequency response of the tire/road noise. The strain distribution in the tread blocks was measured through image processing using a sequential phase-shift stroboscope. The acceleration and sound pressure in the tread blocks were measured by directly attaching a compact-type accelerator and microphone meter to the tread blocks.

To determine the general characteristics of tire radiation noise, a stand-alone table-top test was conducted with reference to JASO C606. The drum surface was a safety walk. Two rotation speeds, 10 km/h and 50 km/h, were considered. The results of the test indicated that the sound pressure has a high peak around 1 kHz at a tire rotation speed of 50 km/h. To determine the influence of the tread block characteristics on the tire/road noise, three physical quantities were measured and analyzed: the strain distribution (Fig.1), sound pressure in the sub-grooves (Fig.2), and acceleration (Fig.3). The measurement results showed that the tread blocks did not vibrate elastically and the impulse vibration is excited when the tread block leaves the ground. Moreover, the acceleration and sound pressure of around 1 kHz were generated even before the tread blocks penetrated the ground surface. The results of the short-time Fourier transform showed that vibration and noise of around 1 kHz were generated at almost all positions during one tire revolution.

The results obtained suggest that although the tread blocks are a source of vibration, the generation of tire/road noise is not dependent on the vibration characteristics of the blocks alone.

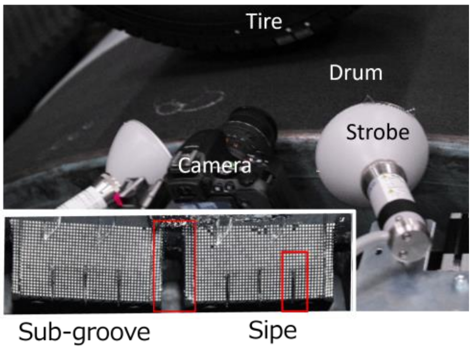

Fig.1 Measurement of strain distribution in the tread blocks using a sequential phase-shifted stroboscope

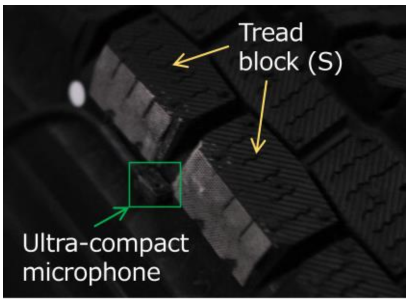

Fig.2 Measurement of sound pressure in the sub-grooves of the tread blocks using an ultra-compact microphone

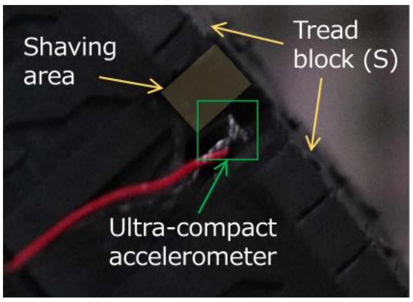

Fig.3 Measurement of acceleration in the tread blocks using an accelerometer