HIGH FIDELITY SIMULATIONS OF FLOW AND ACOUSTIC FIELDS AROUND ROTATING TIRE TOWARD AEROACOUSTIC NOISE REDUCTION

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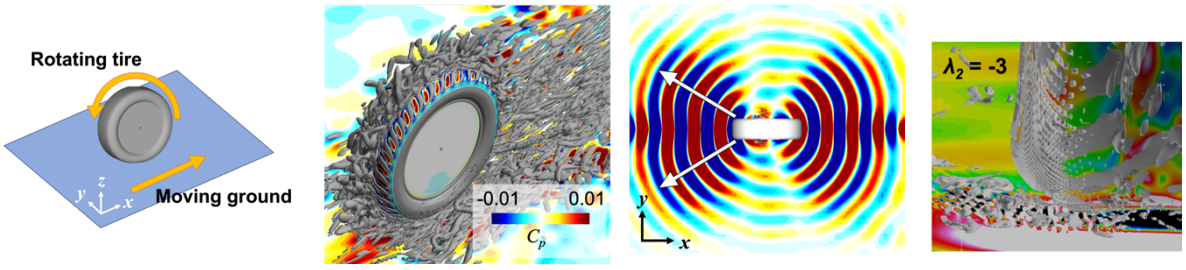
Key Words: *Large-eddy simulation, Rotating tire, Aeroacoustics*

In the present study, we investigate flow fields around rotating tires with/without longitudinal grooves by high fidelity simulations to clarify aeroacoustic noise sources generated by the fluid motions and the relationships between the shape parameters of the grooves and the directivity of the noise. To obtain the acoustic field around the rotating tire (Fig. 1a), the large-eddy simulations using the sixth-order compact finite difference scheme and the tridiagonal filter are performed with multi grids, and acoustic fields are directly obtained by solving Navier-Stokes equations [1]. Four computational cases including the case without groove are considered in the present study. Figure 1b shows the obtained instantaneous flow field around the tire without the groove.

Comparison between the sound pressure level (SPL) distributions on the ground clarified a presence of a groove decreased the SPL of the front part of the tire decreased. In addition, by investigating the correlation coefficient of the SPL of the sound field around the grooved tire with each shape parameter, the following are clarified. The influence of the "top width" on the sound field is large and the sound of the tire front becomes slightly louder when the "top width" increases from the baseline groove shape. We also conducted proper orthogonal decomposition (POD) analysis to clarify the noise sources. The POD analysis indicated two symmetrical sound sources near the front of the tire side surface regardless of the presence or absence of the groove shape (Fig. 1c), and the sound spread toward the front of the tire from the sources. Additionally, visualization of the flow field near the sound sources indicated that the fluid fluctuation generated when the vortex structure flowing along the tire collided with the ground may generate acoustic noise (Fig. 1d).



(a) (b) (c) (d)

Fig. 1 Images of (a) rotating tire, (b) instantaneous flow, (c) first mode of POD, (d) vortices near the noise source.

REFERENCES

[1] K. Asada, K. Ito, S. Sekimoto, K. Fujii, M. Koishi, T. Ikeda, "Analysis of aeroacoustic generated from a rotating tire with a longitudinal groove using large-eddy simulation," *ASME 2021 Fluids Engineering Division Summer Meeting*, Virtual Conference, Online, August, 2021.