講演番号	281

文献番号	20226281

Wheel Development for Aerodynamics and Brake Cooling

Yuta Saito[1)]　Akihiro Narazaki[1)]　Yosuke Nagashima[1)]

1) Toyota Motor Corporation
1, Toyota-cho, Toyota, Aichi, 471-8572, Japan

KEY WORDS: Heat・Fluid, Aerodynamic, Computational Fluid Dynamics, Wind Tunnel Test, Wheel **[D1]**

To reduce greenhouse gas emission and considering market trend, achieving both conflicting performances of aerodynamic drag (C_D) and brake cooling is needed. To achieve this, the effects of wheel shapes on them were investigated simultaneously through CFD simulation. After checking CFD accuracy of flow field and C_D comparing with wind tunnel results, this study was performed based on CFD. Tested vehicle is Sedan shown in Fig.1.

Brake cooling performance can be evaluated using heat transfer coefficient of brake rotor. It is known that the heat transfer coefficient h [W／m^2 ·K] can be explained using surface flow velocity u [m/s] as (1).

$$h \propto u^{4/5} \tag{1}$$

In this study, $h'=u^{4/5}$ was evaluated for brake cooling performance. Now u was calculated using CFD result.

For most production vehicles, the same wheels are installed for both right and left side as shown in Fig.2 (upper) and the spoke shapes to the flow direction are not the same. In this study, as base case (Case1), symmetrical wheels were installed as shown in Fig.2 (lower).

At first, the flow around wheels of Case1 was investigated and 3 points to be improved were found. At first horse-shoe vortex extends outside and makes C_D worse. Secondly flow separation between spokes at upper part of wheel was found and it makes u smaller. The last point is that vortices are found between spokes at front part of wheel and this also makes u smaller.

As countermeasure cases for these 3 points to be improved, 3 cases of spoke shapes were tried as shown in Fig.3. The results of C_D and h' are shown in Fig.4. This result suggests that both C_D and brake cooling performance are improved with optimizing spoke shape to the flow direction. Flow changes were also confirmed with CFD visualization results and 3 problems in Case1 were solved in each case.

Most production vehicles adopt the same wheel for right and left but this result means that, with installing different part number wheels for right and left, the breakthrough can be achieved.

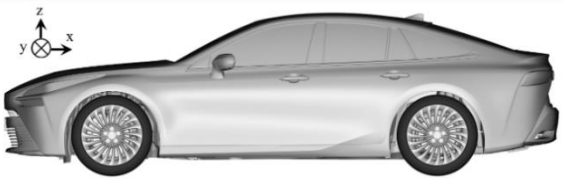

Fig. 1　Test Vehicle

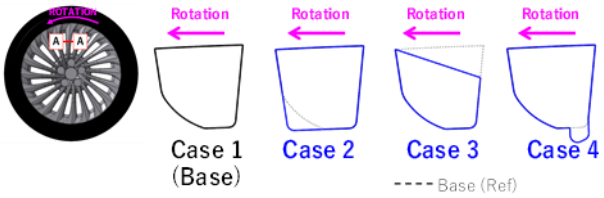

Fig. 3　Study cases of wheel spoke section (A-A)

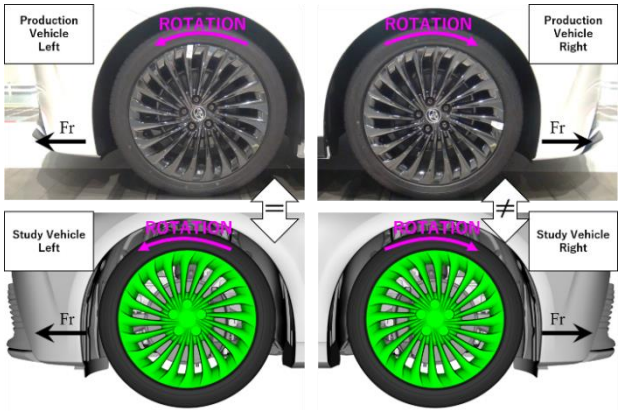

Fig. 2 Front wheel appearance of production vehicle (upper) and CFD base vehicle Case1 (lower).

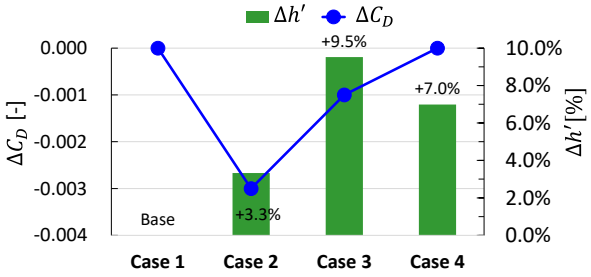

Fig. 4 CFD results of C_D and h'