Influence of Fineness Ratio on Aerodynamic Characteristics of Fight Vehicles

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Responsible Representative

Keiichi Kitamura, Associate Professor, Yokohama National University

Contact Information

Ayano Inatomi (inatomi-ayano-ng@ynu.jp)

Members

Ayano Inatomi, Keiichi Kitamura

Abstract

Generally, aircraft and rockets are slender bodies whose cross sections are close to a circle. In these slender bodies, the aerodynamic characteristics greatly change at a large angle of attack (AoA). As an influence from the change in the aerodynamic characteristics, for example, the flight becomes unstable when the yaw force is large. In this study, we investigated details of flow field around the slender-bodied-vehicle numerically with configurations having different fineness ratios at Reynolds numbers Re = 6*10^5 and 6*10^6. Interestingly, the yaw force increased with Re at 50 degrees of AoA. It was found that the downstream body configuration contributed to the yaw force augmentation. In addition, at 140 degrees of AoA, the configuration which increased the yaw force by the Reynolds number is different from that at 50 degrees of AoA.

Reasons for using JSS2

Because there are many cases with configurations and many grids, it is necessary to use super computer for getting accurate results in an efficient way.

Achievements of the Year

At an angle of attack of 50 degrees, as the Reynolds number increases (Fig. 1), the yaw force coefficient also increases, and the separation position moves to the downstream side as the Reynolds number increases (Fig. 2). As the separation position moves to the downstream side, the expansion expands upstream of the separation of the body part fillet, and the pressure on the surface of the body decreases (Fig. 3). The increment of the yaw force when the Reynolds number is changed is influenced by the downstream body part configuration. On the other hand, at an angle of attack of 140 degrees, the change in yaw force due to the increase in the Reynolds number varies depending on the configuration (Fig. 4), and the separation position moves to the downstream side due to the increase in the Reynolds number. As the separation position moves to the downstream side, the expansion expands upstream of the separation of the nose portion, and the pressure on the surface of the body decreases. The increment of the yaw force when the Reynolds number is changed is influenced by the configuration of the nose

part on the downstream side. In addition, it was also found that the magnitude of yaw force and sign (direction) differ depending on configuration and Reynolds number for both of these two angle of attacks.

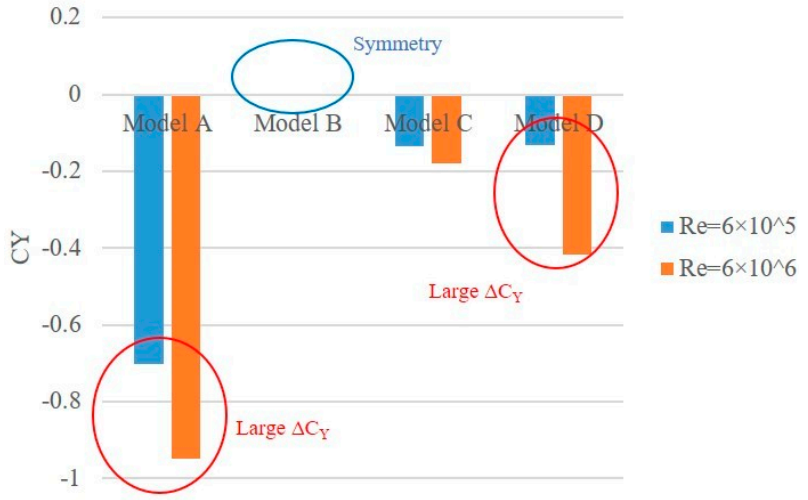

Fig. 1: C_Y of 50AoA

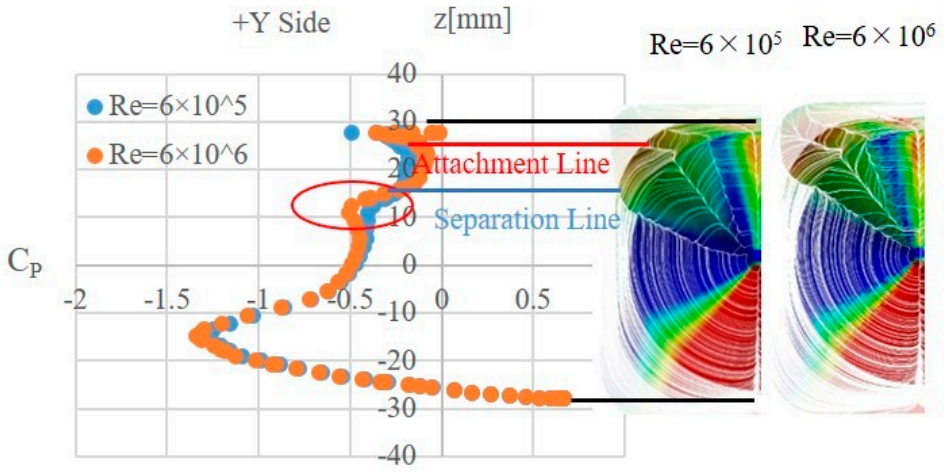

Fig. 2: Cut out of C_P (50AoA)

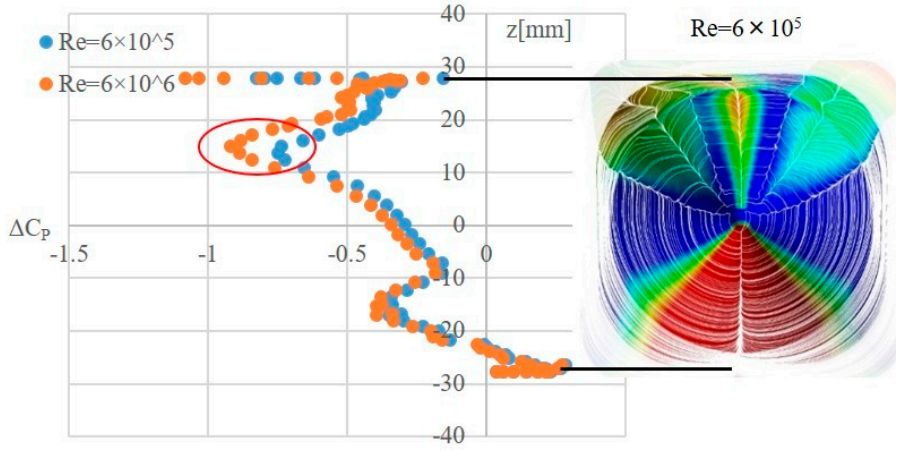

Fig. 3: Pressure Difference between +Y and -Y (65%, 50AoA)

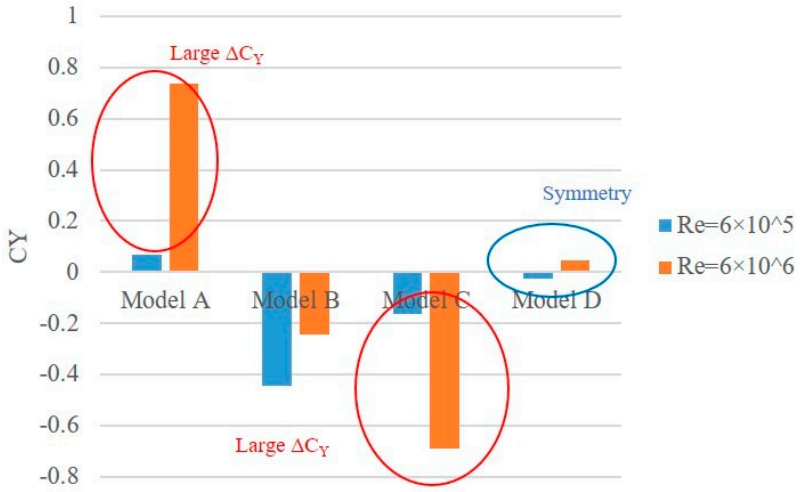

Fig. 4: C_Y of 140AoA

Publications

N/A

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	1024
Elapsed Time per Case	8 Hour (s)

Resources Used

Fraction of Usage in Total Resources[*1] (%): 0.03

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2] (%)
SORA-MA	155,322.82	0.02
SORA-PP	22,680.10	0.18
SORA-LM	593.68	0.28
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2 (%)
/home	6.68	0.01
/data	2,880.10	0.05
/ltmp	1,367.19	0.12

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	0.00	0.00

*1: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

*2: Fraction of Usage: Percentage of usage relative to each resource used in one year.