Influence of Fineness Ratio on Aerodynamic Characteristics of Flight Vehicles

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Abstract

In this study, we investigated details of flow field around the slender-bodied-vehicle numerically with configurations having different fineness ratios. Interestingly, the trend of Re=6x10^6 is totally opposite to that observed in Re=6x10^5 at 140 degrees of AOA. It was found that the configuration where the yaw force could be suppressed in Re=6x10^5 generated the largest yaw force in Re=6x10^6. From this, it was confirmed that the configuration which increases the yaw force varies with the Reynolds number.

Reasons for using of 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

In this study, we investigated details of flow field around the slender-bodied-vehicle numerically. The configuration consisting of 'nose cone' and 'square aftbody' parts was employed as the baseline, and then, compared with other configurations having different fineness ratios. At an angle of attack of 50 degrees, regardless of the Reynolds number, the magnitude relationship of the yaw force is determined by the configuration. On the other hand, at an angle of attack of 140 degrees, the configuration where the yaw force can be suppressed in Re=6x10^5 generates the largest yaw force in Re=6x10^6. From these facts, it was found that the Reynolds number affects the yaw force at an angle of attack of 140 degrees. Also, it is interesting to see a different tendency at angle of attack of 50 degrees and 140 degrees in this way. It was thought that short and blunt shapes could suppress yaw force and asymmetry, but it was newly confirmed that complicated flow fields change with Reynolds number at an angle of attack of more than 90 degrees.

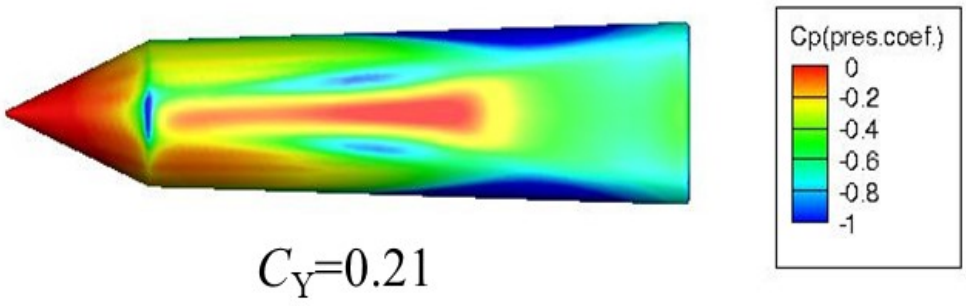

Fig.1 Model A (baseline)(AOA = 140 [degrees], Re=6x10^5)

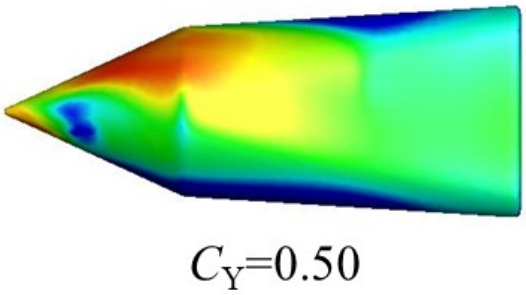

Fig.2 Model B (half size model)(AOA = 140 [degrees], Re=6x10^5)

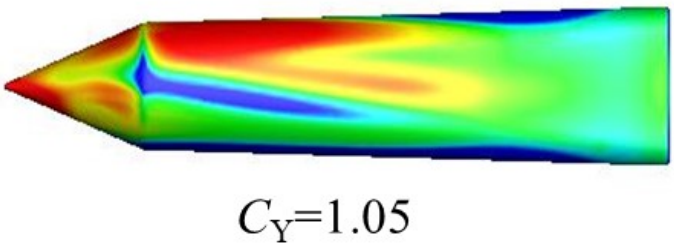

Fig.3 Model A (baseline)(AOA = 140 [degrees], Re=6x10^6)

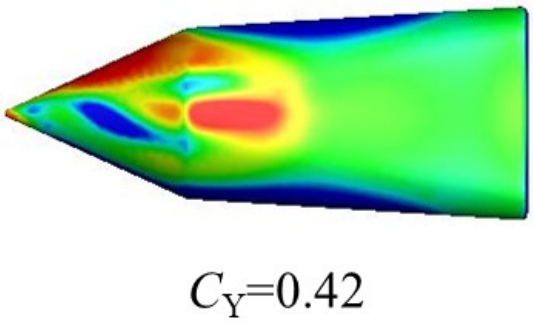

Fig.4 Model B (half size model)(AOA = 140 [degrees], Re=6x10^6)

Publications

- Presentations

1) Inatomi, A., Kitamura, K., Nonaka, S., ' Numerical Analysis on Slender Body towards Reusable Rocket Aerodynamics with Different Configurations', The 48th JSASS Annual Meeting, Sanjo Conference Hall, The University of Tokyo, Japan, Apr. 14, 2017.
2) Inatomi, A., Kitamura, K., Nonaka, S., 'Numerical Analysis on Reusable Rocket Aerodynamics with Reduced-yaw-force Configurations', 31st ISTS, Matsuyama, Japan, Jun 3-9, 2017.

Usage of JSS2

Computational Information

Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	1024
Elapsed Time per Case	8.00 hours

Resources Used

Fraction of Usage in Total Resources*1 (%): 0.01

Details

Computing Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2 (%)
SORA-MA	53,340.31	0.01
SORA-PP	284.39	0.00
SORA-LM	435.27	0.22
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage assigned(GiB)	Fraction of Usage*2 (%)
/home	007.15	0.00
/data	071.53	0.00
/ltmp	1,464.84	0.11

Archiver Resources		
Archiver System Name	Storage used(TiB)	Fraction of Usage*2 (%)
J-SPACE	0.02	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