Effect of Nosecone-length on Aerodynamic Characteristics of Slender Body

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Abstract

In the case of the nose-entry system on vertical-takeoff-and-landing type reusable rockets, this rocket needs a turnover maneuver by using its pitching moment, during return flight. In this study, the effects of three types of slender body with different nosecone-length on pitching moment characteristics and the flow field around the slender body are investigated by numerical analysis. From this study, it was found that Cm (pitching-moment coefficient) increases linearly with the angle of attack in all the configurations with different nosecone-length. Also, in the range of angle of attack from 0 to 20 degrees, as the nosecone-length of the vehicle increases, Cm decreases. These result from flow stagnation and accelerated expansion.

Reasons and benefits of using JAXA Supercomputer System

In this study, there were many configurations and angles of attack to be calculated, and the number of grid points was large. Because of this, it was necessary to use the supercomputer that can calculate efficiently and accurately.

Achievements of the Year

Numerical analysis was performed on three types of slender bodies (Fig. 1) with different nosecone-lengths in the range of angle of attack from 0 to 20 degrees. As a result, it was found that Cm increases linearly with the angle of attack in all the configurations with different nosecone-lengths. In addition, the pitching moments of all the configurations were always positive, but the slender body having the longest nosecone for 150 mm showed the smallest value (Fig. 2). In particular, the shorter the nosecone-length, the larger the positive pitching moment that occurs around the nosecone. This difference was caused by the difference in the stagnation area on the windward side of the nosecone. On the other hand, the negative pitching moment generated behind the moment reference center of the slender body became large (Fig. 3). This is thought to be due to the difference in the number of experiences of accelerated expansion of the flow. In addition, the positive pitching moment generated around the nosecone by stagnation was dominant for the pitching moment of the entire slender body (Fig. 4).

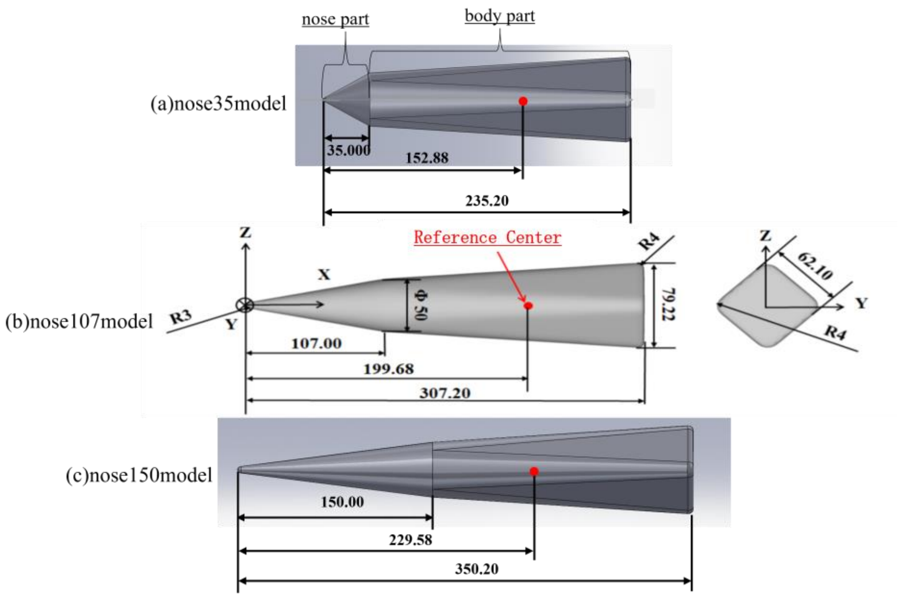

Fig. 1: Configuration

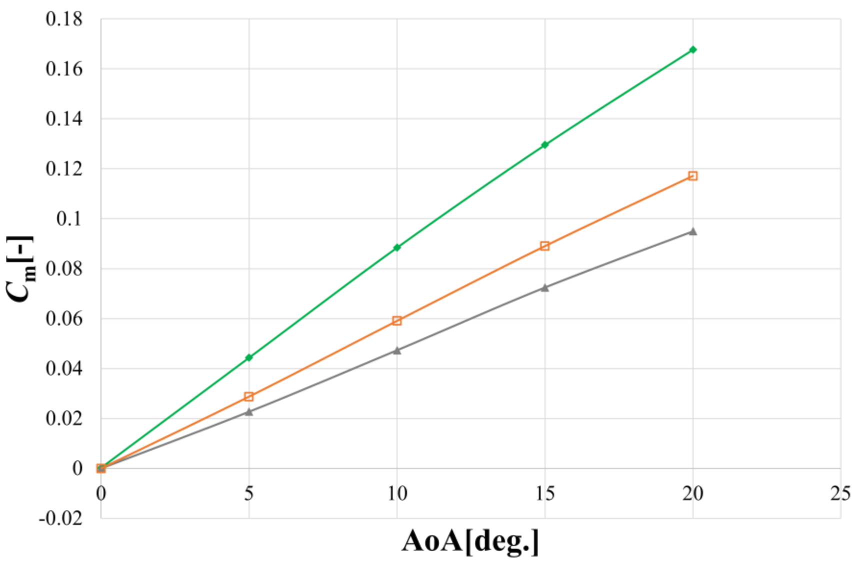

Fig. 2: Pitching moment coefficient of three different configurations vs angle-of-attack

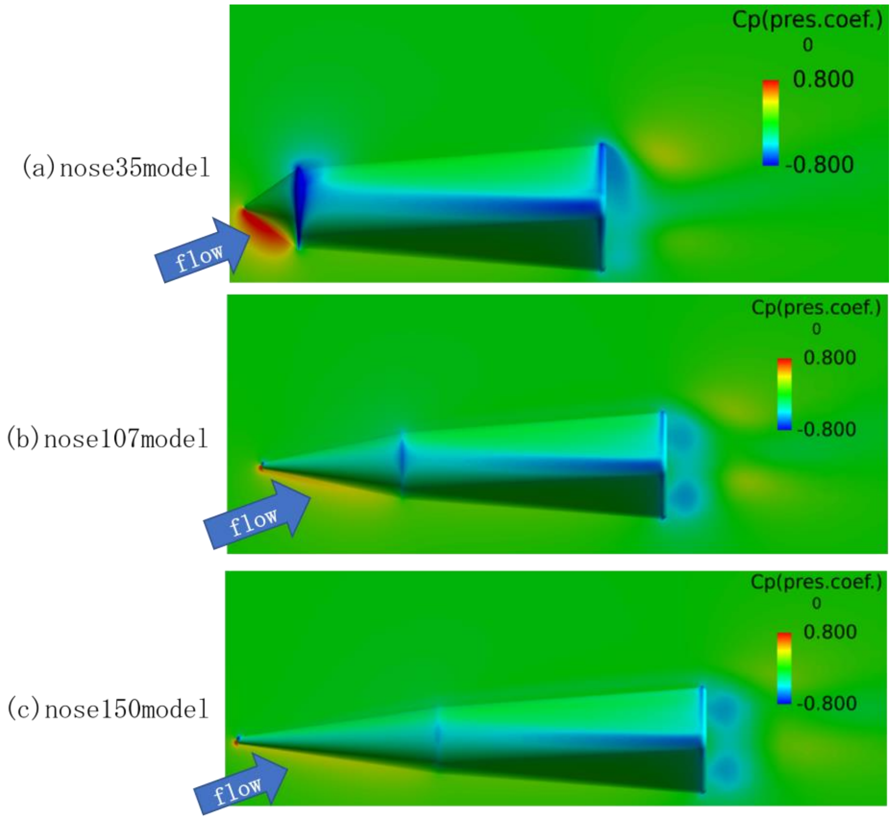

Fig. 3: Cp distribution (AoA=20[deg.])

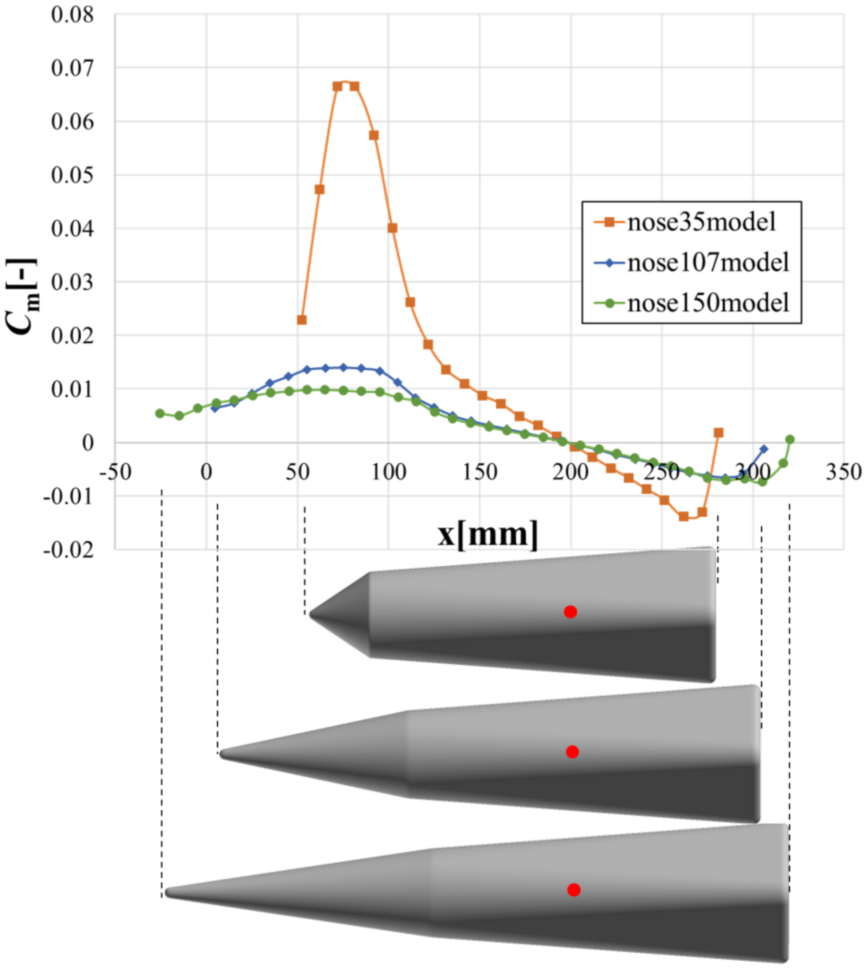

Fig. 4: Local Pitching moment coefficient (AoA=20[deg.])

- **Publications**

  N/A

- **Usage of JSS**

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	96 - 1024
Elapsed Time per Case	12 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources*1(%): 0.28

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage*2(%)
TOKI-SORA	6,550,548.48	0.32
TOKI-ST	61,600.48	0.08
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	869.62	0.02
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2(%)
/home	502.00	0.50
/data and /data2	20,500.00	0.22
/ssd	120.00	0.03

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.

- **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage*2(%)
ISV Software Licenses (Total)	130.12	0.09

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