Technical Training on High-Speed Rotorcraft

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● **Abstract**

Research on the aerodynamic interference of the rotor and wing on the high-speed rotorcraft. Study of the aerodynamic characteristics of a coaxial rotor.

Ref. URL: http://www.aero.jaxa.jp/eng/research/frontier/rotary/

● **Reasons for using JSS2**

This study needed the computational high performance with the rotorcraft analysis code rFlow3d which was developed by JAXA.

● **Achievements of the Year**

We performed CFD analysis with the rFlow3D where the computational mesh of the rotor and wing are shown in Fig. 1. Fig. 2 shows the interference of the rotor downwash on the wing at advance ratio 0.3. Strong interference of rotor downwash on the wing at advance ratio 0.7 is also confirmed.

In thrust variations of the coaxial rotors, different fluctuations are observed as compared with the single rotor. Two characteristics fluctuations, one is the high-frequency vibration and another one is the low-frequency vibration, are observed for the coaxial rotor. The high frequencies are caused by pressure interactions at crossing the coaxial rotor blades as shown in Fig. 3. The cause of low-frequency fluctuations are the interactions between the blades and the tip vortices generated by the preceding blades as shown in Fig. 4.
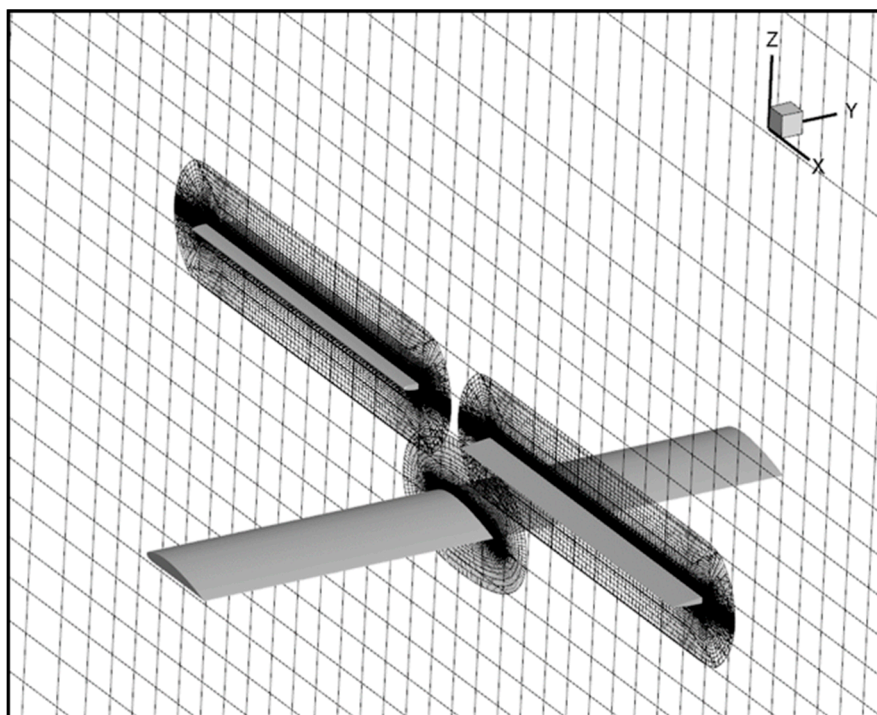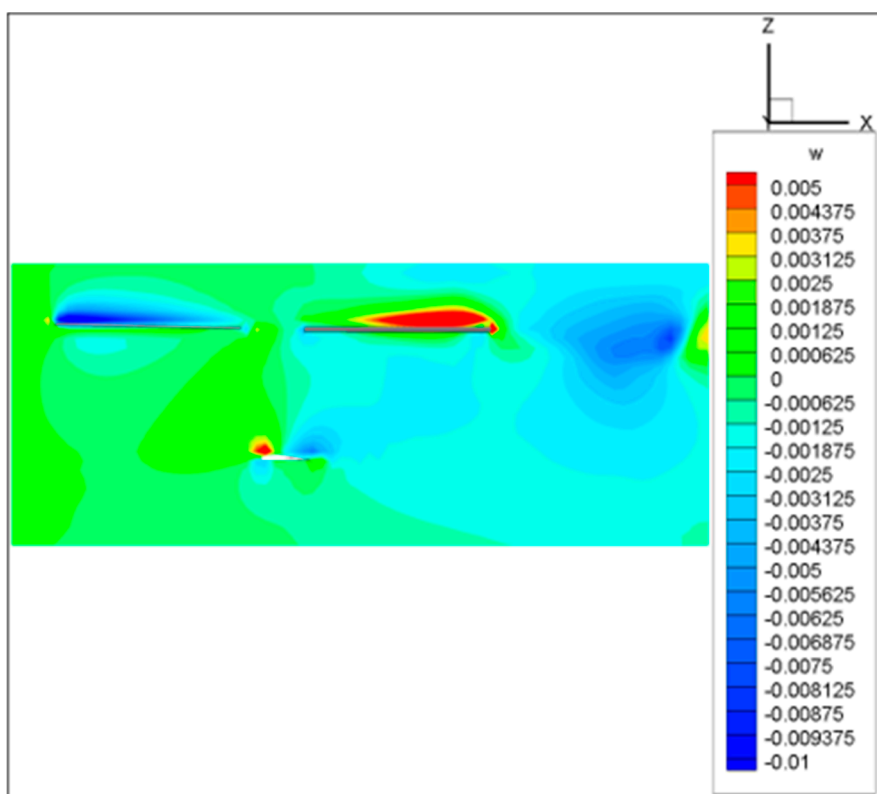
Fig. 1: Computational Mesh of Rotor and Wing

Fig. 2: Vertical Velocity Distribution around Rotor and Wing in Side View:
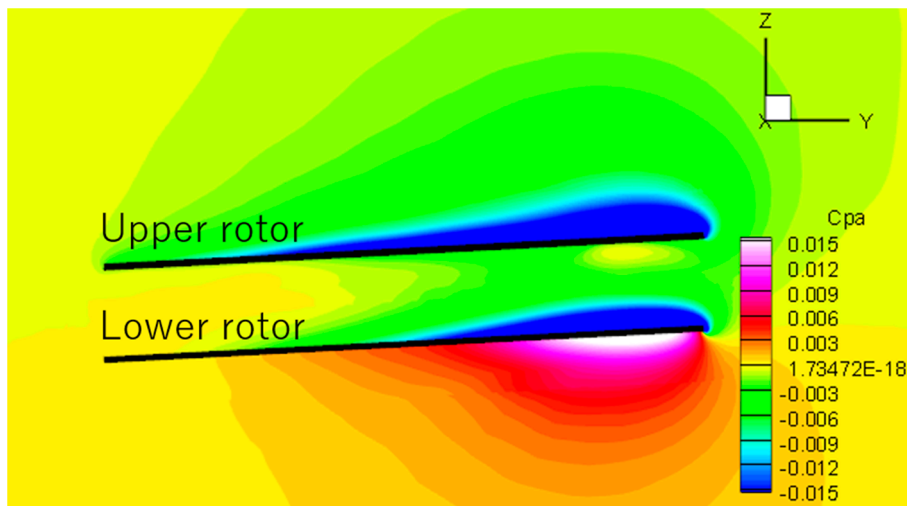
Advance Ratio = 0.3

Fig. 3: Distribution of pressure coefficient at blade crossing for a coaxial rotor. The pressure below the upper rotor is less than the lower one. This phenomena causes adrupt decrease of system thrust.
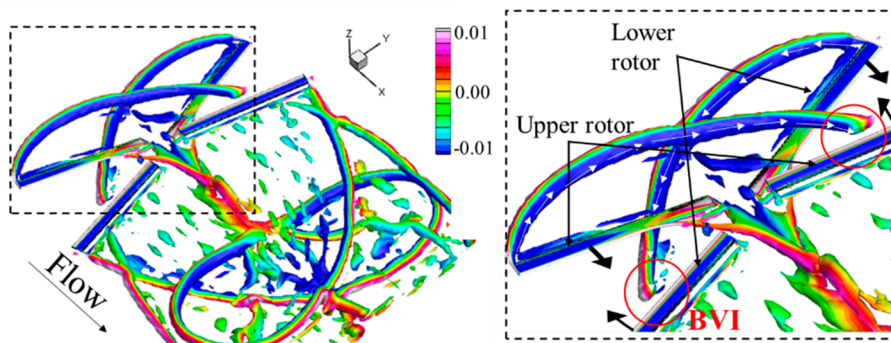

Fig. 4: Visualization of the tip vortex generated by a coaxial rotor in forward flight. The contour on vortex is nondimensionalized (by the sound velocity) flow rate. Blade Vortex Interactions (BVI) are observed. BVI are the causes of thrust fluctuations.

● **Publications**

- Non peer-reviewed papers

1) Hiroki Oshima, Takeshi Akasaka, Yusuke Hamamoto, Noboru Kobiki and Yasutada Tanabe, Experimental Investigation of Aerodynamic Interaction Between the Rotor-Tapered Wings at Hover on a Compound Helicopter, 56th JSASS Aircraft Symposium, Yamagata Telsa, November 14-16, 2018, Paper No. JSASS-2018-5166. (in Japanese)

2) Ryo Hayakawa, Takeshi Akasaka, and Yasutada Tanabe, Numerical Study of Rotor/Wing Interaction on a Compound Helicopter in High Advance Ratio, 56th JSASS Aircraft Symposium, Yamagata Telsa, November 14-16, 2018, Paper No. JSASS-2018-5167. (in Japanese)

● Usage of JSS2

● Computational Information

Process Parallelization Methods	N/A
Thread Parallelization Methods	OpenMP
Number of Processes	1
Elapsed Time per Case	36000 Second (s)

● Resources Used

Fraction of Usage in Total Resources[1] (%): 0.41

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[2] (%)
SORA-MA	330,635.65	0.04
SORA-PP	396,824.58	3.17
SORA-LM	0.00	0.00
SORA-TPP	142,239.75	10.40

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2 (%)
/home	540.42	0.56
/data	22,786.47	0.40
/ltmp	4,340.28	0.37

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.