Development of a New Blade Profile for a Vertical Axis Wind Turbine

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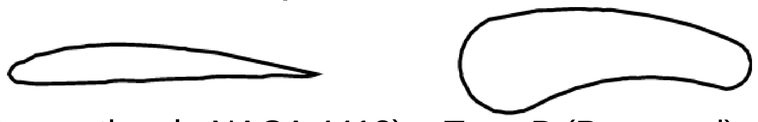
Introduction

To improve rotation performance of vertical axis wind turbine, we propose new blade cross section Type-B effective for wide range of wind speed.

Its performance is evaluated by numerical simulation and wind tunnel experiment.



Type-A (Conventional : NACA 4412) Type-B (Proposed)

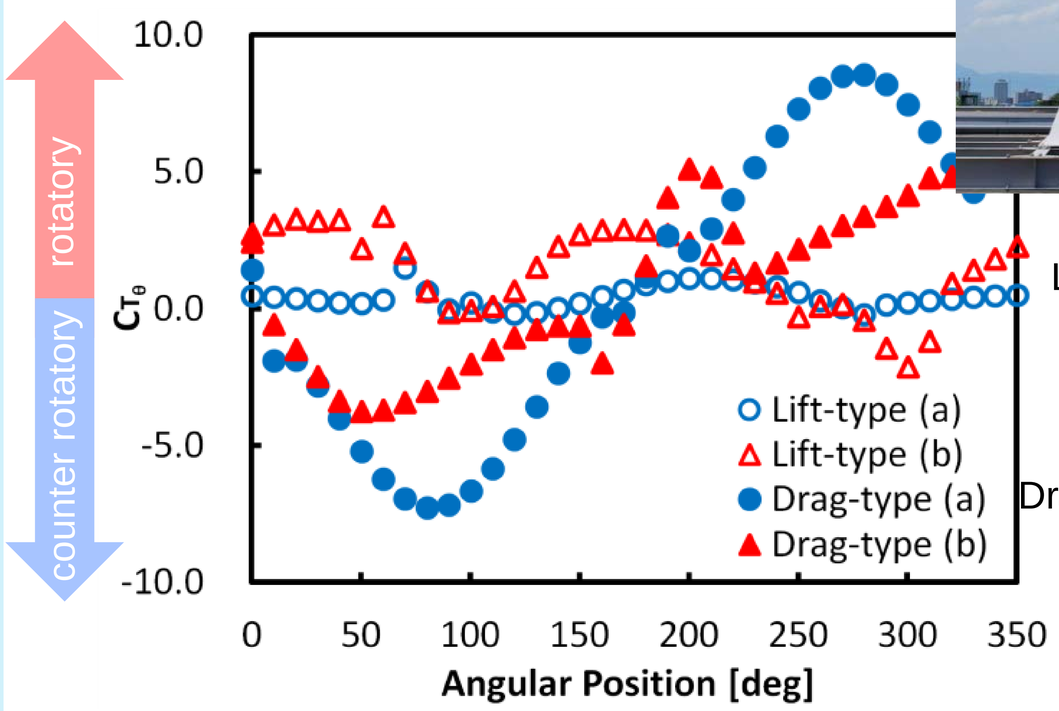
All numerical analysis was carried out by COMSOL Multiphysics with CFD module.

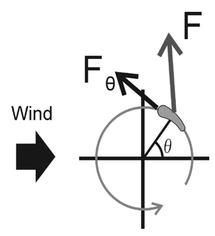
Conclusion

(1) Proposed new blade generates rotor driving torque larger than conventional blade profile.

(2) Pressure distribution and velocity vector obtained by PIV show the difference in flow structures around the blades.
Flow separation over the blade is suppressed in proposed new blade.

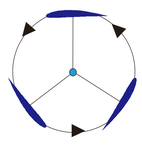
Steady numerical analysis





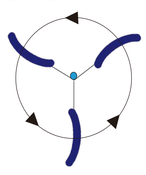
$$C_{T\theta} = F_\theta R / \frac{1}{2}\rho AlU^2$$

Lift-type arrangement



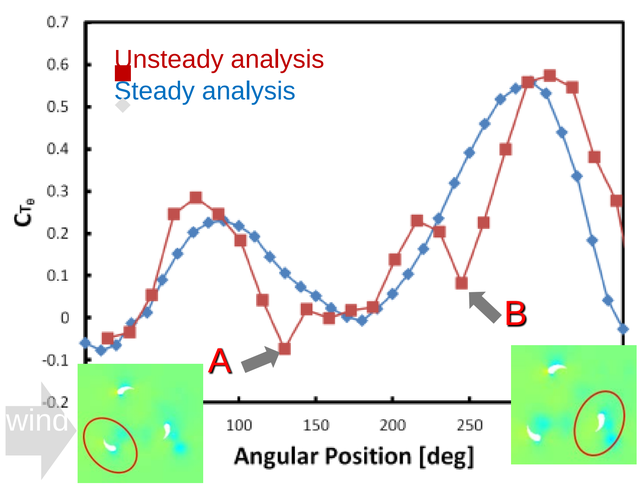
	Max.	Min.	Average
Type-A	2.89	-0.44	0.83
Type-B	6.55	-4.12	2.74

Drag-type arrangement



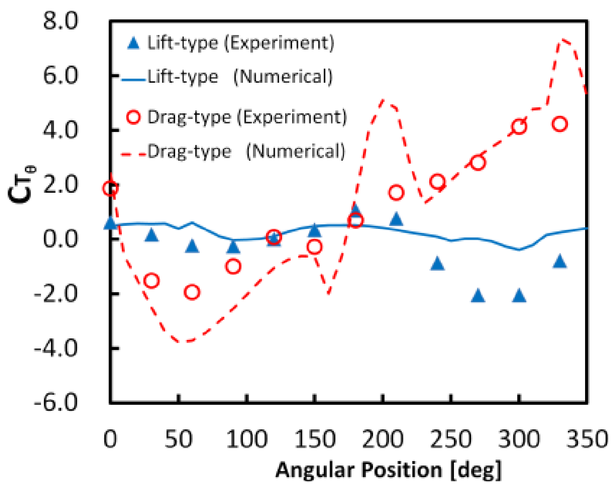
	Max.	Min.	Average
Type-A	16.60	-14.12	1.73
Type-B	14.35	-7.32	2.09

Unsteady numerical analysis (Rotating three blades)



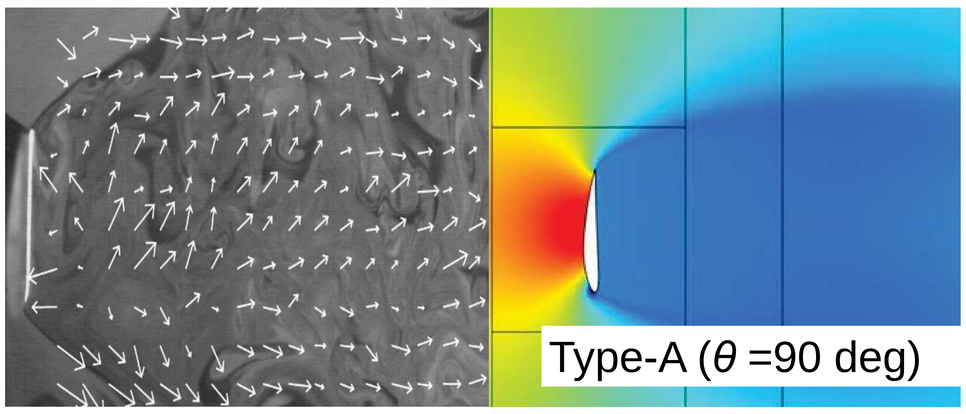
Decrease of $C_{T\theta}$ at A is caused by decrease of airspeed.
Decrease of $C_{T\theta}$ at B is caused by entering wake of following blade.

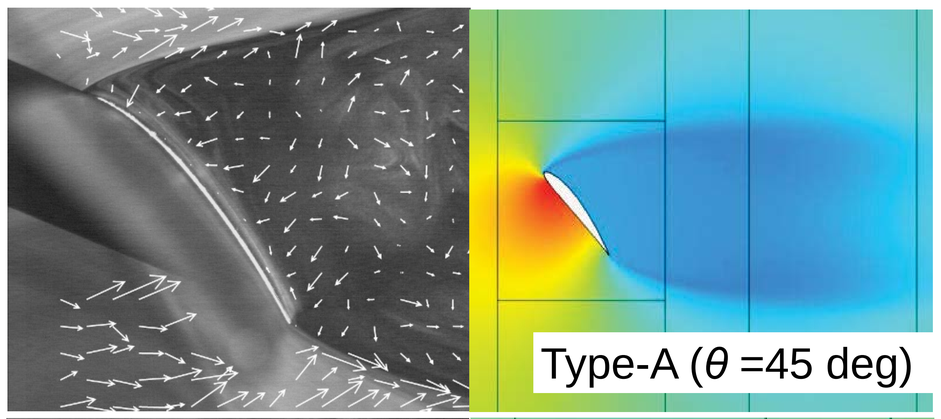
Wind tunnel experiments (Single blade)

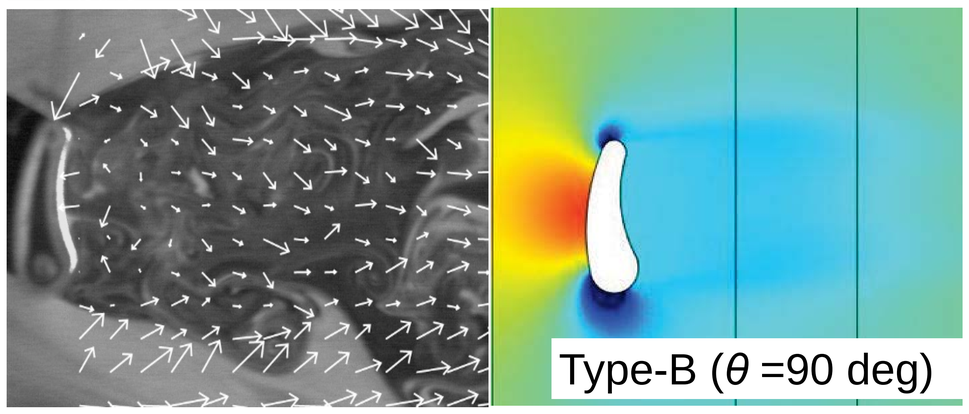


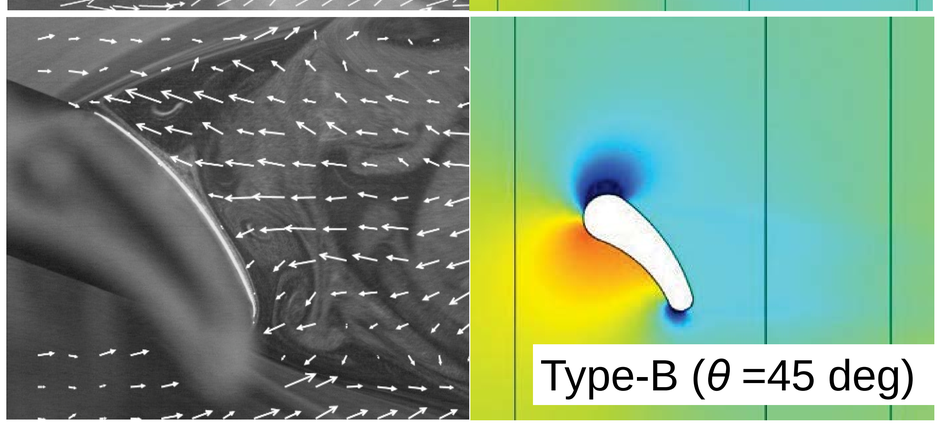
Results obtained by experiments (▲, ○) and numerical simulations (solid and broken lines) agree qualitatively.

Flow structure (velocity vectors , pressure distribution)









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