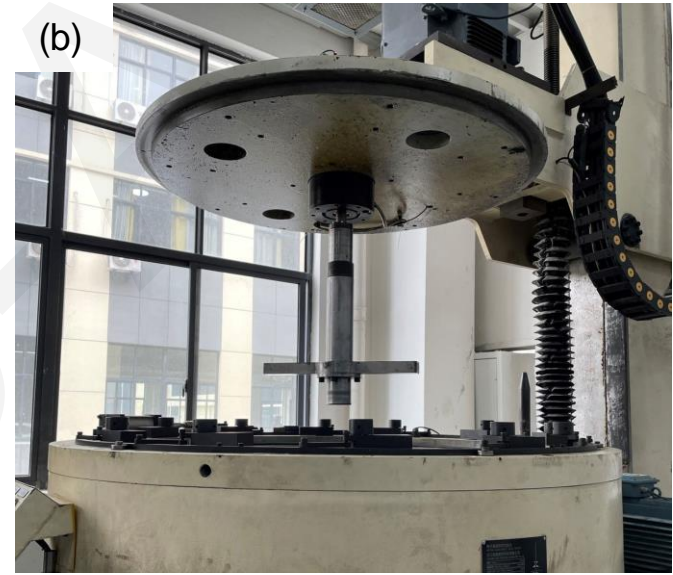
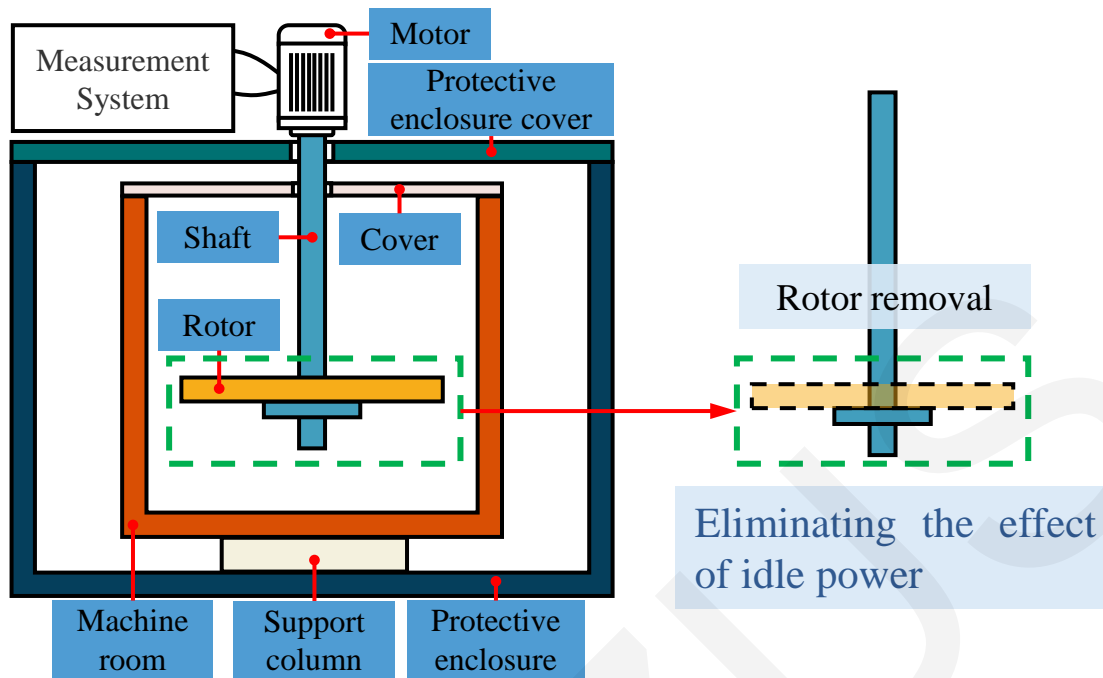


Distribution law analysis and calculating method for windage power in a geotechnical centrifuge

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<https://doi.org/10.1631/jzus.A2300288>

High-Reliability Windage Power Measurement Method

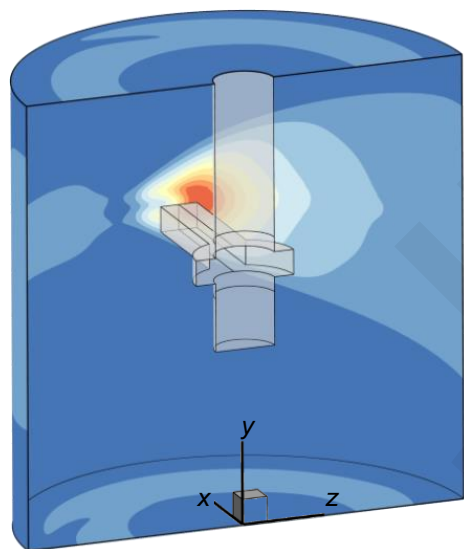
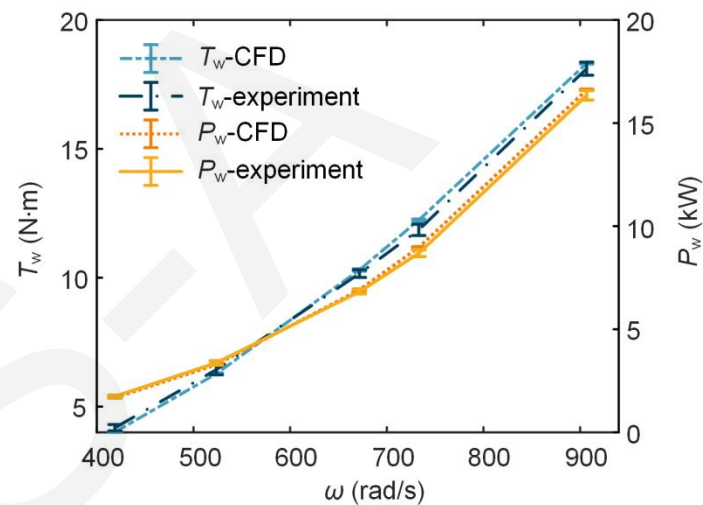
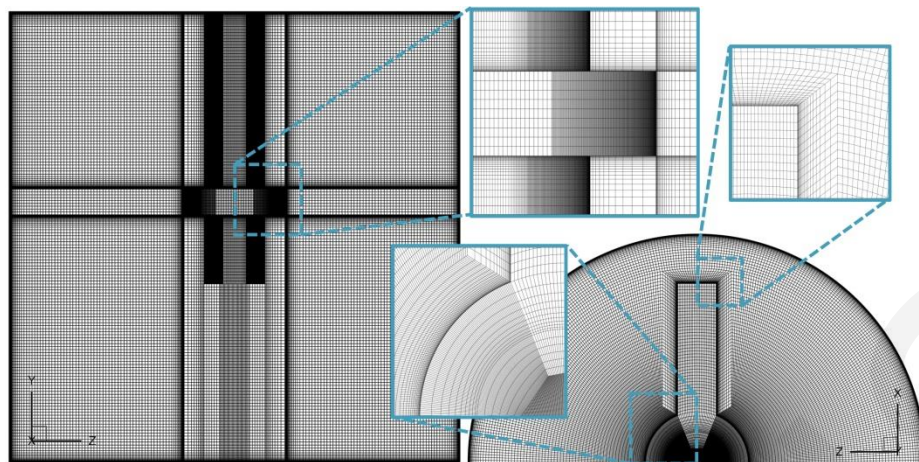


	ω (rad/s)							
	105.29	209.03	313.98	418.68	523.56	671.6	733.04	906.75
e_{P_w} (%)	83.08	22.3	8.57	2.91	3.12	1.46	1.87	1.4
e_{T_w} (%)	83.75	22.43	8.59	2.92	3.12	1.47	1.87	1.4

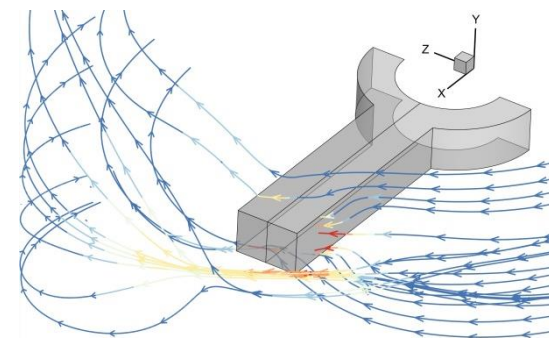
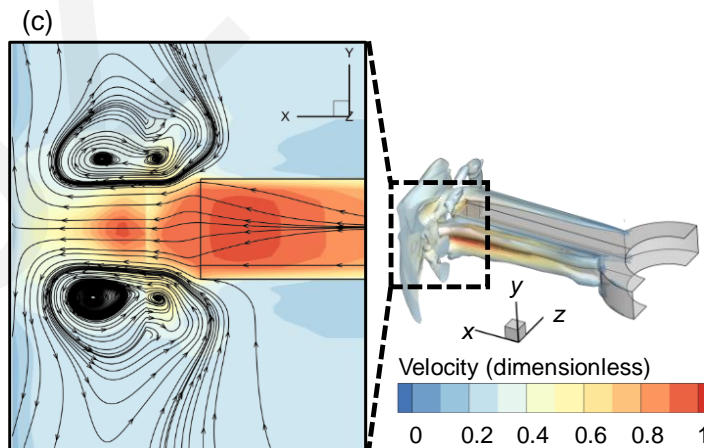
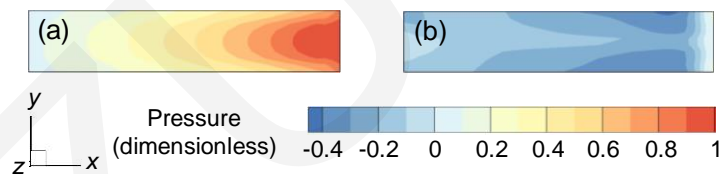
The indirect measurement method introduces significant errors at low speeds.

Accurate Calibration of CFD Models

Model validation by GCI



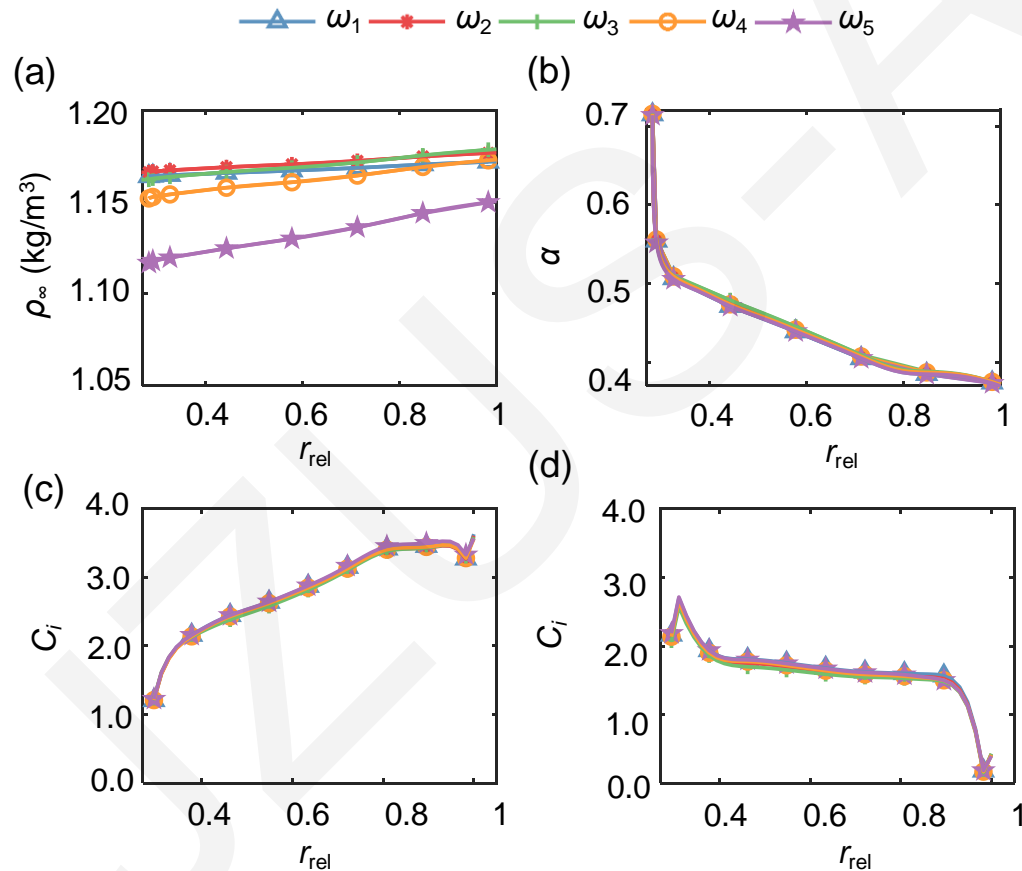
Wall shear stress (dimensionless) 0.1 0.3 0.5 0.7 0.9 1



Velocity (dimensionless) 0 0.2 0.4 0.6 0.8 1

α & C_i Independent of Angular Velocity

Variation rules of ρ_∞ (a), α (b), and C_i (c) on the windward wall and C_i (d) on the leeward wall along with r_{rel} at different ω



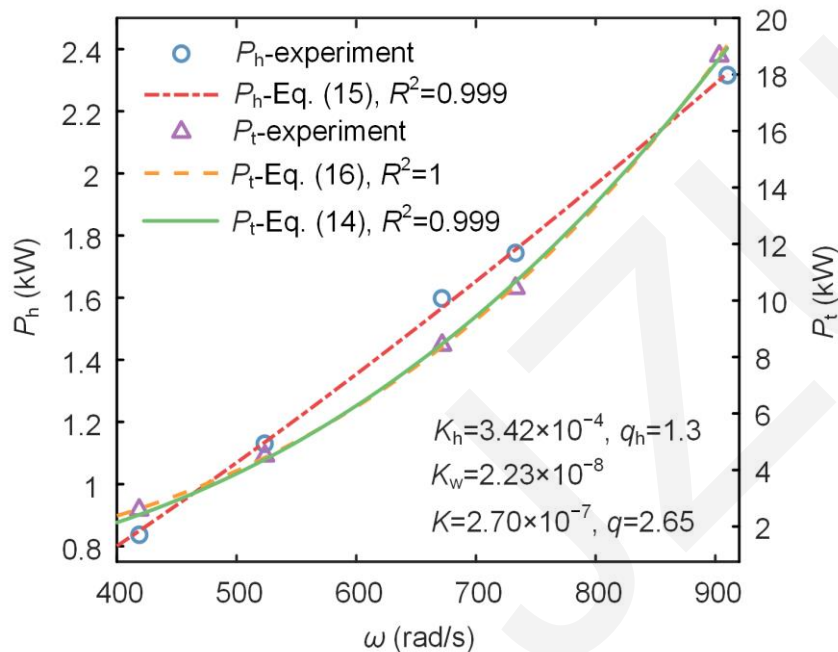
The velocity coefficient (α) and windage coefficient (C_i) are a function of the device geometry and size, and are independent of the angular velocity.

New Equation for Windage Power Calculation

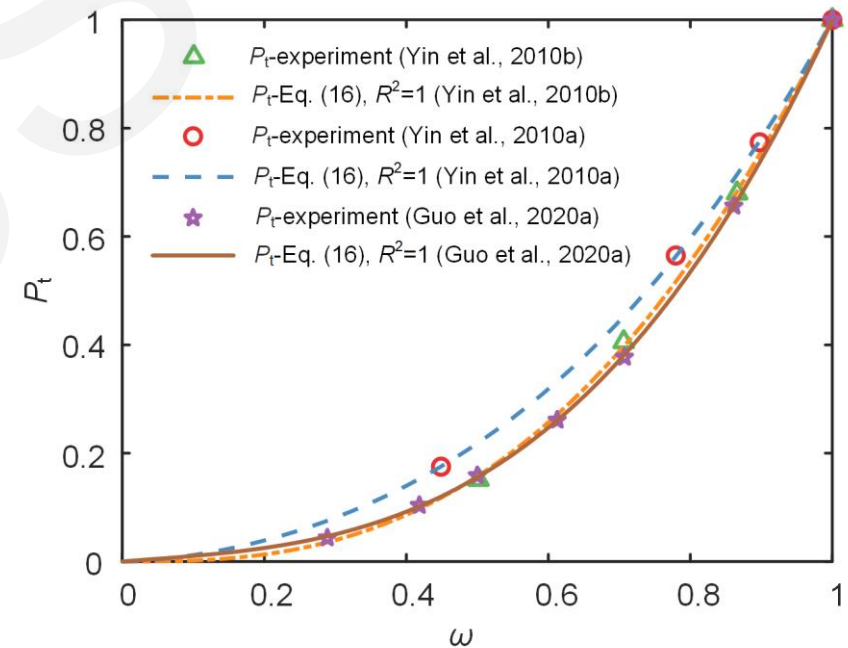
Windage power:
$$P_w = \frac{1}{2} \bar{\rho}_\infty b r_a^4 \omega^3 \Phi \quad \Phi = \int \varphi dr_{\text{rel}} \quad \varphi = C_i(r_{\text{rel}}) [\alpha(r_{\text{rel}})]^2 r_{\text{rel}}^3$$

Total power:
$$P_t = P_w + P_h = K_w \omega^3 + K_h \omega^{q_h}$$

The idle power P_h and the total power curve.



Total power data from the literature fitted via new equation.



The new equation exhibits well adaptability and accuracy.

Conclusions

- 1. Indirect measurement errors significantly impact windage power assessment.**
- 2. The velocity and windage coefficients depend on device geometry rather than angular velocity, simplifying tests and designs by allowing angular velocity to be disregarded.**
- 3. Windage power is directly proportional to the cube of angular velocity when idle power effects are eliminated.**

