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Experimental study of ventilation inception on Olympic serie Kitefoil shaft

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On the kitefoil olympic series, ventilation is commonly reported by athletes as the main limitation to speed and performance. Ventilation is the succion of air bellow the sea water level at the interface between the surface and the foil. It is commonly observed when the foil is surface piercing and has a dramatic effect on the lift and drag of the lifting surface due the substituion of water on a portion of the foil by a low density fluid, air. If ventilation is a shared limitation, athletes point out significant differences of occurences and intensity depending on the race spot, the time of year, the weather conditions and most important the care put on the equipment and surface roughness [1][2]. To assess the effect of surface preparation on ventilation in the ANR project "Carbone à l'Or Olympique", it was choosen to work on controled condition. Reproducing kitefoil condition of ventilation is not possible in a towing tank and asked to build a specific set up based on a semi-rigid motor boat. The semi-rigid has been equiped by a cross beam holding at each end a kitefoil shaft. Loads, motions, angles and videos are systematically recorded and synchronized for different speeds and surface treatement. Several data analysis are compared from load gages and motion signal extraction to image processing from neural network. A physical model based on sub-critical system representing the hysteris behaviour of ventilation is presented. the model highlights a stronger link between the ventilation inception and the dynamics of the inputs such as angle of attack or vertical acceleration, than a link with the actual value of this parameters. It also suggests that if the different treatment could have a beneficial effect on the threshold where the ventilation occures, the more dramatic effect should be expected when reducing the instability or fluctuation when foiling. This study has been previously presented during Sports Physics conference in Rennes, dec 2024 without any mention of the physical model and only preliminary results analysis. We believe that the proposed version for Marine 2025 will be significantly updated.

Left - test set up on the semi-rigid motor boat equiped by two kitefoil shafts. Right - Ventilation observed on a kitefoil shaft during the test

References

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[2] Harwood, Casey M., Yin L. Young, and Steven L. Ceccio. (2016) "Ventilated cavities on a surface-piercing hydrofoil at moderate Froude numbers: cavity formation, elimination and stability." Journal of Fluid Mechanics 800 : 5-56.