Model Test of the Water Current Catamaran Turbine and Their Stability

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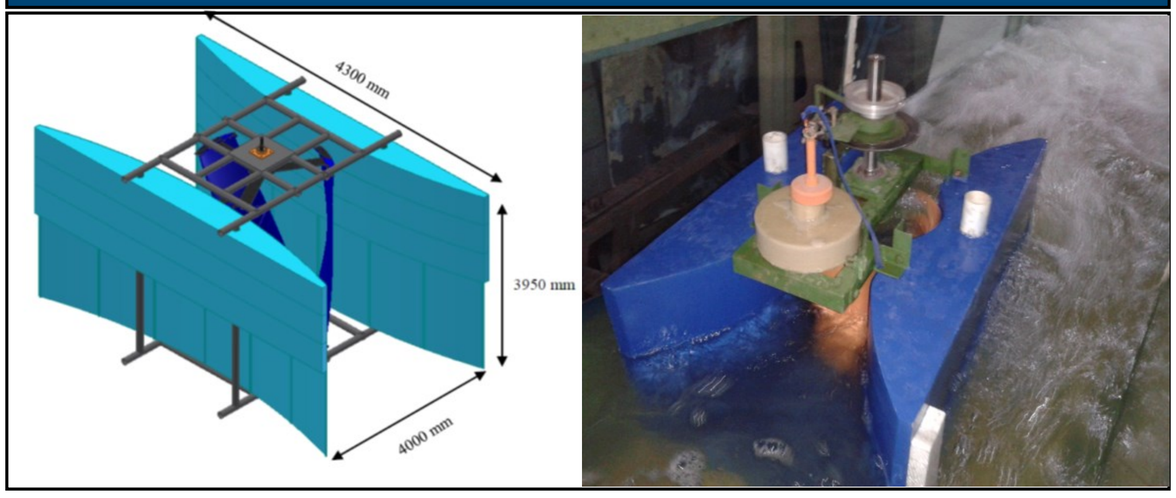
Introduction

The aims of this work is to investigate the performance and stability of the water current Catamaran Turbine Prototype. There are three aspects to be considered in designing process hydrostatic, stability, and performance of floating hydroenergy generator to generate power. CFD analysis conducted to investigate the flow around Catamaran and rotating turbine. The flow stream around Catamaran has oscillated moment and force and these could affect the stability. The model of buoyancy device was produced and tested in water flume. The test result shows that buoyancy device has good stability, it may be seen from the ability of the buoyant to keep its position when there is a disturbance on stability.

The Catamaran Buoyancy Device



The Similarity Principle

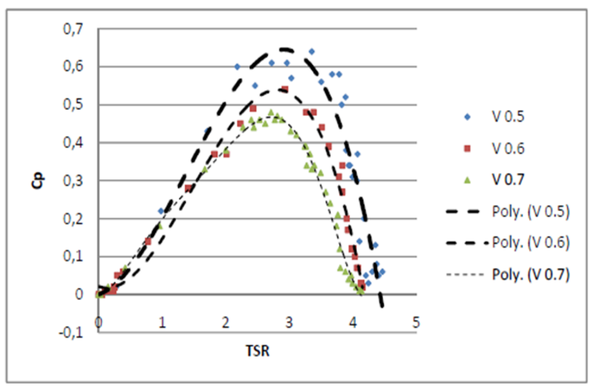
Scaling method to scale down the protoptype to the model use the Pi number of the Buckingham theorem, The law approach can be derives as follows : 1). To define the Law can represents the phenomenon occurs, 2). To simplify the formulation of the law, 3).To make the formulation to the non dimensional parameter.

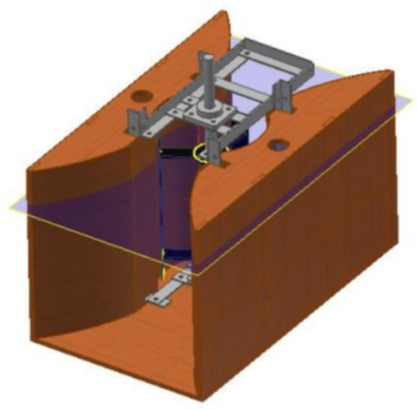
Table 3 Scale Parameters between model and prototype

Geometry	$\Lambda = \frac{Dimensi\ Model}{Dimensi\ Prototipe} = \frac{1}{8.6}$	*Time*	$1/\Lambda^{1/2}$=2.93/1
Acceleration of Gravity	1	*Displacement*	**Λ=1/8.6**
Mass	$\Lambda m = \frac{massa\ model}{massa\ Prototipe} = \frac{1}{636}$	*Angle of Rotation*	1
Mass Moment of Inertia	$\Lambda m*\Lambda^2$= 1/40834	*Velocity*	$\Lambda^{1/2}$=1/2.93
Specific Thrust	$\Lambda m/\Lambda^2$=1/8.6	*Acceleration*	1
Specific Impulse	$\Lambda m/\Lambda^{3/2}$=1/25.22	*Angular Velocity*	$1/\Lambda^{1/2}$=2.93/1
Coefficient of Friction	1	*Angular Acceleration*	**1/ Λ=8.6/1**

The Performance of Turbine

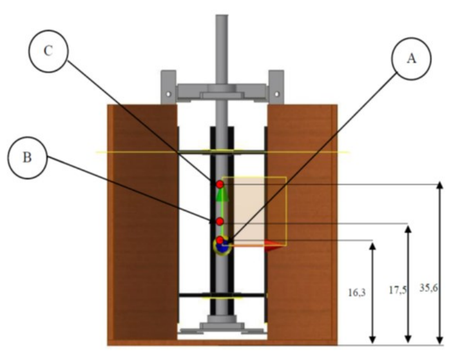
Equipped by concentrator nozzle s/D = 0.8





The Initial Catamaran Model Stability

The model submersed in an water is subjected to an upward force equal to the weight of the displaced fluid. The center of buoyancy calculate from the bottom of the Catamaran model, in the transversal direction.

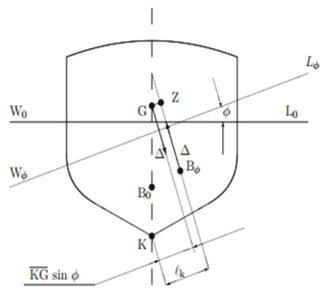


Position of Meta-center (C), Center of Buoyancy (B), Center of Gravity (A)

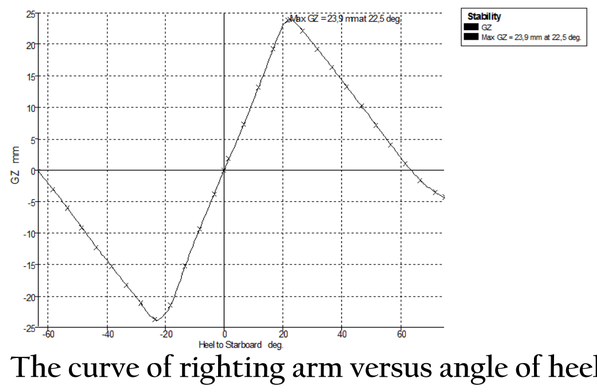
Center Of Gravity (COG)	163 mm
Center Of Buoyancy(COB)	175 mm
BM Transversal	181 mm
BM Longitudinal	101 mm
Metacenter Transversal *(KM)*	356 mm
Metacenter Longitudinal *(KM)*	276 mm
GM Transversal	193 mm
GM Longitudinal	113 mm

The Righting Arm

The righting arm is the displacement of the center of buoyancy due to the change of line action of the buoyancy force intersection when angle of heel to starboard change.



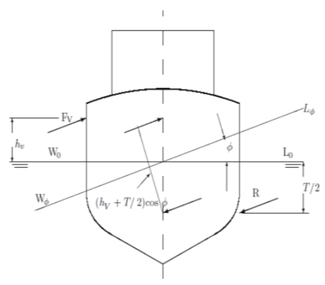
Buoyancy body inclined



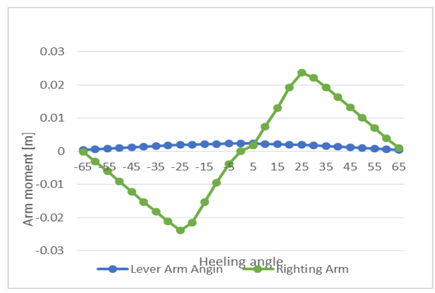
The curve of righting arm versus angle of heel

The Wind Heeling Arm

The stability of the Catamaran model has to be investigates due to the side wind. That is a wind perpendicular to the Center Line plane.

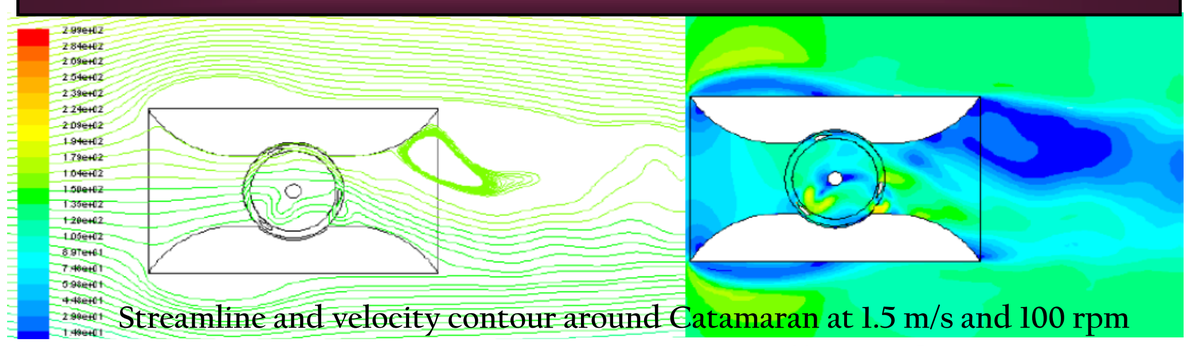


Wind Heeling Arm

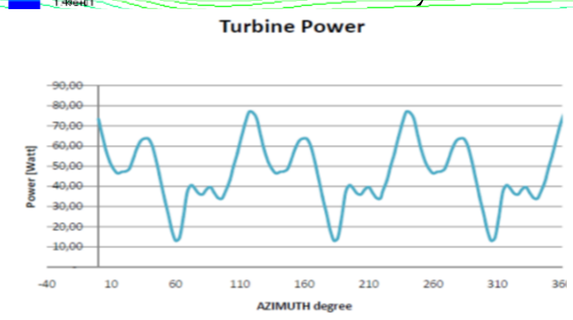


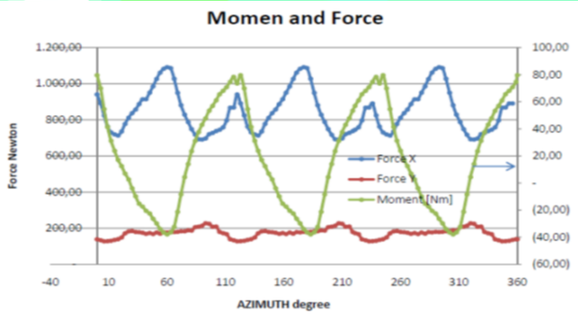
Curve of Wind Level Arm

CFD Simulation Flow around the Turbine Catamaran



Streamline and velocity contour around Catamaran at 1.5 m/s and 100 rpm





Conclusion

The Catamaran model as a buoyancy device has scale of size 1:8.6 with the prototype. Buoyancy device model draught will increase 6,36 mm with 1 kg weight increased. The statical stability of buoyancy device was characterized by its metacentric height (GM) with longitudinal GM 113 mm and transversal GM 193 mm. The Catamaran has four anchors system to keep stable due to the fluctuated force and moment.

Acknowledgment

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References

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2. Priyono Sutikno, Yuliandra Syahrial Nurdin, Doddy Risqi, Eki Mardani, Erpinus Sihombing. Experimental of Three Parallel Water Current Turbine With Optimized Straight Blades And Using Flow Concentrator Channeling Device To Augmented Performance and Self Starting Capability.Applied Mechanics and Materials Vol 758 (2015) pp 153-158 © (2015) Trans Tech Publications, Switzerland, doi:10.4028/www.scientific.net/AMM.758.153