An experimental investigation into the most prominent sources of uncertainty in wave tank testing of FOWTs

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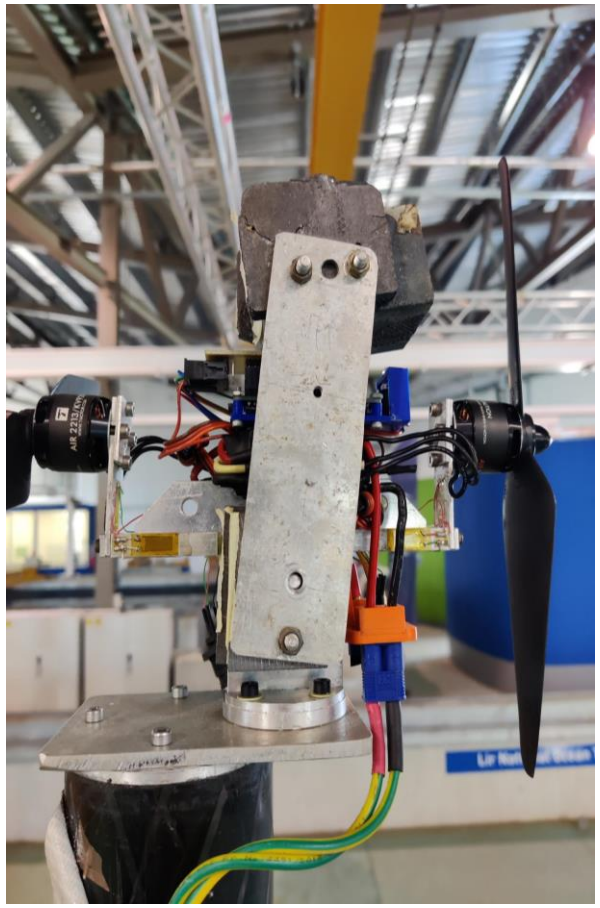


Models Used

Variations

- Sensitivity Analysis completed by adjusting the inertia and CoG conditions for both models.
- Changes based on known errors and uncertainties in the inertia values when testing FOWTs.
- During each variation, the mass, draft, mooring stiffness and hydrostatic stiffness remained constant.

Model	Variation Number	Wind System	Mooring System	% change in I_{xx} relative to base case	% change in I_{yy} relative to base case	% change in I_{zz} relative to base case	% Change in KG_z relative to base case
A	1	Thruster Ifremer	Aerial	-	-	-	-
A	2	Thruster Ifremer	Aerial	-7.2	-7.1	0.2	-8.6
A	3	Thruster Ifremer	Aerial	-9.0	-9.1	-0.1	-10.6
B	9	SIL	Catenary	-	-	-	-
B	10	SIL	Catenary	-8.5	-8.5	-	-9.9
B	11	SIL	Catenary	-4.0	-4.0	-	-5.6



	Desired	Actual	% difference
Mass (tn)	25530	25434	-0.38
Distance between Centre of Gravity z and keel of device	12.04	13.2	9.63
Radius of gyration x (m)	32.43	35.29	8.8
Radius of gyration y (m)	32.42	36.78	13.45
Radius of gyration z (m)	30.49	28.24	-7.38

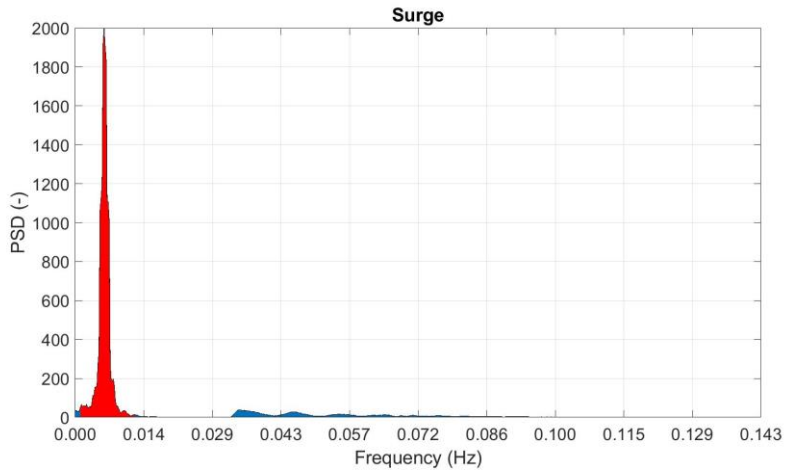

Method

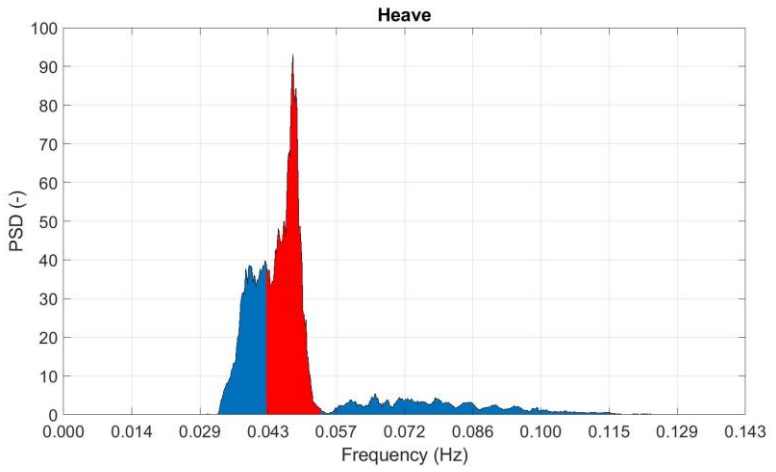
- 3 repeats of Surge, Heave and Pitch Decay tests for each variation.
- 5 Pink Noise waves with a H_s = 0.1m at model scale were completed for each variation.

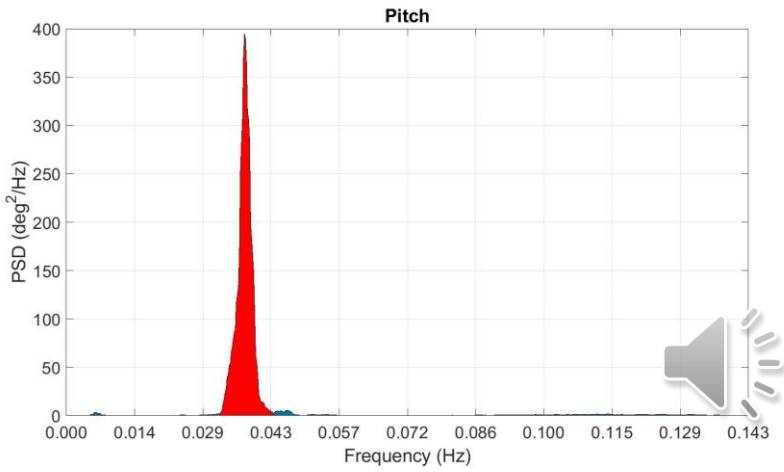
	Min Freq (Hz)	Max Freq (Hz)	Sig Wave Height (m)	Run Time (s)	Repeat Time (s)
Model Scale	0.258	1.111	0.1	660	600
Full Scale(1/60th)	0.0333	0.1434	6	5112.34	4647.58

- Average device motions for each variation was taken.
- Metrics were used for comparison purposes.
- T_r, $T_{r,\,mag}$, M_{WF} metrics were used to compare the results from each variation.

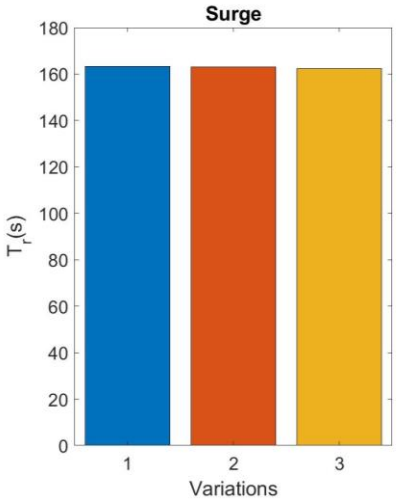
$$T_r = \frac{\int_{f_c-\delta f}^{f_c+\delta f} S_{signal}^4 \, df}{\int_{f_c-\delta f}^{f_c+\delta f} f . S_{signal}^4 \, df} \qquad T_{r,mag} = \int_{f_c-\delta f}^{f_c+\delta f} S_{signal} df \qquad M_{WF} = \sqrt{\frac{\int_{f_1}^{f_2} S_{signal} df}{m_o}}$$

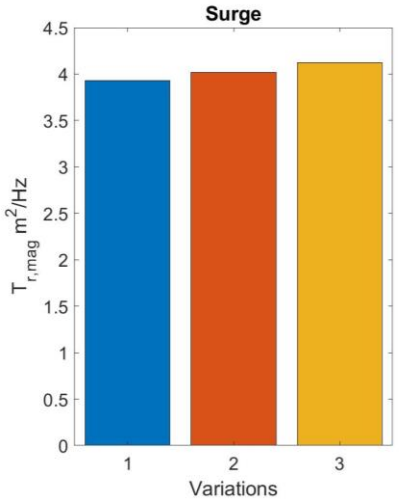


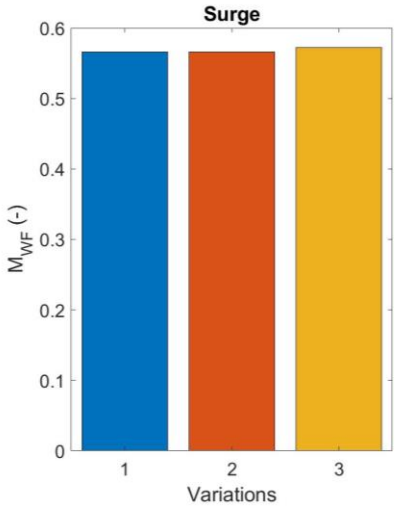


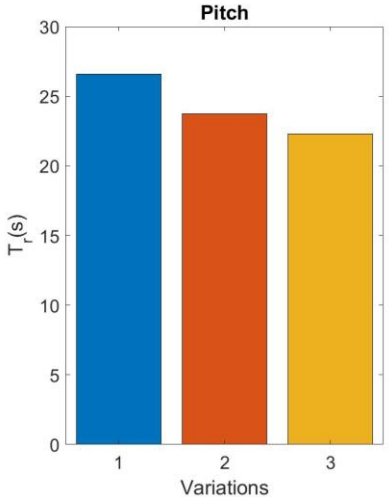


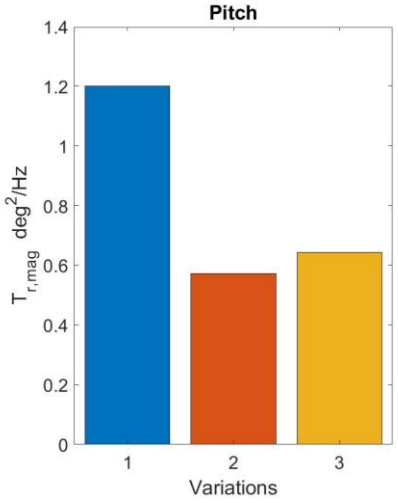
Model A

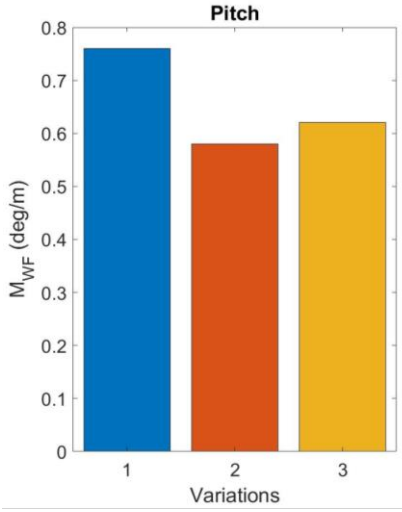




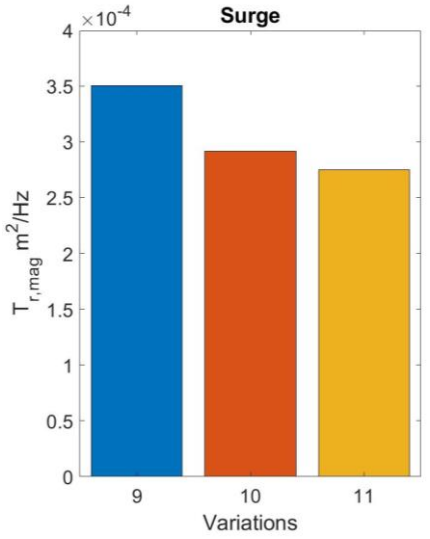


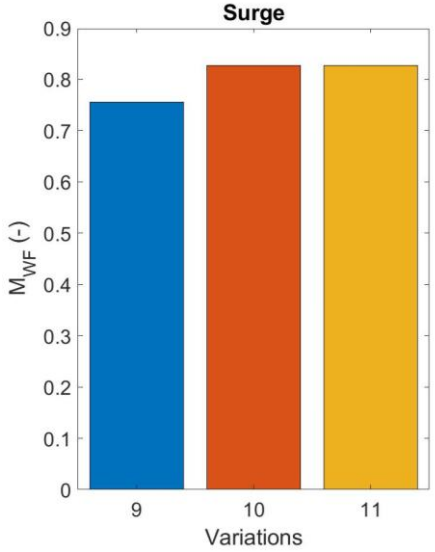


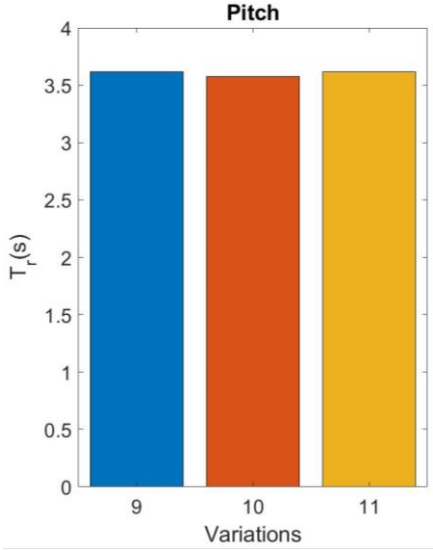


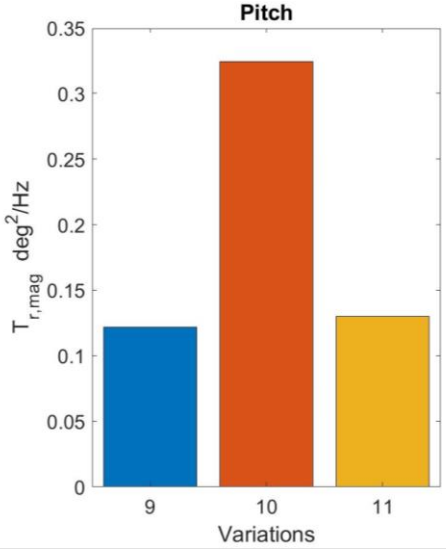


Model B









Conclusions

- Of the variations completed, the uncertainties in inertia about the y-axis, $I_{yy,}$ had more influence on the platform pitch than the inertia about the x-axis, I_{xx}, had on platform surge.
- Uncertainties and errors due to model inertia and CoG have a significant effect on platform motions. The influence of these uncertainties is amplified at resonance.
- The magnitude of device response was more significantly effected than the period of resonance response.
- The effect of the uncertainties and errors in inertia were easier to quantify for model A than model B.
- Conducting a sensitivity analysis across the range of the uncertainty bounds for key parameters like CoG and Inertia helps to assess the effect on device responses that these uncertainties could cause and would further enhance developers' understanding of their platform.