A Concrete Floating Platform for large-scale Offshore Wind Turbines

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Concrete Platform configuration

Brazil has a significant offshore wind potential in the south, southeast, and northeast regions along the coastline. Wind velocities can reach up to 9 m/s with an annual average capacity factor of between 45% and 65%. More than 65% of the offshore wind resources are located in water depths of more than 60 m, where bottom-mounted wind turbines such as monopiles are not economically and technically feasible. This study addresses the preliminary design of a concrete floating platform to support a 15-MW wind turbine. The dimensions are defined through a hydrostatic analysis. A comparison of CapEx and LCOE is done by considering concrete and steel platforms and towers.

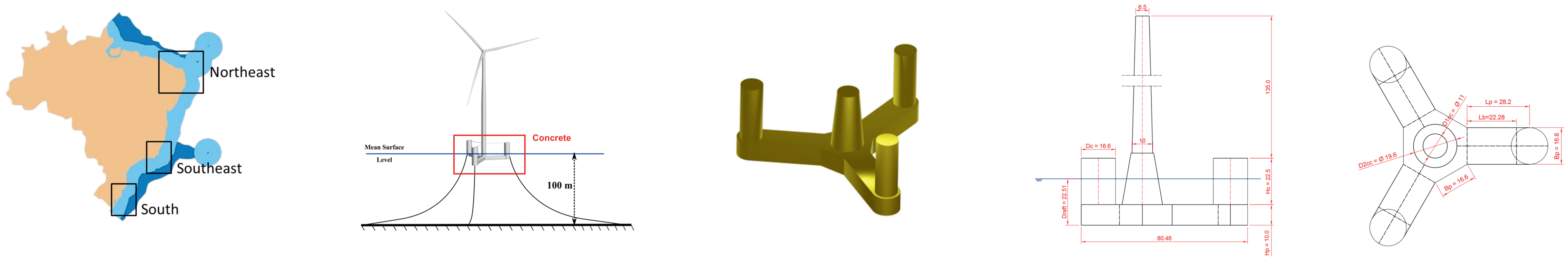

Figure 1. Concrete platform configurations

Hydrostatic analysis and geometry optimization

The objective of the optimization is to minimize the weight of the concrete platform. The Genetic Algorithm is used for the optimization process. **Constraints:** Metacentric height > 1 m, Draft > 10 m (To avoid slamming), Freeboard height >= 10 m, Maximum pitch angle < 3°, 6°, 9° and 12° considering the maximum thrust, Natural period should lay out of the range of the wave periods (5 - 25 s). **Variables:** Lateral column dimensions, Pontoon dimensions, Ballast dimensions, and mass.

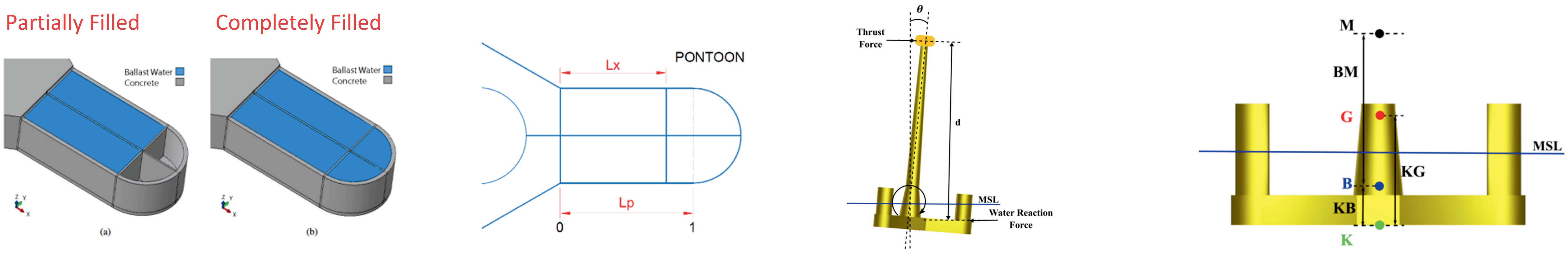

Figure 2. Ballast scheme and stability characteristics

Results

The optimized weight and ballast are shown by considering the concrete and steel tower and comparing them with the Activfloat [1] as a reference system. A higher GM of the unballasted platform shows a higher stability in transportation.

Table 1. Optimized platform characteristics

Weight (t)	Present platform (Concrete Tower)	Present platform (Steel Tower)	ActiveFloat (Steel Tower)
RNA	1,016.50	1,016.50	1,016.50
Tower	4,013.09	1,219.48	1,088.50
Ballast	13,326.45	11,747.95	16,632.00
Platform	26,648.73	23,017.13	22,564.00
Total	45,004.77	37,001.06	41,301.00

Table 2. Unballasted platform characteristics

Platform	Draft (m)	GM (m)
Concrete Tower	10.45	24.38
Steel Tower	9.96	24.25
ActiveFloat	11.53	2.19

Table 3. LCOE considering a 1-GW farm

Parameter	Concrete Platforms	Steel Platforms	Unit
CapEx	3442.60	4433.79	$ millions
DecEx	176.13	176.13	$ millions
OpEx	150.66	150.66	$ millions per year
AEP	4563	4563	GWh per year
LCOE	103.46	122.75	$/MWh

* Umaine VolturnUS-S Platform is used as a reference for the steel platform [2]

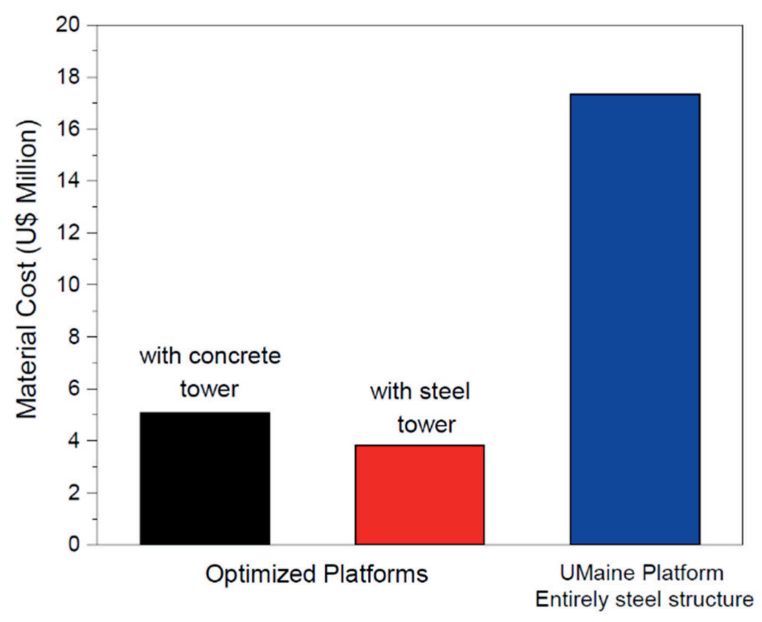

Figure 3. Material cost comparison

length: 350 m
Width: 133 m
Draft: 13.8 m
Lifting Capacity: 2,000 t

Figure 4. Dry Dock in South Brazil

Acknowledgements

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References

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2.Allen, Christopher, et al. Definition of the UMaine VolturnUS-S reference platform developed for the IEA wind 15-megawatt offshore reference wind turbine. No. NREL/TP-5000-76773. National Renewable Energy Lab.(NREL), Golden, CO (United States); Univ. of Maine, Orono, ME (United States), 2020.