Static Performance of Power Augmented Ram Platform

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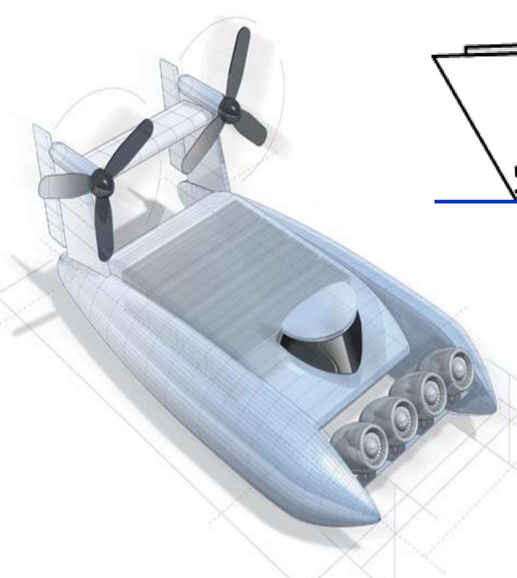
Introduction

- A Power Augmented Ram (PAR) vehicle is a ground-effect craft that travels close to a surface such as water, land, snow or ice.
- PAR vehicles apply ground effect and ram air from jet engines or fans to minimize surface drag and achieve amphibious capabilities.
- There are several advantages of PAR vehicles as high-payload transports such as:
  - High speed (>100 knots)
  - High seaworthiness
  - Reasonably low thrust-to-weight ratio 0.15-0.25
  - Amphibious capability (for landing operations and transportation in Arctic regions)



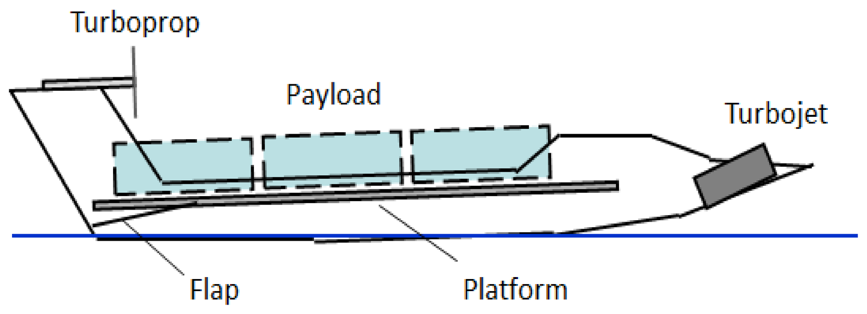


Fig. 2 Detailed description of a PAR vehicle.

Fig. 1 Power Augmented Ram (PAR) vehicle.

Objective

- The goal of this research is to help achieve a better understanding about aero-hydrodynamic phenomena in PAR systems.

Experimental Methods and Materials

- The first experiment simulates a static PAR vehicle with the air jet representing a jet engine and the plate with a flap representing the vehicle's platform.
- An air nozzle and a platform with a flap were placed inside a rectangular tank filled with water. Pressure distribution and water surface elevations were measured in different conditions.
- The independent variables in this experiment included the static water level, platform flap angle, and jet airflow rate.

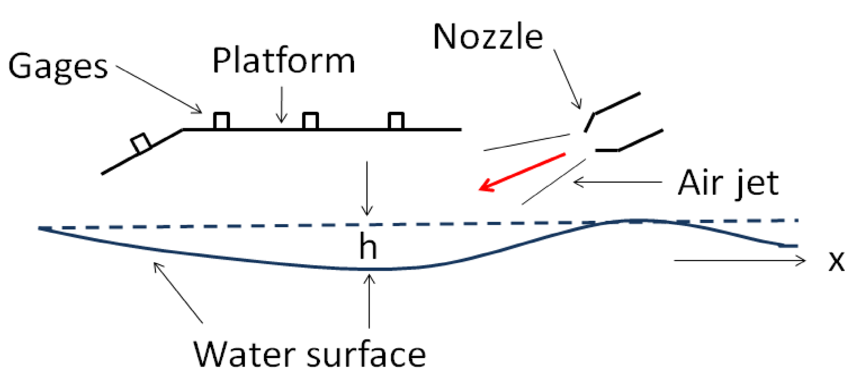


Fig. 3 Schematic of the jet impingement experiment.

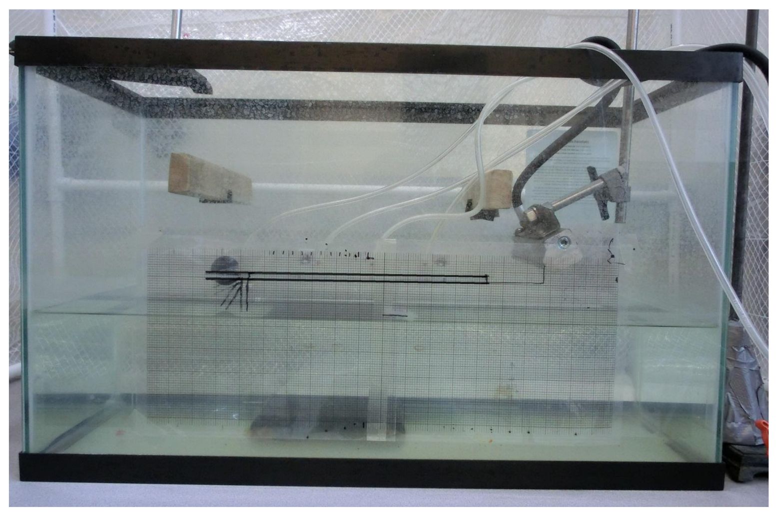


Fig. 4 The jet impingement experiment.

- The second experiment was aimed at measuring airflow velocities and thrust of a free air jet.
- The air jet was placed at five inches above the table top with a board on each side of the jet. A thin pitot tube was utilized with its opening towards the mouth of the air jet to measure the airflow velocities.
- The independent variables were spatial positions of the pitot tube.

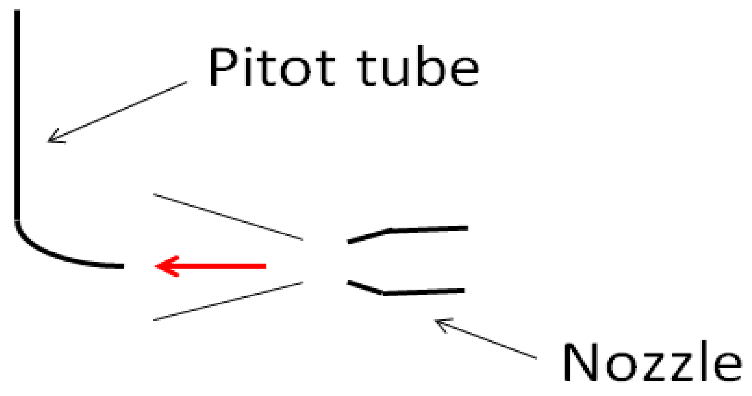


Fig. 5 Schematic of velocity measurement test.

Fig. 6 Velocity measurement experiment.

- The third experiment that was conducted similar to the first experiment, but instead of a straight platform, a slanted platform positioned at five degrees to a horizontal plane was used.
- As before, an air nozzle and a platform with a flap were placed inside a rectangular tank filled with water.
- The only independent variable of this experiment was water level.

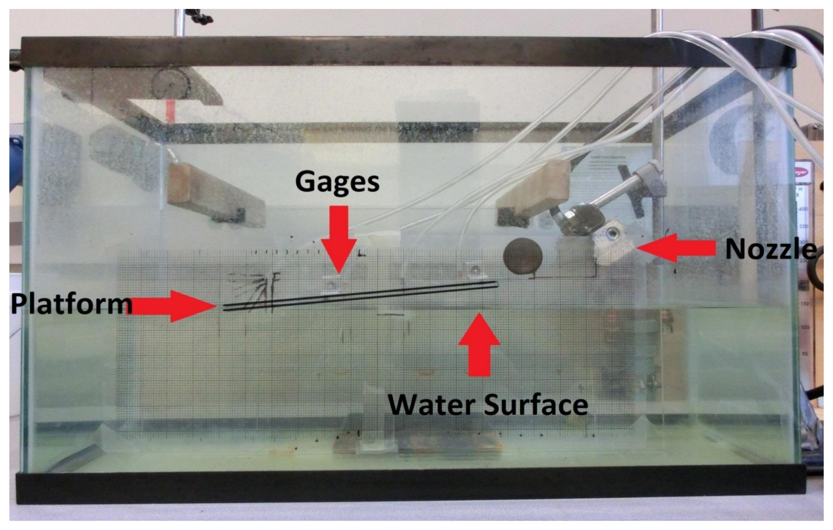
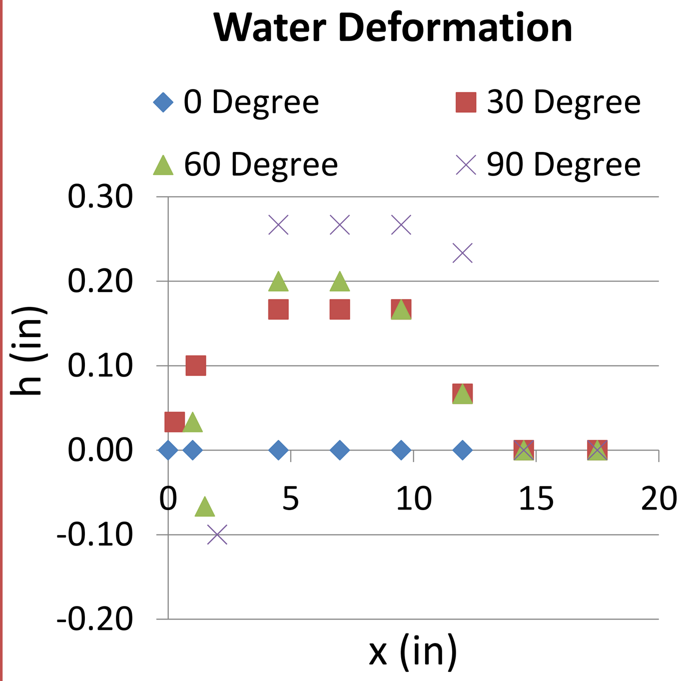


Fig. 7 The slanted platform experiment.

Results

- In the jet impingement experiment, it was found that the highest static pressure under the platform and the most significant water level depression were generated when the flap closed the exit from the under-platform channel.
- With open flap positions, the water in the tank became highly unsteady, and oscillatory wave patterns were developed.



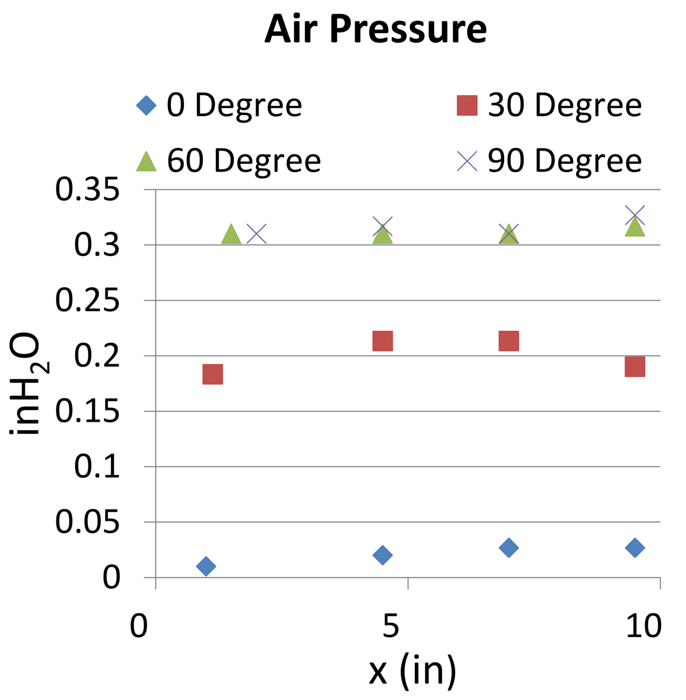
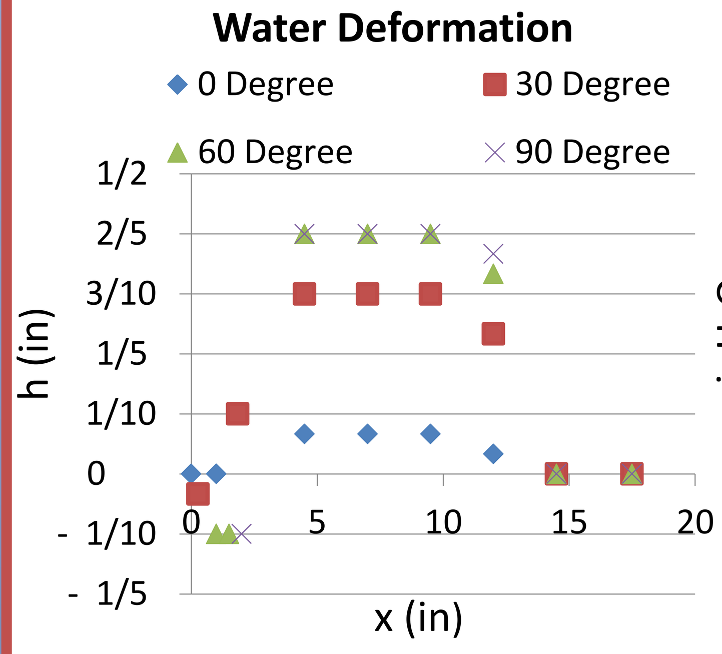


Fig. 8 & 9 Recordings at the static water level set at 1½ inches from the platform and the air jet set at nominal flow rate of 150 SCFH.



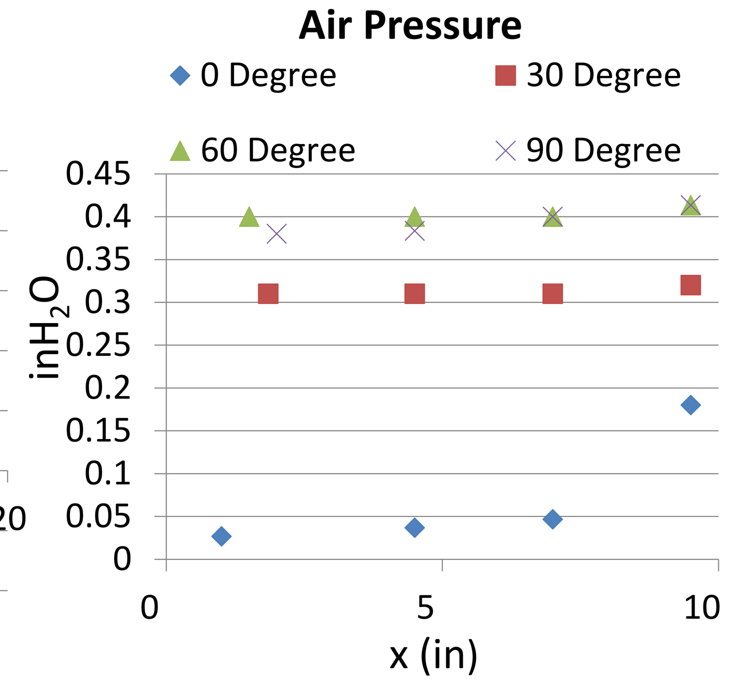


Fig. 10 &11 Recordings at the static water level set at 1 inch from the platform and the air jet set at nominal flow rate of 150 SCFH.

- In the velocity distribution experiment, when the pitot-tube was placed at 1 inch from the nozzle, the measured velocity profile showed a narrow jet.
- When the pitot-tube was placed at three or five inches from the air jet, the jet thickness expanded.

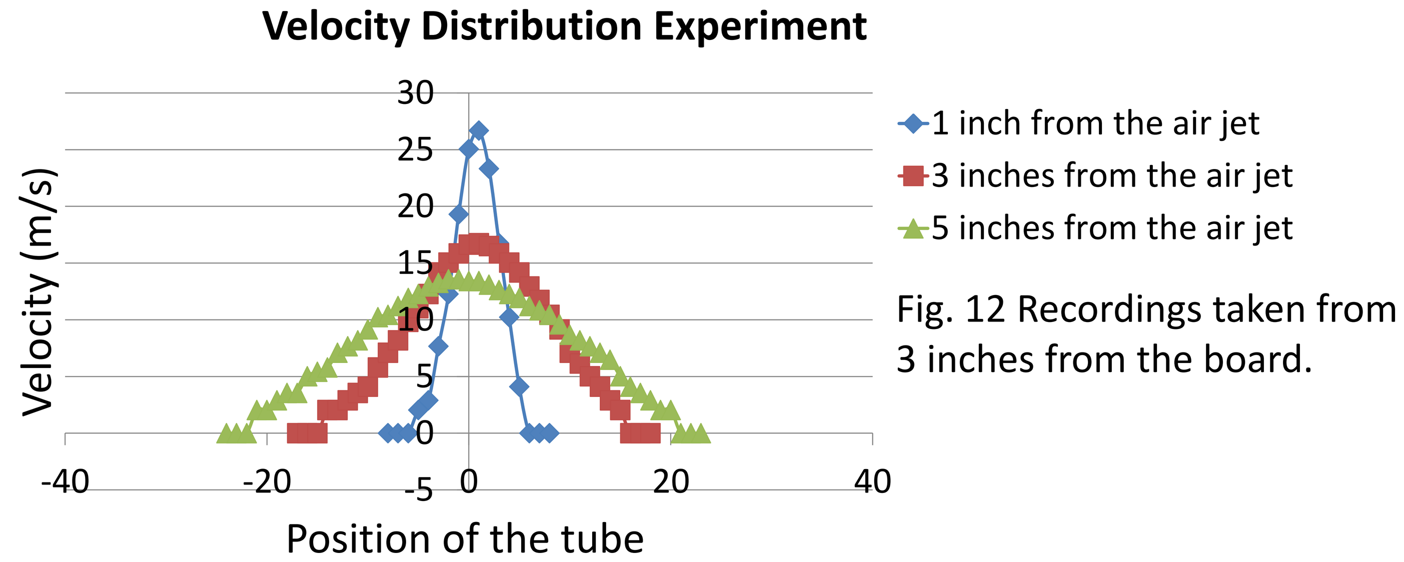
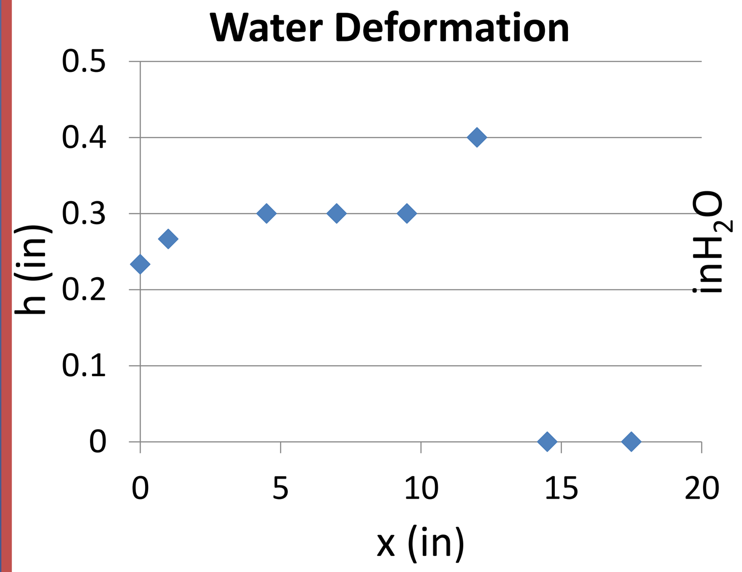


Fig. 12 Recordings taken from 3 inches from the board.

- In the slanted platform experiment, there was higher pressure build-up under the slanted platform compared to the straight platform. This is believed to be due to more pronounced stagnation of air flow.



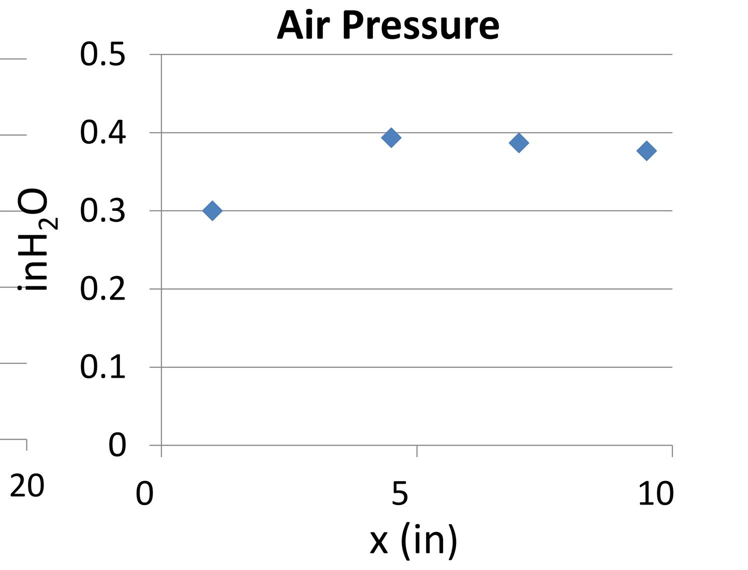


Fig. 13 & 14 Recordings at the static water level set at 1½ inches from the platform and the air jet set at nominal flow rate of 150 SCFH.

Conclusion

- Measured water surface deformations and air pressure distributions under the PAR platform can be used for designing PAR vehicles and validating mathematical models.
- Unsteady regimes (with occurrence of waves and spray) were noticed in the experiments with flap positions at 0 and 30 degrees. Further investigations of such conditions using time-resolved measurements are warranted.

Acknowledgments

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