MODEL TESTING OF "PENDULOR" TYPE WAVE ENERGY CONVERSION DEVICE FOR THE MODIFIED CAISSON

S.D.G.S.P.Gunawardane, M. P.Abeysekera, P.G.H.S.S.Dharmakeerthi, A.M.L.A. Abeyrathne and S.R.B.Wimarshana

Department of Mechanical Engineering, University of Peradeniya.

Introduction

An ocean wave power converter named "Pendulor" has been studied for over twenty years by members of Muroran Institute of Technology in Japan. Recent study by University of Peradeniya on the caisson configuration reveals that there is a high possibility to reduce the caisson length by altering the shape and dimensions of the enlarged gully like mouth leading to the water chamber(Uyanwatte D.). Particle displacement field tests inside the modified caisson have shown that apart from the reduction of length there is a possibility for improving the frequency bandwidth of efficient operation as well(Uyanwatte D.)

The objective of this study was to develop a laboratory scale model of the "Pendulor" and thereby carry out experiments on the performance of the unit subject to varying wave conditions.

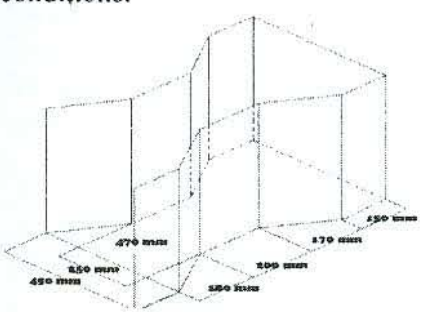


Figure 1. Modified caisson

The principle of the "Pendulor" is to make a generator run from pendulum motion excited by surging water flow in standing waves. It consists of a water chamber open offshore, a flap driven by waves, a hydraulic power transmission unit and a generator.

Methodology

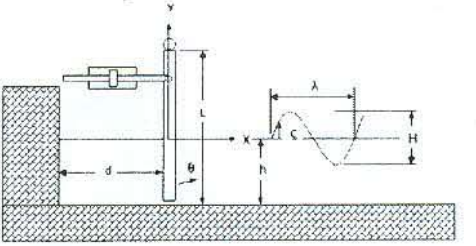


Figure2.Configuration of the system

The energy absorption ratio, η of the "Pendulor" is defined as

$$\eta = \frac{W}{E} = \frac{4\omega^2 N_o N}{[(\sum I)^2(\omega_o^2 - \omega^2)^2 + \omega^2(N_o + N)^2]}$$

where, W–energy absorbed by the hydraulic pump, E–Energy entering the water chamber, ω – Circular frequency of incident wave, ω_0 – Natural frequency of the system, N_o- Damping coefficient of the pump, N - Damping by wave generation, $\sum I$ - Moment of inertia of the pendulum including added mass of water (A. Ando).

The hydrostatic power extraction unit schematic of the 1:16 scale model is

illustrated in Figure 3 and two views of the fabricated model are shown in Figure 4. The Pendulor was tested in stationary wave surges in a 2D wave tank (0.5m x 1m x 10m).

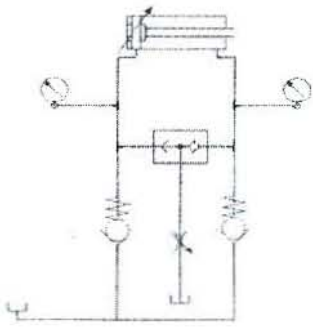
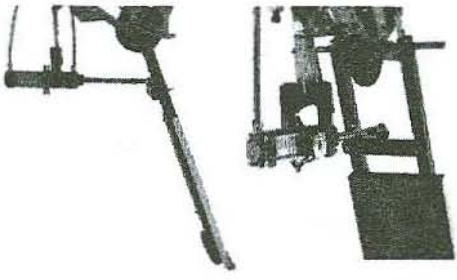


Figure 3. Hydraulic schematic



a) Side View **b) Back View**

Figure 4. Model pendulor

Discussion

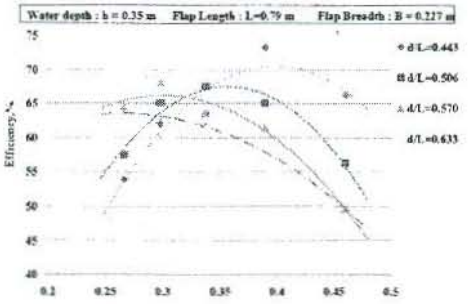


Figure 5. Relationship between incident wave frequency and efficiency

Figure 5 shows the relationships between efficiency and incident wave frequencies inside the modified caisson.

The tests recorded a maximum power absorption of 73% and efficiency values exceed 40% for all tests of varying frequencies, symptomatic of economical feasibility in a likely prototype unit.

It was observed that there exists an optimal location for the positioning of the pendulum inside the modified chamber. Future work will be focused on enhancing the optimal form (shape) and the position of the pendulum inside the caisson for power extraction.

Conclusion

The results show that optimal operation of the 'Pendulor' model inside the modified caisson is observed at the partial standing wave node positions established by a recent study on the displacement field inside the same (*Uyanwatte D).*

Reference

Ando, A., Ohtani, S., Takagi, M., Kuroi, M., Kondo, H., Yano, K. and Watabe, T. (1984). On a flap type wave energy converter, Proceedings of the Engineering Committee on Oceanic Resources (ECOR) International conference, Oct.,1984.

Uyanwatte, D.M. (2009). Performance testing of a "Pendulor" type wave energy device, Project Report, University of Peradeniya, 2009.