EXPERIMENTAL STUDY ON EFFECTS OF SHORTEND CASSION ON THE PERFORMANCE OF "PENDULOR" TYPE WAVE ENERGY CONVERSION DEVICE

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Introduction

The "Pendulor" wave energy device which is a highly efficient unit is a suitable application at moderate wave power climates such as in Sri Lanka (Figure 1). The device mainly consists of a pendulum suspended into the sea which absorbs energy as it is excited by standing waves that occur inside the caisson at resonance condition.

The pendulum is driven by the surging water particle motion of the standing waves formed in the caisson. The horizontal displacements of water particles are a maximum at the node point. Thus for maximum efficiency, the pendulum has to be placed at the node point of the standing wave which occurs at ¼th of the wave length from the caisson back wall. In implementation, this length gets around 25 m for 100 m of design wave length that arrives at the Sri Lankan coasts (*Watabe et al.,2001*). Therefore, it is necessary to have a 25 m extended caisson which is a heavy engineering challenge and cost. To curtail those challenges, a shortened chamber configuration was introduced (Figure 2(b)) and to identify the hydrodynamics inside the caisson a 1/16 scale model of the modified version was tested.

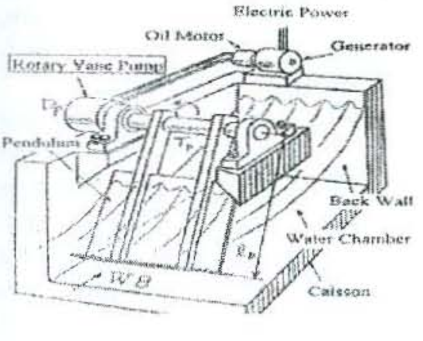
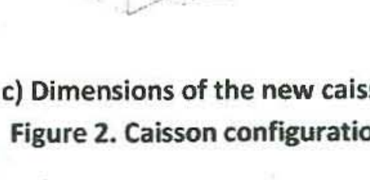


Figure 1. Pendulor wave device

Methodology

The model of the caisson was tested in 0.5m x 1m x 10m wave tank for regular waves. Visualization methods by capturing video images were used to identify the nodal points inside the chamber for varying incident wave frequencies.

a) Straight **b) Modified**



c) Dimensions of the new caisson

Figure 2. Caisson configurations

Results and Discussion

The node point variation inside the modified caisson

Partial standing waves were created inside the modified caisson because of the asymmetric incident and reflecting waves. But it was able to identify a node point for the partial standing wave, where the vertical movement of water particles were at minimum.

Figure 4 shows the measured node points for the partial standing waves of the modified configuration and the node point variation of the straight caisson. Where, ω – Circular frequency of incident wave and λ- wave length.

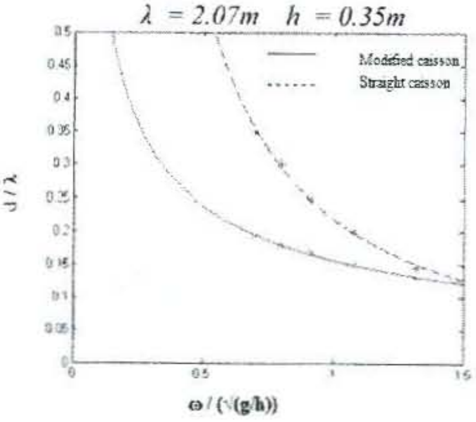


Figure 4. Nodal point variation

The frequency bandwidth of the modified caisson

The efficiency is influenced by the frequency variation of the incident wave because the node point is drifting away from the pendulum operating point with the frequency. Figure 5 shows the maximum theoretical efficiency variation with the frequency variation for a selected frequency range for both types of caissons (*A.Ando*). There it is assumed that the partial standing wave of the modified caisson has a negligible energy loss. Further experiments have to be carried out to investigate and minimize possible reductions of energy capture by the reflection and diffraction of the waves by the modified shape of the caisson.

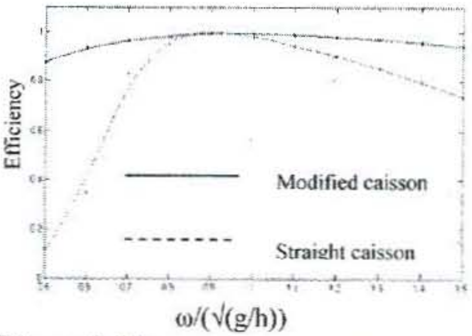


Figure 5. Theoretical efficiency

Conclusion

According to the outcomes of the model tests it was revealed that the modified caisson configuration provides a higher frequency broadband for the device to operate with lesser caisson length of nearly up to 35% of reduction for the design wave length of 100 m.

References

Watabe, T.,Yokouchi, H. and Gunawardane, S.D.G.S.P., (2001) Preliminary study on wave energy utilization in Sri Lanka, *Proceedings of ISOPE 2001. Stavanger, Norway.*

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.*