# WAVE PRESSURE FORMULA FOR PERFORATED CAISSON WITH DOUBLE CHAMBERS

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## INTRODUCTION

Some of perforated caisson breakwaters have double wave chambers, for which no clear guideline for estimating design load is available. The well-known Takahashi's formula (Takahashi and Shimosako, 1994) is basically applicable to single-chamber perforated caisson. Considering this, we conducted physical experiment to develop a wave pressure formula for double-chamber perforated caisson.

## PHYSICAL EXPERIMENTS

Physical experiment was carried out with perforated caisson model shown in Figure 1. The wave loading on the vertical and horizontal forces on each wall of the structure was independently measured by both load cells and pressure transducers. The measurement was carried out with a total of 37 different regular waves for 60 seconds whose wave period from 0.77 to 2.70 s while wave height from 2.8 to 24.8 cm, under three different water depth conditions of 51, 55, and 59 cm. The data sampling rate during the measurement was 800Hz.

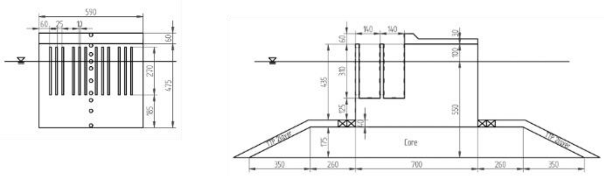

Figure 1 – Front and side views of the caisson model

## FIVE DIFFERENT WAVE PHASES

Figure 2 shows the five phases during positive wave loading on the double-chamber caisson, which are defined following the concept for single-chamber caisson proposed by Takahashi and Shimosko (1994). In the figure, Crest F denotes the wave phase at which the net horizontal wave loading on the front wall reaches its peak, whereas Crest Mi/Mp or Ri/Rp corresponds to the wave phase at the time instant of impulsive/pulsating maximum wave loading on the middle or rear wall, respectively. The definition of the five wave phases can be more clearly understood with Figure 3, which shows time series of the integrated wave forces acting on the vertical walls of the double-chamber caisson.

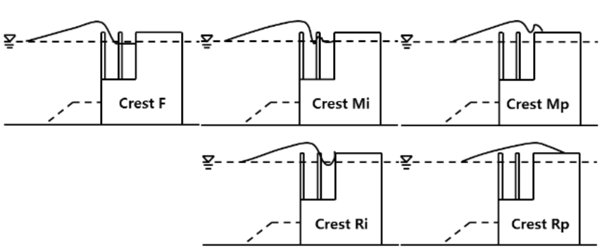


Figure 2 - Five wave phases during positive wave loading on the double-chamber perforated caisson

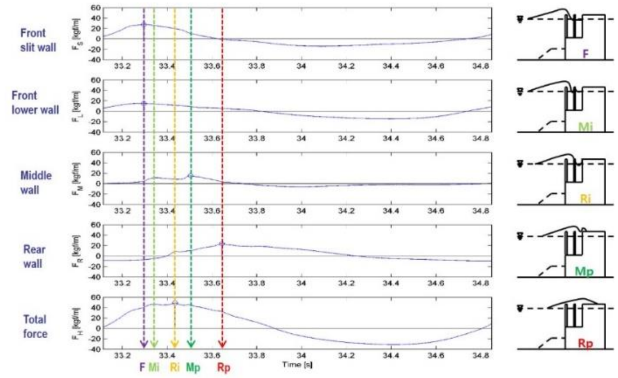


Figure 3 – Time series of wave forces on different walls of the caisson model marked with the five wave phases

## EXPERIMENTAL RESULTS

The left panel of Figure 4 shows the measured wave forces ($f_S^E$) acting on the front slit wall at Crest F, normalized by the estimates from Goda's formula ($f_S^G$). The values of $f_S^E/f_S^G$ range from 0.5 to 1.0, indicating smaller wave loading on the front slit wall than estimates from Goda's formula in general. The horizontal line in the figure corresponds to the mean plus standard deviation of the data. Based on this fitted line, the force adjustment factor $\lambda_{S1}$ for the front slit wall at Crest F was determined as 0.84. Another plot for the middle wall at Crest Mp is shown in the right panel of Figure 4. Similarly, the force adjustment factor for the middle wall at this wave phase was estimated to be $\lambda_{M1}$= 0.51 base on the fitted line.

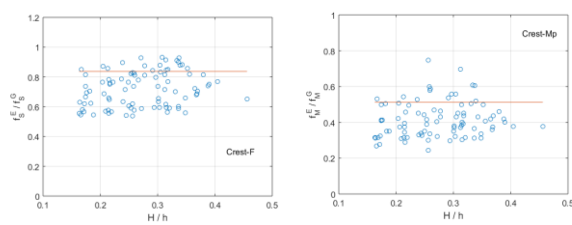


Figure 4 – Normalized forces on the front slit wall at Crest-F (left) and the middle wall at Crest-Mp (right)

In this manner, a new wave pressure formula was developed by determining all the force adjustment factors for the vertical and horizontal walls of the double-chamber caisson. The applicability of the newly developed formula is being investigated for practical use in the design of double-chamber caisson. More detailed description about the experiments and the formula will be presented at the conference.

## REFERENCES

Takahashi, S. and Shimosako, K. (1994). Wave pressure on a perforated wall caisson, International Conference on Hydro-technical Engineering for Port and Harbor Construction (HYDRO-PORT '94), 747-764.