Coastlab12, 2012, Ghent, Belgium. Book of Abstracts of the Fourth International Conference on the Application of Physical Modelling to Port and Coastal Protection. ISBN 978 90 382 2008 6

HYDRODYNAMIC LOAD ON BUILDING CAUSED BY OVERTOPPING WAVE

XUEXUE CHEN [1], WIM UIJTTEWAAL [2], SEBASTIAAN.N. JONKMAN [3] & TOON VERWAEST[4]

[1] *Delft University of Technology,*
Stevinweg 1, 2628 CN, Delft, The Netherlands, x.chen-2@tudelft.nl

[2] *Prof. dr. ir., Delft University of Technology,*
Stevinweg 1, 2628 CN, Delft, The Netherlands, w.s.j.uijttewaal@tudelft.nl

[3] *Dr.ir., Delft University of Technology,*
Stevinweg 1, 2628 CN, Delft, The Netherlands, s.n.jonkman@tudelft.nl

[4] *Ir., Flanders Hydraulics Research,*
Berchemlei 115, 2140 Antwerp, Belgium, toon.verwaest@mow.vlaanderen.be

1. Introduction

In Belgian coastal towns, many buildings have been built very close to the existing dikes and are at a high risk from coastal flooding. There is a chance that storm surges occurring in coastal areas trigger overtopping over wide crested dikes (Verwaest, T et al., 2010). The overtopping wave may result in hydrodynamic load on the buildings (Figure 1). However, few studies have investigated this kind of hydrodynamic load on structures. Therefore, the goal of the present research is to understand and describe the load on a building exerted by the overtopping wave.

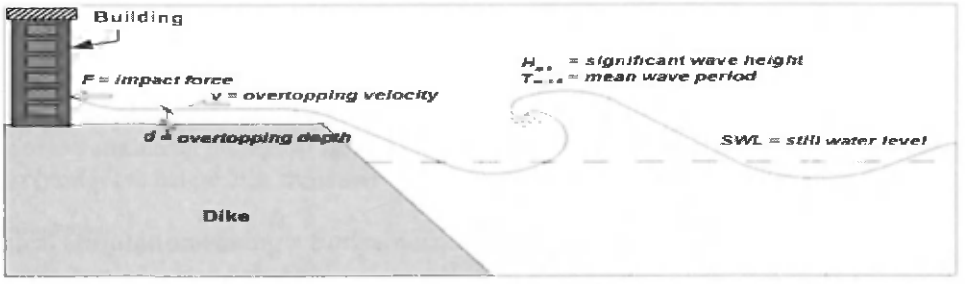


Figure 1. Schematic of wave overtopping on the wide crest dike (adapted from Veale, et al., 2011).

2. Physical model tests

The physical model tests were executed on a schematized model scaled 1/30 (Chen, 2011). The scaled model is simplified to clarify the basic hydraulic characteristics. The simplified model consists of two parts: a schematized wide crested sea dike and a schematized building (a vertical plate) placed on top of the dike (referred to Figure 2). This "building" was secured to the sides of the wave flume. Several aspects have been excluded in the model, such as the foreshore profile, sea walls, the slope of the crest and the roughness of the crest.

The tests were performed in a 2-D small wave flume (length 32 m, width 0.70 m, height 0.86 m) in the Flanders Hydraulics Research Laboratory (Antwerp, Belgium) with regular waves generated by a piston type wave generator. The testing procedures involved impacting the vertical plate with a series of waves and recording the force by a single load cell and the pressure by four sensors (P1, P2, P3 and P4). Due to time constraint, the number of tests had to be restricted and so only a limited number of parameters could be varied. Despite these restrictions, the experiments revealed the impact process of overtopping wave very well under the two dike configurations included: the dike side case with a dike crest width of 0 meter and the inland case with a dike crest width of 0.5 meter in the model scale.

3. Results and Conclusions

The experiment results are shown in Figure 3. Two strong trends with little scatter were observed. Equation [1] is obtained based on the best-fit curves for the inland and the dike side cases, where F is the average overtopping hydrodynamic load, H_m is the average wave height near the dike, R_c is the free board and ξ is the

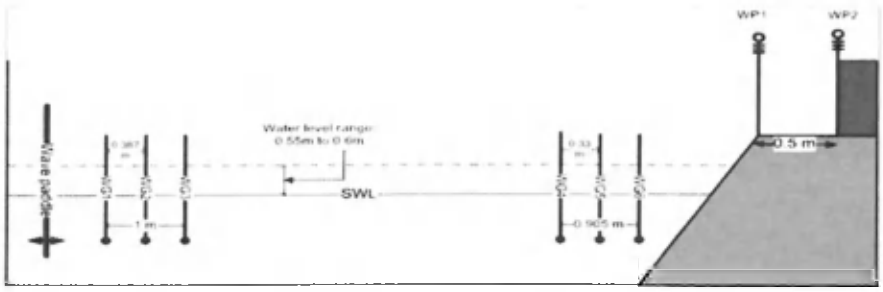


Figure 2. Physical model set-up

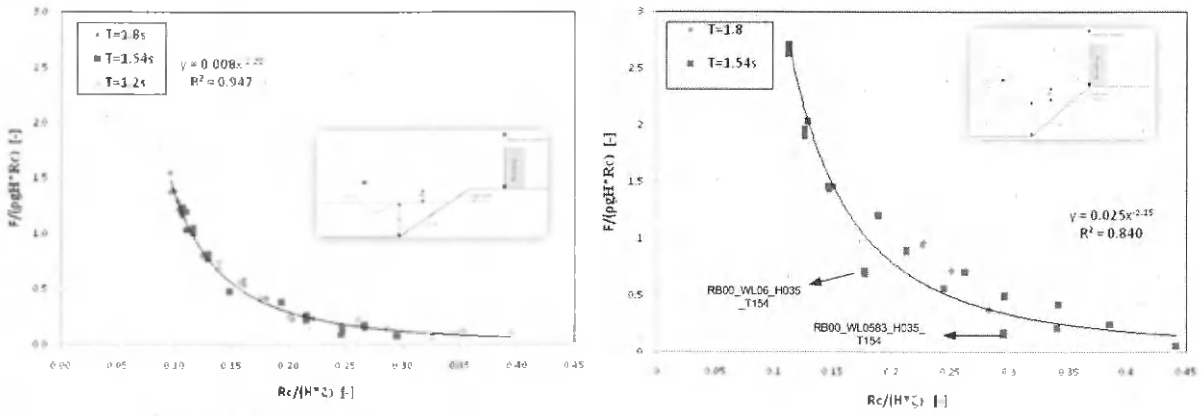
breaker parameter, α is a coefficient which relates to the width of crest of the dike and β is a coefficient around -2.2 for the both cases.

$$\frac{F}{\rho g H_m R_c} = \alpha \left(\frac{R_c}{H_m \xi} \right)^{\beta} \quad [1]$$

$$F^* = \frac{F}{\rho g H_m{}^2 \cdot \left(R_c / H_m \right)} \quad [2]$$

The left hand side of Equation [1] can be rewritten in the form of Equation [2], where: F^* is the dimensionless overtopping force, $\rho g H_m{}^2$ is the average incident wave energy and R_c H_{m0} is the freeboard divided by the wave height used for determining the interaction between the waves and dike crest height. So the hydrodynamic load of the overtopping wave is contributed by a part of the incident wave energy above still water level and can be estimated by Equation [1].

The present experiment did not include the foreshore profile which influences the incident water energy. Due to the fact that only two crest widths were tested in the present study, α could not be presented as a function of crest width in Equation [1]. Therefore, in a future study, the foreshore effect will be considered and for the same scale model, variation of the width of the dike crest will be increased.



(a) B=0.5 m for inland case

(b) B=0 m for dike side case

Figure 3. Dimensionless overtopping force versus dimensionless freeboard

References

Chen, X. 2011. 'Hydrodynamic loads on buildings caused by overtopping waves'. Master thesis for Delft University of Technology, Delft, Netherlands; Project number: 770_59 for Flanders Hydraulics Research, Antwerp, Belgium.

Veale, W, Suzuki, T, Hassan, W, Balens, N, Spiesschaert, T, Verwaest, T, 2011. 'SUSCOD Pilot 1: Wenduine Wave Overtopping Scale Model: Experimental Set-Up'. Version 1_1. WL Rapporten, 759_02a. Flanders Hydraulics Research, Antwerp, Belgium.

Verwaest, T., Vanpoucke, P., Willems, M., Mulder, T. D. 2010. 'Waves overtopping a wide-crested dike', Coastal Engineering 2010, pp. 1-9.