Harbour Research Laboratory
Sea Civil Engineering UPM

Laboratorio de Puertos
CÁTEDRA PABLO BUENO

OVERTOPPING CHARACTERIZATION FOR THE ELABORATION OF VULNERABILITY MAPS IN PORTS FACILITIES

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POLITÉCNICA

UCLM UNIVERSIDAD DE CASTILLA-LA MANCHA
Escuela de Ingenieros de Caminos Canales y Puertos de Ciudad Real

1. INTRODUCTION

Technologic development

Increase in ship's dimensions

Economies of scale

Development of coastal areas and sea transport

Unavailability of natural sheltered bays

Demand of port's facilities at deep water

SEVERE WAVE ACTION

Overtopping event at Gijon's Port

NON-OVERTOPPED BREAKWATERS

EXPLOITATION

RISK

- **When** is overtopping likely to occur?
- **How** is the water mass overtopped?
- **Consequences?**

OVERTOPPING WIDELY STUDIED

i.e.: European project
CLASH (2000-2010)
EUROTOP (2007)

Hazards based on:

- q = mean overtopping discharge
- Vmax = maximum overtopping volume

BUT

DEEPER KNOWLEDGE NEEDED for risk management

Spatial distribution?

Density?

Energy?

WORKFLOW OF THE WHOLE PROJECT between Harbour Research Laboratory of the Technical University of Madrid and Puertos del Estado

NIOVE PROMES project. **Llana et al (2012)**

Which are the overtopping flow properties of **this type** of episode?

Study of economic and exploitation consequences derived from overtopping event based on real cases

OVERTOPPING HAZARD

Spatial distribution?
Density?
Energy?

VULNERABLE AREA

FLOW-STRUCTURE INTERACTION

Under which conditions does **this type** of overtopping event appear?

TOPIC OF THE PRESENT POSTER

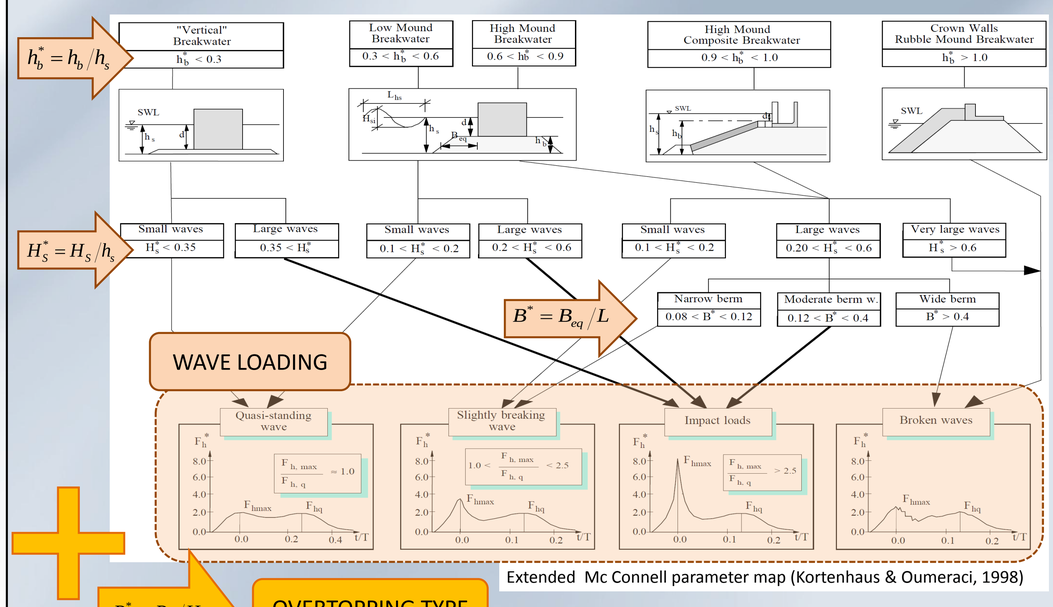
Which are the expected damages with **this type** of overtopping event?

Elaboration of vulnerability and risk maps derived from overtopping events

PORMAT. **Alises et al (2012)**

2. OBJECTIVES

GENERAL OBJECTIVE: Evaluate the feasibility of extending the "parameter map" proposed by Mc Conell including an overtopping term



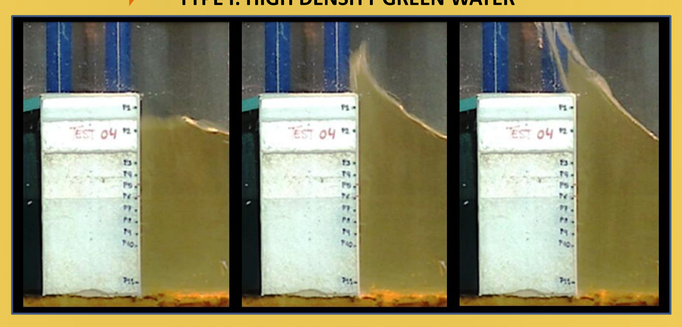
Extended Mc Connell parameter map (Kortenhaus & Oumeraci, 1998)

$R_C^* = R_C / H_s$
$s = H_S / L$

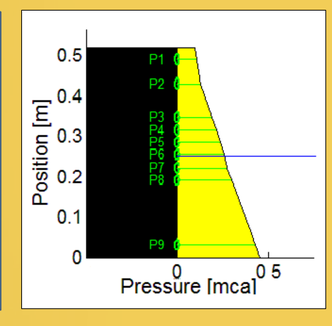
OVERTOPPING TYPE

Analyzed overtopping types:

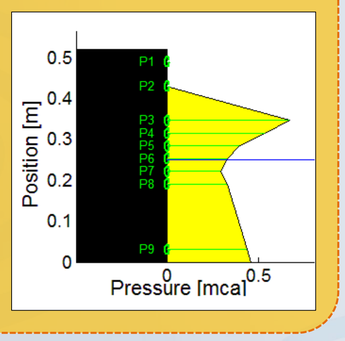
TYPE I: HIGH DENSITY GREEN WATER



Related to wave loading?

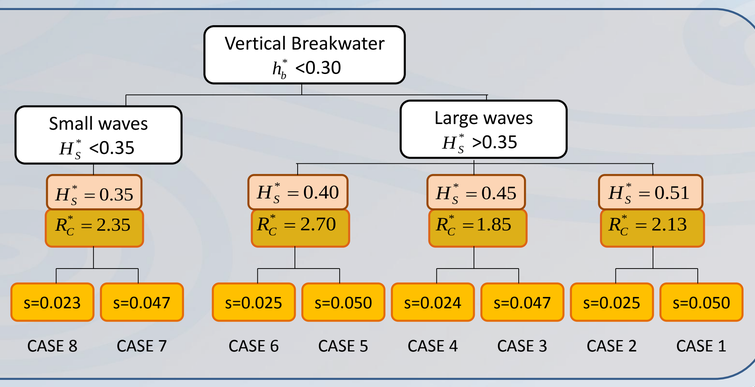


TYPE II: LOW DENSITY GREEN WATER



CASES STUDIED

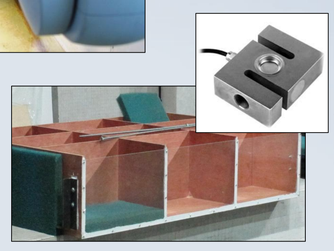
8 preliminary 2D tests at the wave flume of the Harbour Research Laboratory of the Technical University of Madrid (1 m wide by 1,6 m height by 52 m long). Wave conditions generated by piston-paddle wavemaker with dynamic absorption system on.

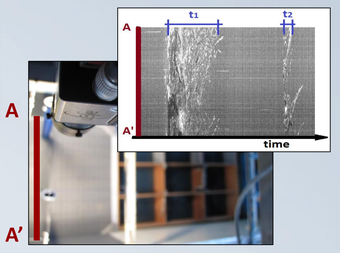


3. METHODOLOGY

INSTRUMENTATION

1. Resistor sensors
2. Processed Videoimagery (Time-stack using ZEUS, Zenital Unattended System. Molina et al., 2005, Gómez et al., 2010)
3. Pressure transducers
4. Overtopping tank weighing system
5. Optical sensors + Videoimagery





MEASURED VARIABLES

1. H_S, T_P, Number of Waves
2. Number of Overtopping Events, Duration of Overtopping Events
3. Number of Impact Loads

$$F^* = \frac{F}{\rho g H_S^2}; \quad F^* > 4 = \text{Impact Load}$$

4. $$q = \frac{\text{Total volume}}{\text{Test duration } x \text{ Width}} \text{ [l/s/m]}$$

$$Q = \frac{q}{\sqrt{g H_S^3}}$$

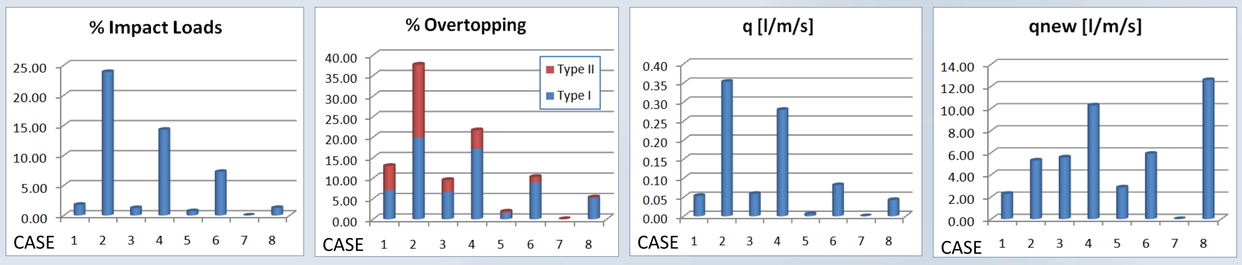
$$q_{NEW} = \frac{\text{Total volume}}{\text{Overtopping duration } x \text{ Width}} \text{ [l/s/m]}$$

$$Q_{NEW} = \frac{q_{NEW}}{\sqrt{g H_S^3}}$$

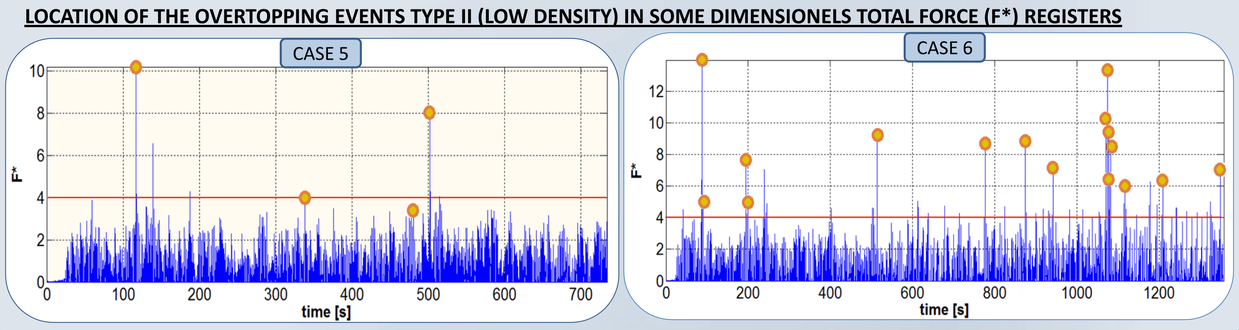
5. Overtopping typeclassification : TypeI or TypeII

4. RESULTS

RESULTS OF THE PRELIMINARY TESTS



LOCATION OF THE OVERTOPPING EVENTS TYPE II (LOW DENSITY) IN SOME DIMENSIONELS TOTAL FORCE (F*) REGISTERS



5. CONCLUSIONS

- In this poster, some **preliminar results of a wider project** between the Harbour Research Laboratory of the Technical University of Madrid and Puertos del Estado are presented.
- Results on wave loading satisfy Mc Connell's parameter map just when H_S^* is propagated with the lower value of the steepness, but not for this particular higher values. More tests are needed to evaluate the **dependence of impact loads on the steepness**. A further discussion is needed in order to establish a characteristic impact load threshold.
- Two overtopping types have been distinguised: Type I (low density green water) and Type II (high density green water). The results shows that **Type I is related directly to impact forces but not vicebersa**: in some cases, overtpping Type II also leads to high preassures on the wall, causing overtopping with an important vertical component. In the following studies it is recommendable to include a subcategory in Type II in order to classify specifically this interaction.
- A **new mean overtopping rate (*qnew*) has been proposed**, taking into account just the total overtopping time instead of the total test's duration *(q)*. *qnew* seems to permit a more realistic characterization of overtopping in a **probabilistic aproximation:** Case 8 has one the lowest value of *q*, but the highest value of *qnew*. In fact, Case 8 has a low probability of overtopping which leads to a low cumulative volume overtopped. However, the overtopping rate in the majority of the single events is high. This distinction if fundamental in the estimation of the vulnerability in a risk evaluation.

Puertos del Estado