



# Il LINC tra ricerca e realtà: Reef Ball e la protezione dell'antico lungomare de l'Havana (Cuba)

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**Convegno sul tema:  
Opere marittime e off-shore**

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**Ferrara, 19 Settembre 2014**



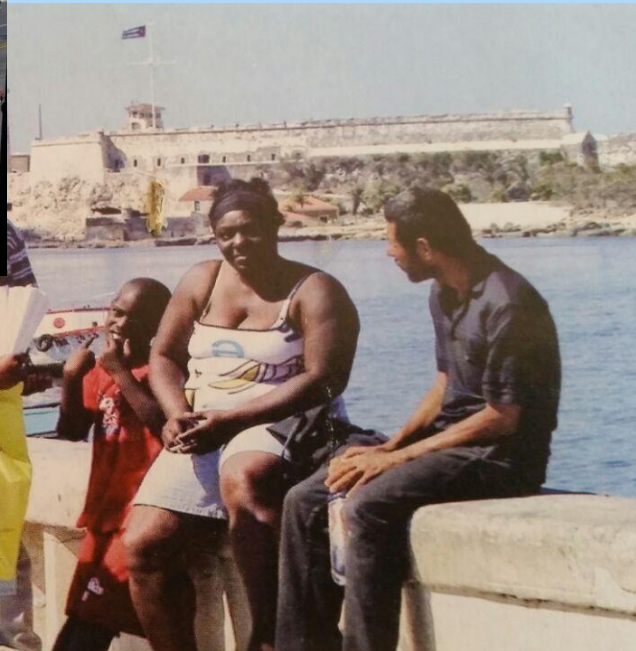
# PRACTICAL ENGINEERING PROJECTS



# PHYSICAL MODEL TESTS FOR THE DESIGN OF THE “MALECÒN TRADICIONAL”, L’HABANA CITY (CUBA)



The Malecón is a seawall which stretches for 8 km along the coast in Havana. Construction of the Malecón began in 1898, during temporary U.S. military rule. Revolts against Spanish rule had occurred for some years in Cuba. In the late 1890s, anti-Spanish propaganda agitated American



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View of the Malecón



# FACILITIES

## Small Scale wave Flume (SSF)



- 25m long
- 0.50m wide
- 0.75m deep

# FACILITIES

## Large Scale wave Flume (SSF)



- 40m long
- 2m wide
- 2m deep

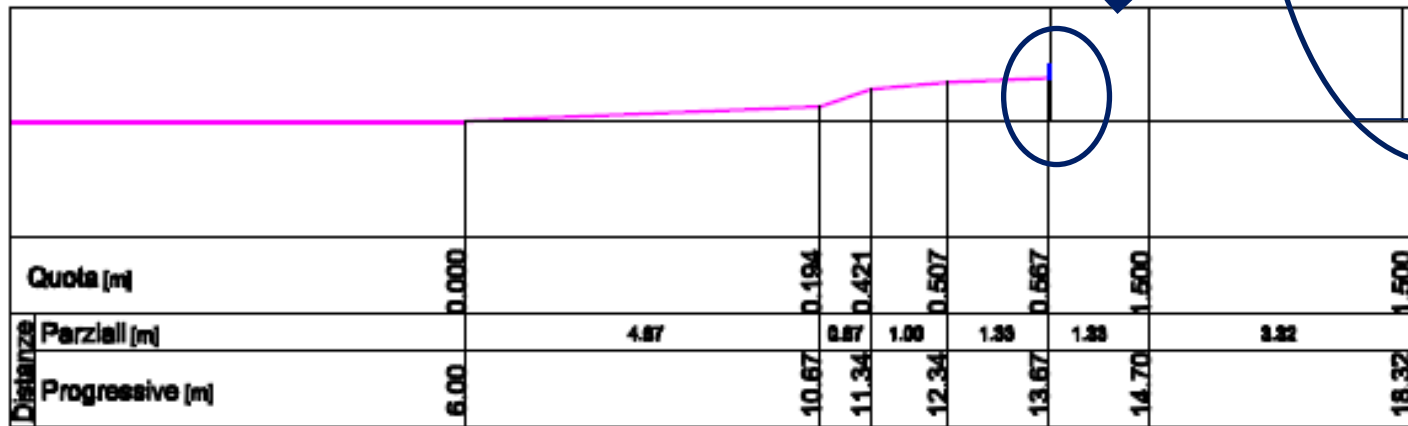
# FACILITIES

## RAndom wave TAnk (RATA)

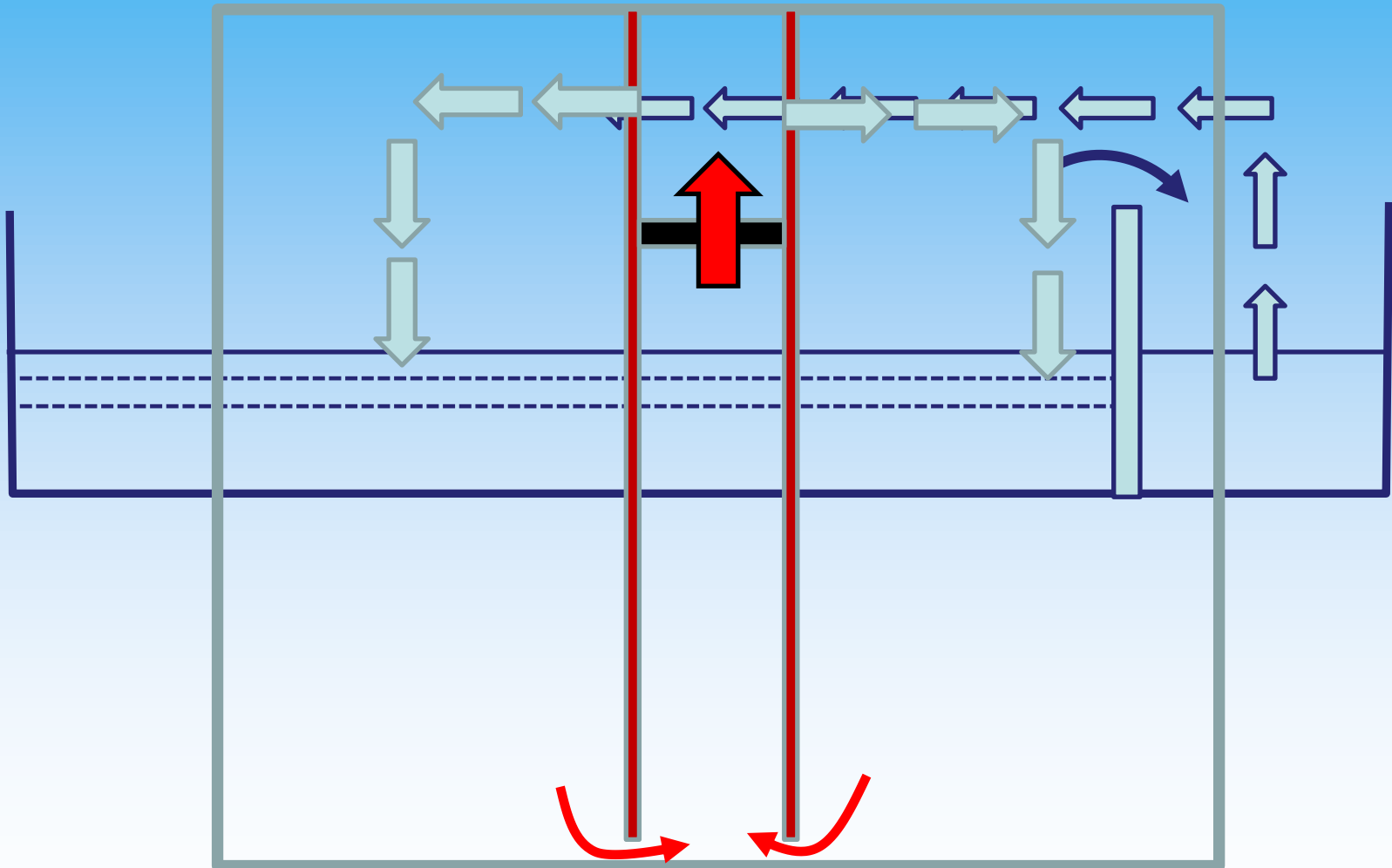


- 32m long
- 18m wide
- 1.2m deep

# THE EXPERIMENTS IN THE WAVE BASIN



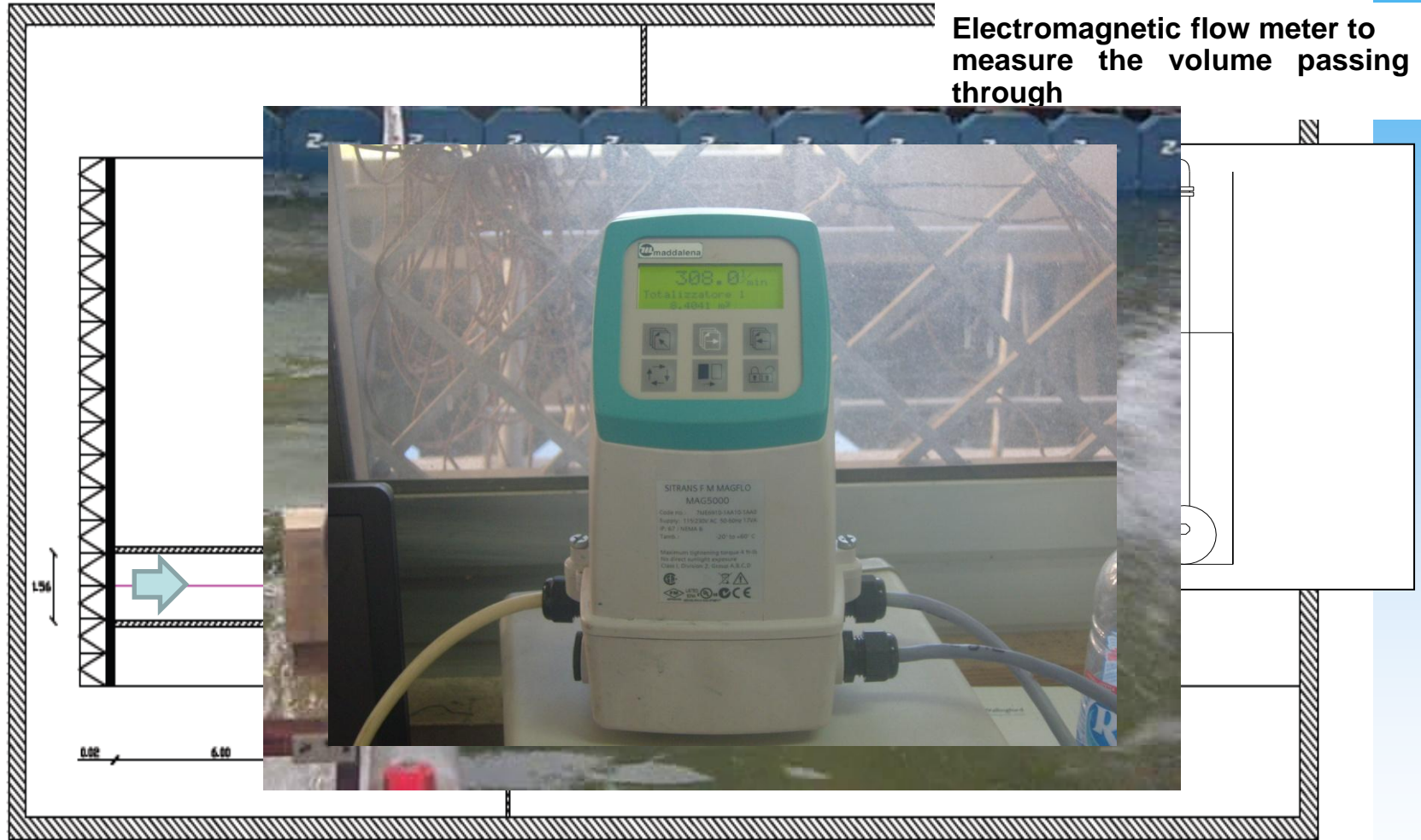
# WHY EXPERIMENTS IN A WAVE BASIN?



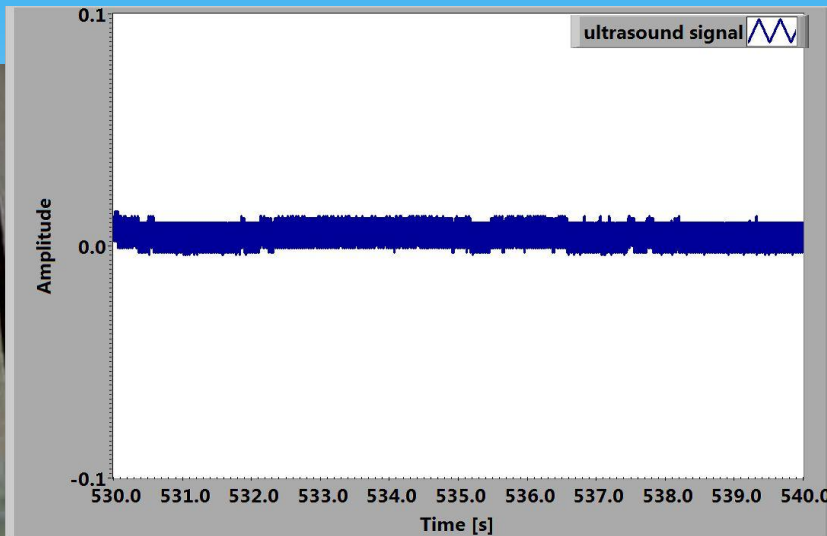


# MEASURING THE OVERTOPPING RATE

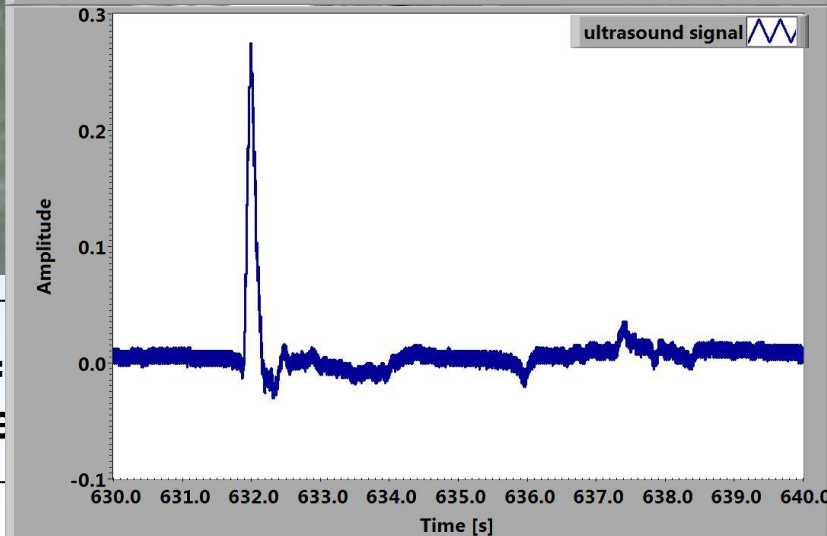
Electromagnetic flow meter to measure the volume passing through



# MEASURING THE OVERTOPPING RATE



ULTRASONIC PROBE TO COUNT THE NUMBER OF OVERTOPPING EVENTS



Q =  
rese

of the reservoir- final volume of the

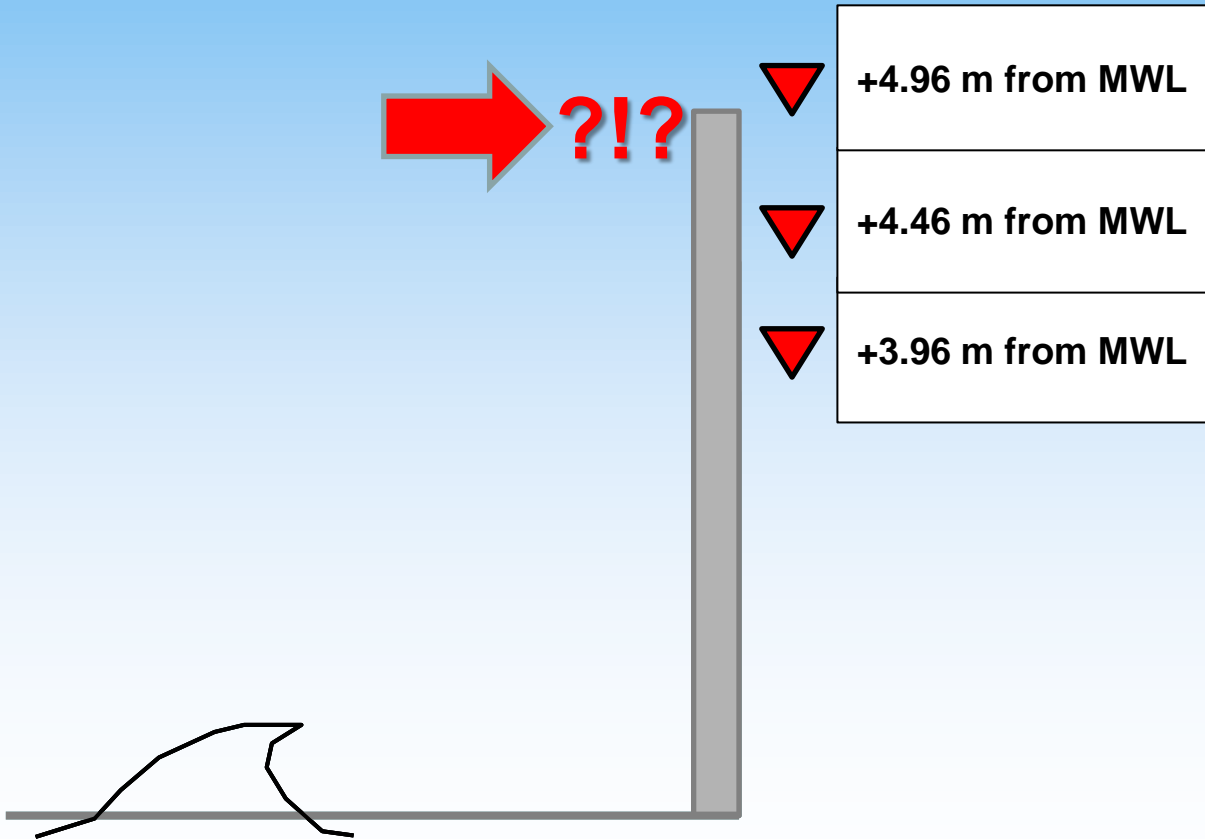
# THE TESTS

## SIMPLE WALLS WITH DIFFERENT HEIGHTS AND SHAPE CURVED vs VERTICAL



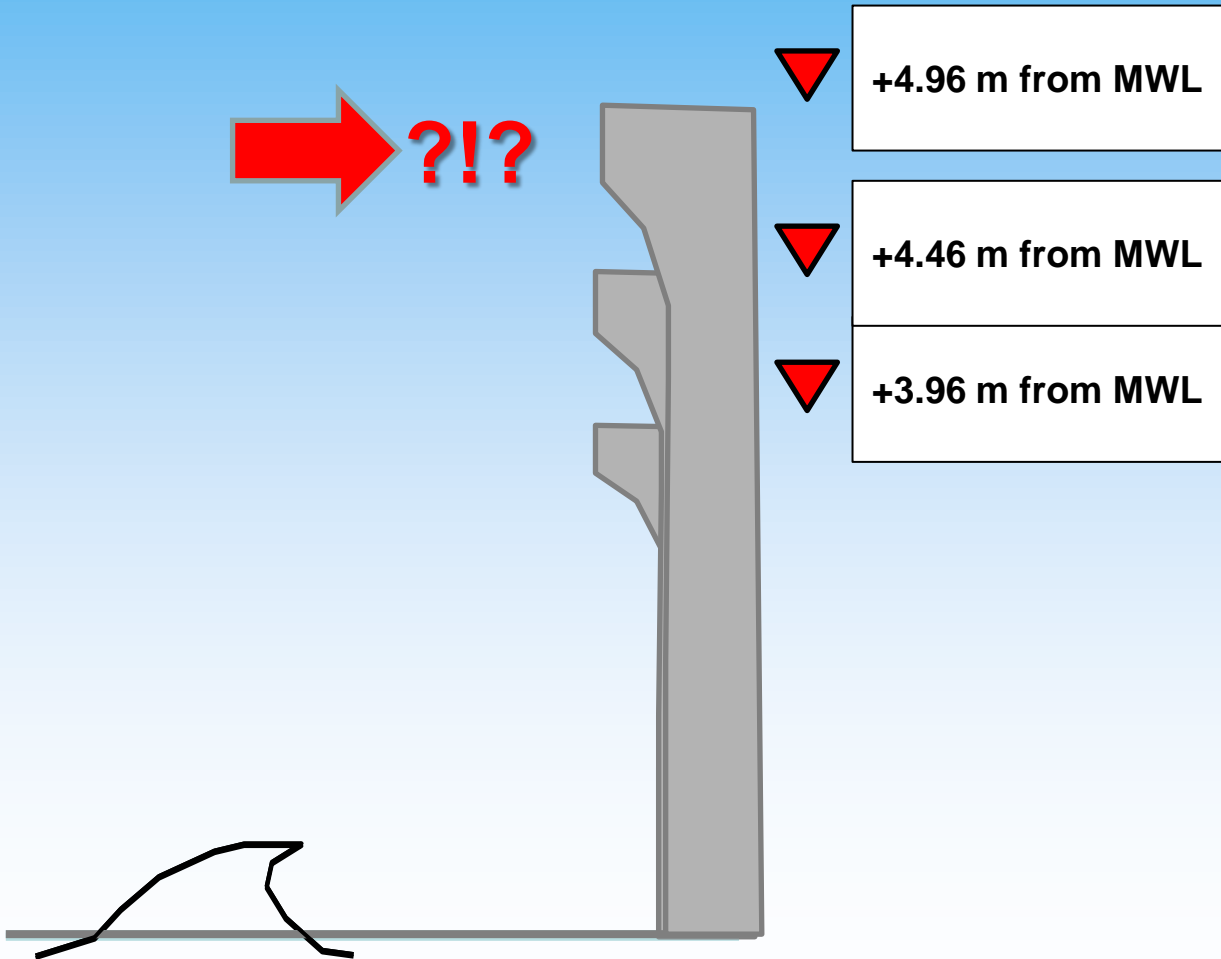
# THE TESTS

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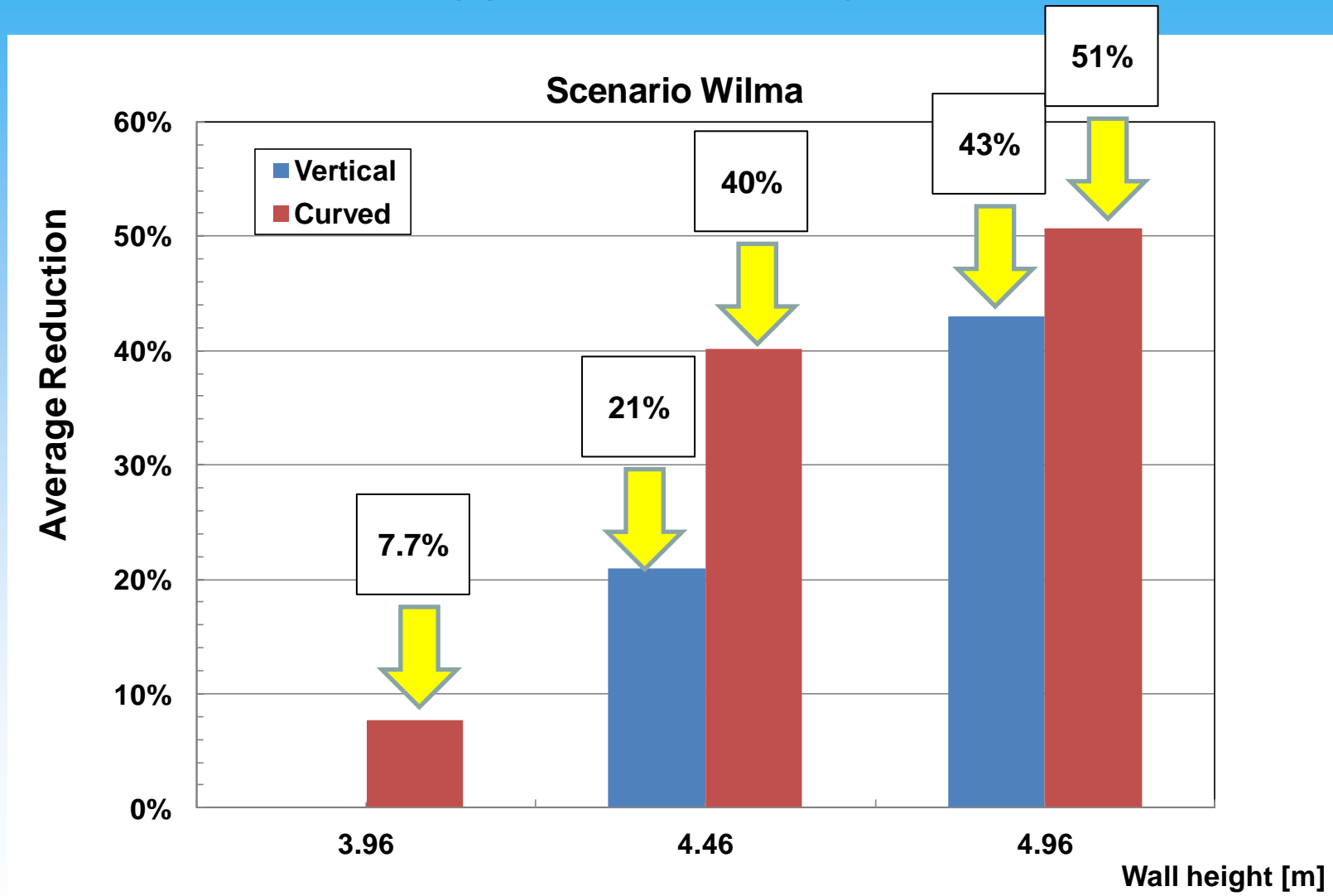




# THE RESULTS

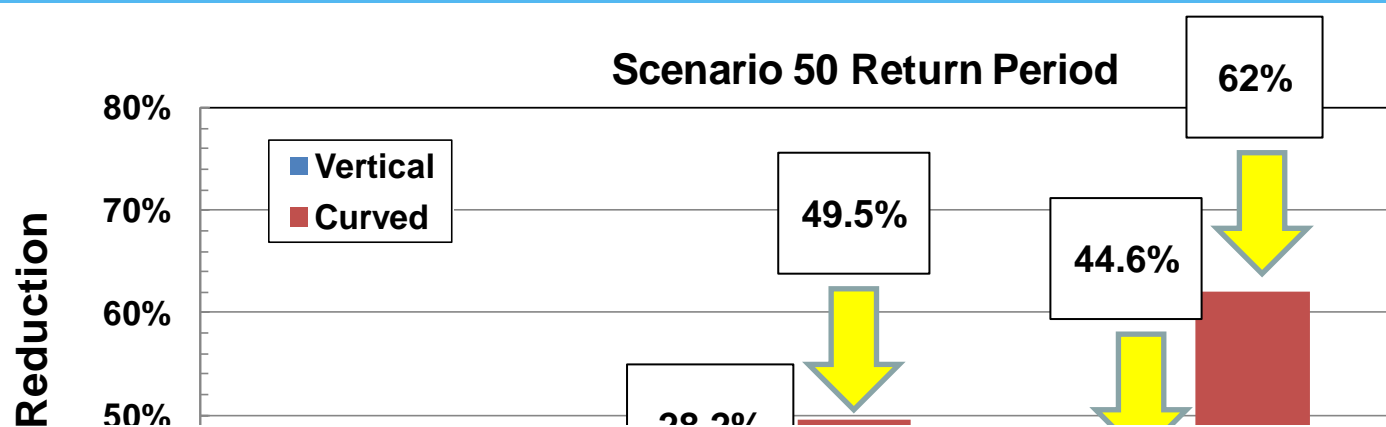
## SIMPLE WALLS WITH DIFFERENT HEIGHTS AND SHAPE

### CURVED vs VERTICAL

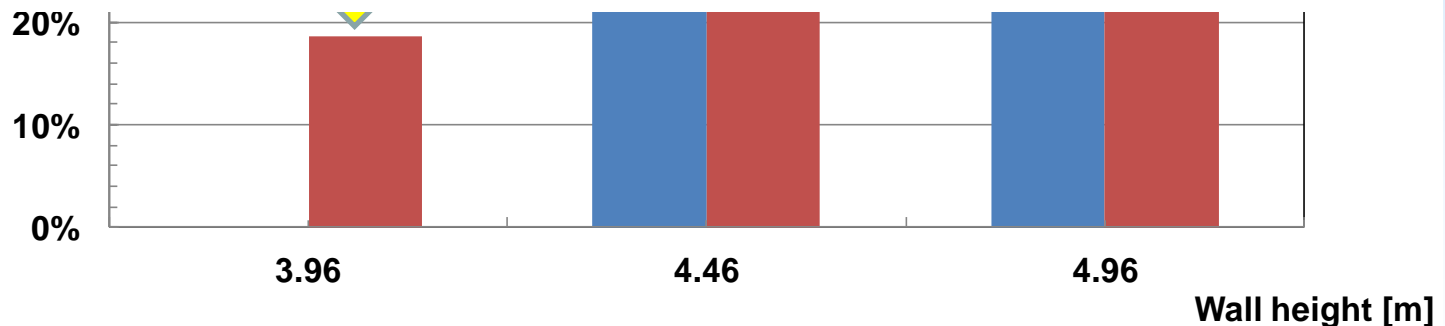


# THE RESULTS

## SIMPLE WALLS WITH DIFFERENT HEIGHTS AND SHAPE CURVED vs VERTICAL



**CONCLUSION: AT + 0.5m THE CURVED WALL GIVES THE LARGEST BENEFITS COMPARED TO THE VERTICAL ONE**



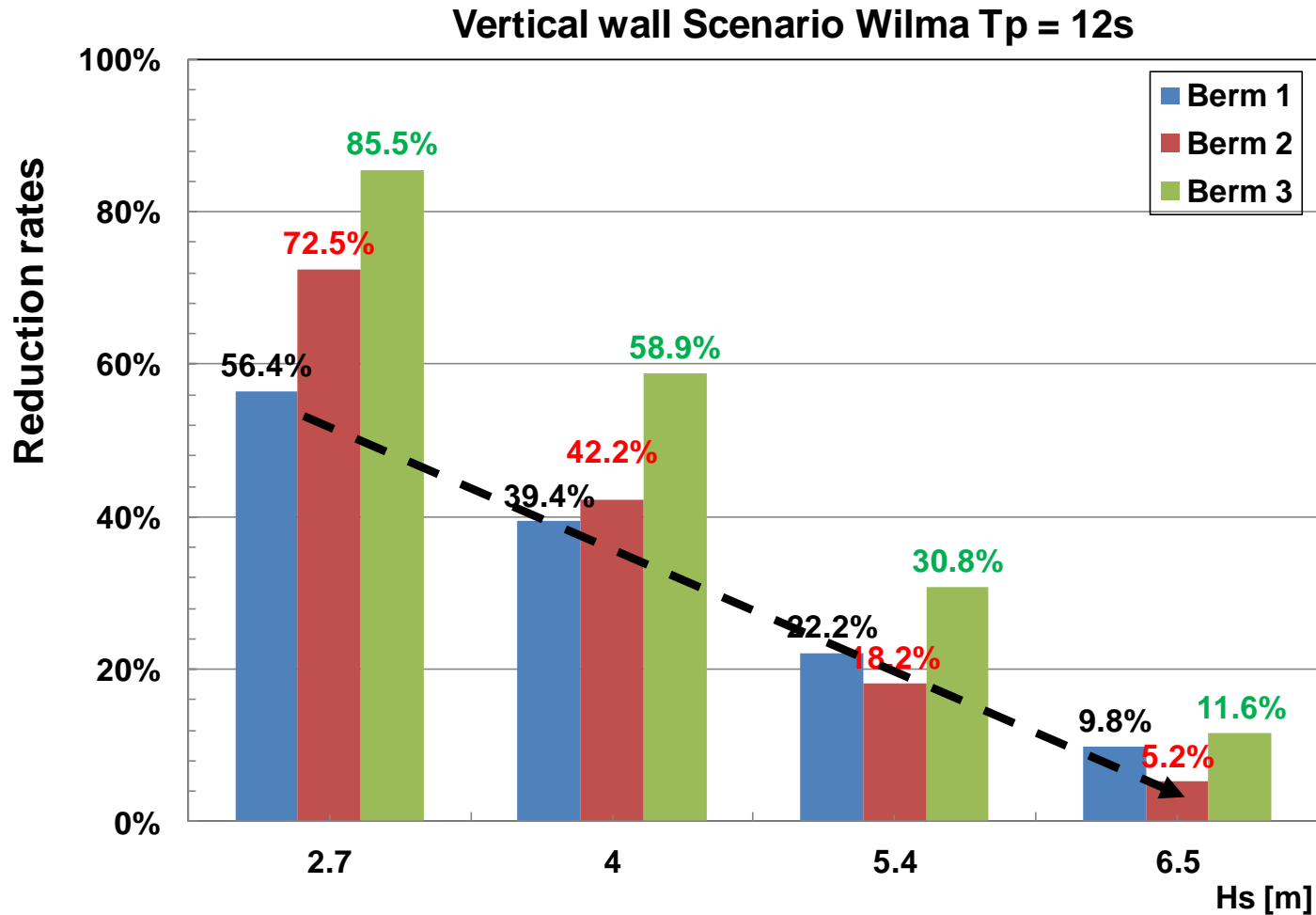
# THE TESTS

## PROTECTING BERMS



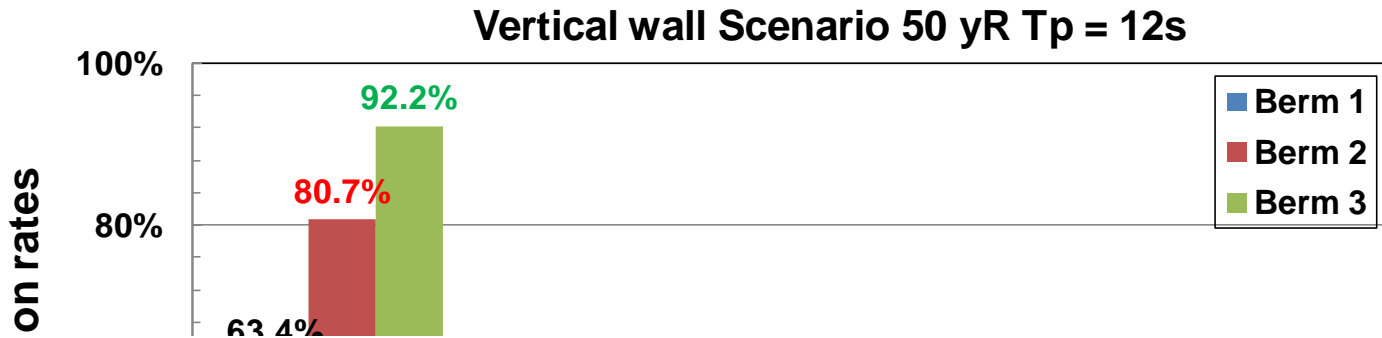
# THE RESULTS

## PROTECTING BERMS

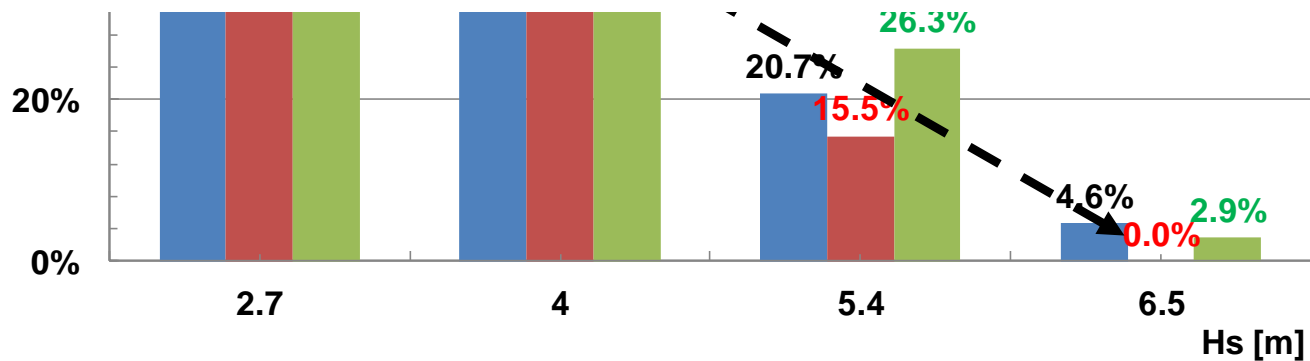


# THE RESULTS

## PROTECTING BERMS



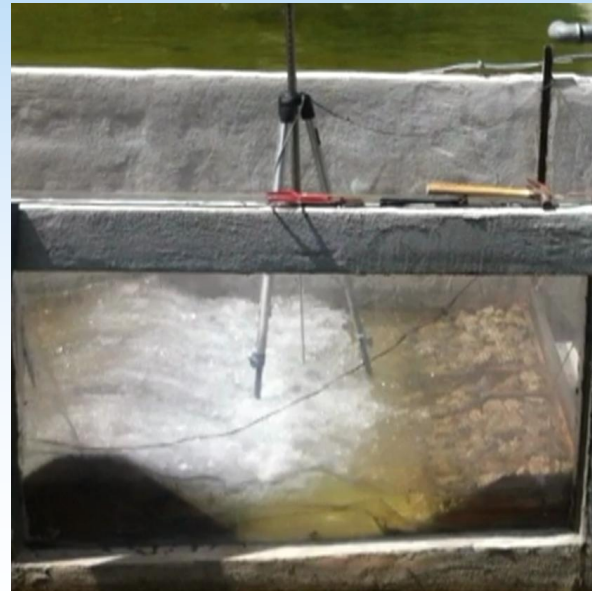
**CONCLUSION: WITH THE VERTICAL WALL AT THE CURRENT HEIGHT THE BERM 3 MIGHT BE A SOLUTION FOR  $H_s$  UP TO 4m**





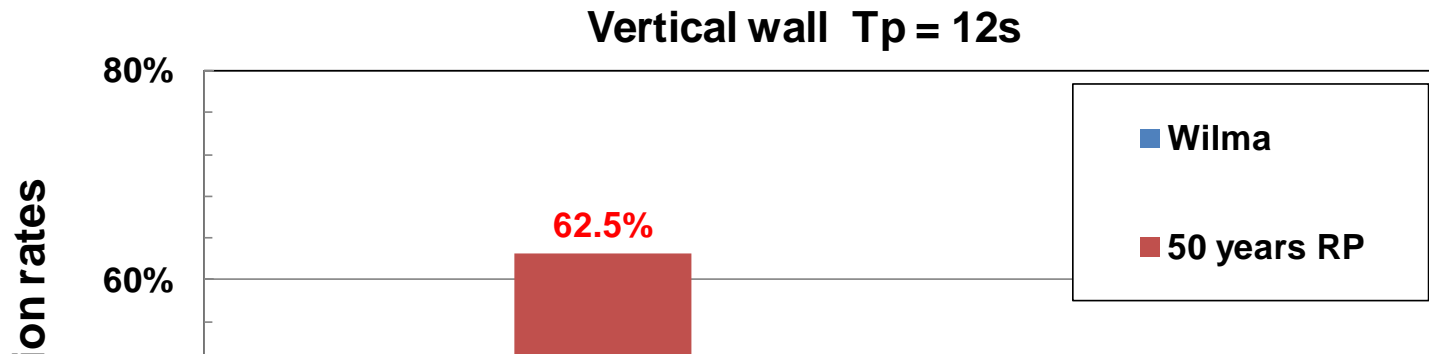
# THE TESTS

## BERM+BREAKWATER

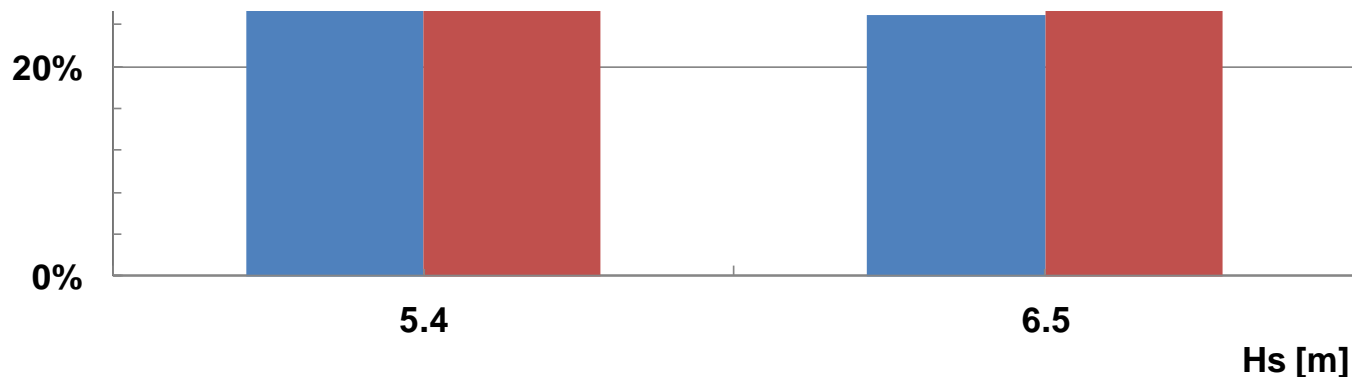


# THE RESULTS

## BERM+BREAKWATER

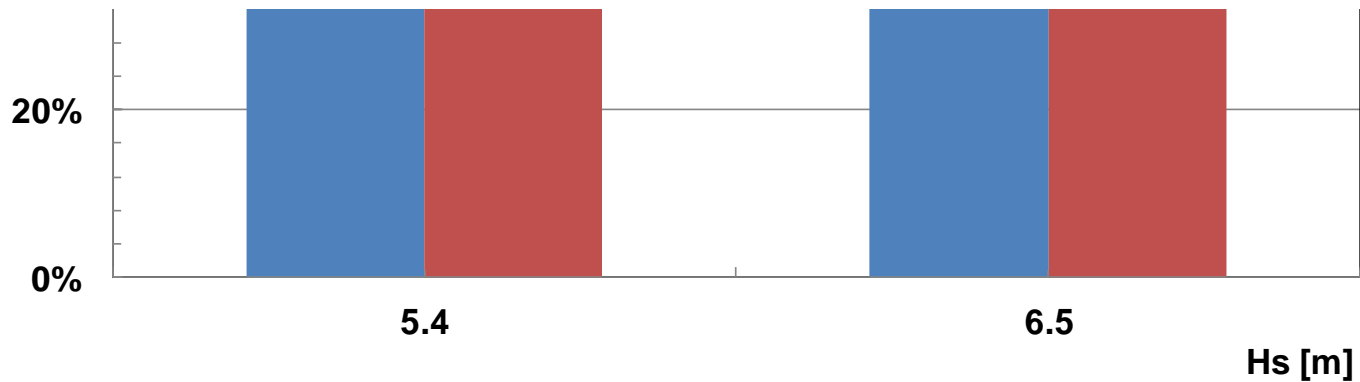
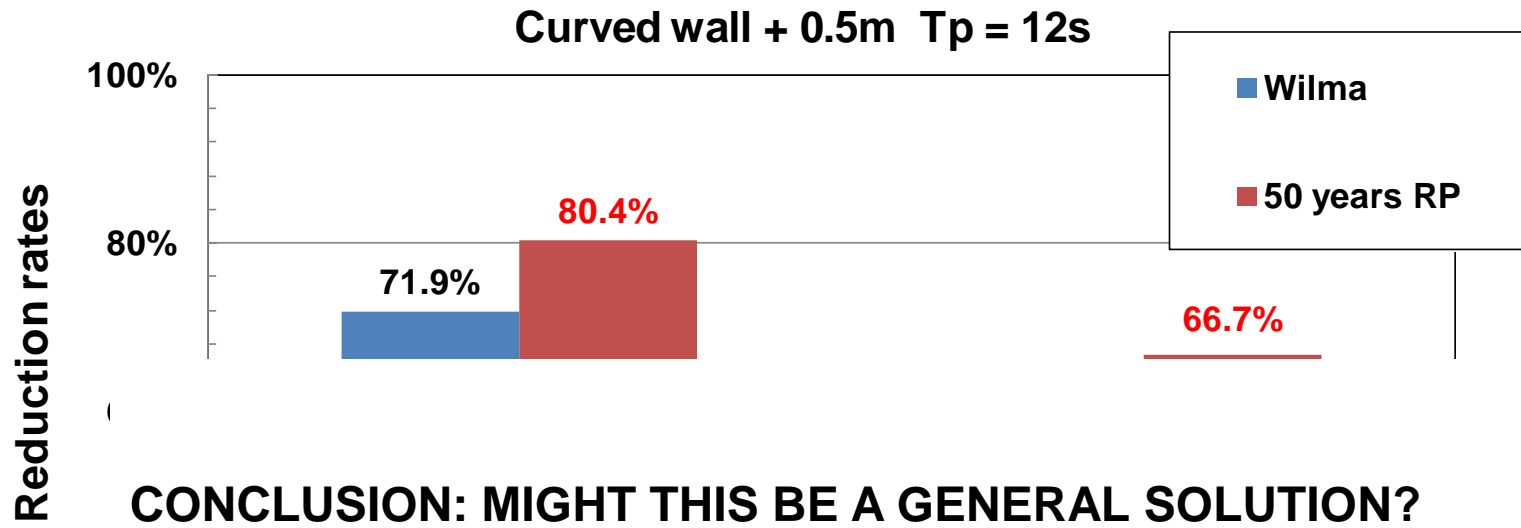


**CONCLUSION: WITH THE VERTICAL WALL AT THE CURRENT HEIGHT THE BREAK+ BERM 1 MIGHT BE A SOLUTION FOR Hs UP TO 5.4m**



# THE RESULTS

## BERM+BREAKWATER



# NEXT STEP

