

# Chapter 2: Positioning the subject

ct5308 Breakwaters and Closure Dams

H.J. Verhagen

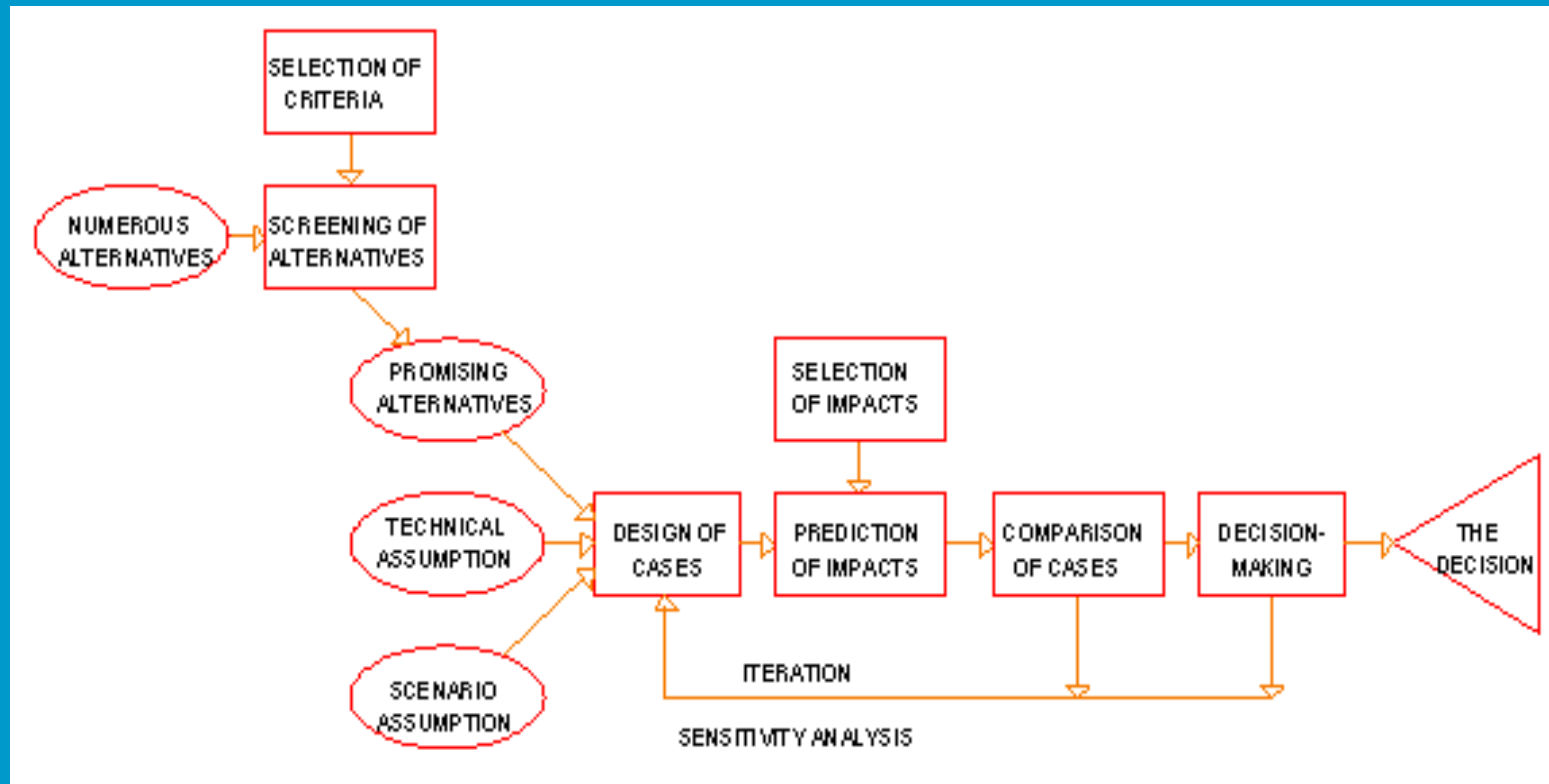
March 28, 2012



1

# Focus on:

- Technical aspects
- Technical impacts only



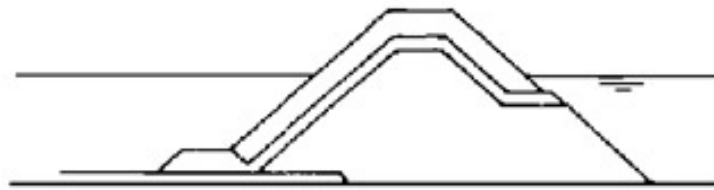
# Breakwaters and Closure dams

- Comparable items:
  - similar materials
  - similar execution methods
- Differences:
  - load difference (wave action vs. currents)
  - life time

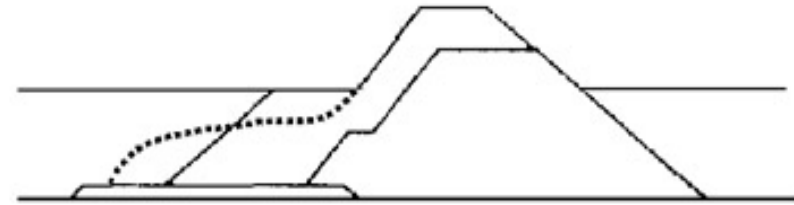
# Characteristic values

Type of structure	$H/\Delta d_n$
Sandy beach	>500
Gravel beach	20-500
Rock slope	6-20
Berm breakwater	3-6
(Stable) rubble mound breakwater	1-4
caisson	<1

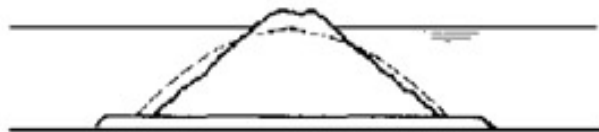
# mound breakwater types



conventional rubble mound



berm breakwater

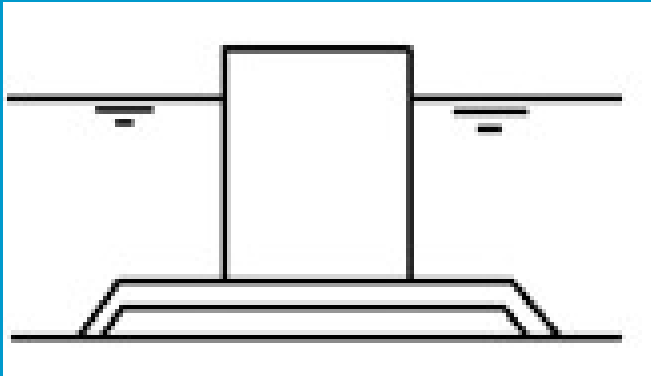


reef breakwater



low-crested / submerged breakwater

# Monolithic breakwater type

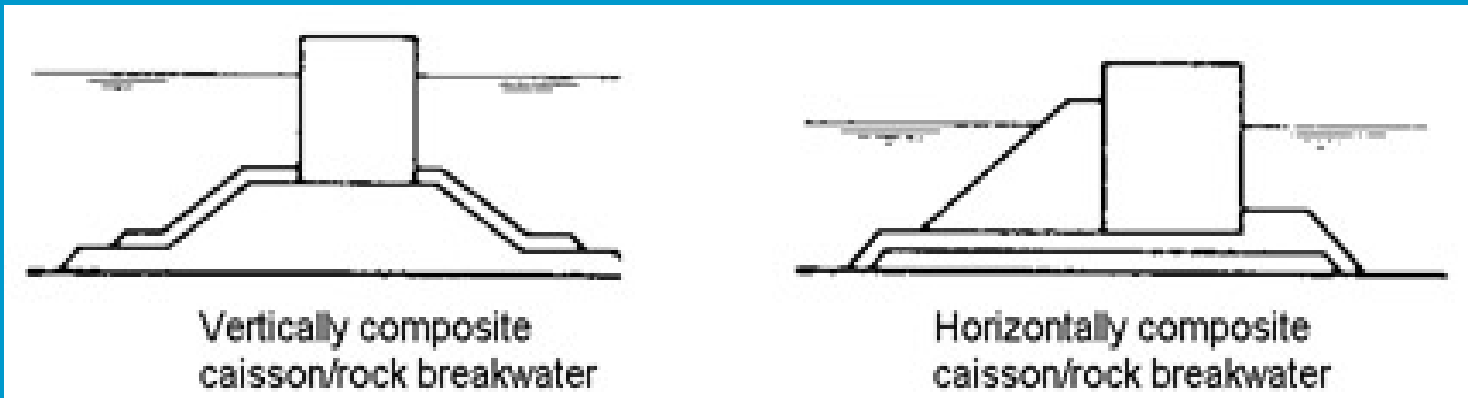


# Sometimes vertical wall is only option



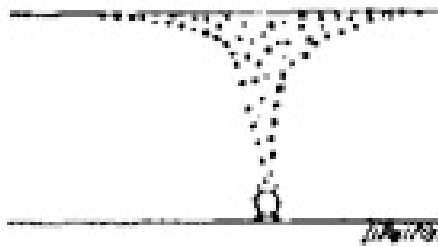
Cardiff  
Barrage  
14 m tidal  
range  
(situation at  
high water)

# Composite breakwater types

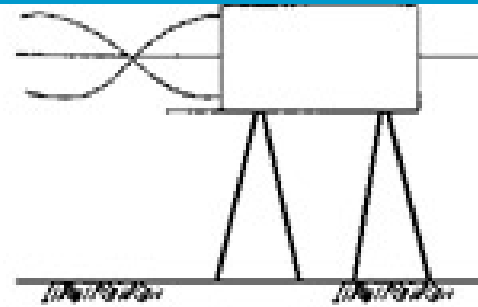




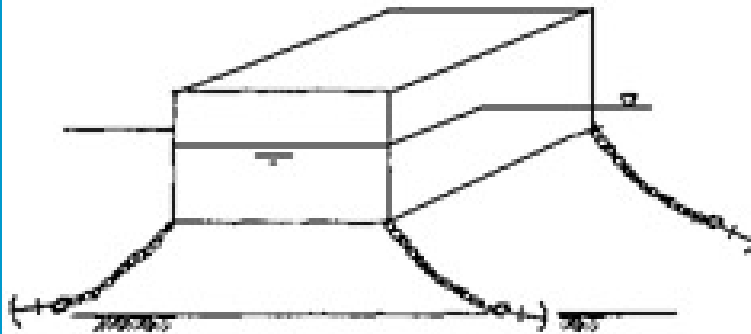
# Special breakwater types



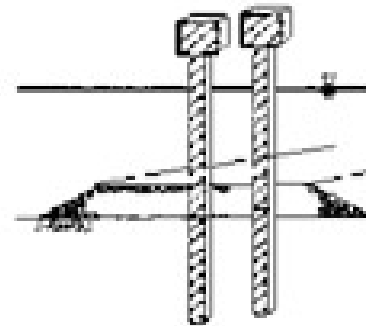
Pneumatic/hydraulic Breakwater



Horizontal plate breakwater



Floating breakwater



Pile breakwater

# Floating breakwater in Italy

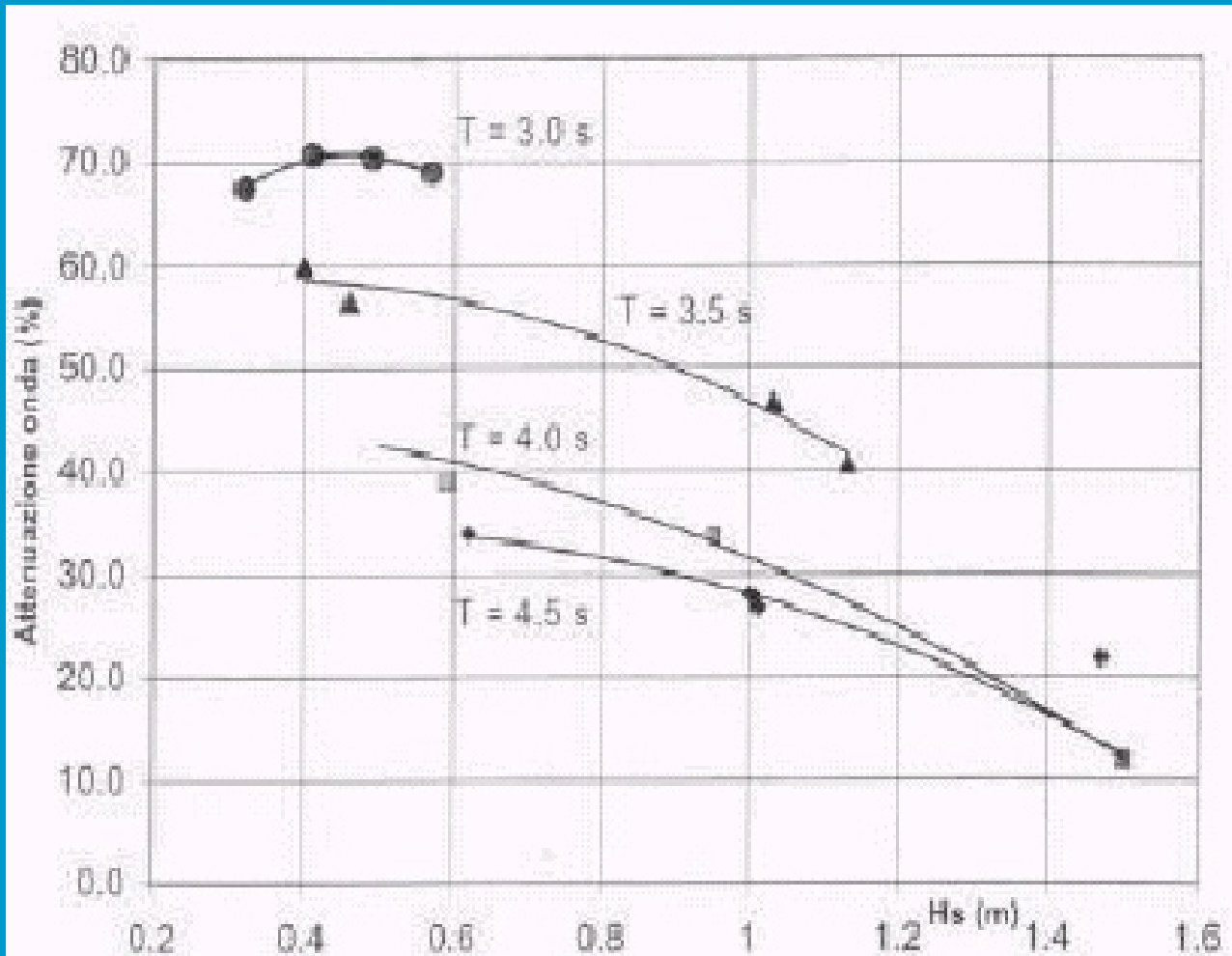
(Marina di Verbania, Lago Maggiore)



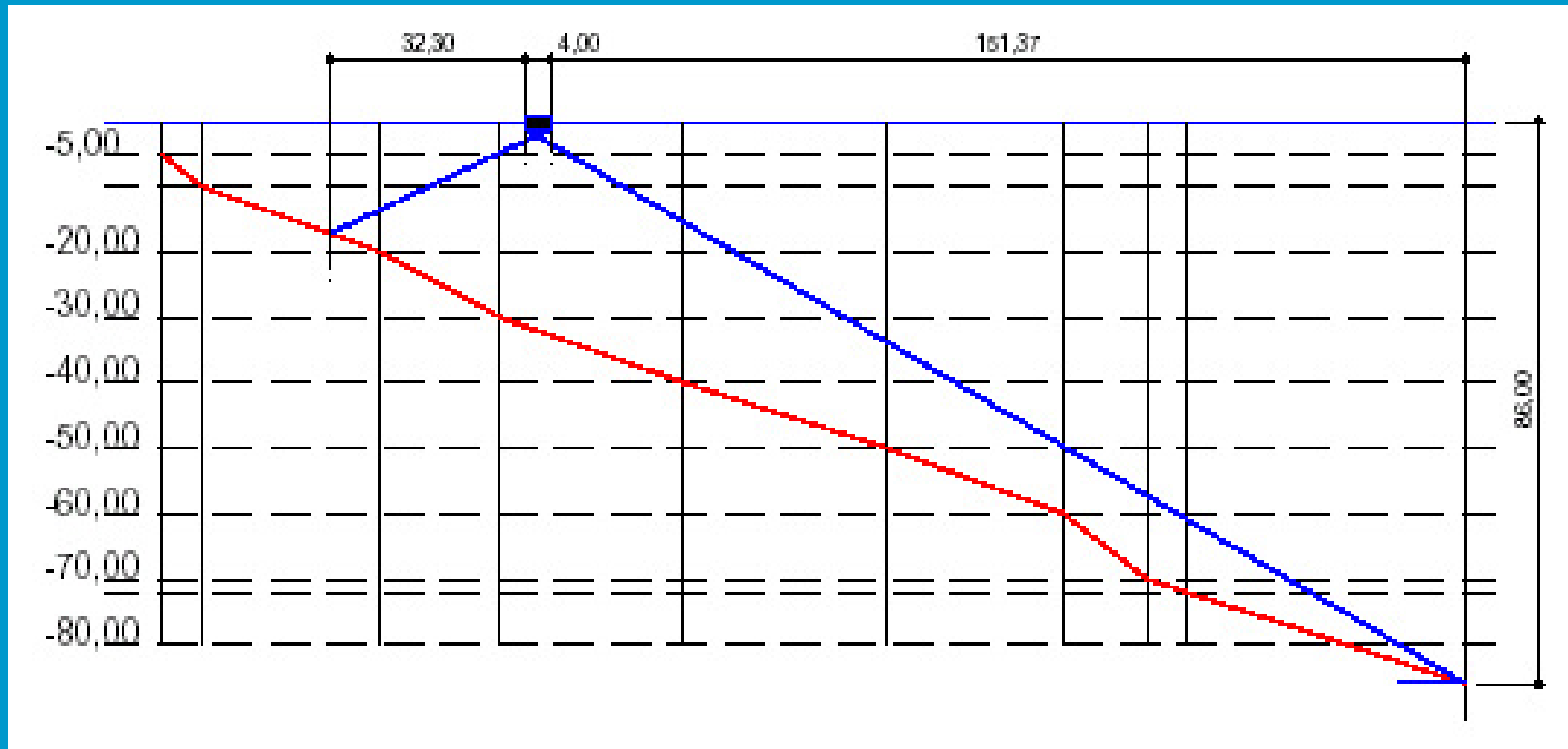
March 28, 2012

10

# Floating breakwater in Italy



# Floating breakwater in Italy



# Vertical screens

(Royal Prince Alfred Yacht Club, Sydney, Australia)

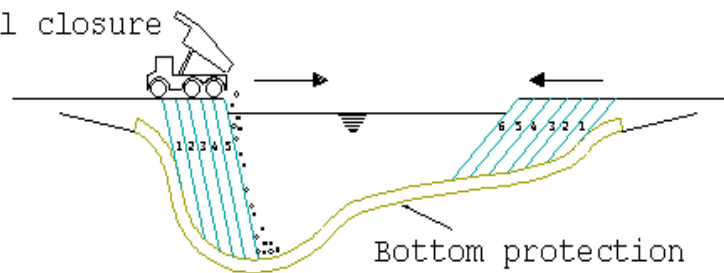


March 28, 2012

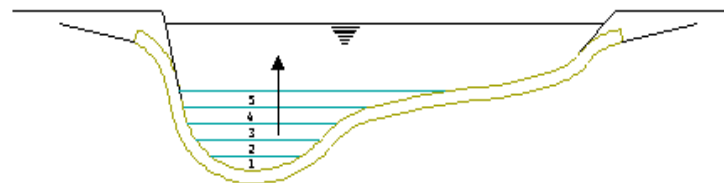
13

# Basic methods of closure

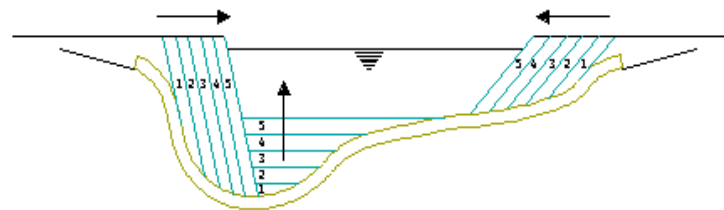
Horizontal closure



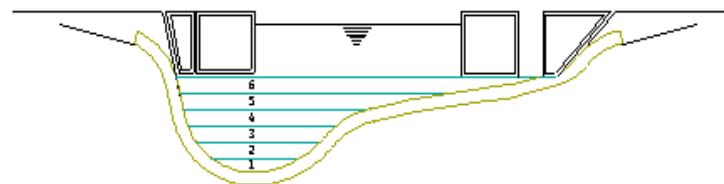
Vertical closure



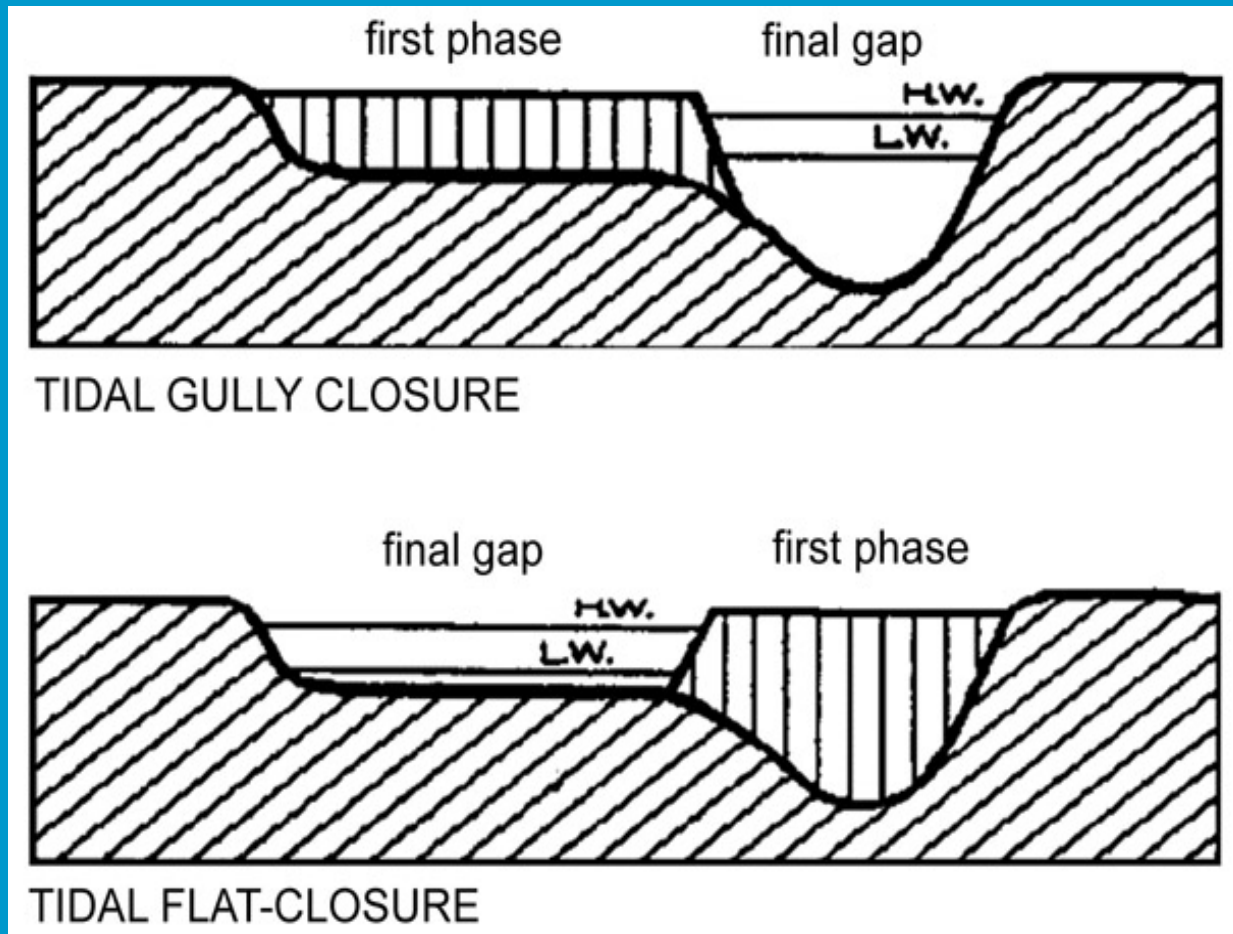
Combined closure



Combined closure, using caissons

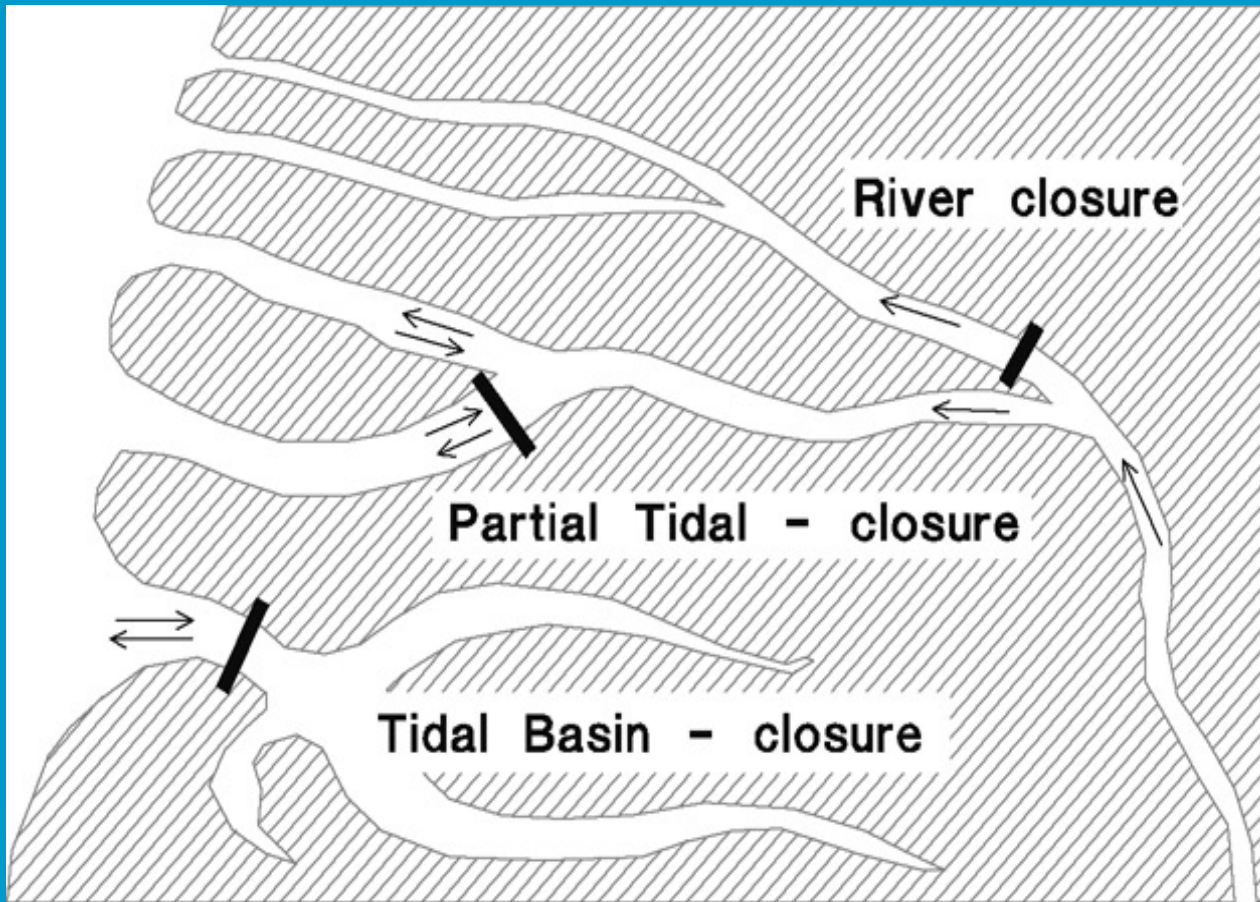


# Closure named after topography





# Closures named after hydrologic conditions

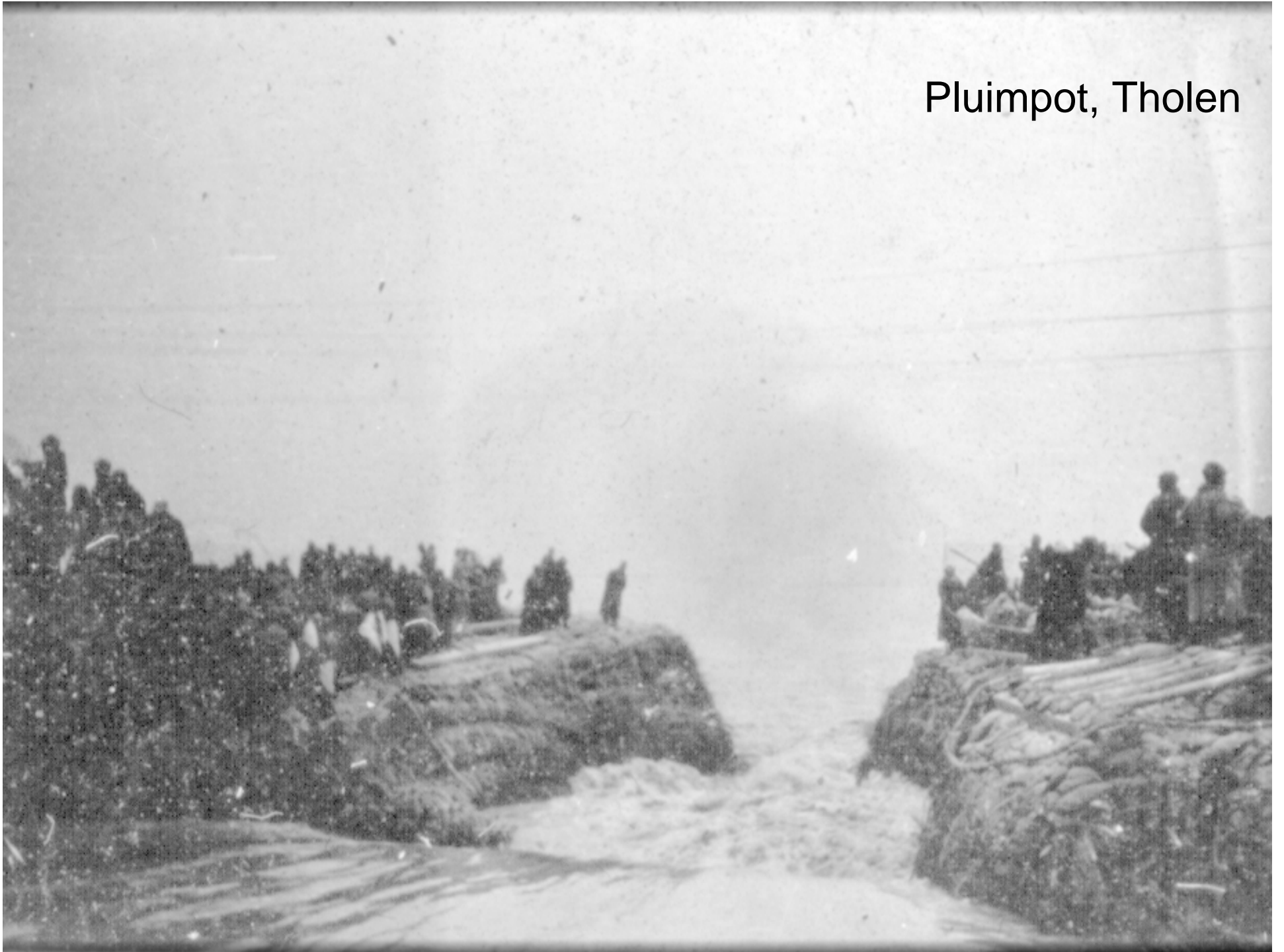




# closures named after materials used

- stacking up willow mattresses  
(opzinken)
- sand closure
- clay or boulder clay closure
- stone dam closure (rock closure)
- caisson closure

Pluimpot, Tholen



sand closure





## Afsluitdijk

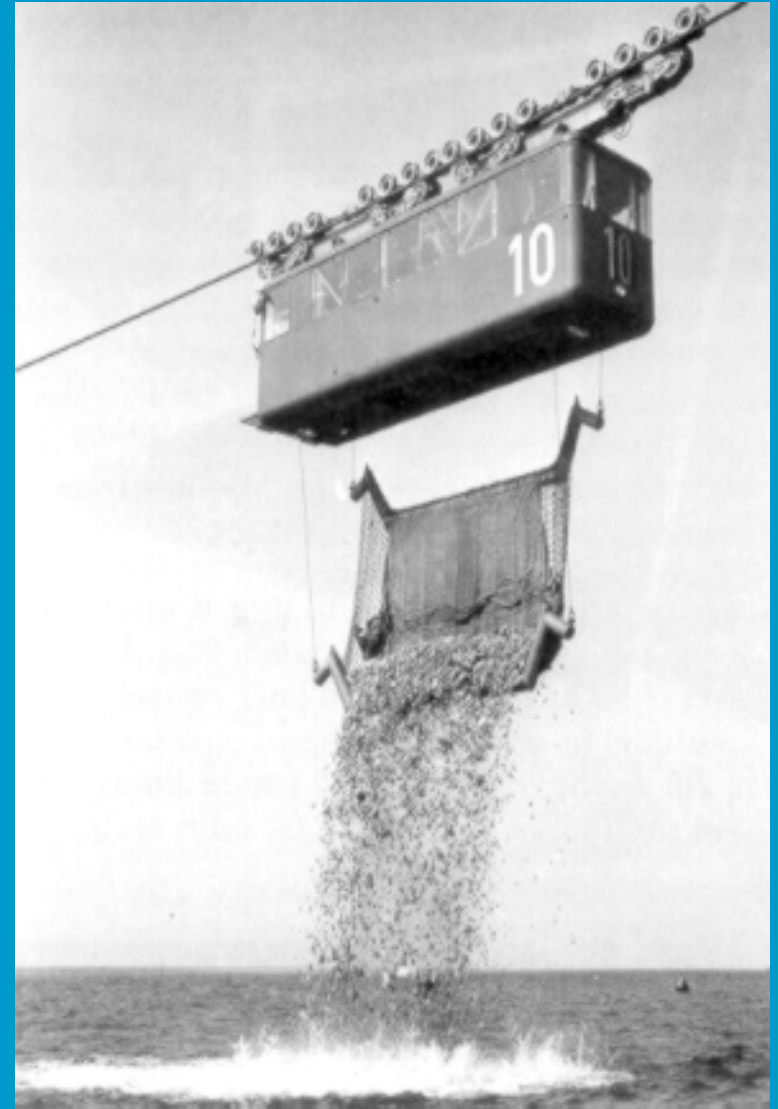
March 28, 2012

20





## rock closure



March 28, 2012

21

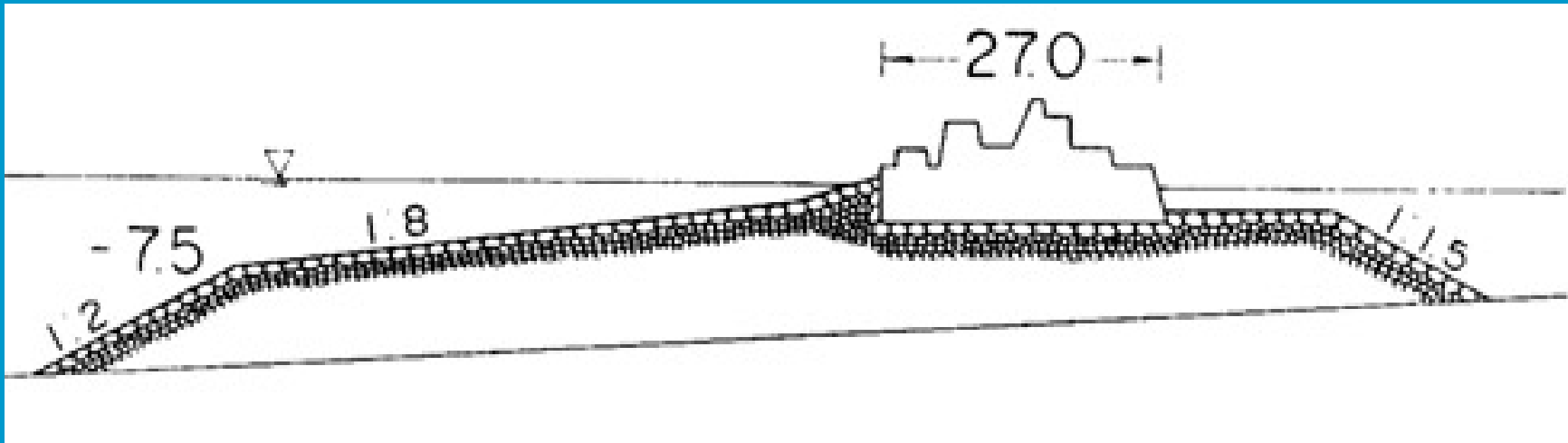


## caisson closure

March 28, 2012

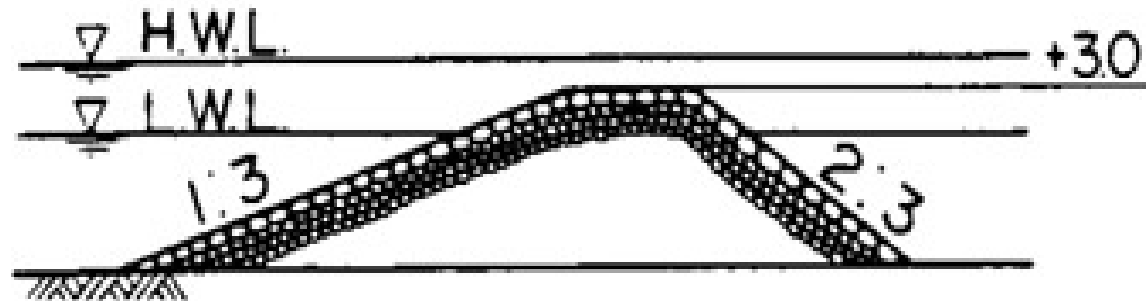
22

# Rubble mound breakwater at Cittavecchia



# Breakwater at Cherbourg

1812



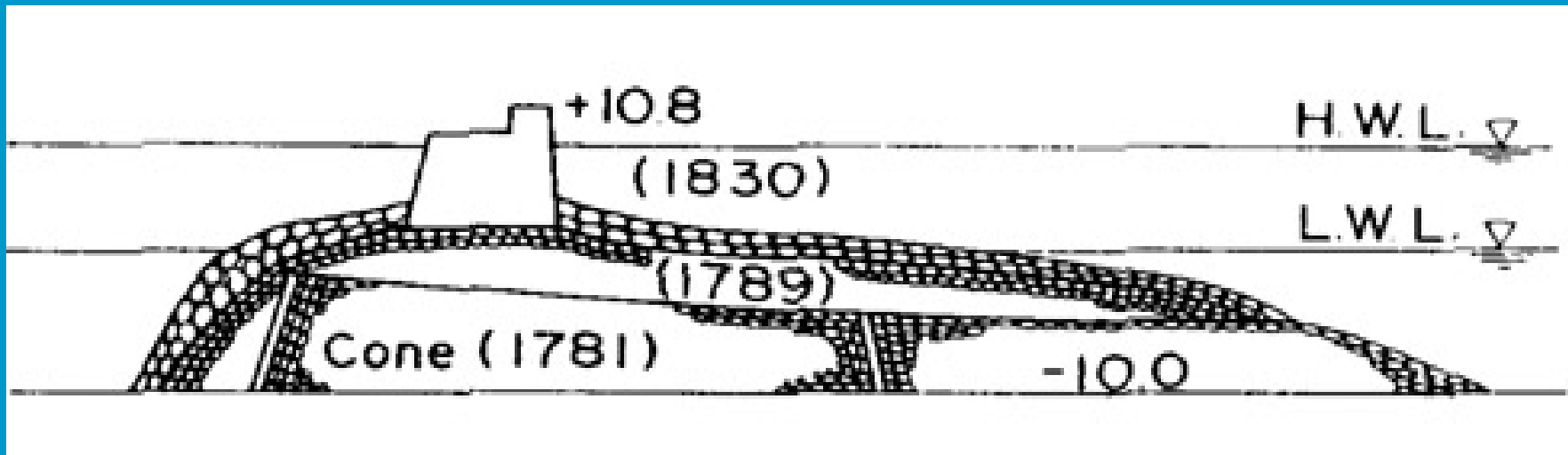
1841

(b)

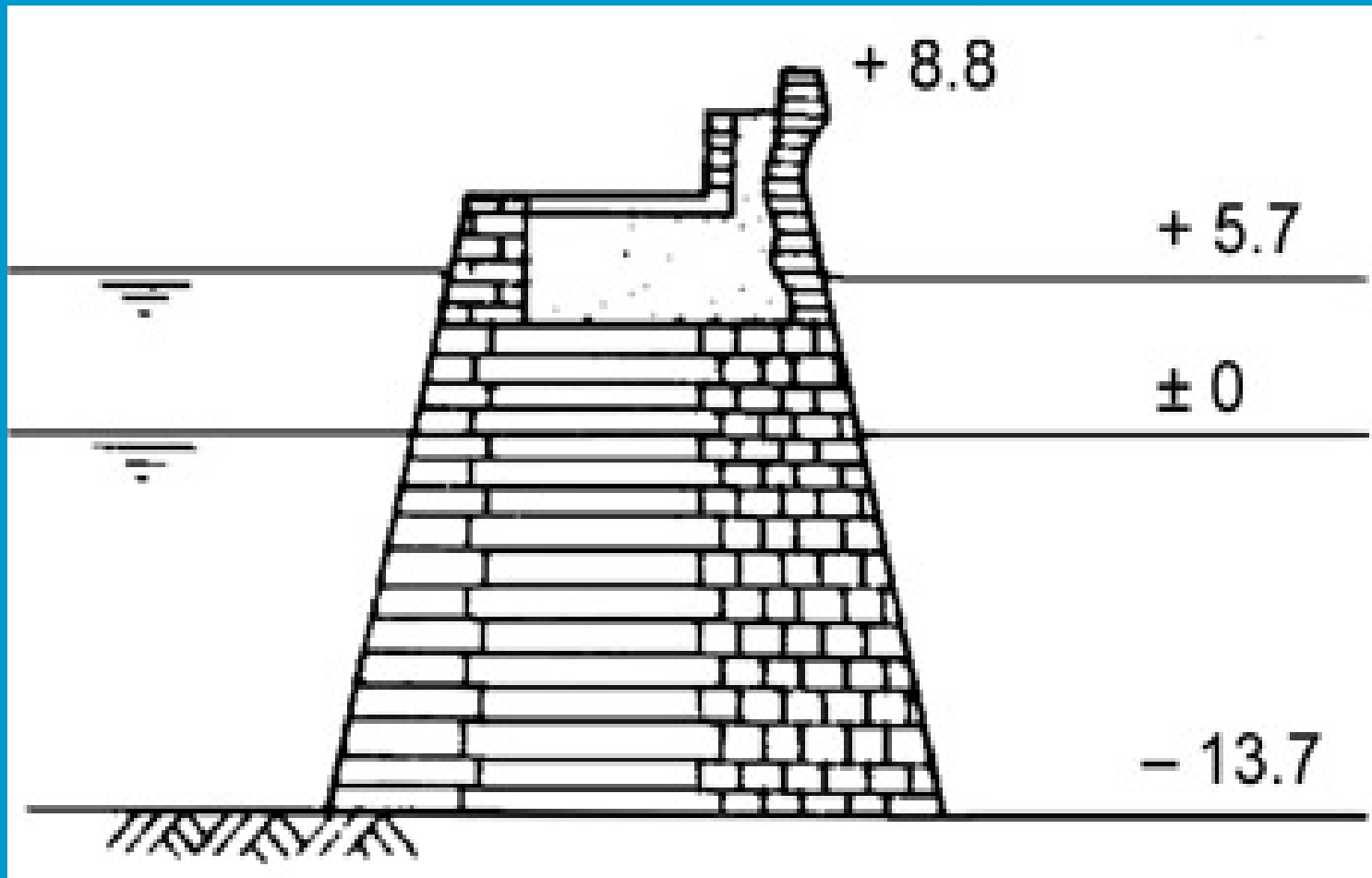




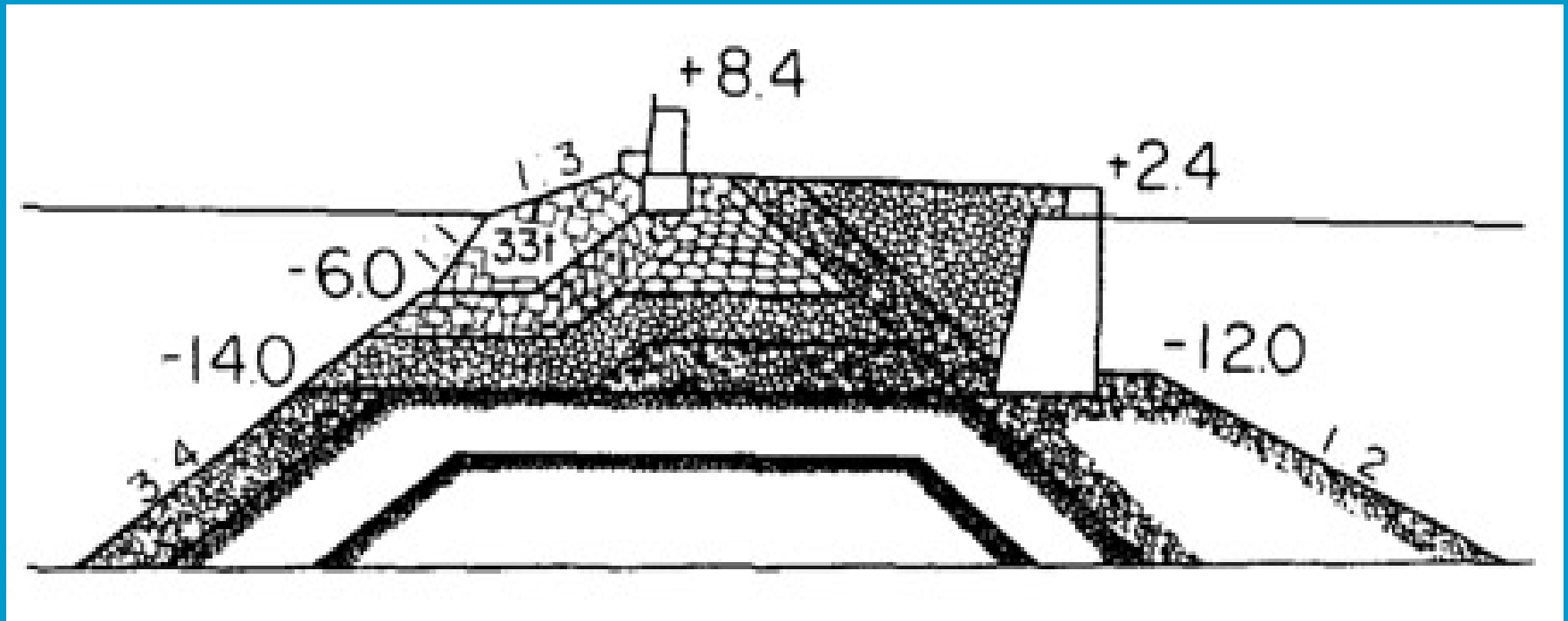
# Breakwater at Plymouth



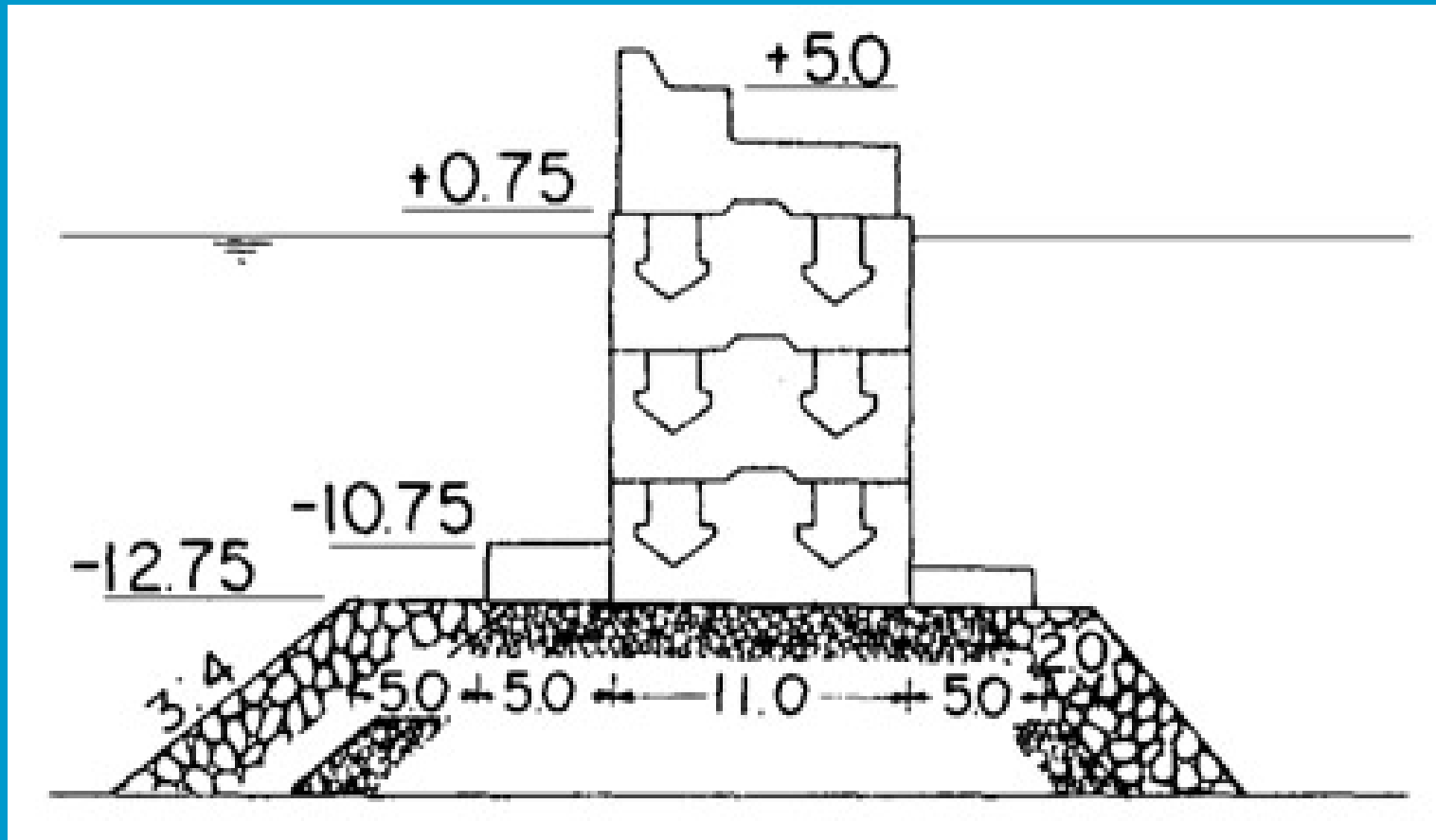
# Monolithic breakwater at Dover



# Breakwater at Marseilles



# Typical breakwater along the Mediterranean coast

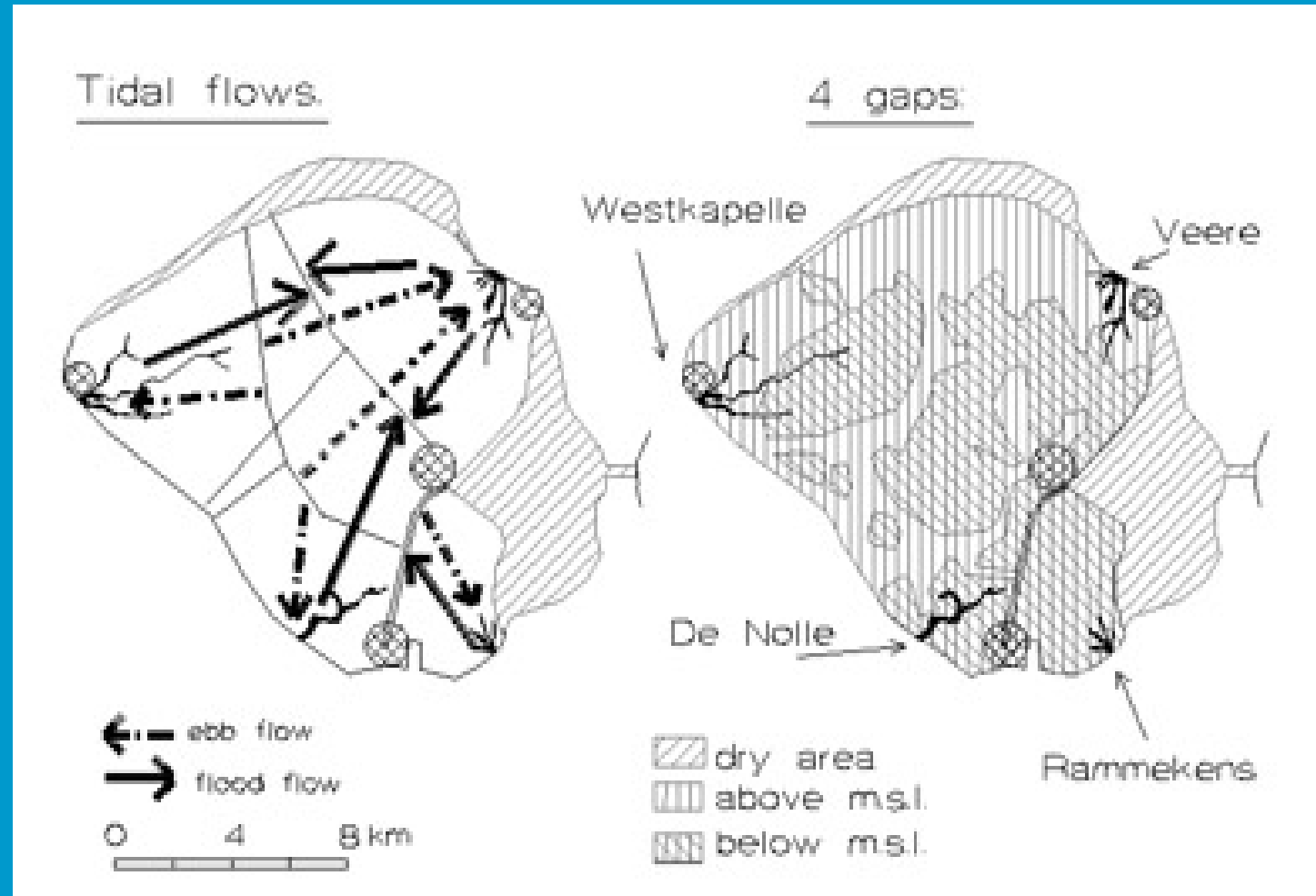


# Historical closures

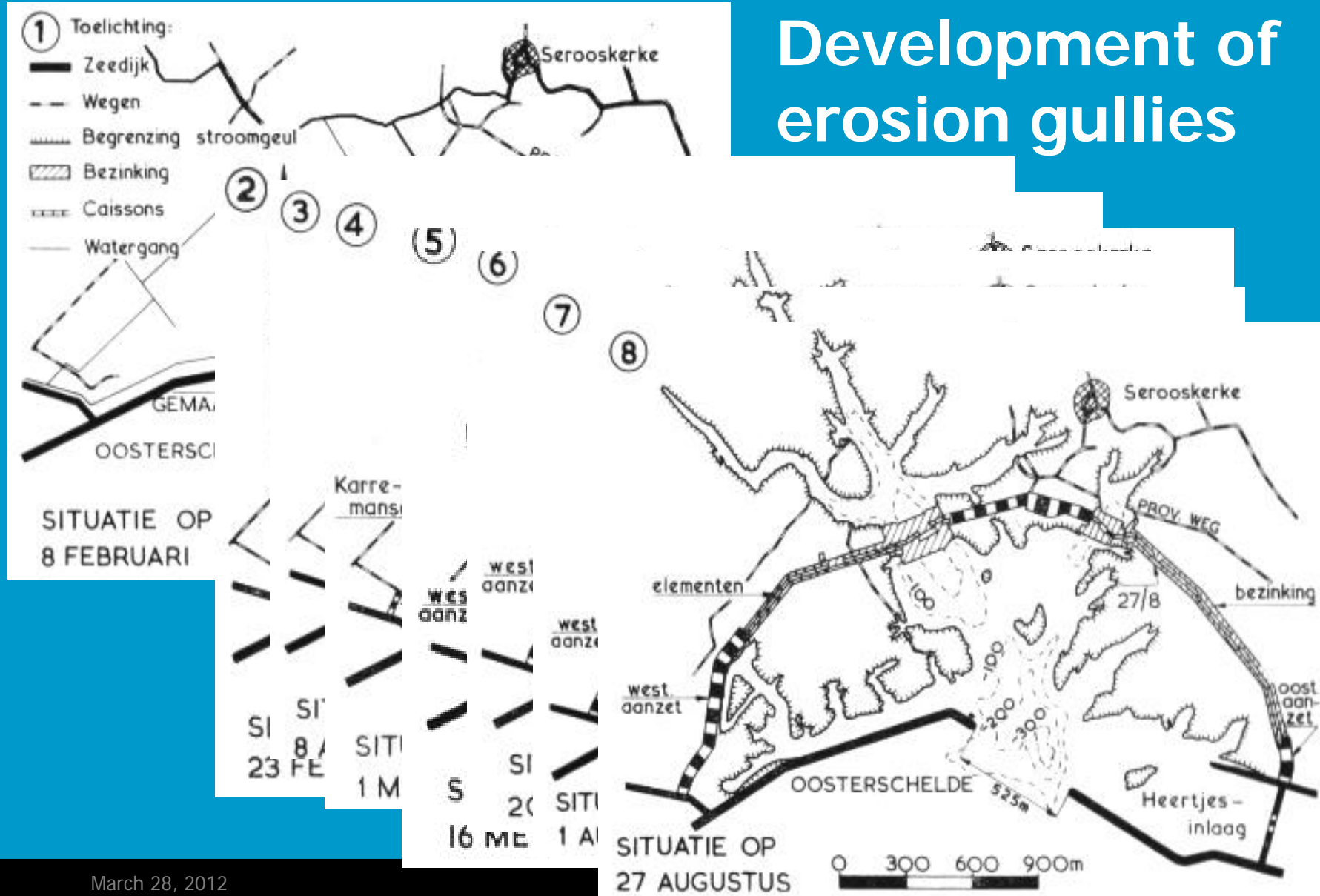
- Rhine damming (Wijk bij Duurstede)
- Sloe closure (pakwerk)
- Hindeburgdam



# Walcheren, four gaps on one island



# Development of erosion gullies



March 28, 2012