**COASTAL PROCESSES**



***Cellini’s (1500-1571) Salt Cellar, Vienna, Kunsthistorisches Museum***

**“the Land and the Sea, both sitting, with their legs intertwined, like some branches of the Sea enter the Earth and the Earth enters the Sea”**

Text, formulas and paragraphs marked in blue or yellow are not part of the course program;

*Paragraphs in italics provide exercises to be carried out in the classroom or as homework*

**What happens when waves hit the coast?**

This is the domain of many specialized courses in Maritime Hydraulic and Maritime Constructions: the methods to tackle this problem are numerous, are based on complex theories, long engineering practise, extensive laboratory experiments, and complex numerical solutions. These aspects cannot obviously cannot be tackled here.

However, when carrying out risk assessment on large extension of coast **(“large scale** risk assessment”) , a detailed analysis of each specific situation is neither possible, nor useful , at least on a first instance. **Quick look** methods are available to provide a quick evaluation of the risk associated with high waves.

A first distinction has to be made between direct damage caused by the **flooding** and / or the **impact** of waves on structures, and long term damage (indirect damage), caused by the gradual action of waves on the coast which induces **erosion**.

**WAVE DIRECT DAMAGE**

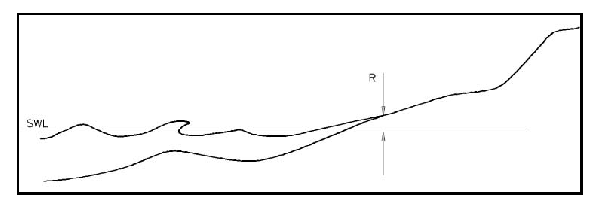
It is caused by single extreme storms – even though damage from successive storms may add up over the time. The main parameters are: Significant Wave Height (Hs,SWH), average period Tm, Direction.



A distinction has to be made between coasts with a small slope (basically, beaches) and steep coasts , with or without protections (wave breakers, groins, sea walls).

**Small slopes : beaches. Wave run-up**

In the breaker area part of the moment associated with the oscillating movement is sonverted into a forward and upwards translation of the water mass. This is the so called **run-up ( Ru),** defined as the elevation of the sea water height on a coast



 The run up is a dynamic and random quantity – since it is generated by a random succession of waves; it is also to be expected that its distribution should be similar to the offshore wave height distribution (i.e. the Rayleigh )

**Run-up**  can be dangerous for beaches and beach establishments and buildings[[1]](#footnote-1),

It is therefore important that the distribution of extreme Run-up values should be known as a function of the offshore sea conditions. This is usually made through empirical formulas, such as for instance,

*Maze’s*: (No need to learn the numerical constants, just the structure of the formulas )

is Irribarren offshore number tan(θ): beach slope Lo Ho: offshore (deep water) wave length and height- When dealing with costal processes average Lm and SWH must be used

        : 2% of the Run up heights will exceed Ho\*R2

 : 10% of the Run up heights will exceed Ho\*R1/10

: 33% of the Run up heights will exceed Ho\*R1/10

      : the average Run up height is given by Ho\*Rmedio

So :

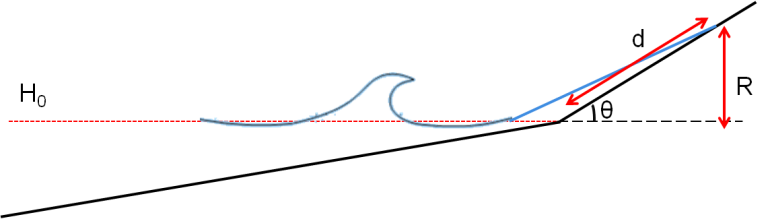
R2%= the run-up value of the 2% highest waves

R1/10 = the run-up value of the 10% highest waves

R1/3 = the run-up value of the 1/3 highest waves 1/3

Rmedio= the average run-up

  .

L

How to compute run-up for a beach. d=flooding distance; R=run up; θ=beach slope; H0= off-shore SWH.

The flooding distance **d,** an important parameter , is easily calculated as:

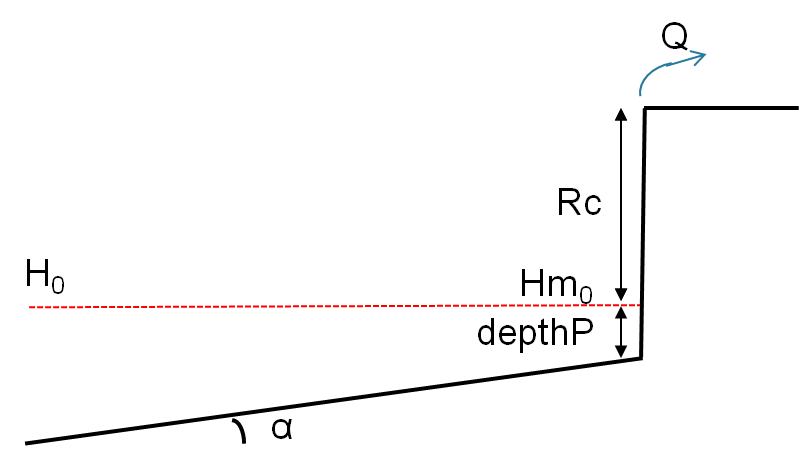
d= R/sin

and the horizontal flooded length L

L= R tan (90-

**Vertical or Sub-vertical wall**

Often – specially when protection structure are present, the important parameter is not the flooded distance, but the amount of water (flow rate , e.g. m3/s) that **overflows** the structure:



Procedura per il calcolo overflow nel caso di parete sub-verticale . Parametri: Q=portata di overtopping, Rc= altezza della porzione emersa della barriera e/o parete sub-verticale; depthP=profondità al piede.

When the coast is protected by a sea wall, the important parmater form the point of viwe of the coastal hazrd, is the overtopping flow rate Q (also indicated as q)

A possible approach is repor.ted by Allsop et al[[2]](#footnote-2)

In the following:

**T** is the mean wave period

**Hmo** is the significant wave height offshore (in deep water)

**Rc** is the elevation of the structure over the sea level

**depthP** is the depth at the toe of the structure

The first step is to compute the wave breaking depth:

Three different procedures have to be adopted according to the h\* parameter

Overtopping flow rate q (Q)

* non impulsive ()

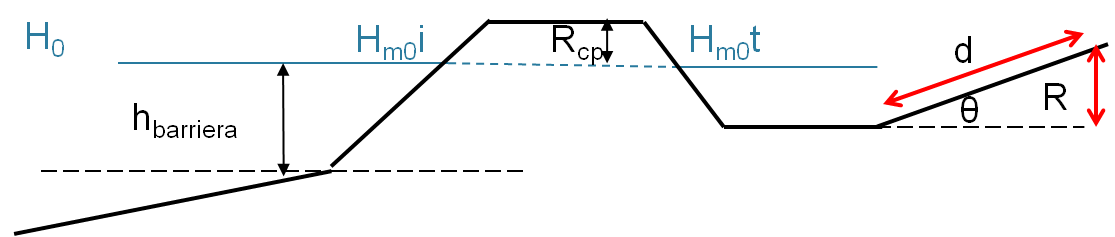
(3)

* impulsive ()

(4)

* intermediate (0.2 < )

**A beach with a sewall detached seawall**



Caso di spiaggia protetta da barriera. Parametri: d=distanza di allagamento; R=run-up; θ=angolo d’inclinazione della spiaggia; H0=altezza d’onda significativa off-shore; Hm0i=altezza d’onda significativa incidente; Hm0t=altezza d’onda significativa incidente; Hm0t=altezza d’onda significativa trasmessa; hbarriera=profondità al piede della barriera; Rcp=altezza della porzione di barriera emersa.



1. **Parete sub-verticale e barriera di protezione distaccata**

Questo scenario è la combinazione degli scenari B e C (Fig. 7). Si tratta del caso in cui alle spalle di una barriera di protezione non aderente è presente una parete verticale.

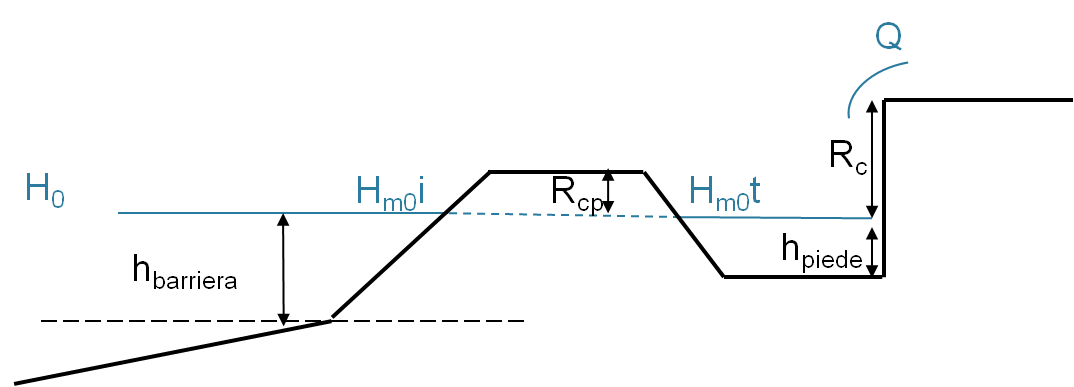


Figura 43 - Caso di parete sub-verticale protetta da barriera. Parametri: H0=altezza d’onda significativa a largo; Hm0i=altezza d’onda significativa incidente; Hm0t=altezza d’onda significativa trasmessa; hbarriera=altezza della porzione di barriera sommersa; Rcp=altezza della porzione di barriera emersa; Rc=altezza della porzione di parete emersa; hpiede=profondità al piede

1. Italian laws, for instance, prescribe that before a beach establishment is authorized, a risk analysis must be carried out [↑](#footnote-ref-1)
2.  [↑](#footnote-ref-2)