Iribarren Revisited

The ca. 1950 experiments on the limiting slope between wave reflection and breaking using SPH

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Ramón Iribarren, brief CV

Irún, Guipuzcoa, Basque Country, 1900

Roads, Waterways and Ports Engineer, Special School of Madrid

Positions held:

- Head of the Group of Ports of Guipuzcoa (40's – 67)
- Ports Professor (40's - 61) Special School
- Creator (51) and Director (51-67) of the Ports Laboratory of the School (since 1957 **CEPYC** of CEDEX)
- Counselor (Ports section) of Public Works Council

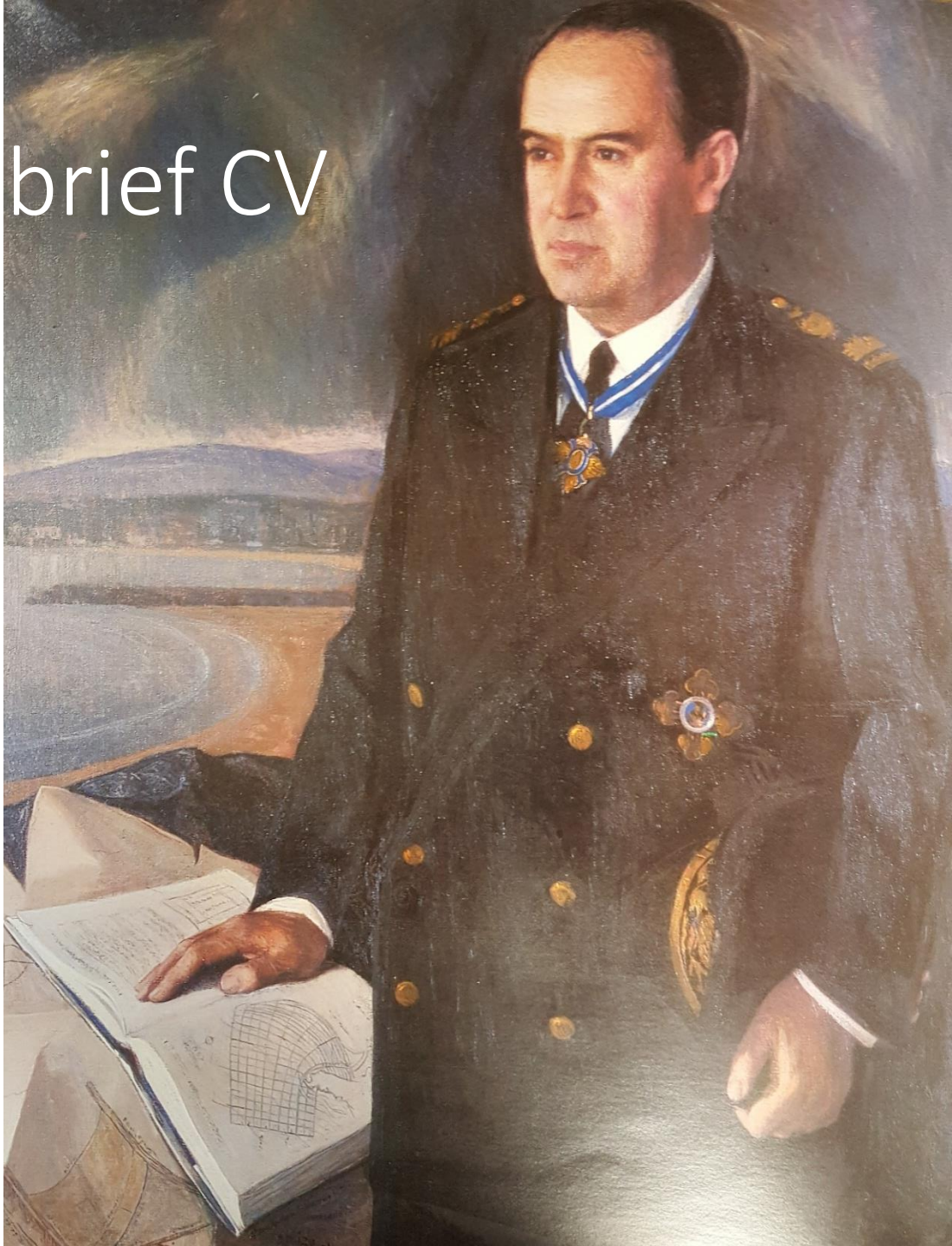
Honor (among many others):

- Knigth of the Legion d'Honour, RF, 1966

Tragic death, 1967

Main contributions:

- Wave plans method (1930's)
- Rational formula for rubble mound breakwater stability (1950's)
- The 'Iribarren parameter' (named by J. Battjes, 1974):



Iribarren ca. 1950 Experiments

Conducted in a small wave flume

- L x W x H : 3.00 x 0.40 x 0.50 m
- A scale model for the Ports Laboratory Flume
- With double actuated, piston & flap paddle

Water depth: 0.225 m

Test Cases: 3 regular wave trains over variable slopes

Goal: To study waves propagating on uniform sloping bottoms and to identify the limiting slopes for:

- ‘Full’ breaking wave conditions
- ‘Full’ reflection wave conditions
- Limiting, average slope in between

‘Full’: wave conditions dominated by br / rf

Iribarren Test cases and Slope Results

Intermediate to shallower water depths

h/L

Medium - high to medium – low wave steepness

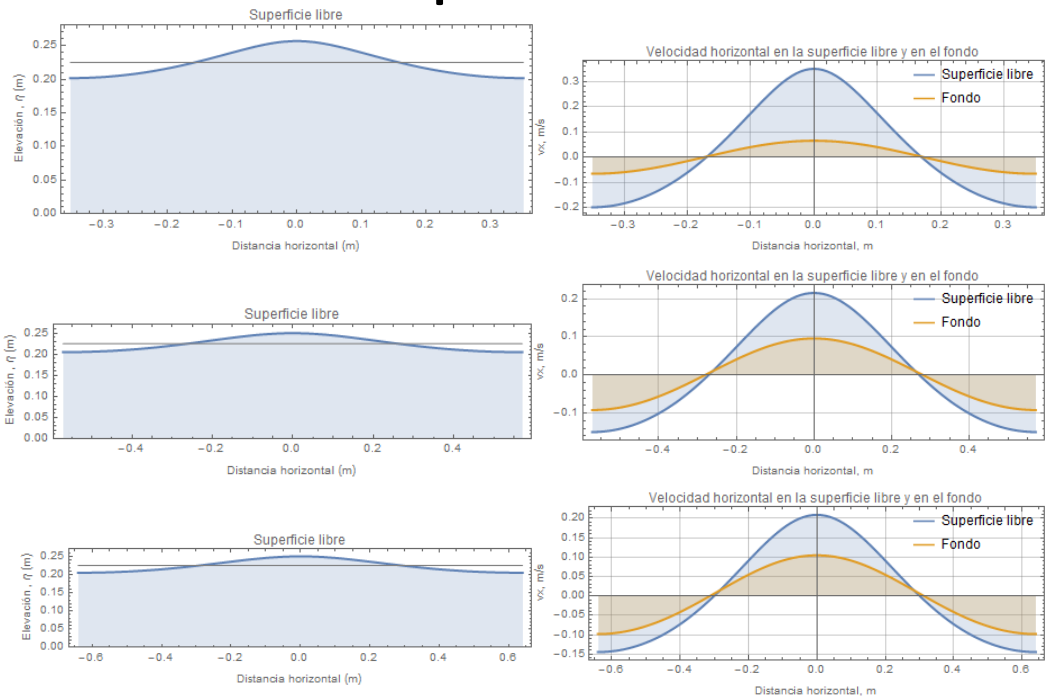
H/L

Results reported in Iribarren & Nogales, PIANC Congress, Lisbon, 1949

Breaking for smaller slopes

Reflection for higher slopes

Decreasing average limiting slope for longer, less steep waves

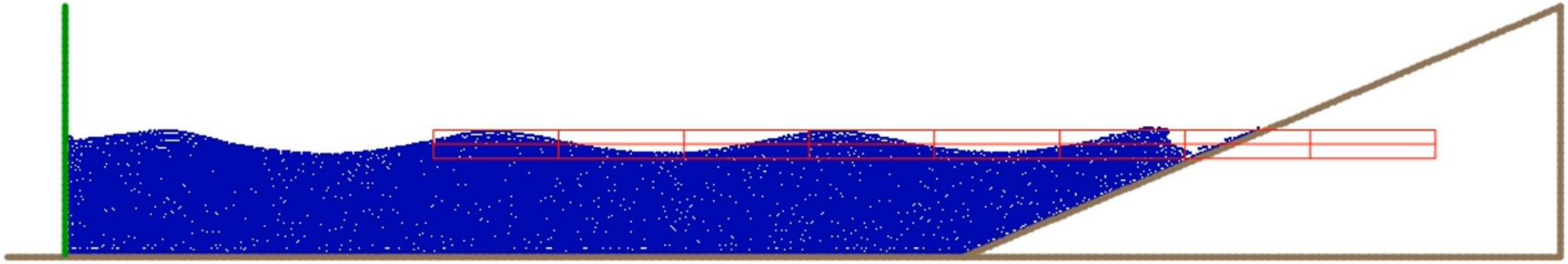


Case	H, cm	T, s	h/L	H/L	*i brk*	*i ref*	*i avg*
1	5.5	0.66	0.32	0.078	0.42	0.86	0.64
2	4.5	0.92	0.20	0.039	0.29	0.59	0.44
3	4.5	1.00	0.17	0.035	0.33	0.49	0.41

Iribarren Case 1 on SPH

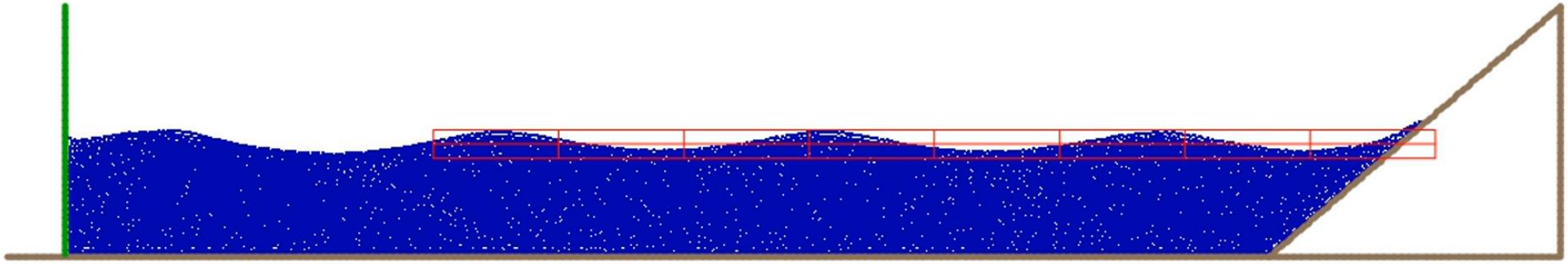
Case 1, (H = 0.055 m, T = 0.66 s, i = 0.42)
Breaking, Iribarren Ir = 1.46

t = 6.150



Case 1, (H = 0.055 m, T = 0.66 s, i = 0.86)
Reflection, Iribarren Ir = 2.98

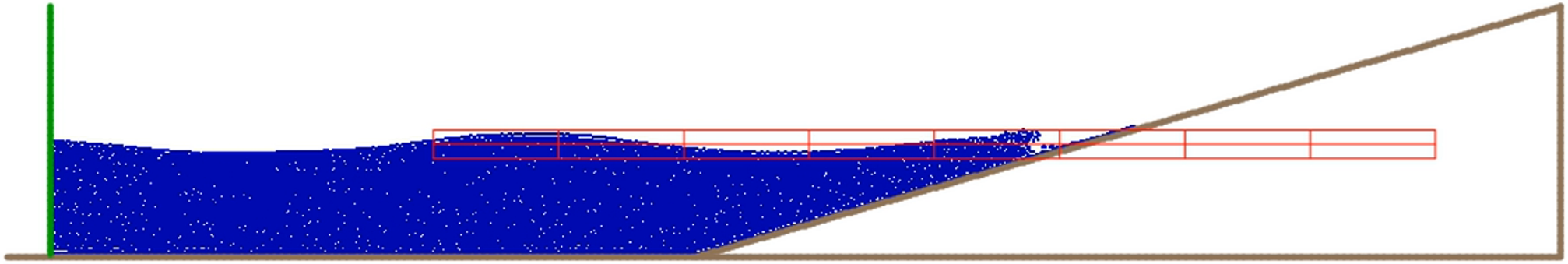
t = 6.150



Iribarren Case 2 on SPH

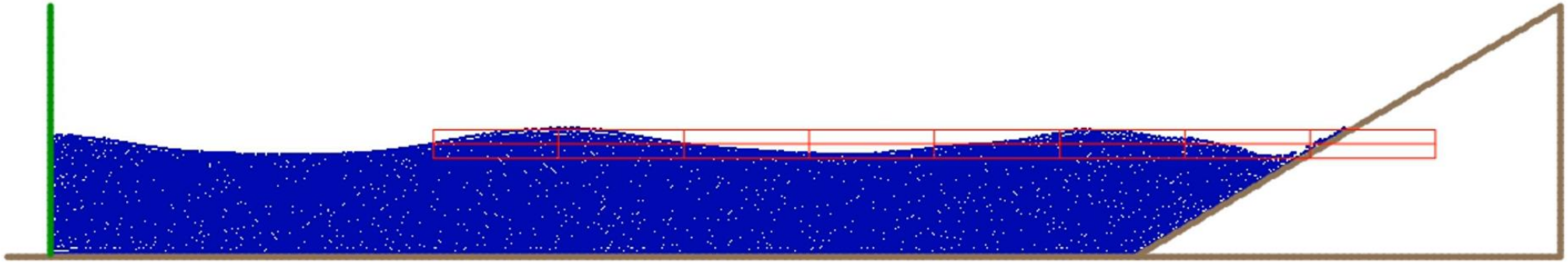
Case 2, (H = 0.045 m, T = 0.92 s, i = 0.29)
Breaking, Iribarren Ir = 1.45

t = 7.250



Case 2, (H = 0.045 m, T = 0.92 s, i = 0.59)
Reflection, Iribarren Ir = 2.95

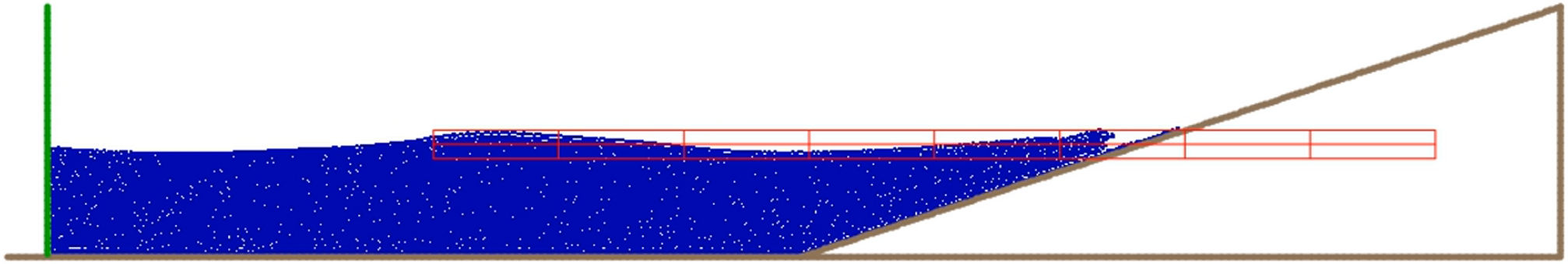
t = 7.250



Iribarren Case 3 on SPH

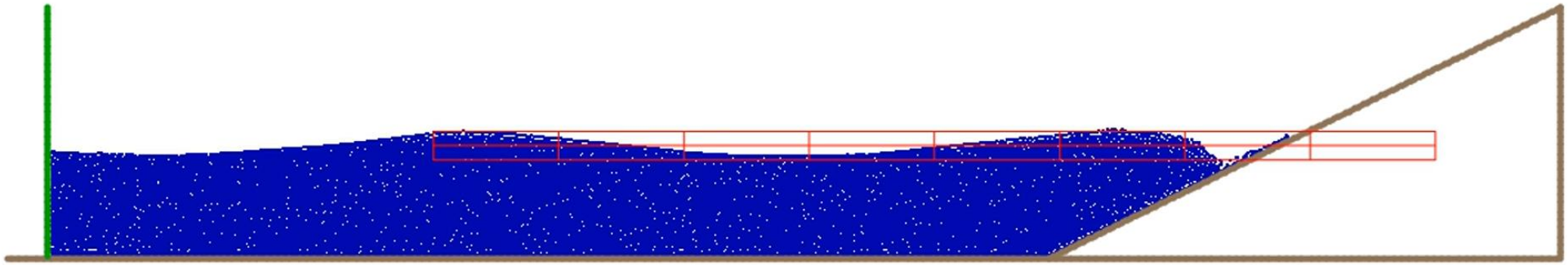
Case 3, (H = 0.045 m, T = 1.00 s, i = 0.33)
Breaking, Iribarren Ir = 1.75

t = 6.750

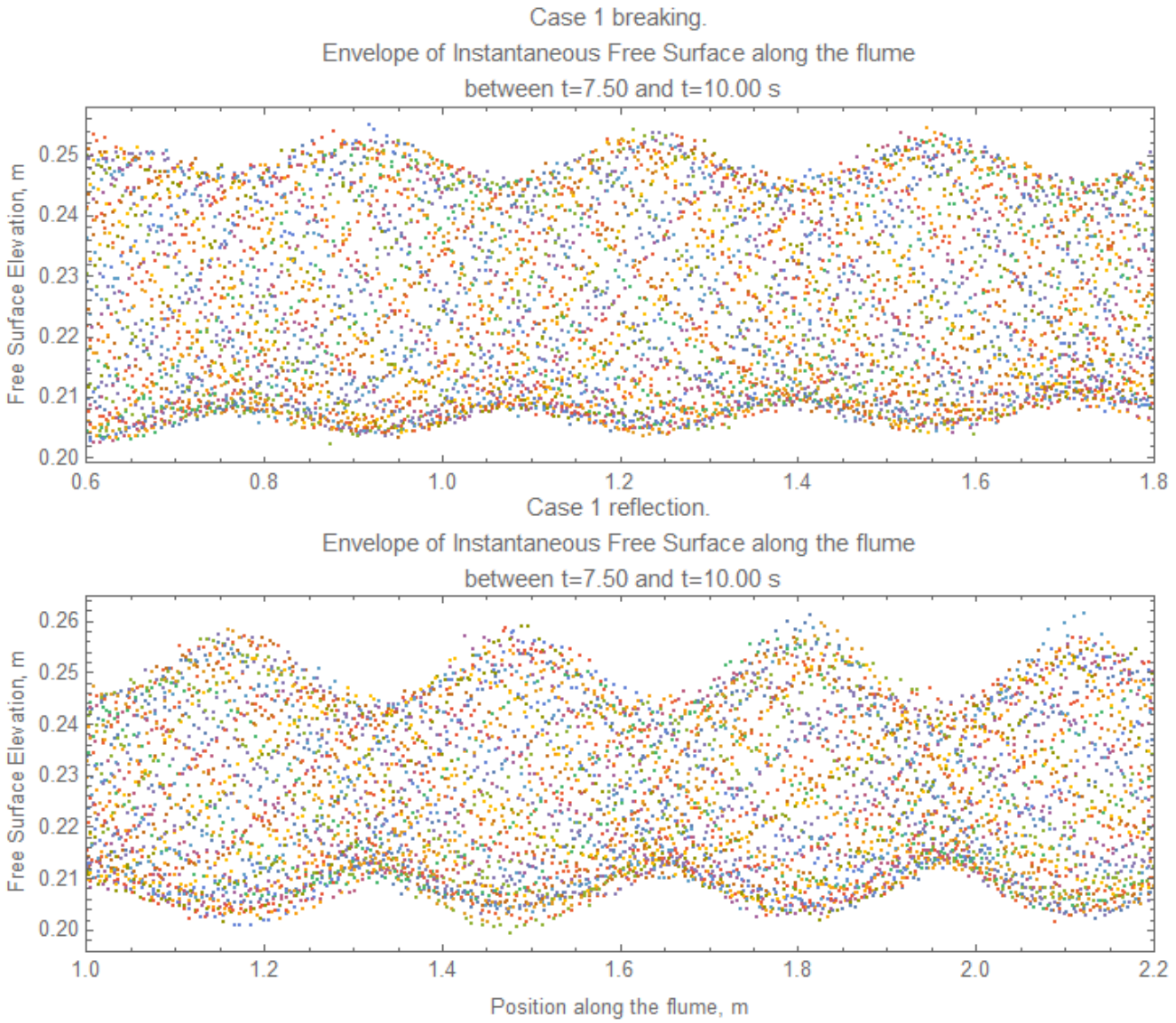


Case 3, (H = 0.045 m, T = 1.00 s, i = 0.49)
Reflection, Iribarren Ir = 2.59

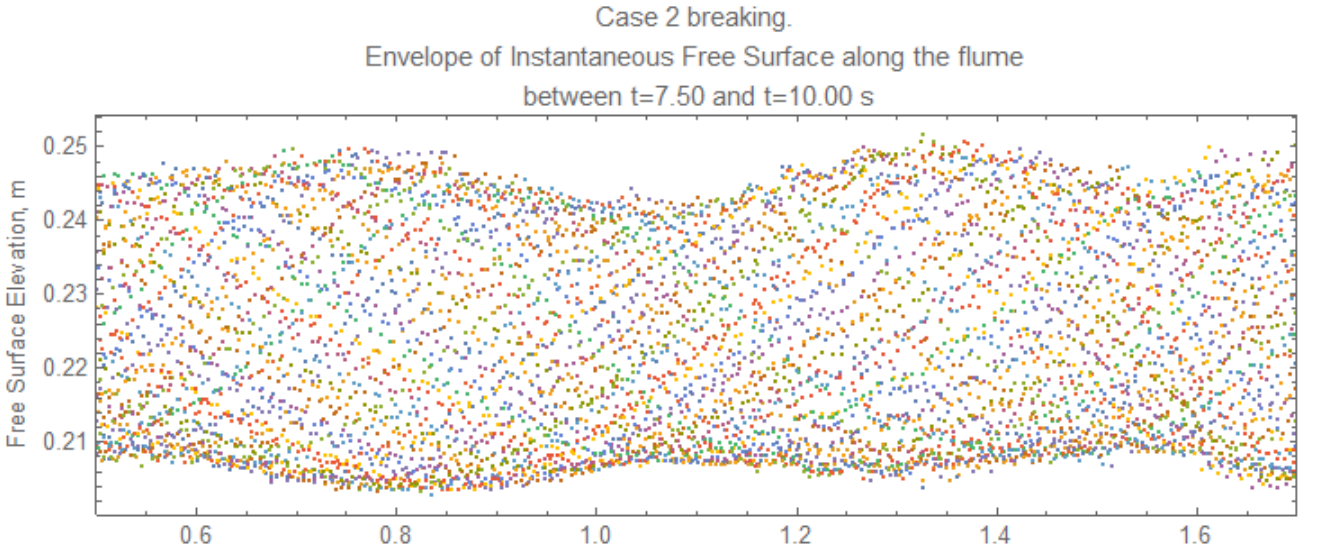
t = 6.750

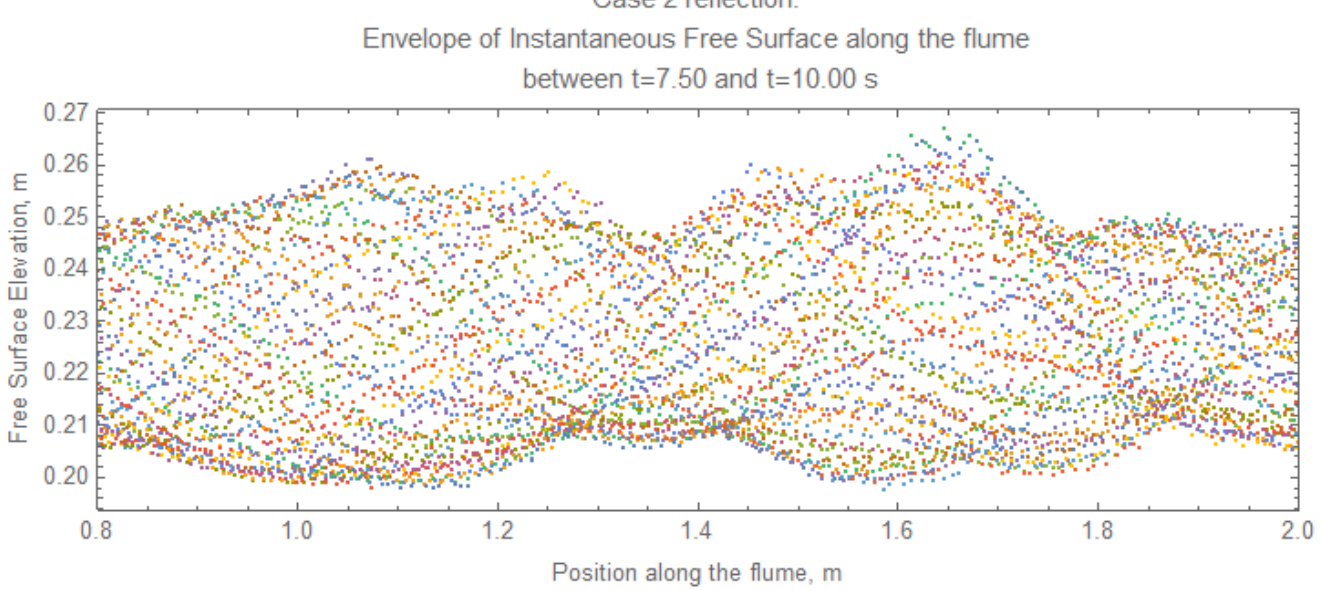


Iribarren Case 1 envelopes

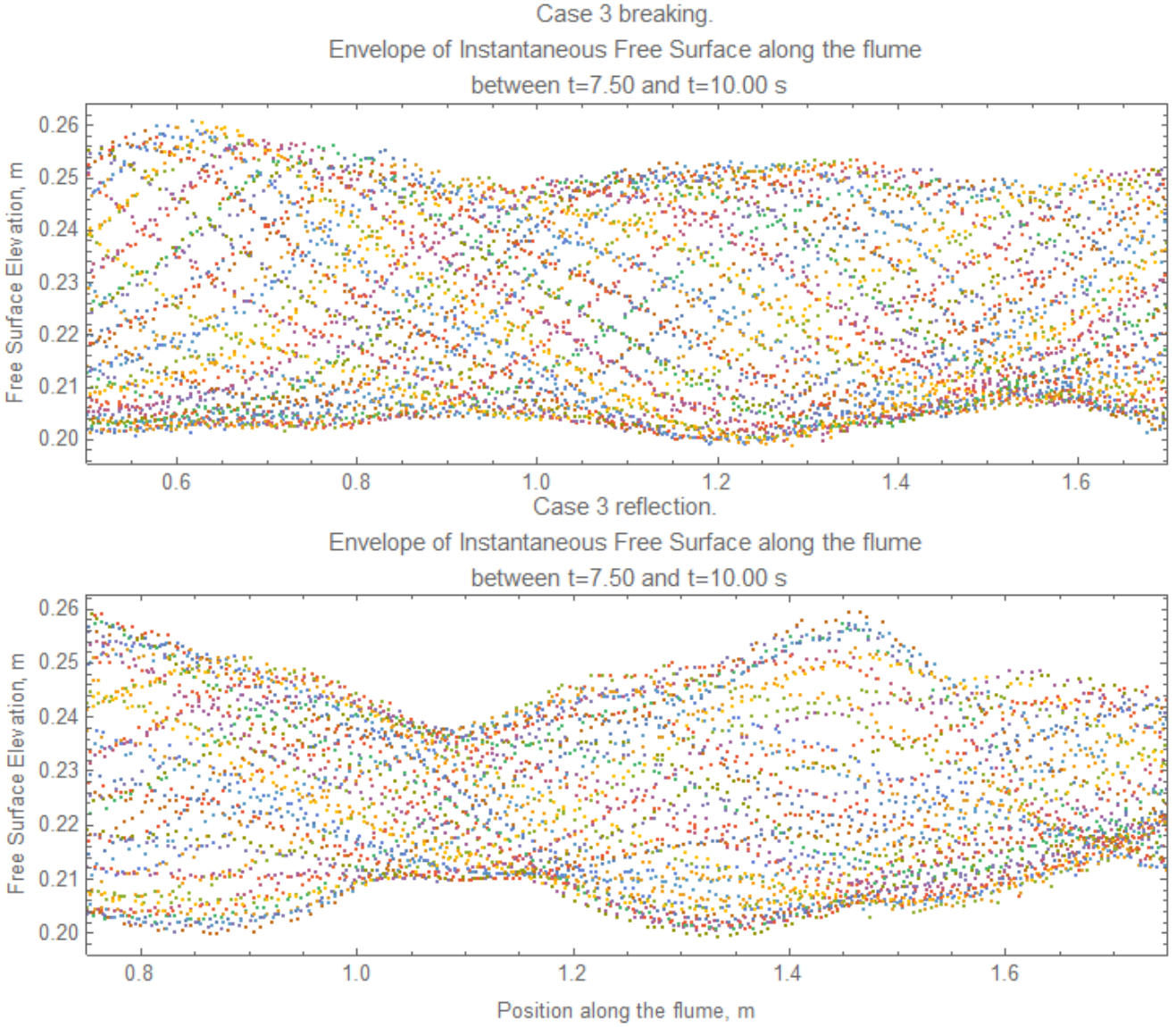


Iribarren Case 2 envelopes





Iribarren Case 3 envelopes



Main finding:

From teoretical considerations, (Iribarren & Nogales, 1948) had found the limiting slope (*), *i*, as a function of wave steepness, H/L_0:

$$i_{lim} = \frac{4}{\sqrt{\pi}}\sqrt{H/L_0}$$

And compared (Iribarren & Nogales, 1949) the results with the average experimental slope between breaking and reflection:

Case	H, cm	T, s	*i brk*	*i ref*	*i avg*	*i lim*
1	5.5	0.66	0.42	0.86	0.64	0.66
2	4.5	0.92	0.29	0.59	0.44	0.42
3	4.5	1.00	0.33	0.49	0.41	0.38

*(Larras, 1961) shows an equivalent formula with coefficient $\sqrt{1/0.196}$, attributed to (Iribarren & Nogales, 1938). I have not found such ref.

Meanwhile…

At the same 1949 PIANC Lisbon Conference, (Thysse y Schijf, 1949) stated that reflection was a function of slope $i = t / h$ and adimensional water depth (h/L)

And, at the Grenoble 1949 IAHR Conference (Schoemaker y Thijsse, 1949) presented results of reflection tests coefficients as a function of adimensional horizontal length of the slope, (t / L) as major parameter and adimensional water depth.

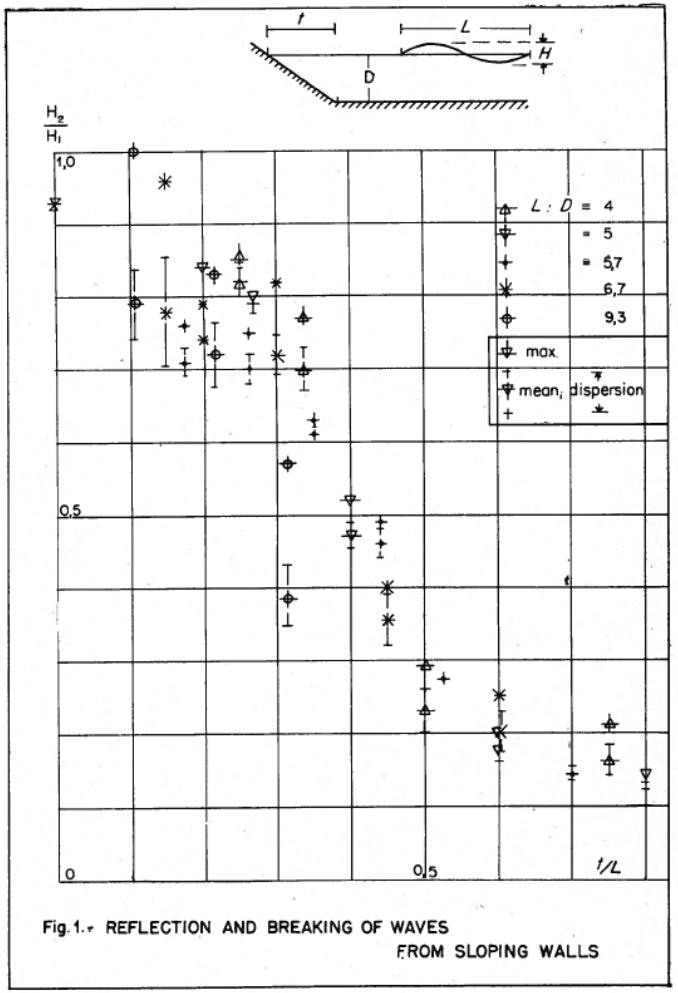


Fig. 1.– REFLECTION AND BREAKING OF WAVES FROM SLOPING WALLS

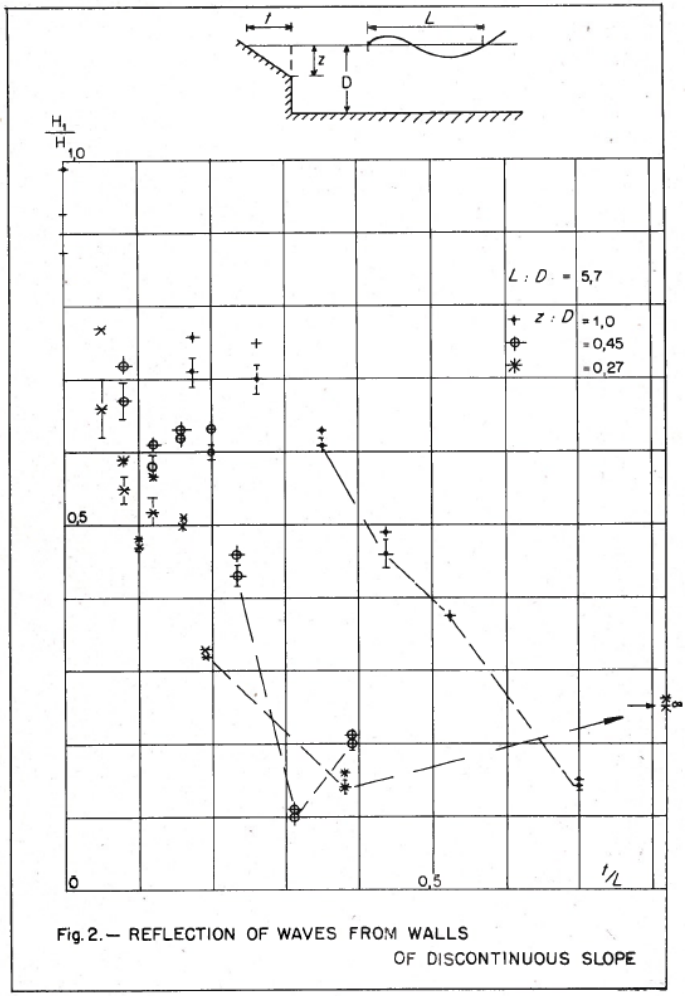
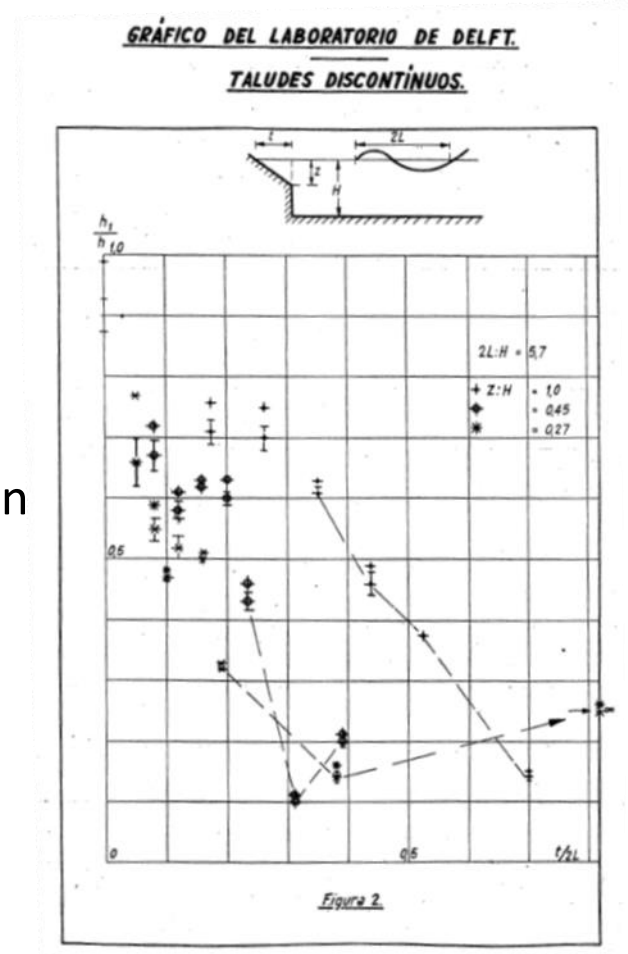


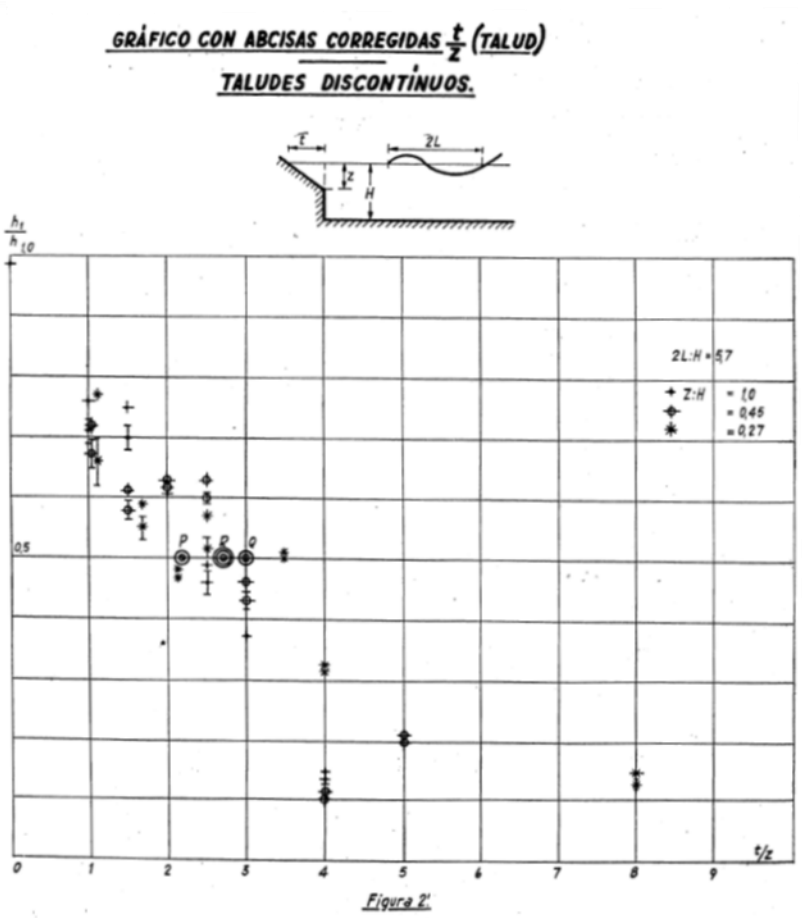
Fig. 2.– REFLECTION OF WAVES FROM WALLS OF DISCONTINUOUS SLOPE

But...

Iribarren got the Grenoble Proceedings Contribution, criticized the parameterization of (Schoemaker y Thijsse, 1949) and represented the results (Iribarren y Nogales, 1950) as a function of slope as main parameter.

This seems a more appropiate parameterization.





Closure...

(Batjjes, 1974) proposed to name **Iribarren Parameter** to the coefficient of the expression of the limiting slope between reflection and breaking:

$$I_r = i/\sqrt{H/L_0}$$

'The importance of this parameter for so many aspects of waves breaking on slopes appears to justify that it be given a special name. In the author's opinion it is appropriate to call it the "Iribarren number" (denoted by "Ir"), in honor of the man who introduced it and who has made many other valuable contributions to our knowledge of water waves.' (Batjjes, 1974)

Summary, conclusion, further work

The physical experiments supporting the discovery of the limiting slope between breaking and reflection can ☺ / ~~cannot~~ ☹ be approximated using SPH numerical techniques, like /~~ unlike~~ other landmark experiences such as the Russell wave generator experiments (Monaghan & Kos, 2000).

Numerical modelling may contribute to analyze in a detailed way influential experiences of the past and, probably, to support genuine discoveries.

The experiments described may be further analized not only qualitatively but in a quantitative way.

Remark: SPH and similar techniques may play an important role in the study of storm flood risk and protection of urban coasts

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Thanks but… what's the relevance today?

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