University of Rome
“Roma Tre”

Environmental and Maritime
Hydraulic Laboratory – University
of L’Aquila

University of Rome
“Tor Vergata”

Tsunami experimental modeling: 2D and 3D wave propagation, 2D runup and overtopping

Dr. Marcello DI RISIO

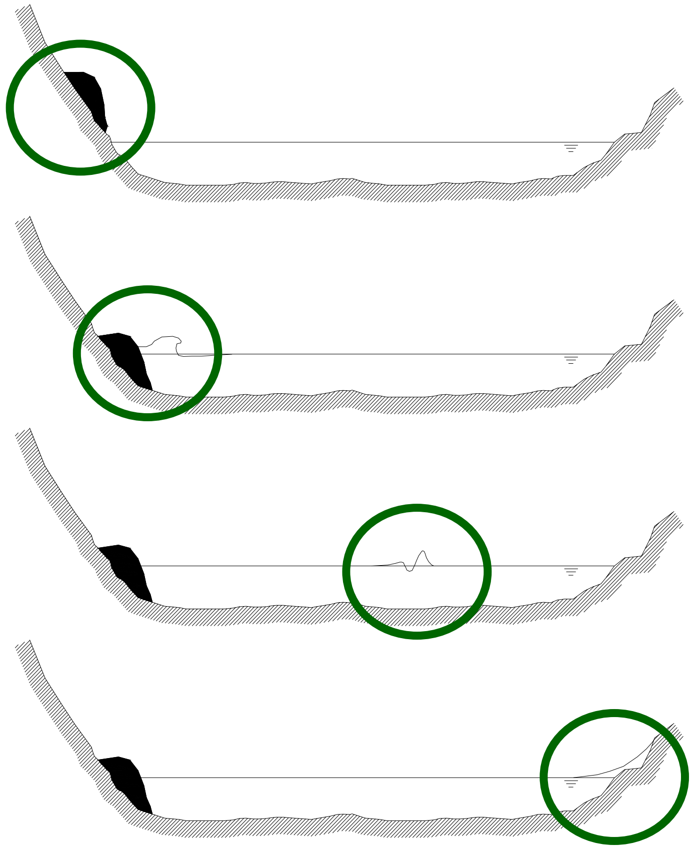
The phenomenon of landslides-tsunami event

i. **The landslide starts to move from one of the boundaries of the water body**

ii. **The landslide interacts with the free surface initially at rest and a transient perturbation is generated**

iii. **The perturbation propagates into the water body**

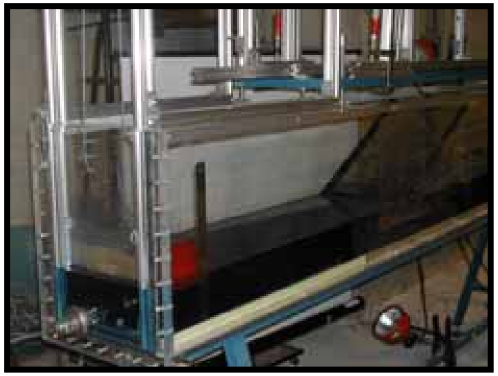
iv. **The perturbation reaches the coastal boundaries and wave runup occurs (if a dam exists wave overtopping may occur)**



Experimental facilities

- **Wave flume**

(18.0 m x 0.30 m x 0.45 m)



- **Wave tank**

(12.00 m x 6.00 m x 0.80 m)

- **Wave gauges**

  (time series of free surface oscillations)

- **Accelerometer**

  (time series of landslide accelerations)

- **Digital video system**

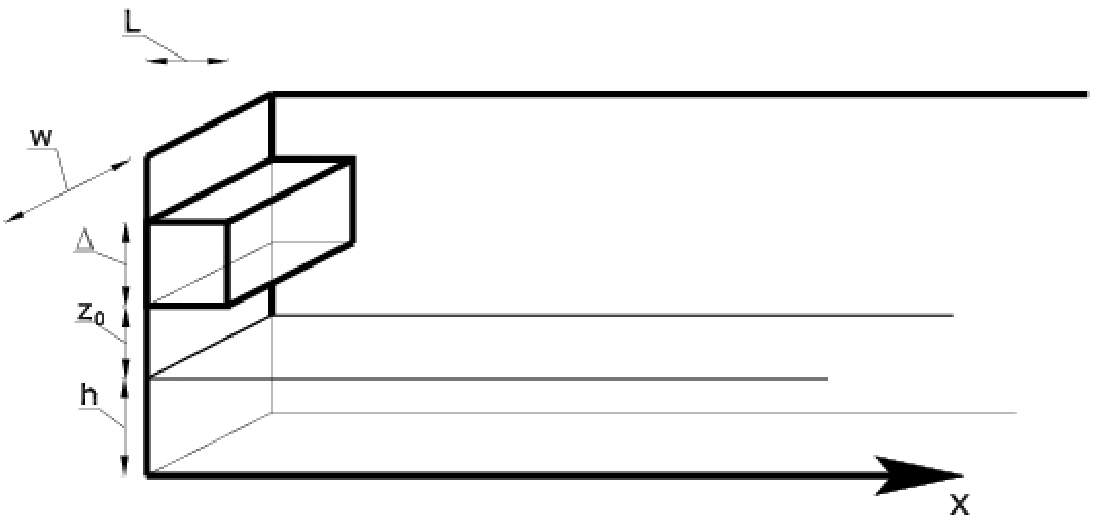
  (visualization of the phenomenon)

University of Rome "Roma Tre"

Environmental and Maritime Hydraulic Laboratory – University of L'Aquila

University of Rome "Tor Vergata"

Generation and propagation of vertical slump generated waves: the 2D problem



$$\Theta = f\left(L, w, \Delta, h, z_0, x, v_0, p, \rho_s, \rho, \mu, g, t, T_u, \Delta V\right).$$

$$\Pi_\Theta = \phi\left(\frac{L}{h}, \frac{w}{h}, \frac{\Delta}{h}, \frac{z_0}{h}, \frac{v_0}{\sqrt{gh}}, \frac{x}{h}, p, \frac{\rho_s}{\rho}, \frac{\mu}{\rho h\sqrt{gh}}, t\sqrt{\frac{g}{h}}, T_u\sqrt{\frac{g}{h}}, \frac{\Delta V}{\sqrt{gh}}\right)$$

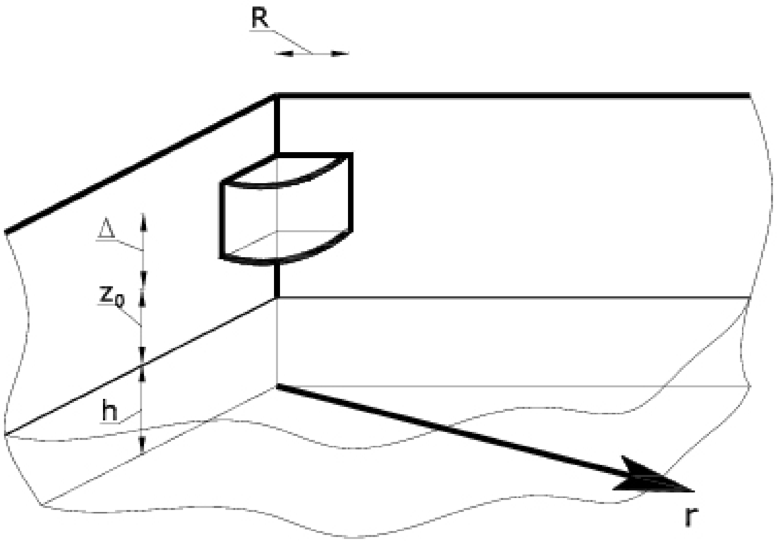
2D

Shear stresses are negligible

Landslide dimensions and energy

- **L,w,Δ: landslide dimensions**
- **h: water depth**
- **z_0: initial position above still water level**
- **x: distance from generation area**
- **v_0: impact velocity**
- **p: landslide porosity**
- **ρ_s: landslide density**
- **ρ: water density**
- **μ: water dinamic viscosity**
- **g: gravitational acceleration**
- **t: elapsed time**
- **T_u: underwater phase duration**
- **ΔV: velocity variation at impact**

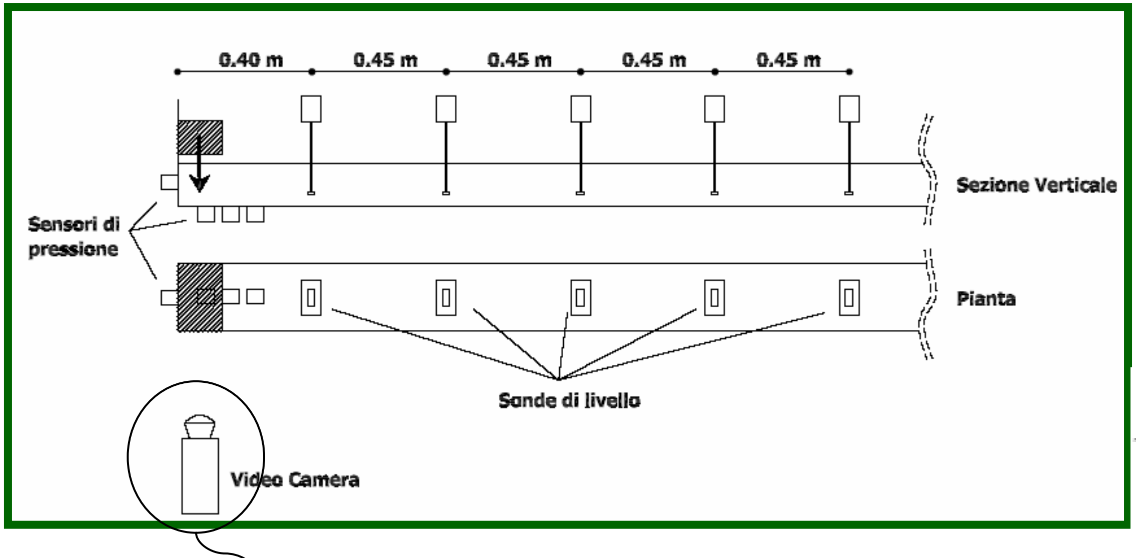
Generation and propagation of vertical slump generated waves: the 3D problem

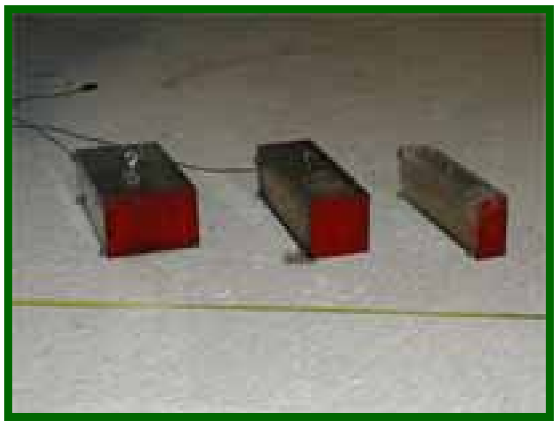


$$\Theta = f\left(R, \Delta, h, z_0, r, v_0, p, \rho_s, \rho, \mu, g, t, T_u, \Delta V\right)$$

- **R,Δ: landslide dimensions**
- **h: water depth**
- **z_0: initial position above still water level**
- **r: distance from generation area**
- **v_0: impact velocity**
- **p: landslide porosity**
- **ρ_s: landslide density**
- **ρ: water density**
- **μ: water dinamic viscosity**
- **g: gravitational acceleration**
- **t: elapsed time**
- **T_u: underwater phase duration**
- **ΔV: velocity variation at impact**

Generation and propagation of vertical slump generated waves: the experiments

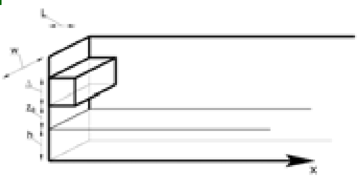




Experimental parameters

(90 tests - 720 experimental points)

h $[m]$	L $[m]$	z_0 $[m]$	x $[m]$
0.06	0.05	0.01	0.40
0.10	0.10	0.03	0.85
0.18	0.15	0.05	1.30
0.23		0.07	1.75
		0.10	2.20
		0.15	3.10
		0.20	4.00
			5.35



$$\frac{H}{h} = \phi_H\left(\frac{L}{h}, \frac{v_0}{\sqrt{gh}}, \frac{x}{h}\right)$$

$$T\sqrt{\frac{g}{h}} = \phi_T\left(\frac{L}{h}, \frac{v_0}{\sqrt{gh}}, \frac{x}{h}\right)$$