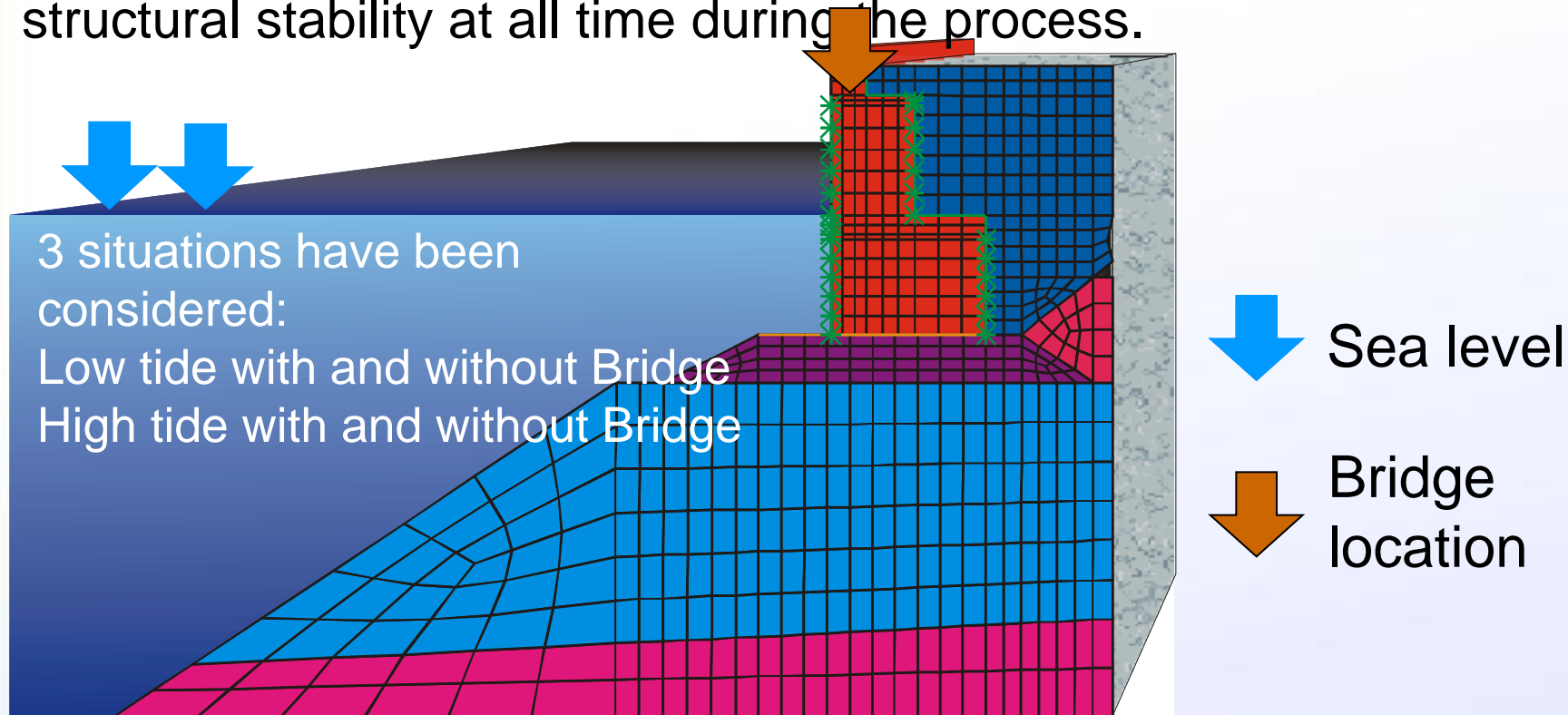


# Concrete Breakwater Seismic Analysis of the Bilbao harbor



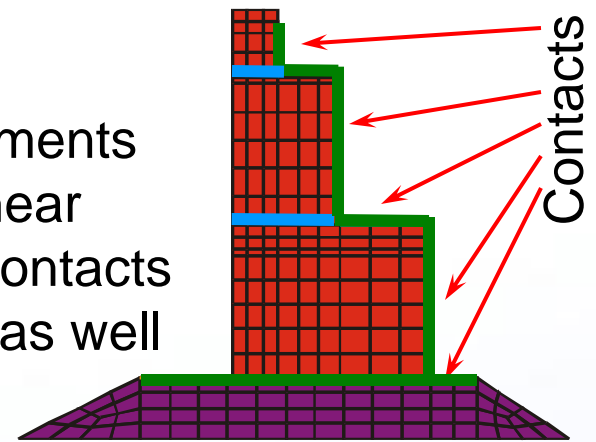
# Project Description

Check of stress analysis and displacement of several harbor walls of the Bilbao harbor when subjected to a seismic load. The structure and soil will be checked against mechanical and structural stability at all time during the process.



# Finite Element Model

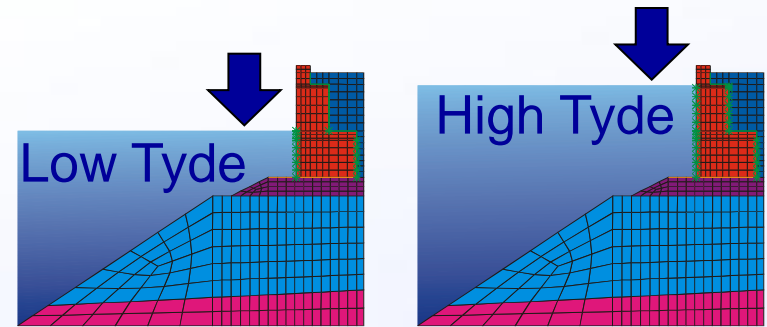
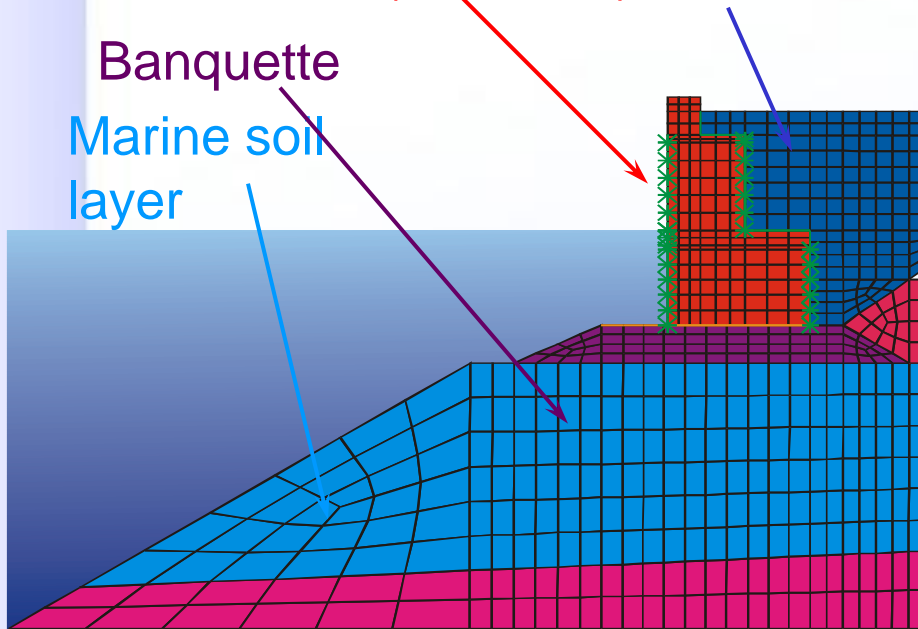
A 2D model consisting of PLANE42 elements was used, taking into account the non linear behavior of the soil, the sea effect, and the contacts between the soil and the concrete caissons as well as among the concrete caissons.



**Breakwater (Concrete) Rocks**

**Banquette**

**Marine soil layer**



**Soil Layer**

**Rock**

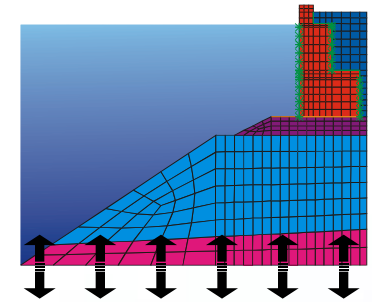
**Mesh Data**

<b>Elements</b>	1047
<b>Nodes</b>	1141

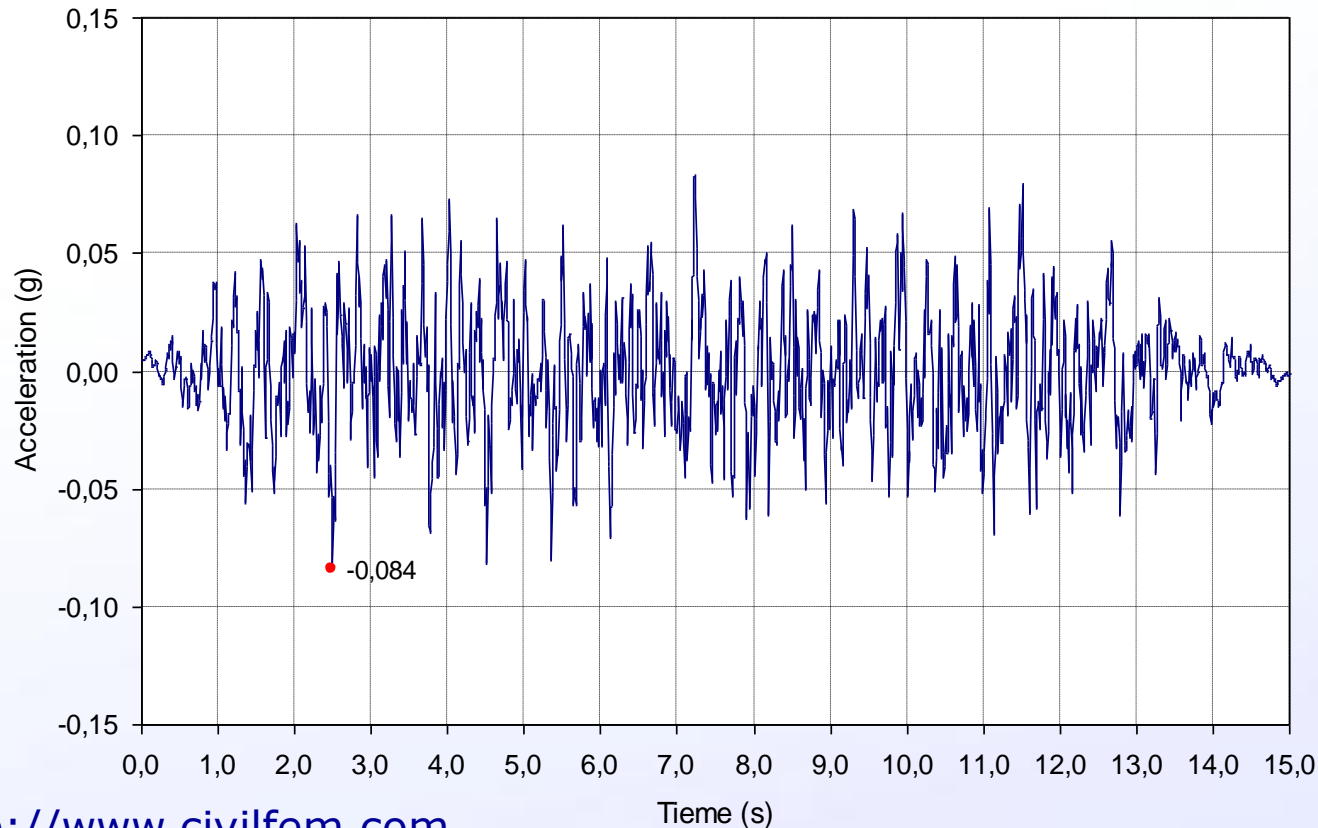


# Applied Loads I

- Vertical accelerogram SSE (ASSEV)
- Horizontal accelerogram SSE (ASSEH)
- Self weight

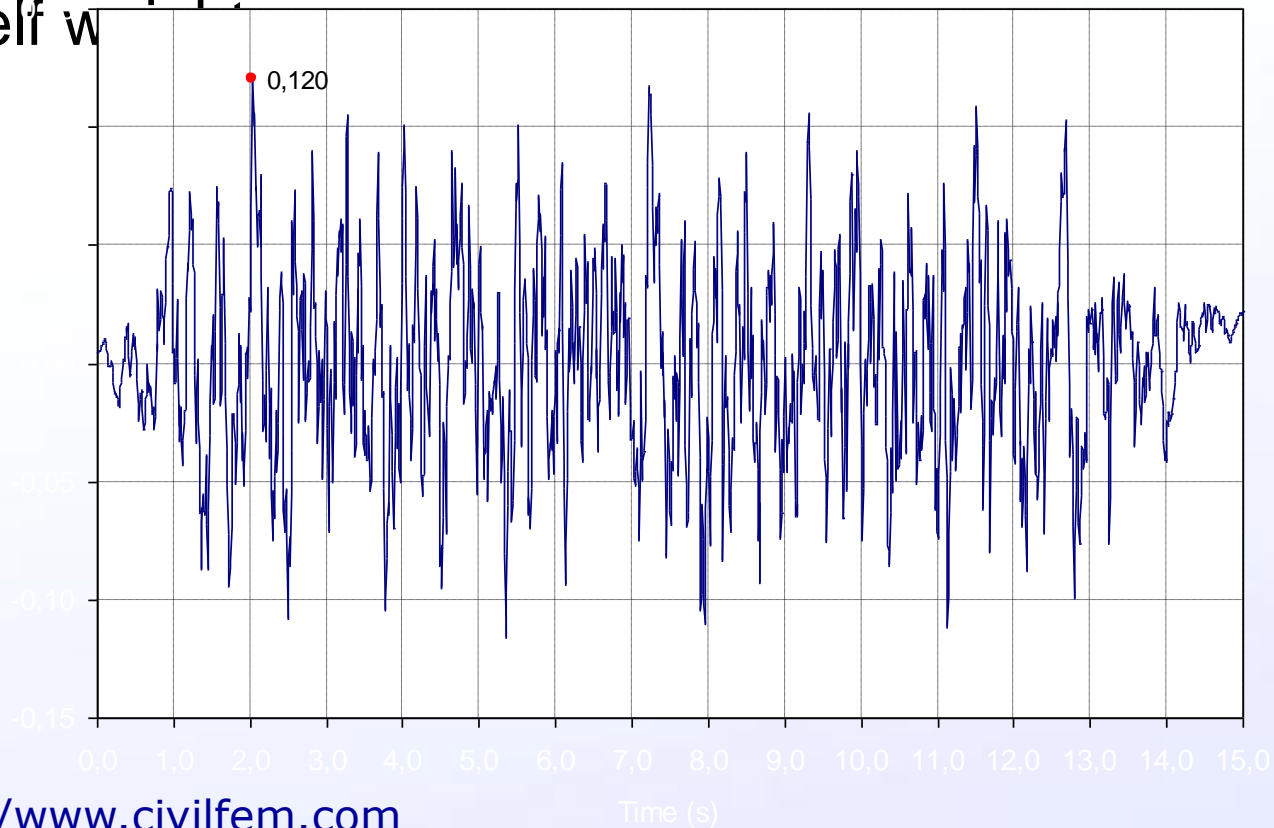
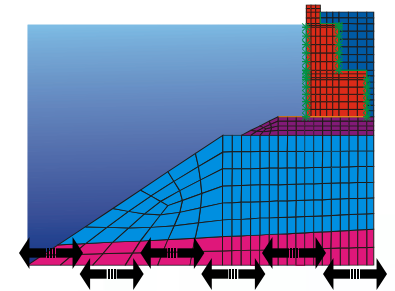


SSE vertical



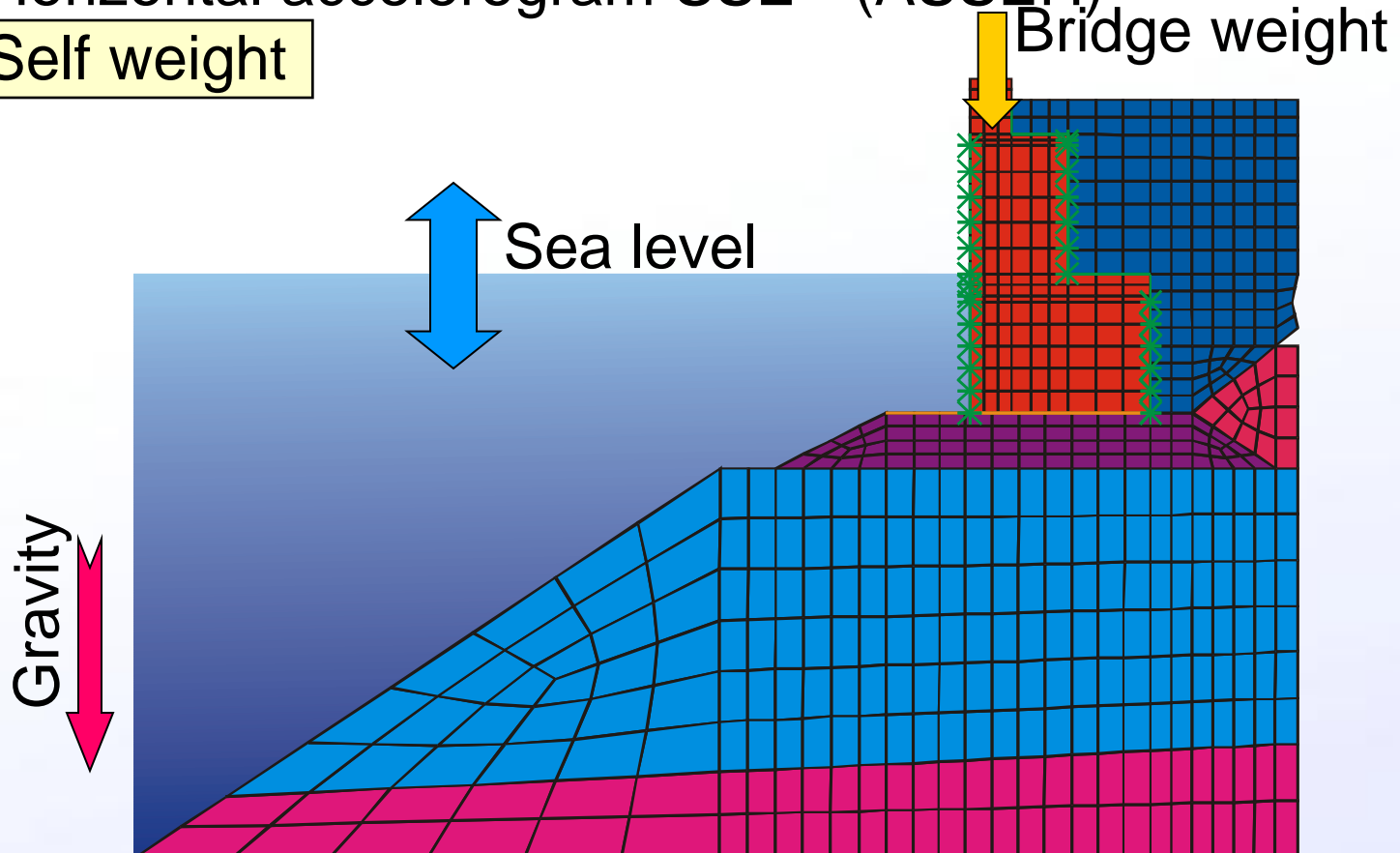
# Applied Loads II

- Vertical accelerogram SSE (ASSEV)
- Horizontal accelerogram SSE (ASSEH)
- Self weight



# Applied Loads III

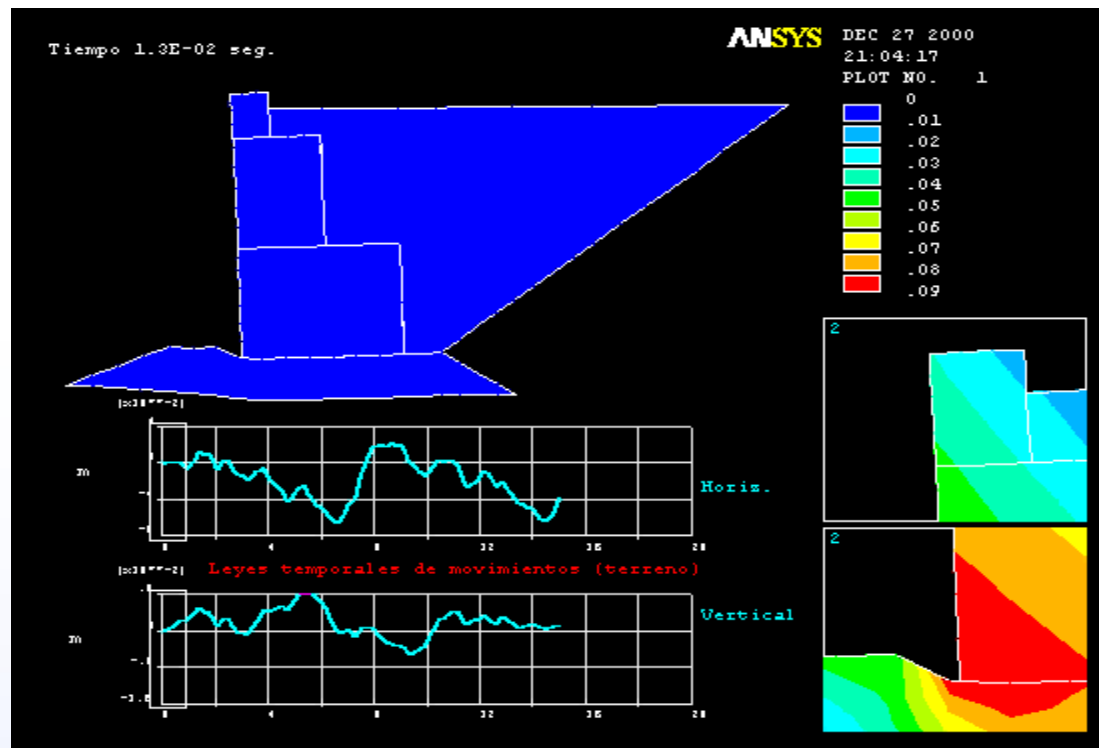
- Vertical accelerogram SSE (ASSEV)
- Horizontal accelerogram SSE (ASSEH)
- Self weight



## Results

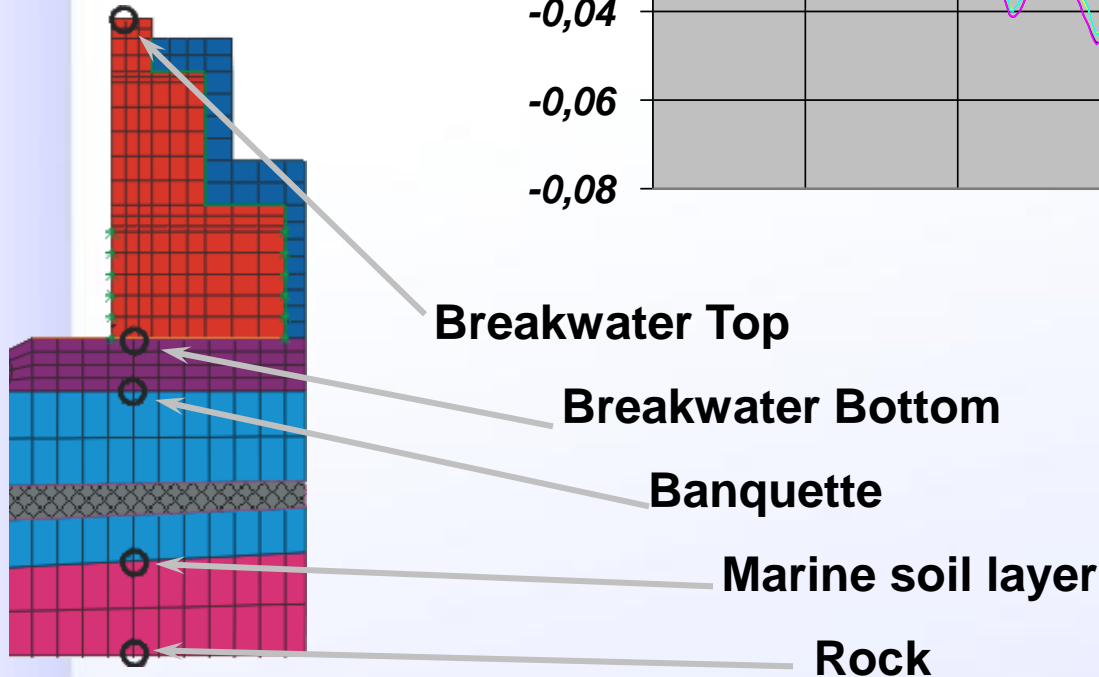
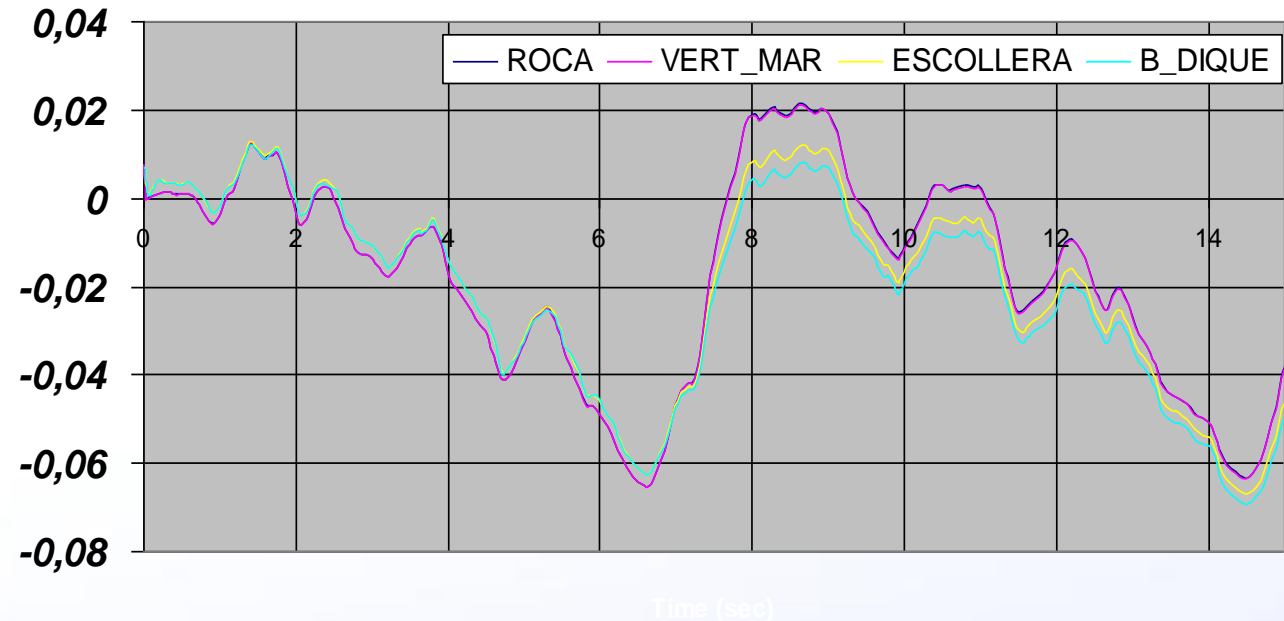
Results  
(displacements)

animation



## Results

*Horizontal Displacements*

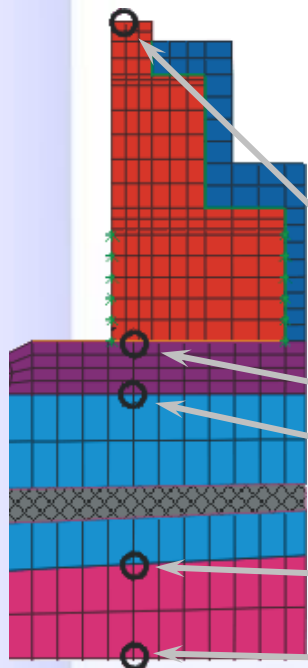
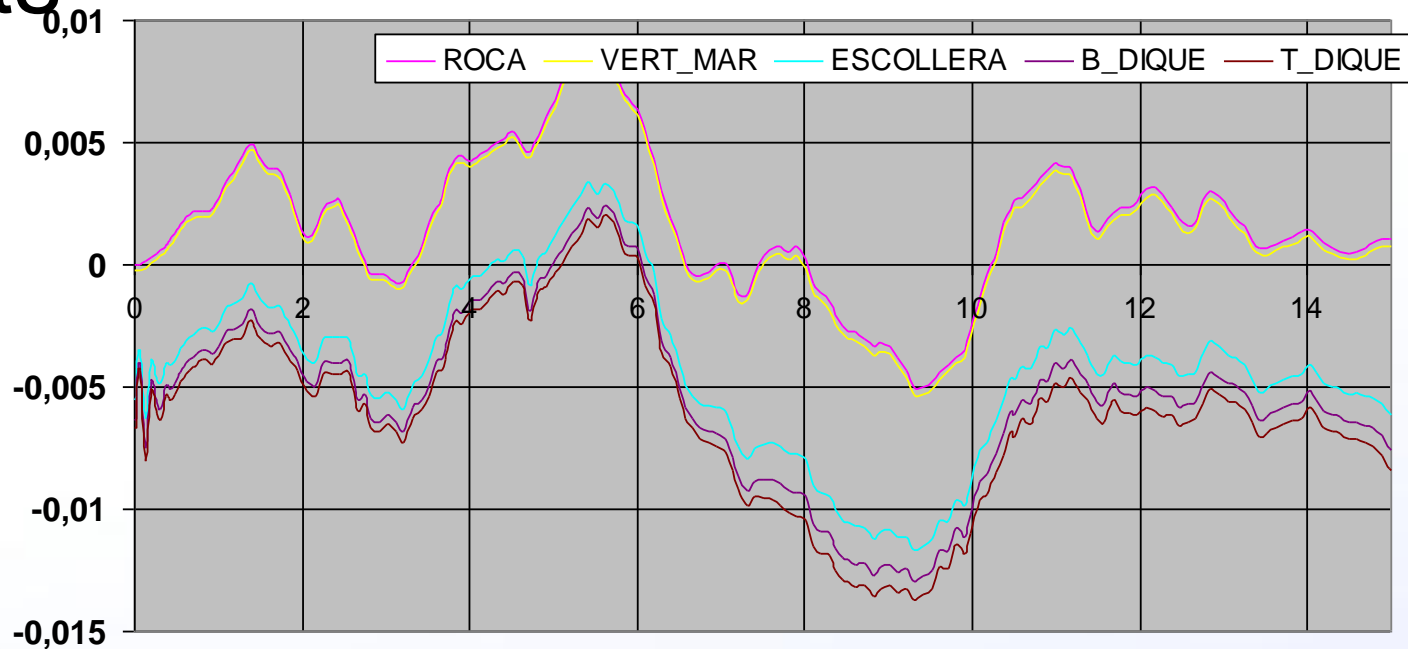


- Obtained horizontal displacements in five representative points of the structure



## Results

*Vertical Displacements*



**Breakwater Top**

**Breakwater Bottom**

**Banquette**

**Marine soil layer**

**Rock**

- Obtained vertical displacements in five representative points of the structure

