



PIANC French Section

PIANC Mediterranean Days and Conference «Port of the future» by Cerema 25 to 27 october 2023 in Sete France

BIM methodology applied to maritime works

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1. Dep. de Engenharia Física, Universidade de Aveiro (UA)

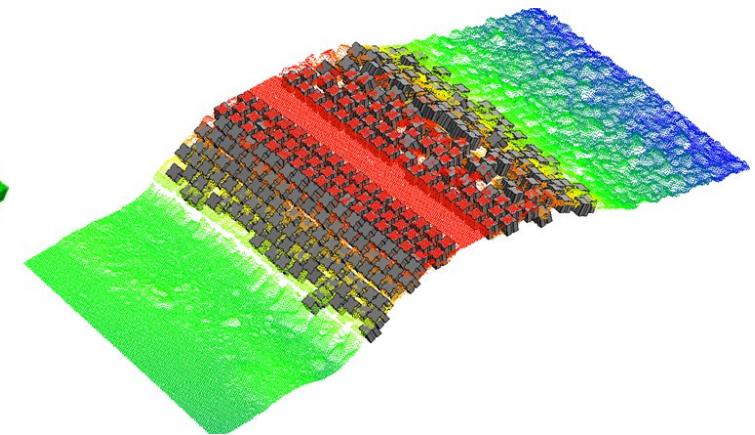
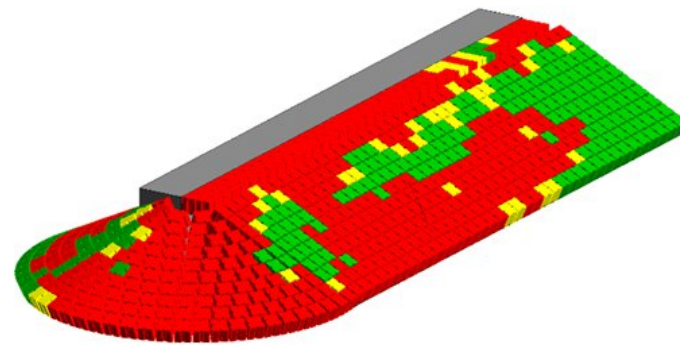
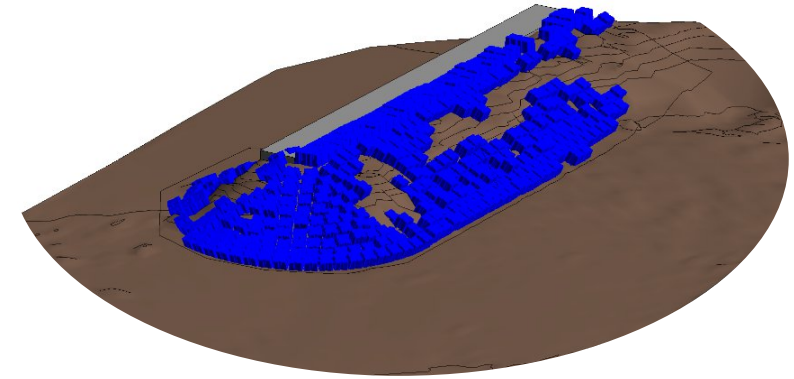
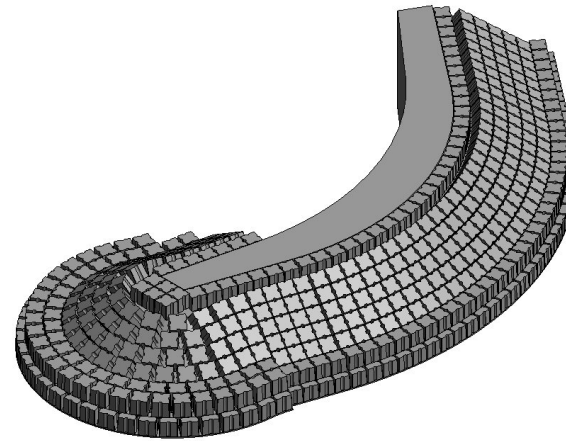
2. R5 Marine Solutions

3. Dep. de Engenharia Civil, Universidade de Aveiro (UA)



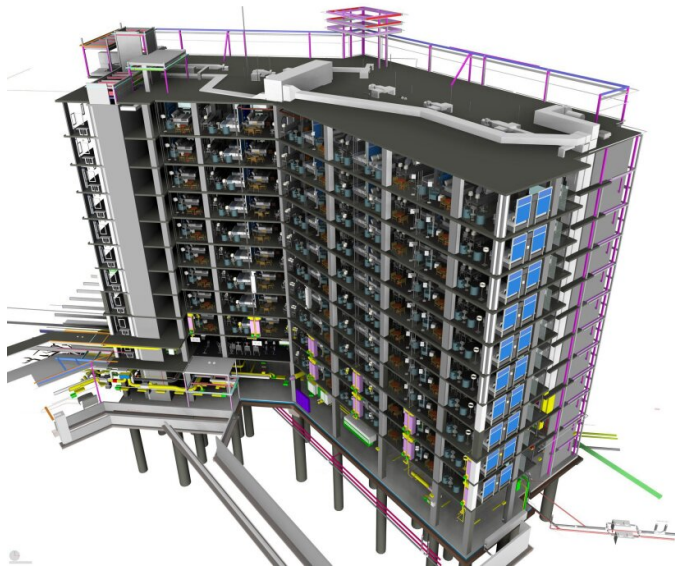
Summary

1. BIM (Building Information Modelling)
2. Family parameterization
3. BIM models in maritime works
4. Building a model of a breakwater
5. Versatility of the model
6. Damage analysis model
7. Work in progress...



1. BIM (Building Information Modelling)

BIM (Building Information Modeling) is a digital representation of the physical and functional characteristics of an object through three-dimensional parametric models, which form a reliable basis for making decisions and helping with design, construction and operation processes.



BIM model of a building with the different project specialties.

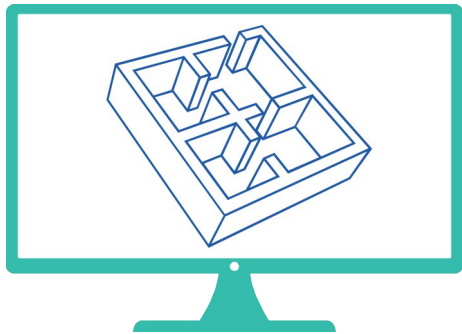


Life cycle of a building, including the use of a BIM model.



1. BIM (Building Information Modeling)

A fundamental and intelligent model-based process for transforming the company and the industry.



It uses 3D models to capture, exploit and maintain consistent and coordinated planning, design and construction data.



Provides a better understanding of the project in terms of costs, deadlines and construction capacity



You use and share the same consistent data, whether you're at your desk or in the field



Enables a rapid response to change with smarter and faster processes

2. Family parameterization



$$V_{antifer}(m^3) = \frac{W(kN)}{\gamma_{betão}(kN/m^3)}$$

$$V = 1.0247H^3$$

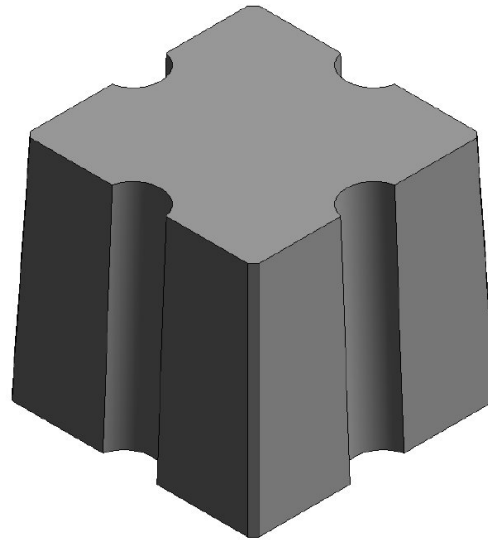
$$A = 1.086H$$

$$B = 1.005H$$

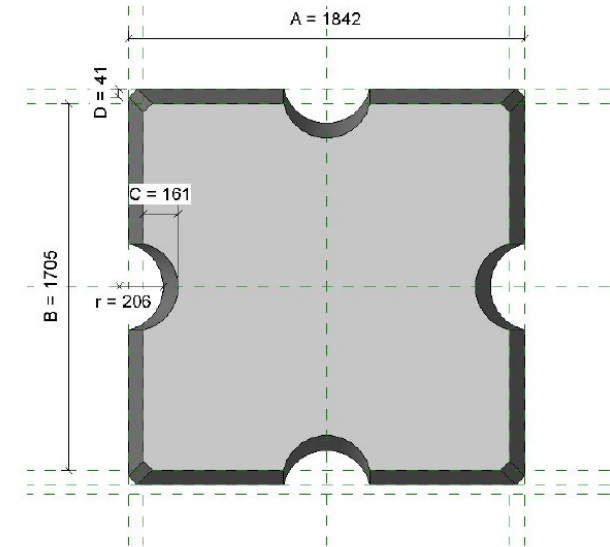
$$C = 0.095H$$

$$D = 0.024H$$

$$r = 0.1215H$$

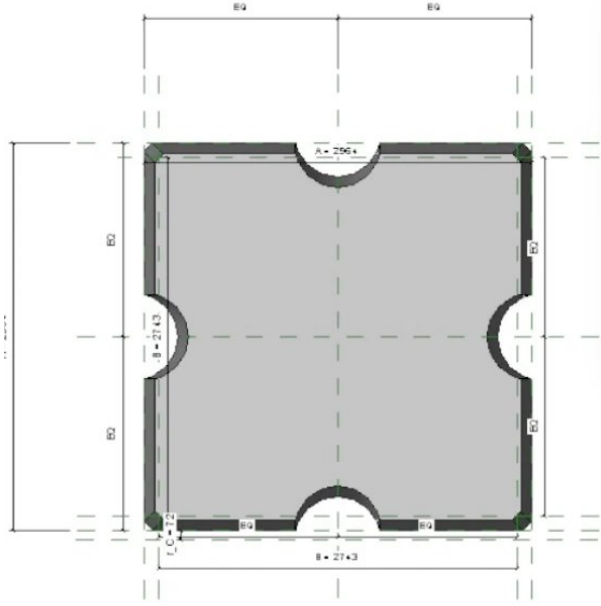


3D parametric model of the Antifer cube.



Top view

fa - Floor Plan: Nível de referência



Family Types

Type name: antfer_global_4

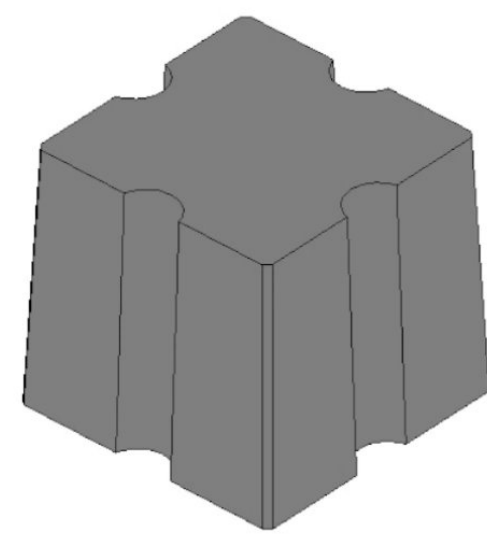
Search parameters

Parameter	Value	Formula	Lock
Constraints			
Default Elevation	1219.2	=	<input type="checkbox"/>
Dimensions			
H	2729.3	$= (V / 1.0247) ^ (1 / 3)$	<input checked="" type="checkbox"/>
A	2964.0	$= 1.086 * H$	<input checked="" type="checkbox"/>
B	2743.0	$= 1.005 * H$	<input checked="" type="checkbox"/>
C	259.3	$= 0.095 * H$	<input checked="" type="checkbox"/>
D	65.5	$= 0.024 * H$	<input checked="" type="checkbox"/>
r	331.6	$= 0.1215 * H$	<input checked="" type="checkbox"/>
r_C	72.3	$= -C + r$	<input checked="" type="checkbox"/>
IFC Parameters			
Type IFC Predefined Type		=	
Export Type to IFC As		=	
General			
V	20.833	$= W / (g / 1 m^3)$	
W	500.000000	=	
g	24.000000	=	
Identity Data			

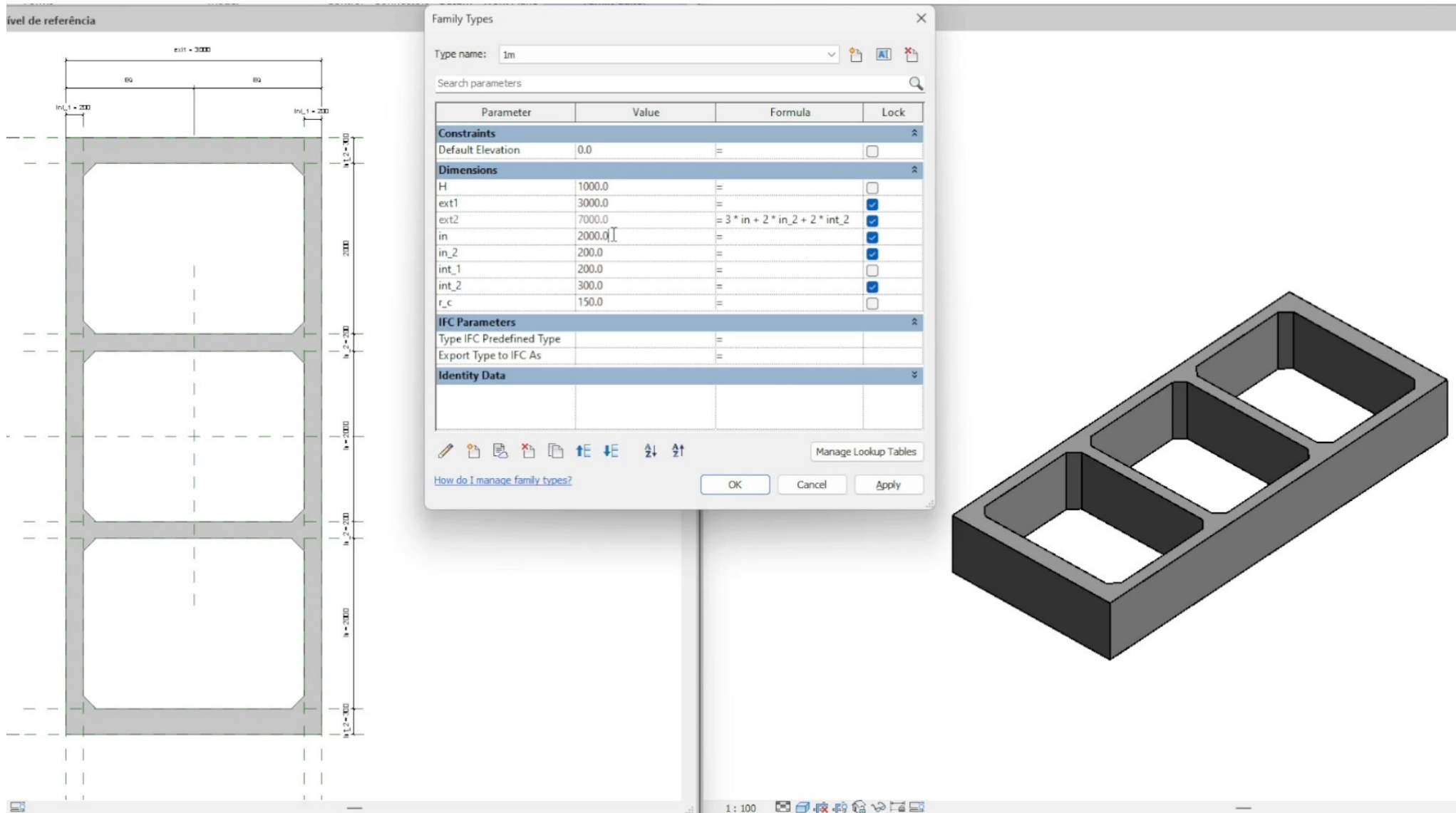
Manage Lookup Tables

How do I manage family types?

OK Cancel Apply



1 : 100



Family Types

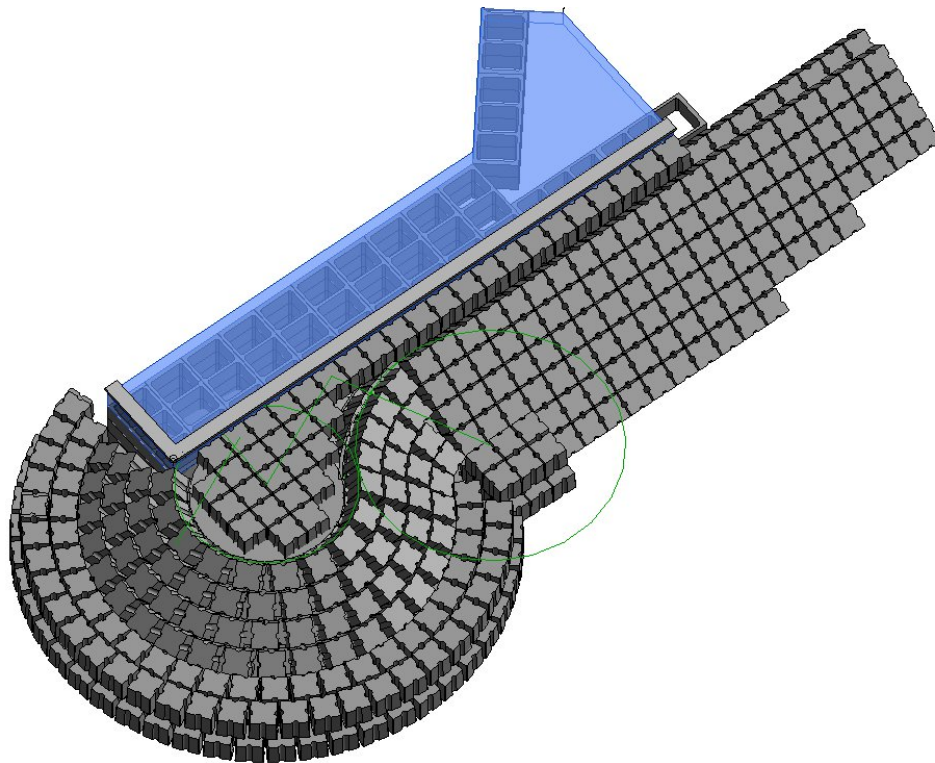
Type name: 1m

Search parameters

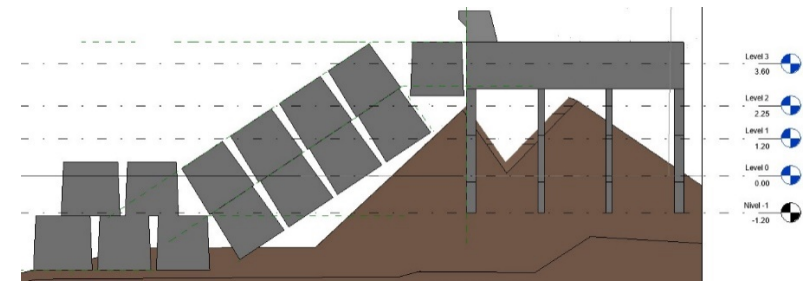
Parameter	Value	Formula	Lock
Constraints			
Default Elevation	0.0	=	<input type="checkbox"/>
Dimensions			
H	1000.0	=	<input type="checkbox"/>
ext1	3000.0	=	<input checked="" type="checkbox"/>
ext2	7000.0	= 3 * in + 2 * in_2 + 2 * int_2	<input checked="" type="checkbox"/>
in	2000.0	=	<input checked="" type="checkbox"/>
in_2	200.0	=	<input checked="" type="checkbox"/>
int_1	200.0	=	<input type="checkbox"/>
int_2	300.0	=	<input checked="" type="checkbox"/>
r_c	150.0	=	<input type="checkbox"/>
IFC Parameters			
Type IFC Predefined Type	=		
Export Type to IFC As	=		
Identity Data			

How do I manage family types?

3. BIM models in maritime works

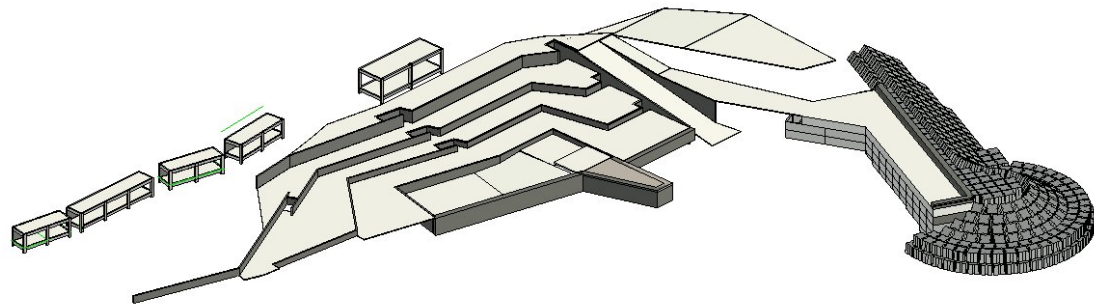


BIM model of a breakwater - resistant mantle with Antifer blocks and core made of concrete staves.

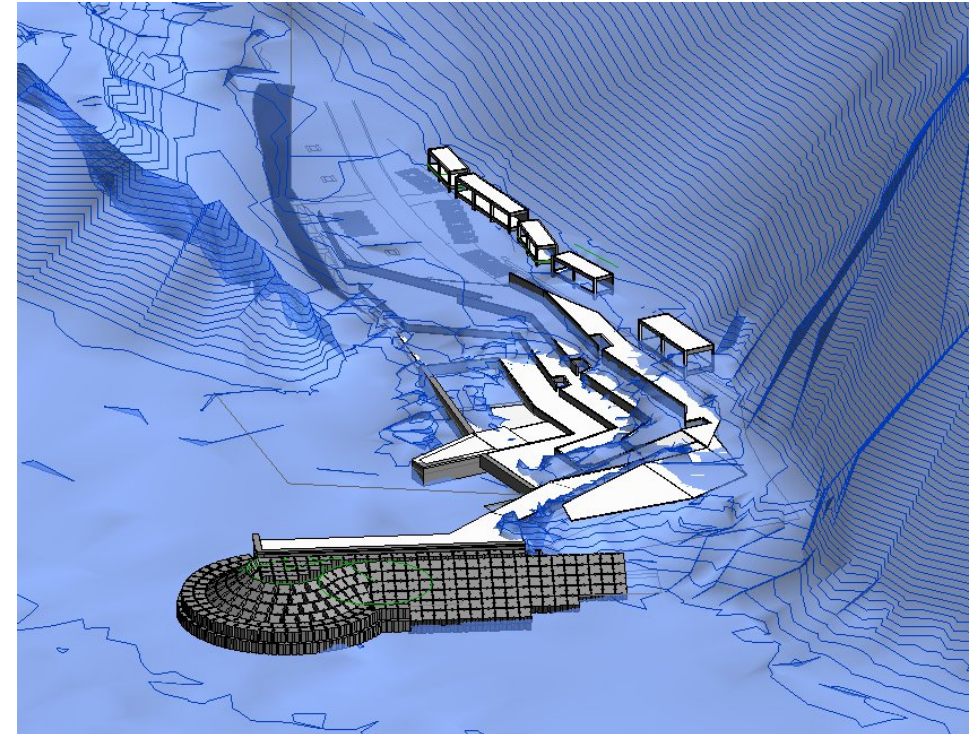


Example of view section and levels in the model..

3. BIM models in maritime works

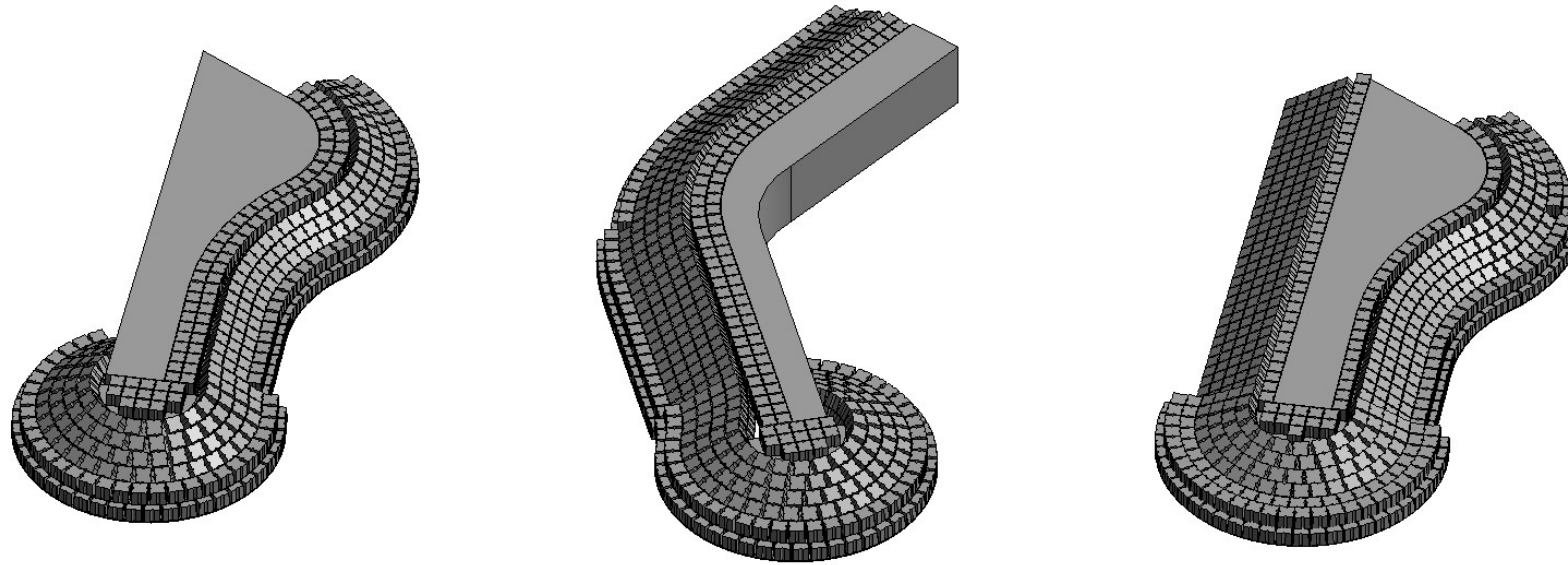


Modelling of other elements in Revit.



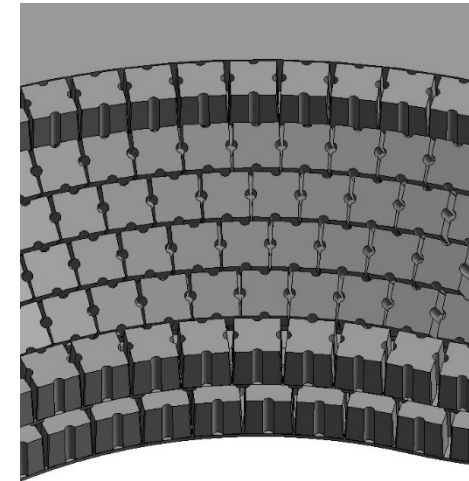
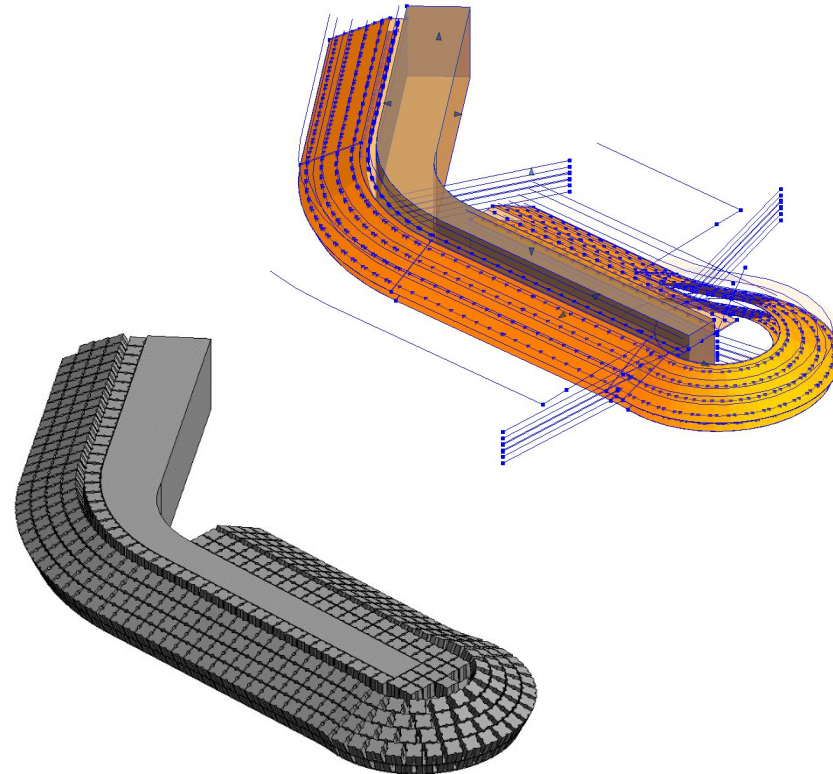
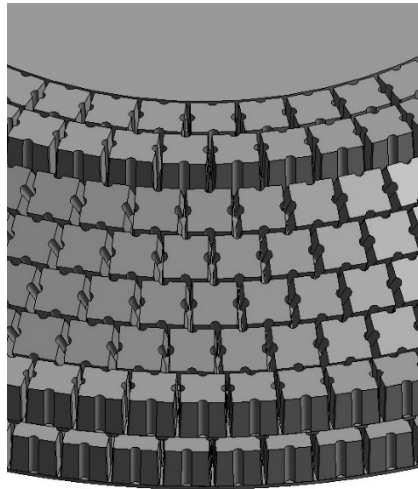
Final model with the existant topography.

4. Building a model of a breakwater



4. Building a model of a breakwater

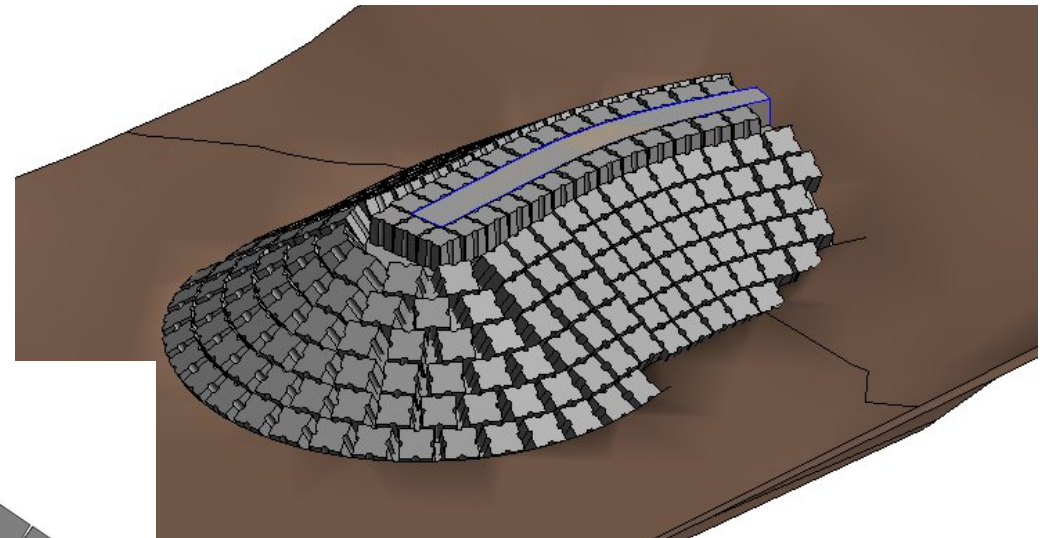
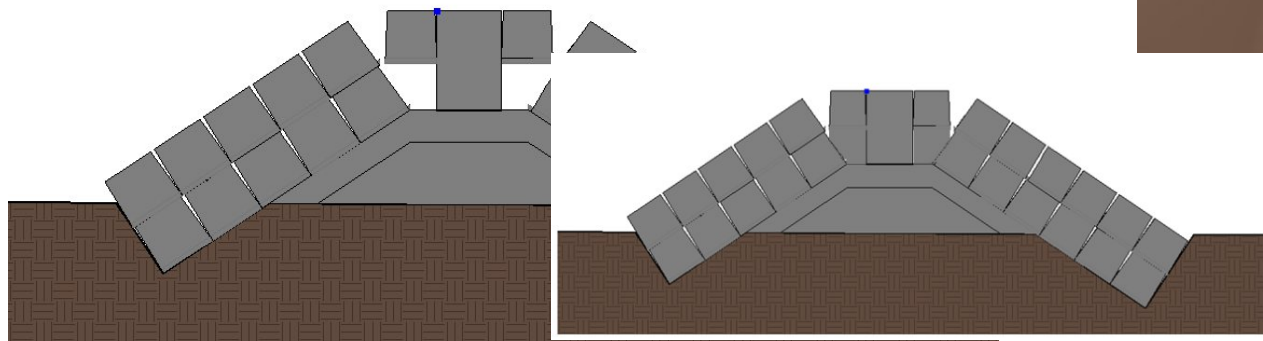
Calculation and distribution of Antifer blocks.



4. Building a model of a breakwater

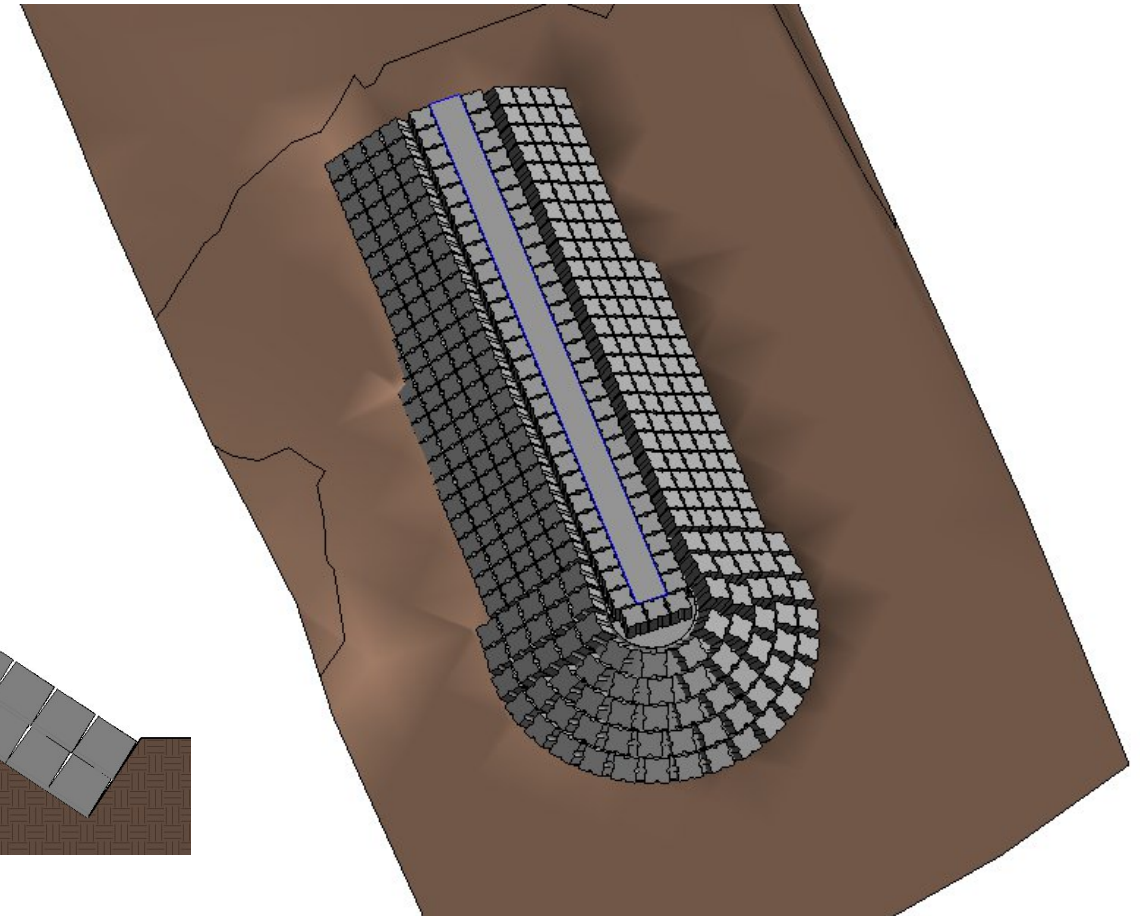
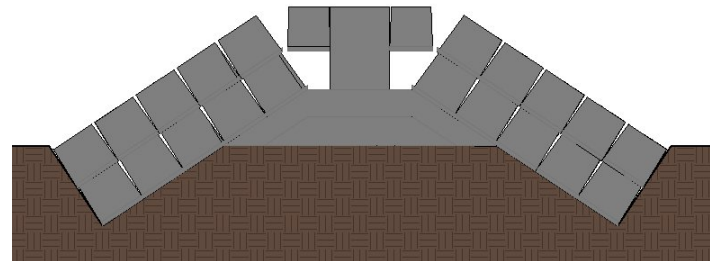
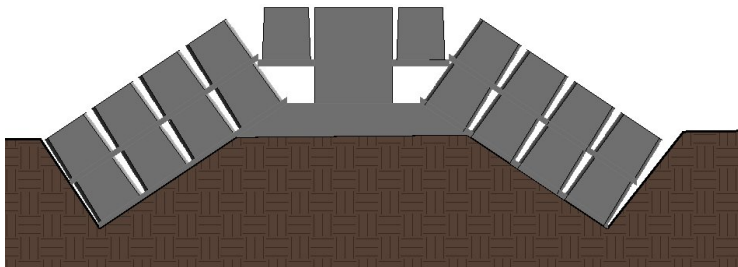
Calculation and adjustment of the model to the existing topography

Elemento	Quant.	Volume (m ³)	W (kN)
antifer_global - Tronco	283	3,202	80
antifer_global_1 - Cabeça	142	4,803	120
Topography (CUT)	1	578,588	
Camada 1 (Sub-manto)	1	233,773	
Camada 2 (Núcleo)	1	134,208	



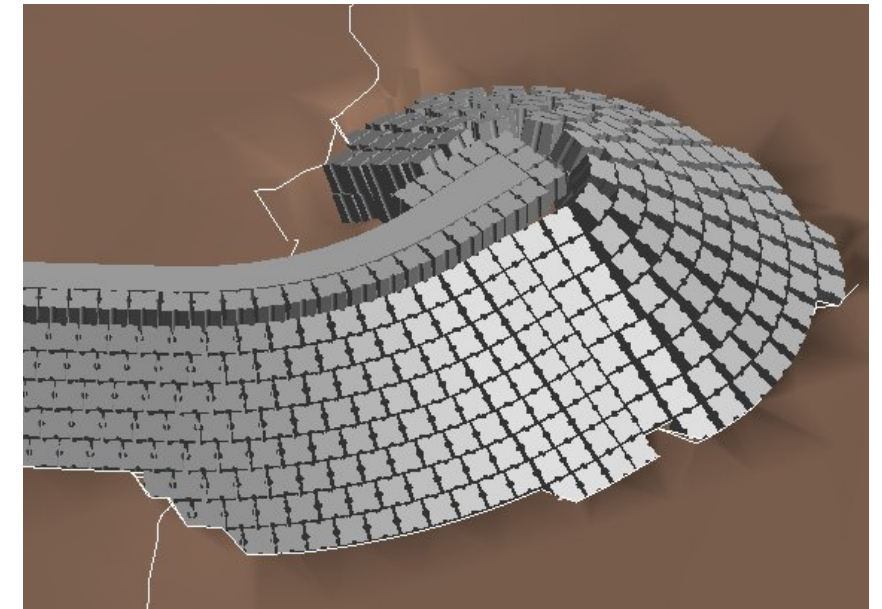
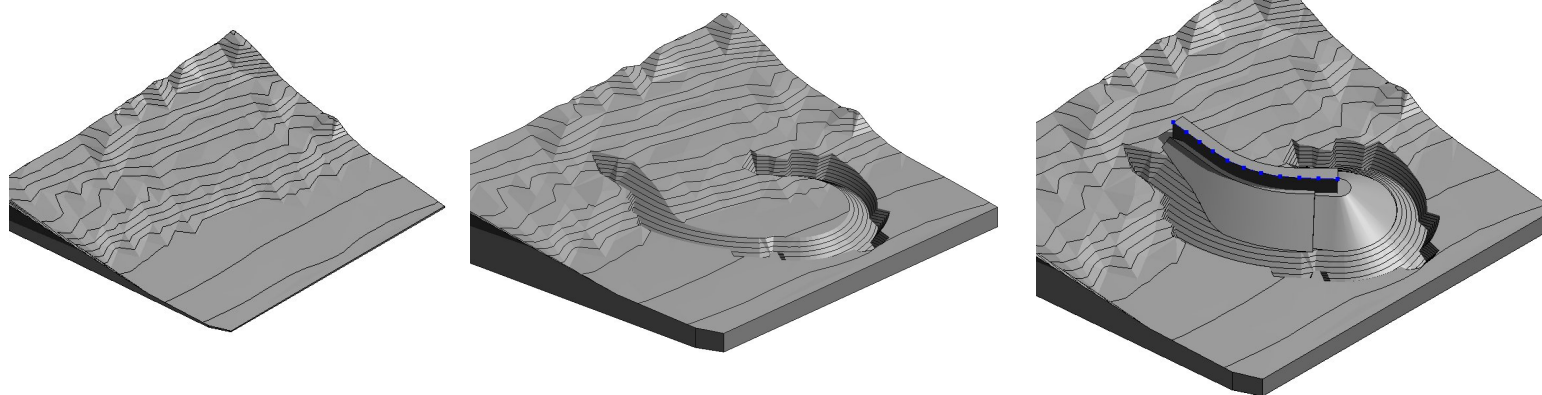
4. Building a model of a breakwater

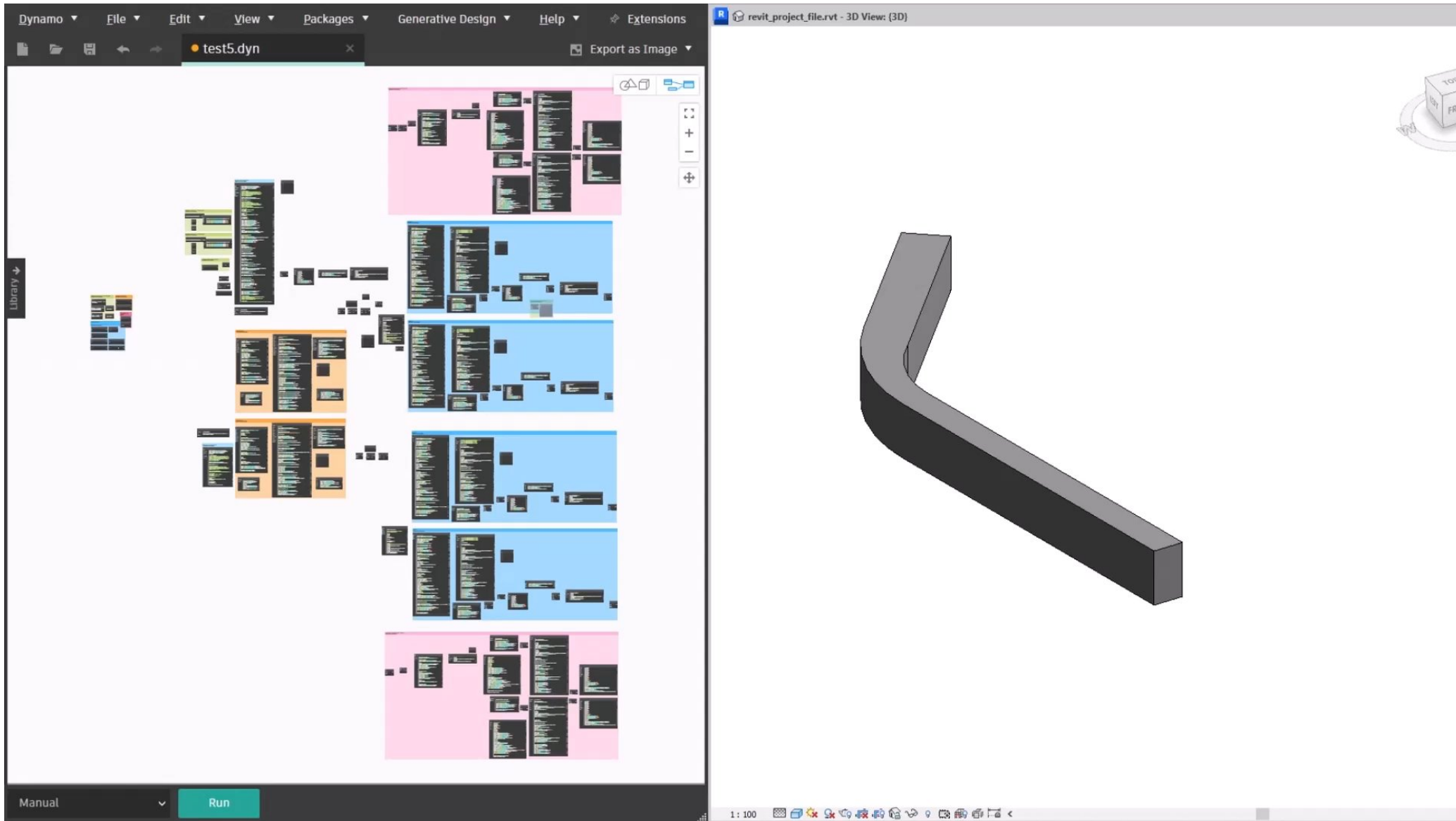
Elemento	Quant.	Volume (m ³)	W (kN)
antifer_global - Tronco	479	3,202	80
antifer_global_1 - Cabeça	142	4,803	120
Topography (CUT)	1	855,450	
Camada 1 (Sub-manto)	1	320,048	
Camada 2 (Núcleo)	1	141,289	

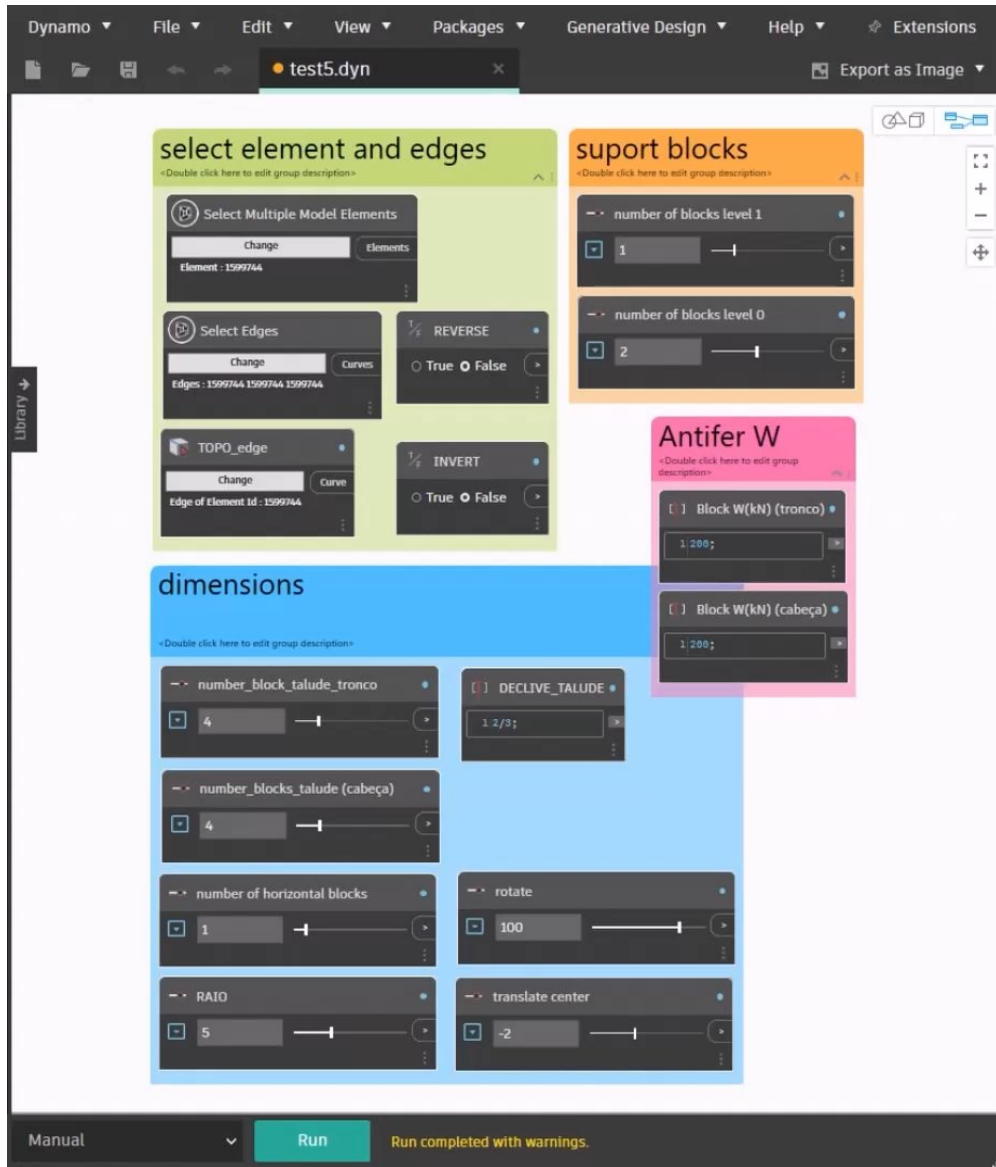


4. Building a model of a breakwater

Name	Quant.	Volume	W (kN)
antifer_global - Tronco	333	3,202	80
antifer_global_1 - Cabeça	240	4,803	120
Topography (CUT)	1	733,900	
Camada 1 (Sub-manto)	1	406,634	
Camada 2 (Sub-manto)	1	306,486	
Camada 3 (Núcleo)	1	367,794	



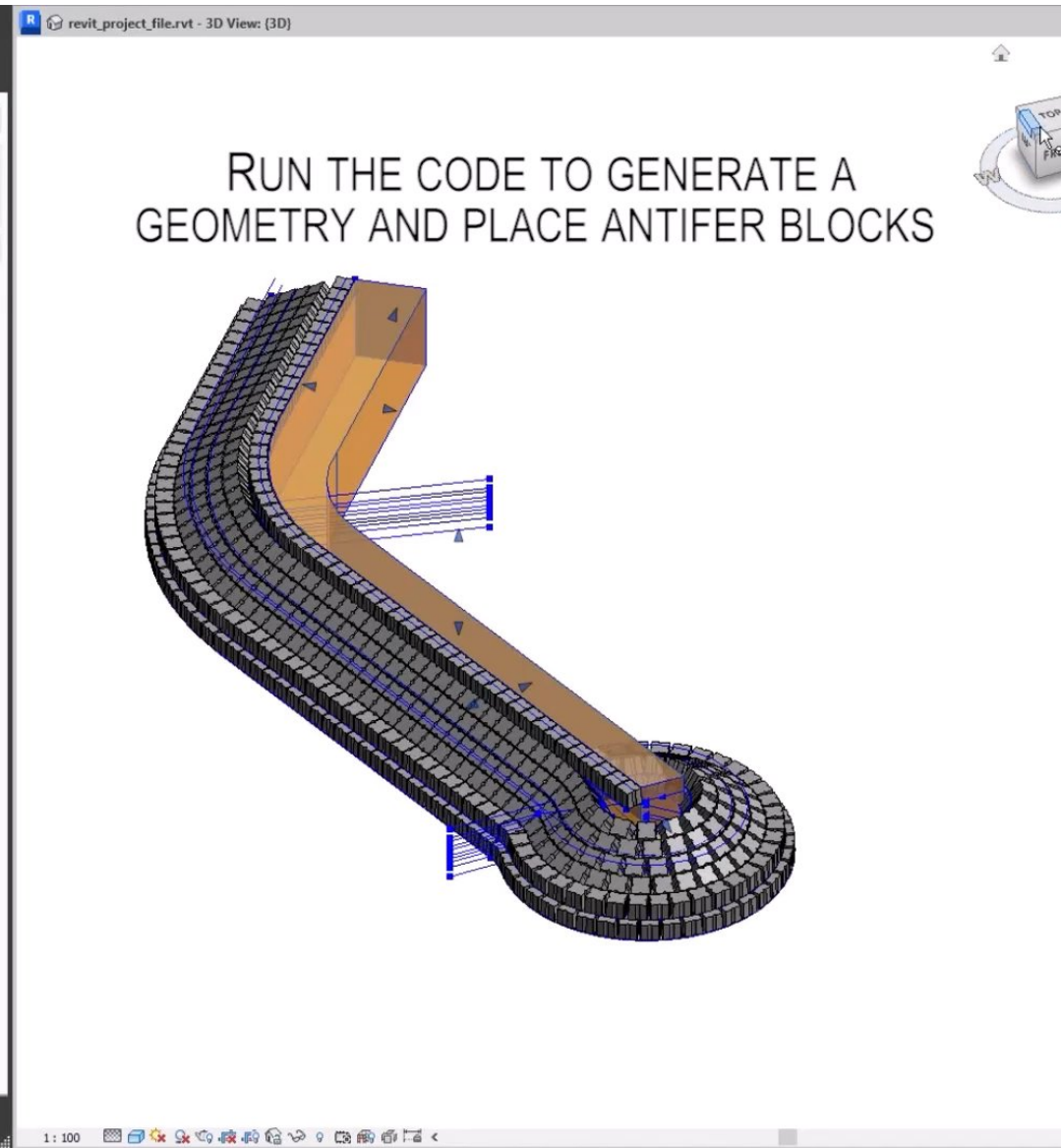




The screenshot shows the Dynamo software interface with the following components:

- select element and edges** (green panel):
 - Select Multiple Model Elements: Element: 1599744
 - Select Edges: Edges: 1599744 1599744 1599744
 - TOPO_edge: Edge of Element Id: 1599744
- suport blocks** (orange panel):
 - number of blocks level 1: 1
 - number of blocks level 0: 2
- Antifer W** (pink panel):
 - Block W(kN) (tronco): 1.200
 - Block W(kN) (cabeça): 1.200
- dimensions** (blue panel):
 - number_block_talude_tronco: 4
 - DECLIVE_TALUDE: 1.2/3
 - number_blocks_talude (cabeça): 4
 - number of horizontal blocks: 1
 - rotate: 100
 - RAIO: 5
 - translate center: -2

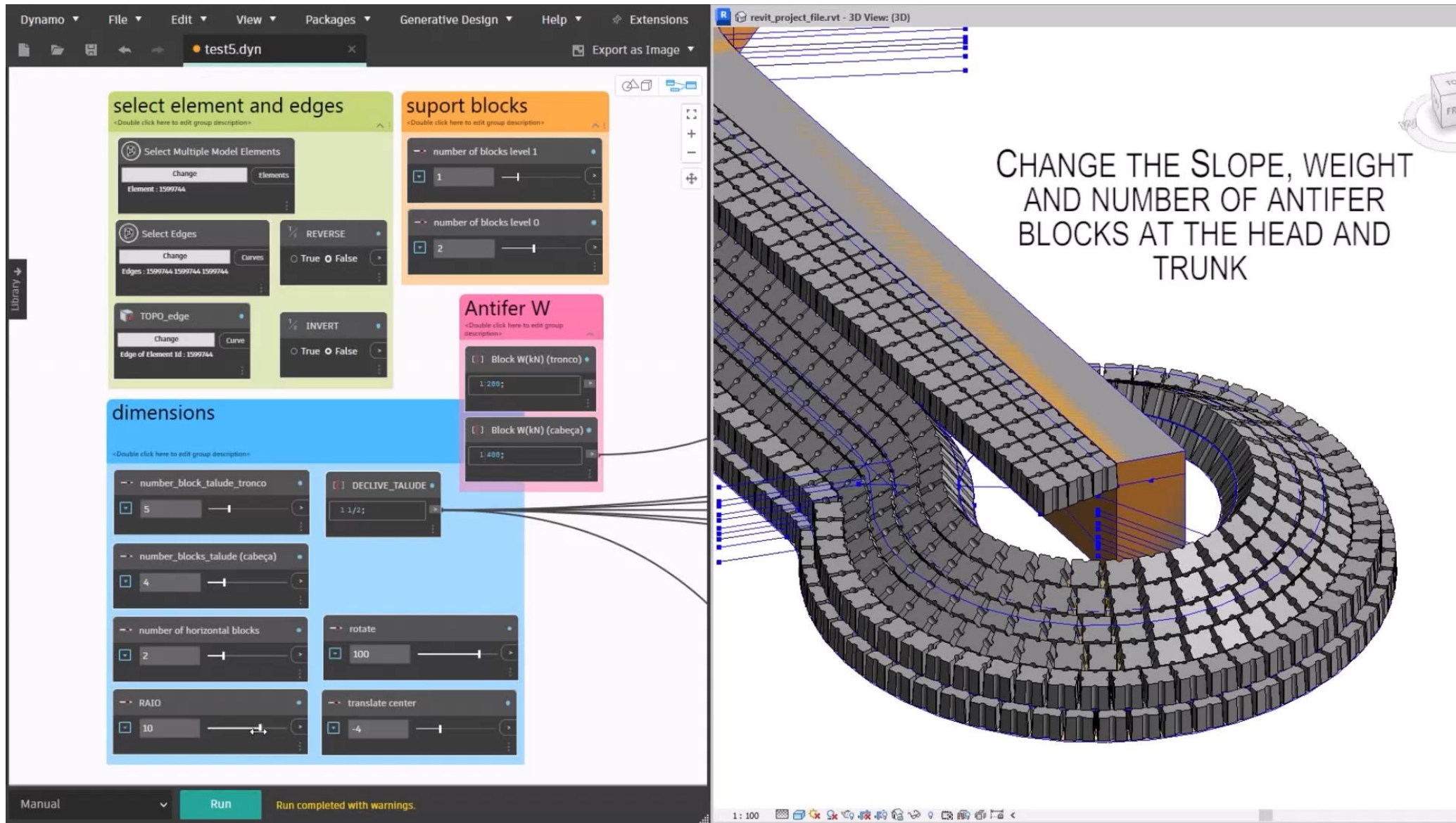
At the bottom, a **Run** button is visible, with a status message: **Run completed with warnings.**



revit_project_file.rvt - 3D View: (3D)

RUN THE CODE TO GENERATE A GEOMETRY AND PLACE ANTIFER BLOCKS

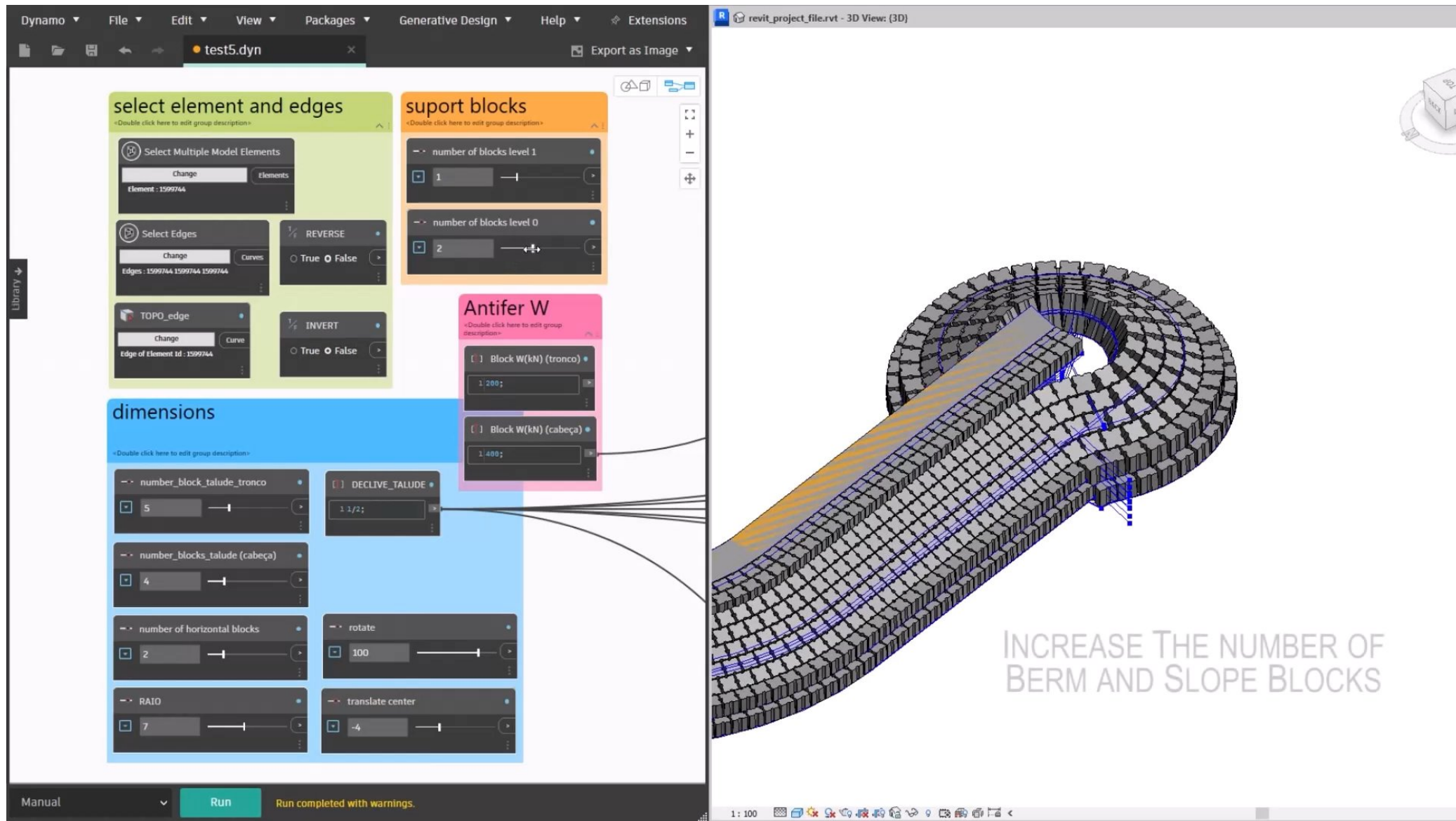
The 3D model shows a curved structure with a grid of blocks. A central channel is formed by the blocks, and a curved ramp or structure is visible on the right side. The blocks are arranged in a pattern that follows the curve of the structure.



The image displays a screenshot of a Dynamo script interface for Revit, showing a 3D model of a curved structure (likely a ship's hull or a large pipe) composed of many small, rectangular blocks. The interface includes several panels:

- select element and edges:** Contains nodes for selecting multiple model elements, edges, and topological edges, along with options to reverse or invert the selection.
- suport blocks:** Contains nodes for defining the number of blocks at different levels (level 1 and level 0).
- Antifer W:** Contains nodes for defining the weight of blocks at the trunk and the head.
- dimensions:** Contains nodes for defining various dimensions, including the number of blocks, the slope (DECLIVE_TALUDE), the number of horizontal blocks, the radius (RAIO), and the rotation and translation of the center.

A text overlay on the right side of the image reads: "CHANGE THE SLOPE, WEIGHT AND NUMBER OF ANTIFER BLOCKS AT THE HEAD AND TRUNK".

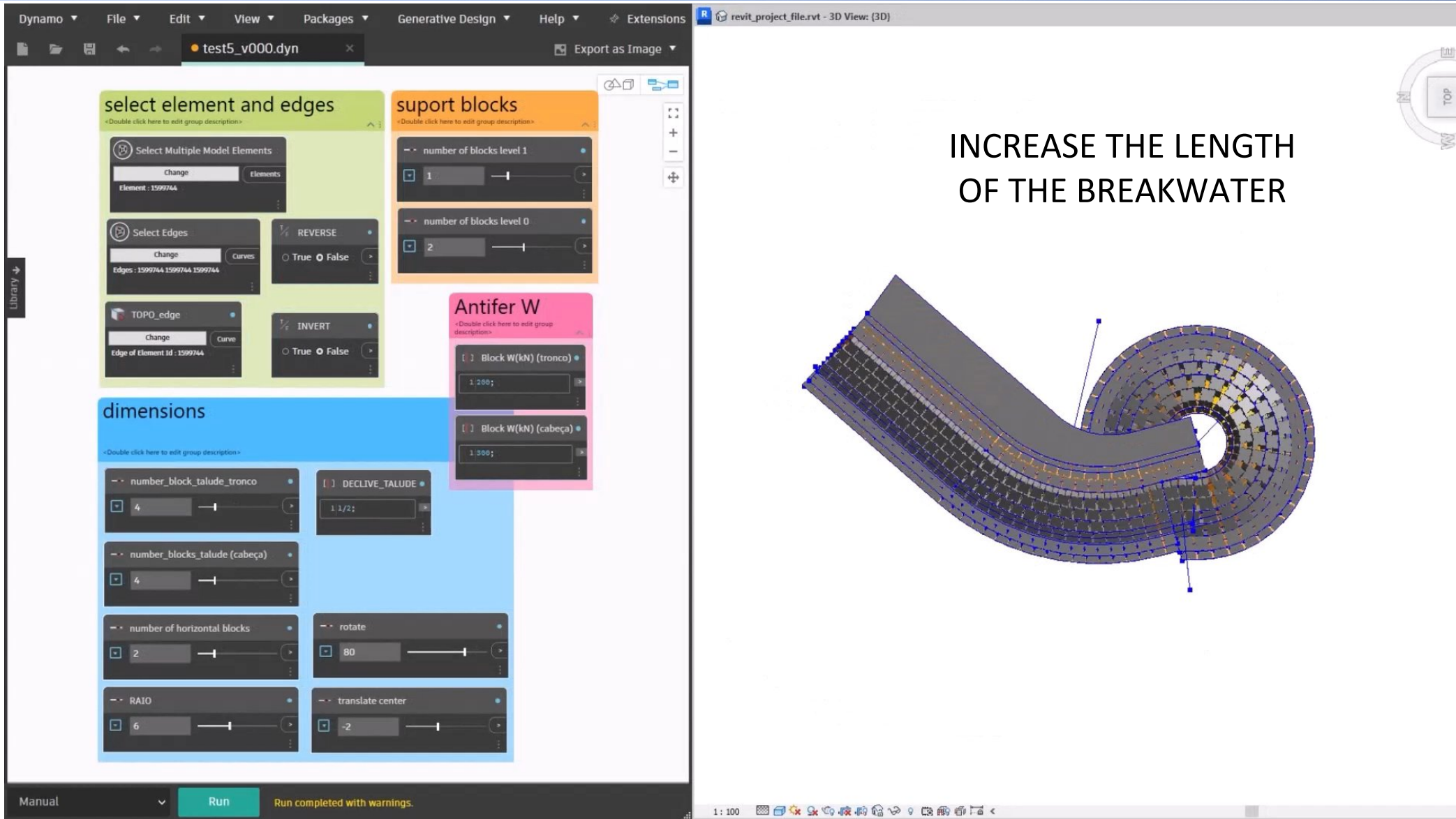


The image displays a screenshot of a Dynamo script interface for Revit, showing a 3D model of a stone structure (likely a breakwater or pier) and various script nodes used to generate it. The interface includes a menu bar (Dynamo, File, Edit, View, Packages, Generative Design, Help, Extensions) and a toolbar. The script is titled "test5.dyn".

The script nodes are organized into several groups:

- select element and edges** (green group):
 - Select Multiple Model Elements (Element: 1599744)
 - Select Edges (Edges: 1599744, 1599744, 1599744)
 - TOPO_edge (Edge of Element Id: 1599744)
- suport blocks** (orange group):
 - number of blocks level 1 (value: 1)
 - number of blocks level 0 (value: 2)
- Antifer W** (pink group):
 - Block W(kN) (tronco) (value: 1,200)
 - Block W(kN) (cabeça) (value: 1,400)
- dimensions** (blue group):
 - number_block_talude_tronco (value: 5)
 - DECLIVE_TALUDE (value: 1 1/2)
 - number_blocks_talude (cabeça) (value: 4)
 - number of horizontal blocks (value: 2)
 - rotate (value: 100)
 - RAIO (value: 7)
 - translate center (value: -4)

The 3D model shows a complex stone structure with a curved top and a long, straight section. The structure is composed of many small, rectangular blocks. The text "INCREASE THE NUMBER OF BERM AND SLOPE BLOCKS" is overlaid on the model.



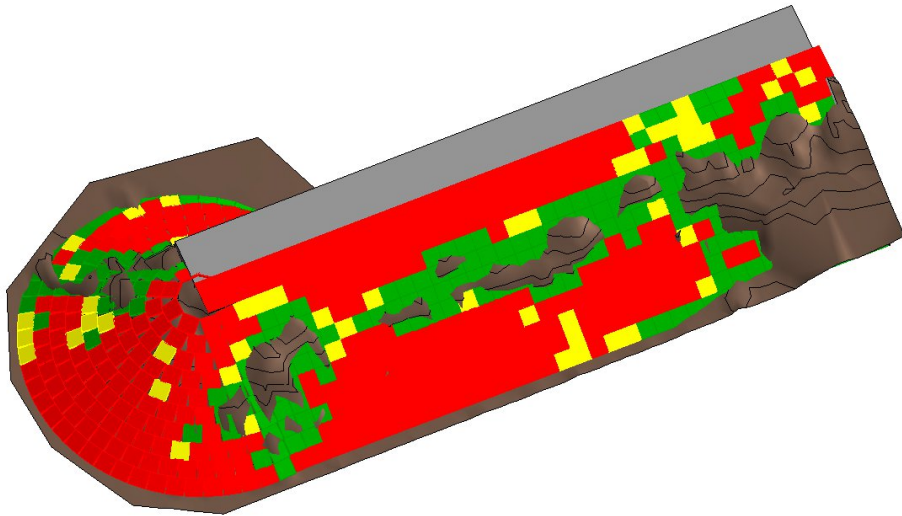
The image displays a screenshot of a Dynamo script interface for Revit, used for parametric modeling of a breakwater structure. The interface is divided into several functional areas:

- select element and edges:** Contains nodes for selecting model elements and edges, with options for reversing and inverting the selection.
- support blocks:** Includes sliders for the number of blocks at different levels (level 1 and level 0).
- Antifer W:** A pink node defining block weights for 'tronco' (1.200) and 'cabeça' (1.300).
- dimensions:** A large blue node containing various parameters such as 'number_block_talude_tronco' (4), 'DECLIVE_TALUDE' (1 1/2), 'number_blocks_talude (cabeça)' (4), 'number of horizontal blocks' (2), 'rotate' (80), 'RAIO' (6), and 'translate center' (-2).

On the right side, a 3D model of the breakwater is shown, illustrating the output of the script. The text **INCREASE THE LENGTH OF THE BREAKWATER** is overlaid on the model, indicating the goal of the parametric study. A 'TOP' view button is visible in the upper right corner of the 3D view.

6. Damage analysis model

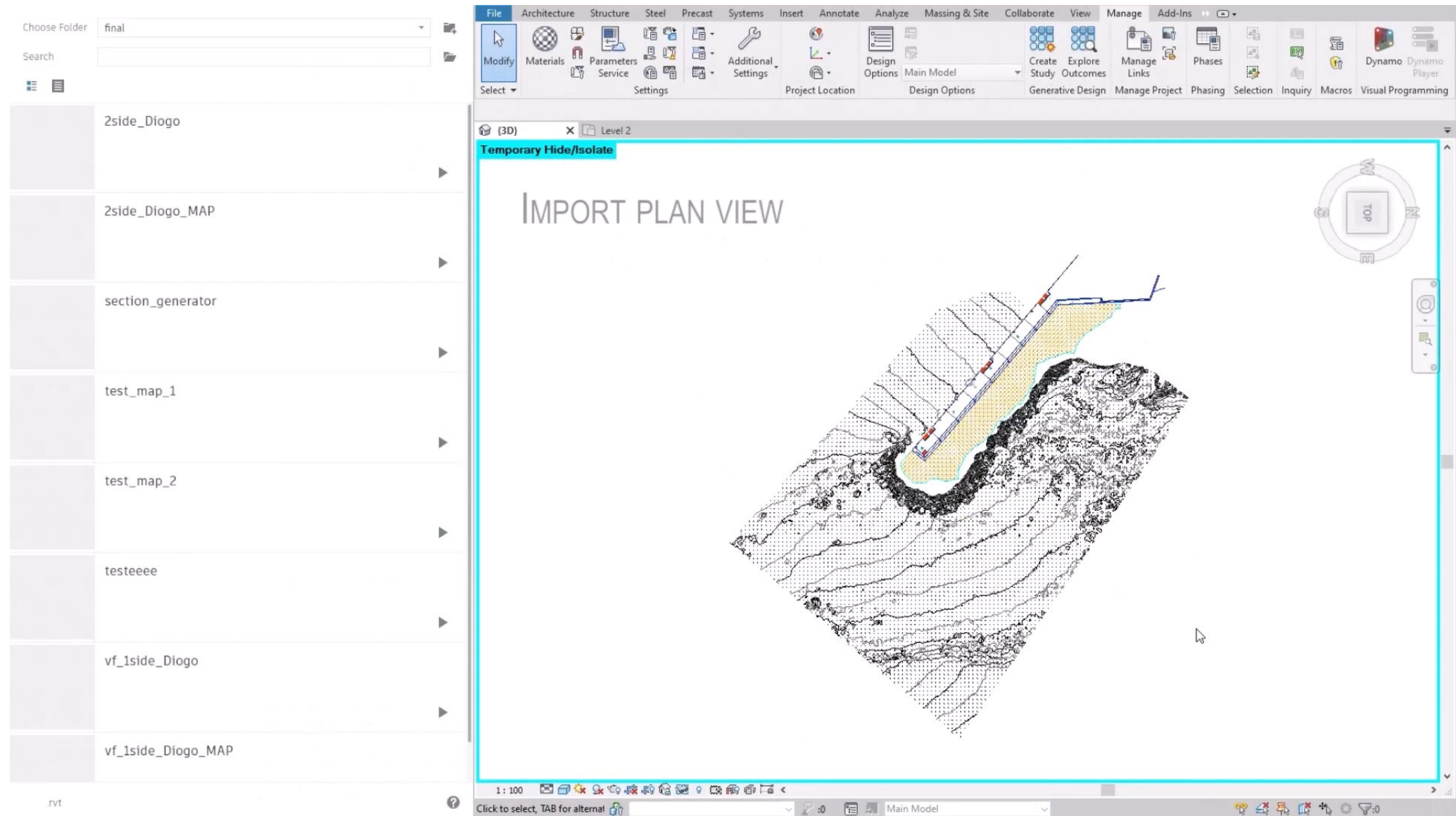
Over time, through maritime agitation or even more adverse events such as storms, the damage to coastal structures needs to be surveyed and assessed.



Damage map calculated with Dynamo.



Destroyed breakwater in Flores, Azores.



vf_1side_Diogo

.TOPO_edge
Total Elements: 4
Show Elements

berm 0_head 0 | 5 0

berm 0_trunk 0 | 5 0

berm 1_head 0 | 5 0

berm 1_trunk 0 | 5 0

Block W(kN) (head) 400

Block W(kN) (trunk) 400

Family Types bloco_antiferes_globalNS:antifer_...

Family Types bloco_antiferes_globalNS:antifer_...

g betão 25

number of horizontal blocks 0 | 10 2

number_block_talude_trunk 0 | 20 10

number_blocks_talude_head 0 | 20 10

RAIO 0 | 15 3.5

rotate -180 | 180 -80

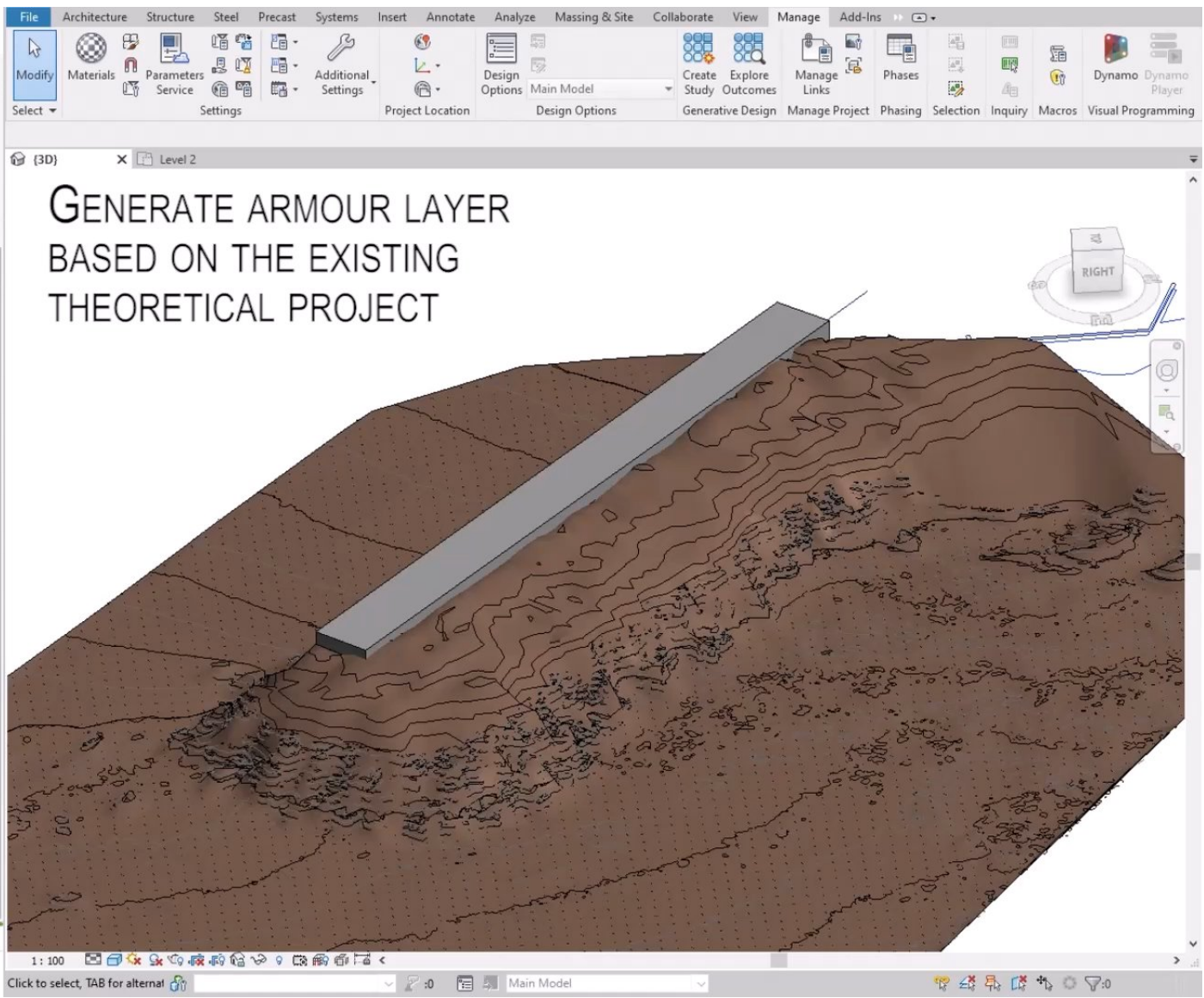
SLOPE 1/2

translate center -10 | 10 -6

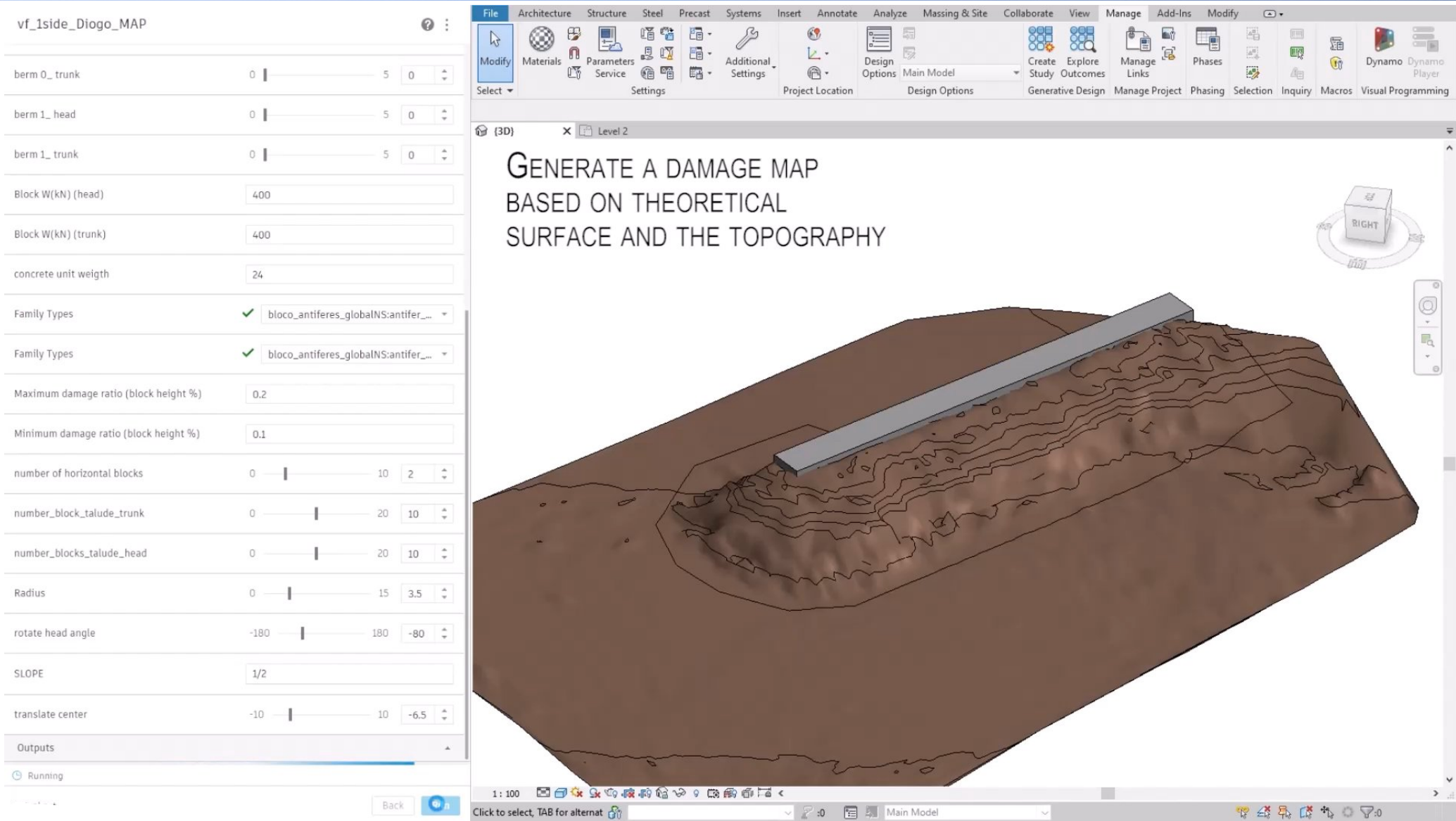
Outputs

Ready to run

Back Run



GENERATE ARMOUR LAYER
BASED ON THE EXISTING
THEORETICAL PROJECT



vf_1side_Diogo_MAP

berm 0_trunk	0	5	0
berm 1_head	0	5	0
berm 1_trunk	0	5	0
Block W(kN) (head)	400		
Block W(kN) (trunk)	400		
concrete unit weight	24		
Family Types	✓ bloco_antiferes_globalNS:antifer_...		
Family Types	✓ bloco_antiferes_globalNS:antifer_...		
Maximum damage ratio (block height %)	0.2		
Minimum damage ratio (block height %)	0.1		
number of horizontal blocks	0	10	2
number_block_talude_trunk	0	20	10
number_blocks_talude_head	0	20	10
Radius	0	15	3.5
rotate head angle	-180	180	-80
SLOPE	1/2		
translate center	-10	10	-6.5

Outputs

Running

Back

1 : 100

Click to select, TAB for alternat

Main Model

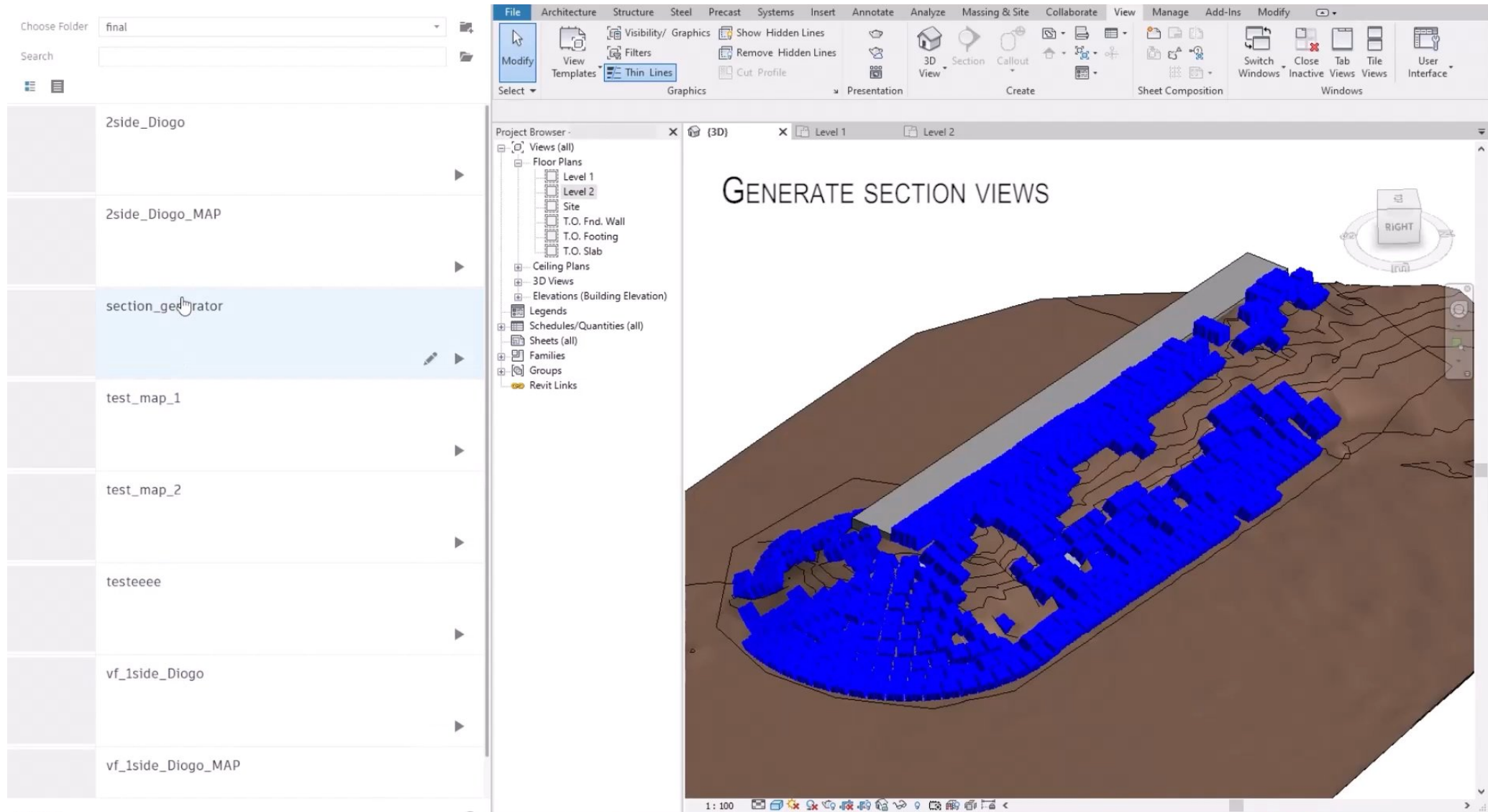
GENERATE A DAMAGE MAP BASED ON THEORETICAL SURFACE AND THE TOPOGRAPHY

RIGHT

vf_1side_Diogo_MAP

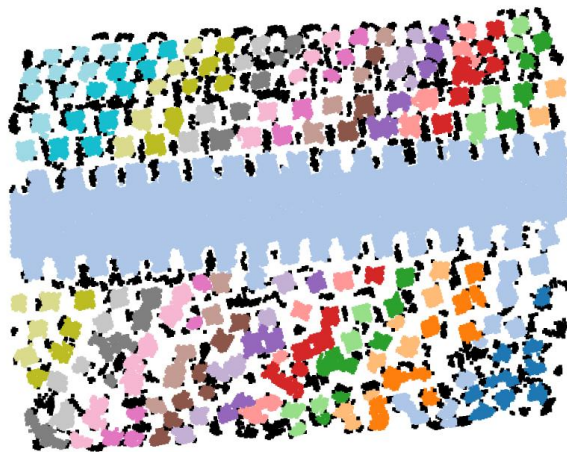
berm 0_ trunk	0	5	0
berm 1_ head	0	5	0
berm 1_ trunk	0	5	0
Block W(kN) (head)	400		
Block W(kN) (trunk)	400		
Family Types	<input checked="" type="checkbox"/> bloco_antiferes_globalNS:antifer_global_1		
Family Types	<input checked="" type="checkbox"/> bloco_antiferes_globalNS:antifer_global		
fator1	0.1		
fator2	0.2		
g betão	25		
number of horizontal blocks	0	10	2
number_block_talude_trunk	0	20	10
number_blocks_talude_head	0	20	10
RAIO	0	15	3.5
rotate	-180	180	-80
SLOPE	1/2		
translate center	-10	10	-6.5
Outputs			
<input checked="" type="checkbox"/> Ready to run			

Back Run

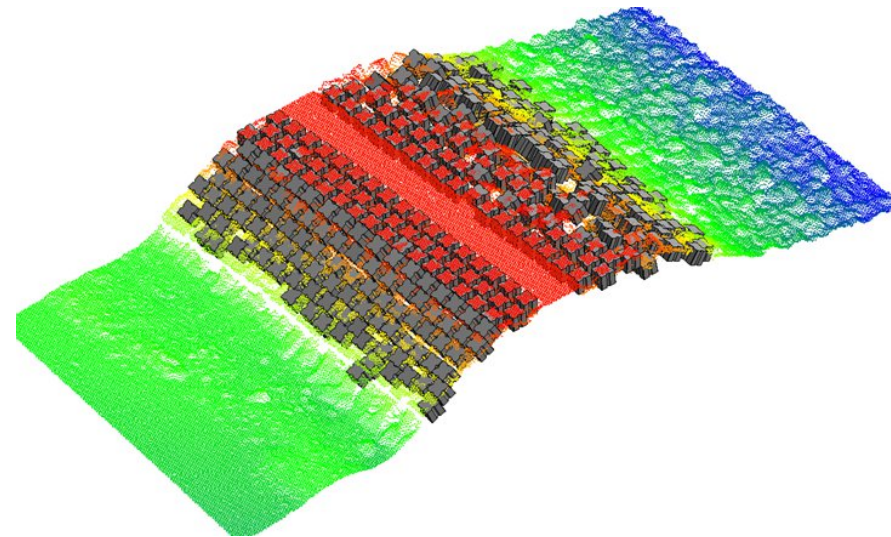


7. Work in progress ...

Reconstruction of BIM models based on point clouds through the recognition of Antifer blocks.



Point cloud pre-processing in Python.



BIM model of the existing structure.



Cloud of colored points (Google Earth).



THANK YOU FOR YOUR ATTENTION!

Diogo Oliveira

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www.r5engineers.com/marine



universidade de aveiro

