



[www.jetsj.pt](http://www.jetsj.pt)


# CASE STUDY: BIM AND GEOTECHNICAL PROJECT IN URBAN AREA – INFINITY TOWER, LISBON, PORTUGAL

Parallel Session 10 – Underground Construction  
14<sup>th</sup> August 14:00-16:00  
Room 03/28

João Gondar, *JETsj Geotecnia*  
Alexandre Pinto, *JETsj Geotecnia*  
Catarina Fartaria, *JETsj Geotecnia*

[info@jetsj.com](mailto:info@jetsj.com)  
[apinto@jetsj.com](mailto:apinto@jetsj.com)  
[cfartaria@jetsj.com](mailto:cfartaria@jetsj.com)

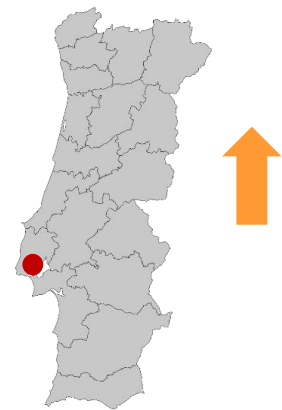
## TABLE OF CONTENTS

- 
1. Introduction
  2. Infinity Tower Project
  3. Proposed Earth Retaining Solution
  4. Design Methodology
  5. Final Remarks

## 1. INTRODUCTION

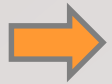
# 1. INTRODUCTION

## LOCATION



## TABLE OF CONTENTS

1. Introduction



2. Infinity Tower Project

3. Proposed Earth Retaining Solution

4. Design Methodology

5. Final Remarks

## 2. INFINITY TOWER PROJECT













## ARCHITECTURAL FEATURES

- ❑ The future tallest modern building of Lisbon will feature 26 floors and 4 basements.
- ❑ An iconic building in Lisbon's skyline with an impressive contemporary architecture.

<https://www.infinity-tower.com/>



## GEOTECHNICAL FEATURES

- ❑ Heterogeneous Urban Fills.
- ❑ About 20m excavation depth intersecting Urban Fills and the Lisbon Volcanic Complex: mainly basalts and clay tuffs
- ❑ Lisbon Volcanic Complex: formed 72 million years ago by several important volcanic episodes, showing mainly basaltic sheets, volcanic tuffs, pyroclasts, volcanic breccias, etc,





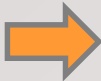
Basalts

Tuffs

Landfills



## TABLE OF CONTENTS

1. Introduction
2. Infinity Tower Project
-  3. Proposed Earth Retaining Solution
4. Design Methodology
5. Final Remarks

### 3. PROPOSED EARTH RETAINING SOLUTION

## MAIN RESTRAINTS

- ❑ Geotechnical and Geological: Landfills + Lisbon Volcanic Complex.
- ❑ Topographic: small hill.
- ❑ Surrounding Infrastructures: Alcantara WW Drainage Tunnel.
- ❑ Surrounding Infrastructures: Roads + Roadway Viaduct.
- ❑ Surrounding Infrastructures: Railway Line.

## WW Drainage Tunnel





## **GEOTECHNICAL AND GEOLOGICAL**

- ❑ The ground characterization was made through 9 boreholes with SPT tests, continuous sampling collection for laboratory tests and piezometers.
- ❑ The area is covered by a landfill deposit layer, over the Lisbon Volcanic Complex (LVC).
- ❑ 4 main geotechnical Zones were established:
  - ZG1, regarding the landfill layer;
  - ZG2 for pyroclastic tuffs and low-quality basalts;
  - ZG3 and ZG4 for medium to high-quality basalts.

## GEOTECHNICAL AND GEOLOGICAL



9 boreholes  
location

## GEOTECHNICAL ZONES - ZG

Geotechnical Zone	Description	$\gamma$ (kN/m <sup>3</sup> )	$\phi'$ (°)	$c'$ (kPa)	$E_s$ (MPa)
ZG1	<u>Landfill</u> ( $5 \leq \text{NSPT} \leq 17$ )	18	30	0	15
ZG2	<u>Pyroclastic tuffs and low-quality basalts</u> W4 to W3-4; F5 to F4-5 with recovery ranging from 60% e 100% e RQD=0%	22	33	50	65
ZG3	<u>Basalts</u> W3 to W3-2, F4 to F4-5, with 90% recovery ranging and <u><math>20\% \leq \text{RQD} \leq 75\%</math></u> , interbedded with basalts W3-2, F4-5 with 100% recover and <u><math>47\% \leq \text{RQD} \leq 74\%</math></u>	22	37	80	120
ZG4	<u>Basalts</u> W3-2 to F4-3, with 100% recovery and <u><math>56\% \leq \text{RQD} \leq 76\%</math></u>	22	45	100	150



## TOPOGRAPHY

- The existing topography, with the building location laying over a small hill, leads to an excavation depth ranging from 18m to 7m at the opposite alignments



Railway line



## MAIN RESTRAINTS – Topography

Railway Line + Roadway Viaduct

Viaduct



## MAIN RESTRAINTS – Surrounding Infrastructures

Alcantara Stream, 1912





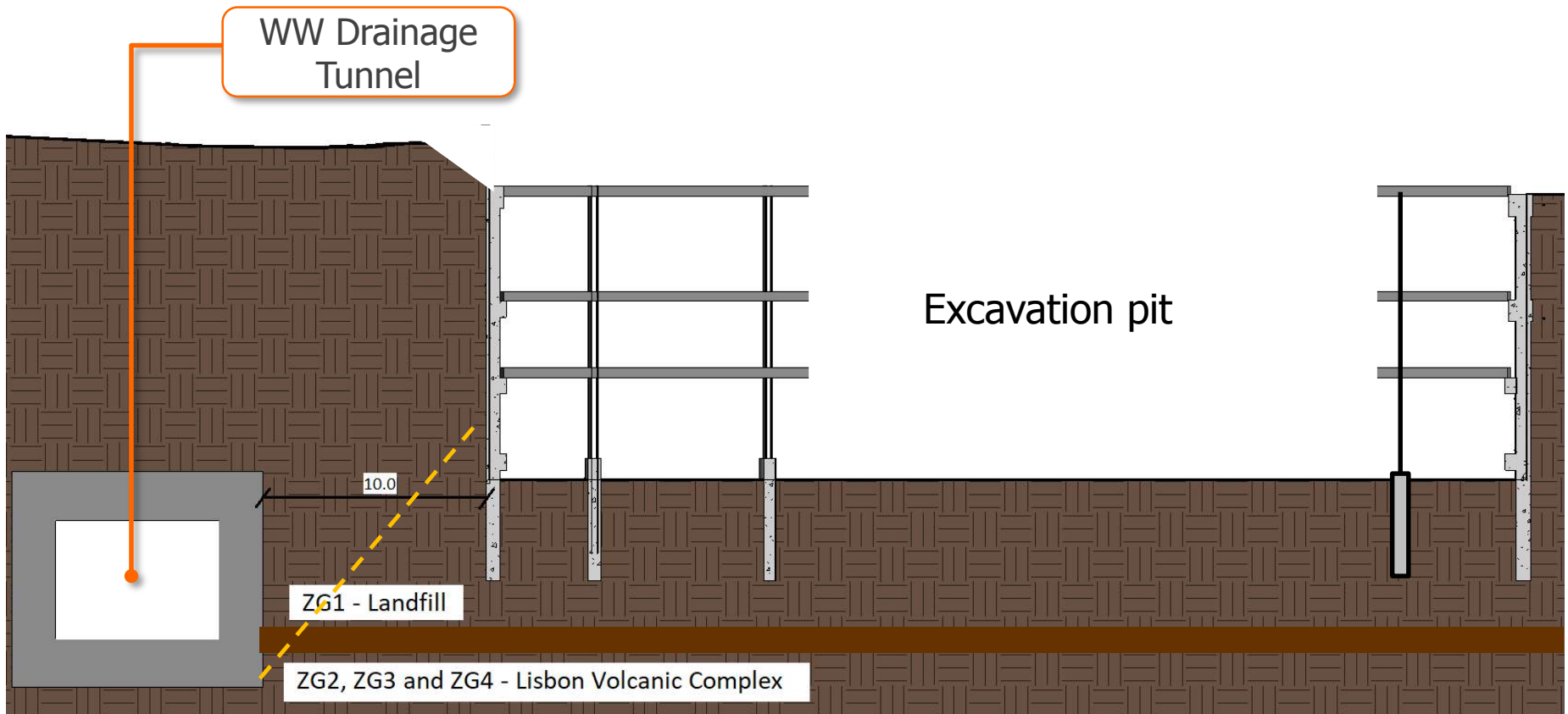
## **MAIN RESTRAINTS – Surrounding Infrastructures**

Alcantara Waste Water Drainage Tunnel, 1945



## MAIN RESTRAINTS – Surrounding Infrastructures

Alcantara Waste Water Drainage Tunnel, close to excavation pit



## **PROPOSED SOLUTION**

- ❑ The solution was proposed considering the existing restraints, with the following purposes:



## PROPOSED SOLUTION

- ❑ The solution was proposed considering the existing restraints, with the following purposes:



- ❑ Control the ground deformation;
- ❑ To minimize the interferences with the surrounding infrastructures and services;
- ❑ Improve Safety + Decrease Schedule + Decrease Costs.

## PROPOSED SOLUTION

- ❑ The solution was proposed considering the existing restraints, with the following purposes:



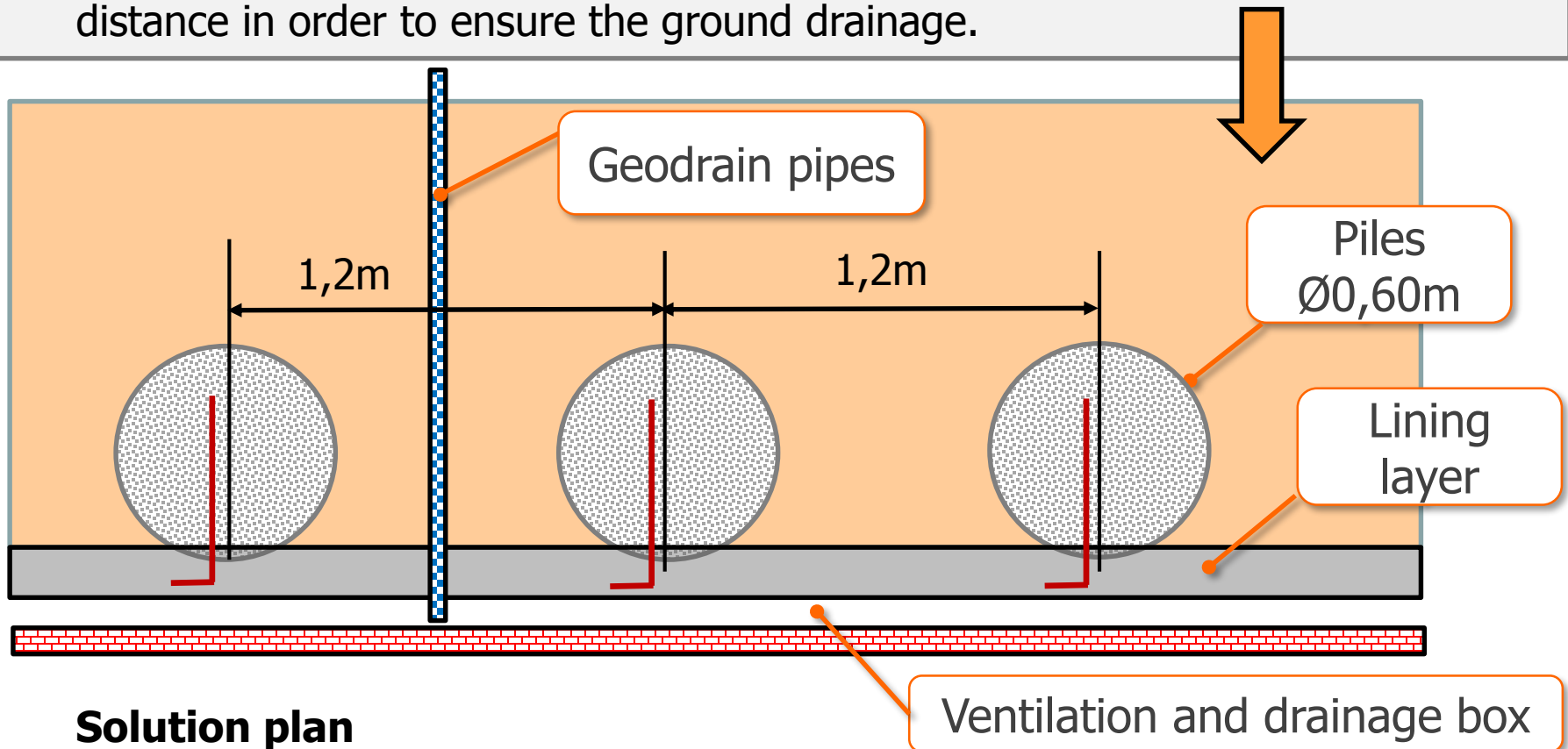
- ❑ Control the ground deformation;
- ❑ To minimize the interferences with the surrounding infrastructures and services;
- ❑ Improve Safety + Decrease Schedule + Decrease Costs.



- ❑ Bored Piled Wall solution with 600mm diameter pile and a plan space ranging between 0.80m and 1.20m.
- ❑ The total pile's depth ranges from 21.60m to 10.30m, all with a minimum embedment length of 4.00m.

## PROPOSED SOLUTION

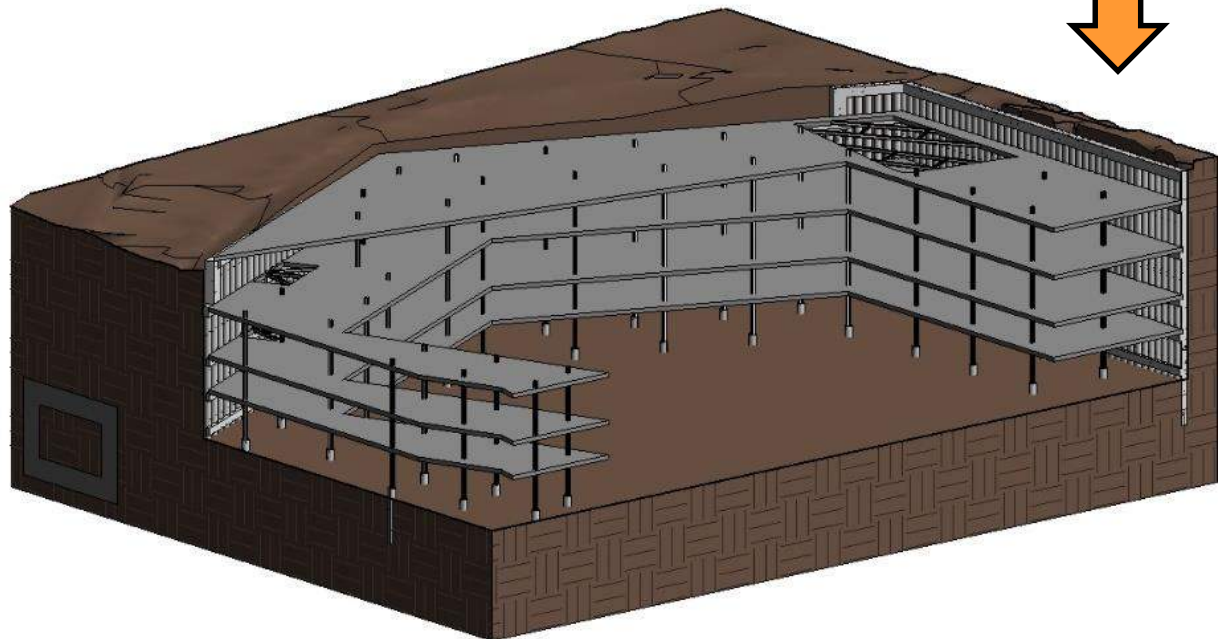
- ❑ The ground between the piles will be lined by a shotcrete layer of 150mm minimum thickness
- ❑ Geodrain pipes with 3m length will be installed with a minimum of 3.60m plan distance in order to ensure the ground drainage.





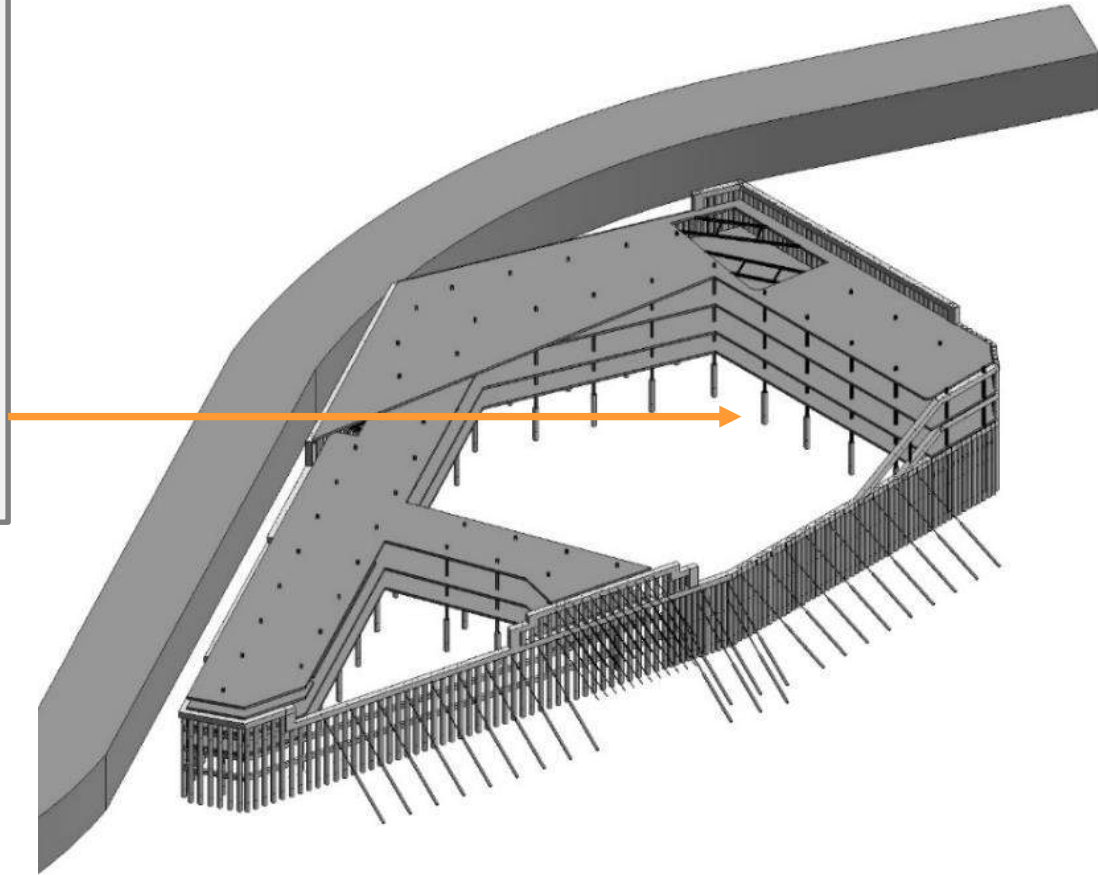
## PROPOSED SOLUTION

- ❑ In the west view, the wall will be braced by one level of temporary ground anchors to be installed at level -2 with 3.60m plan space.
- ❑ The remaining excavation alignments will be stabilized with slab bands of 12m width and 0.35m minimum thickness, compatible with both the architecture and structural solutions.



## PROPOSED SOLUTION

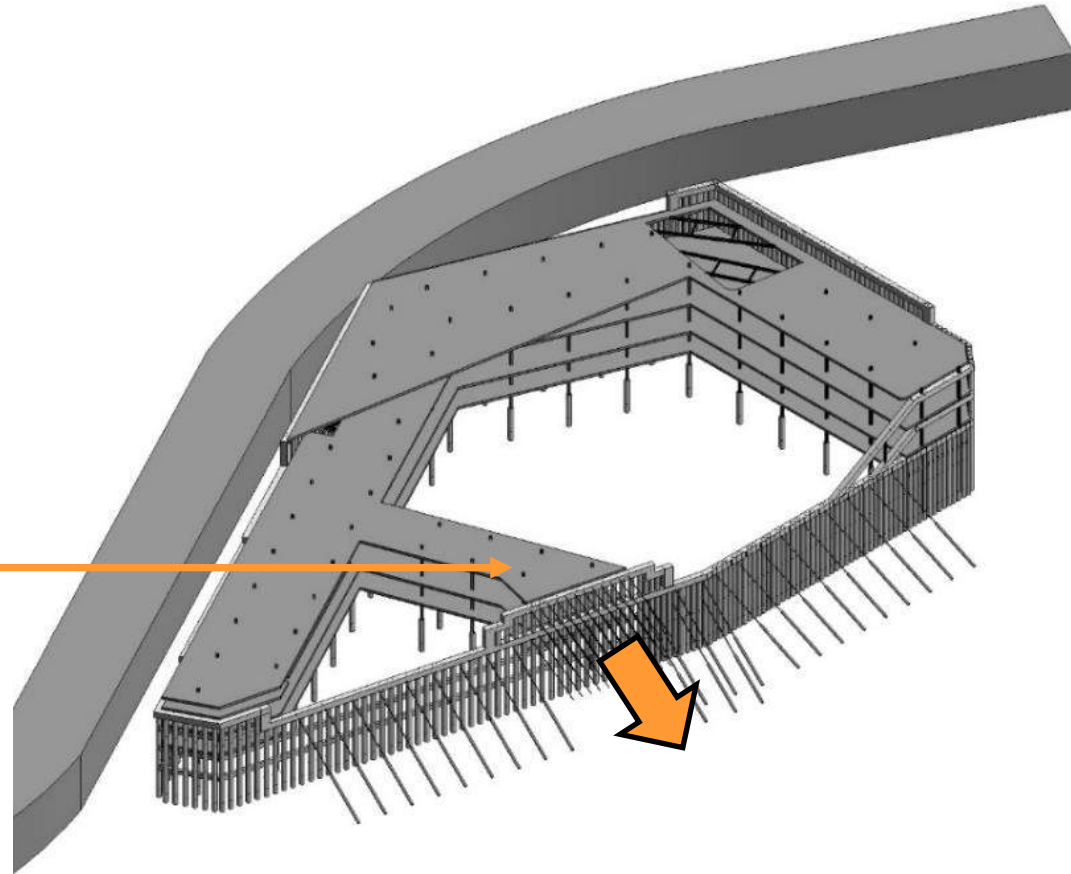
- The slab bands will be supported by vertical steel profiles HEB260 embed in 600mm bored piles, 4m below the excavation final level.



## PROPOSED SOLUTION


- ❑ The slab bands will be supported by vertical steel profiles HEB260 embed in 600mm bored piles, 4.00m below the bottom level of excavation.

- ❑ The slab bands above level -2 will be supported by slimmer slab strips of about 7m width that will react against the piles wall at the west view.



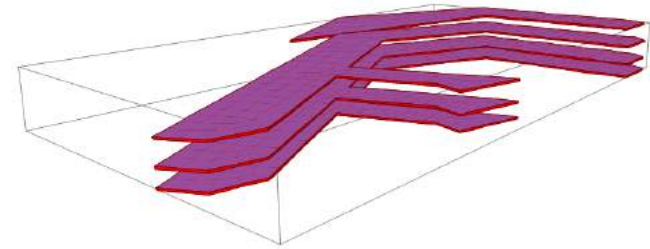
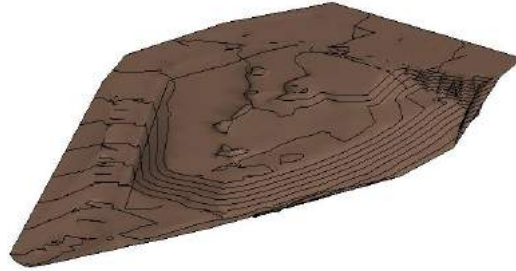


## TABLE OF CONTENTS

1. Introduction
2. Infinity Tower Project
3. Proposed Earth Retaining Solution
-  4. Design Methodology
5. Final Remarks

## 4. DESIGN METHODOLOGY

## DESIGN METHODOLOGY



**Preparation**

Units  
Phasing  
Levels  
Geolocation



**Topography**

Earthworks  
quantities  
Restraints



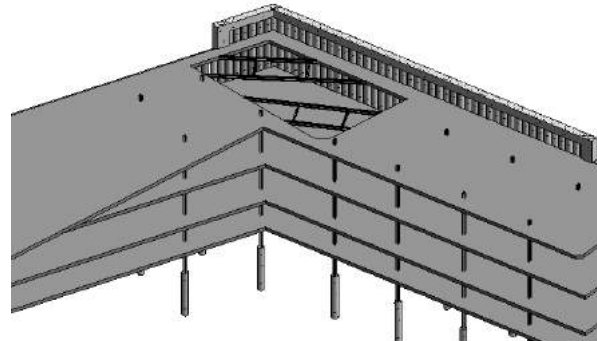
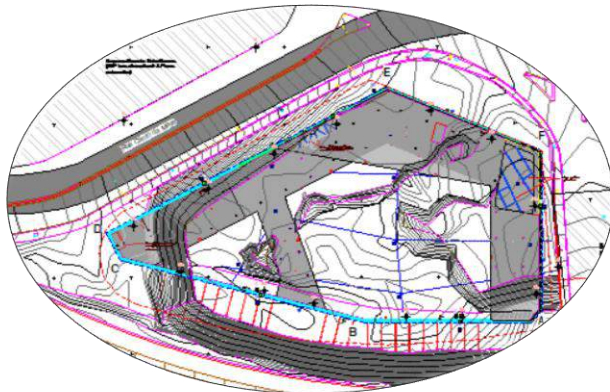
**Structure**

Bored Piles  
Slab bands  
RC beams  
Steel profiles  
Ground  
anchors



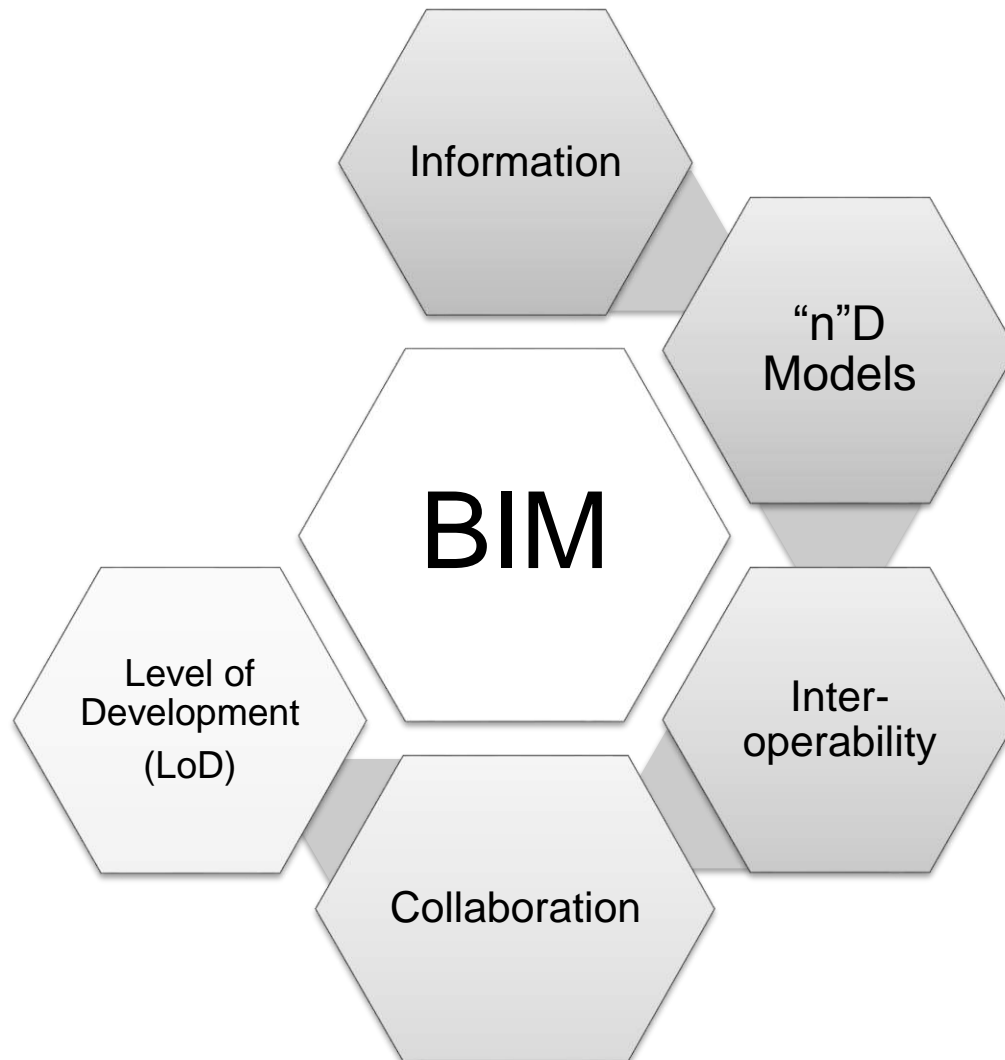
**Analysis**

Plaxis  
SAP2000





## DESIGN METHODOLOGY



### □ Information

Centralized in the 3D objects.

### □ "n"D Models

Time (4D), Budget (5D), Sustainability and facility management (6D and 7D).

### □ Interoperability

Capacity to seamlessly exchange information within different platforms.

### □ Collaboration

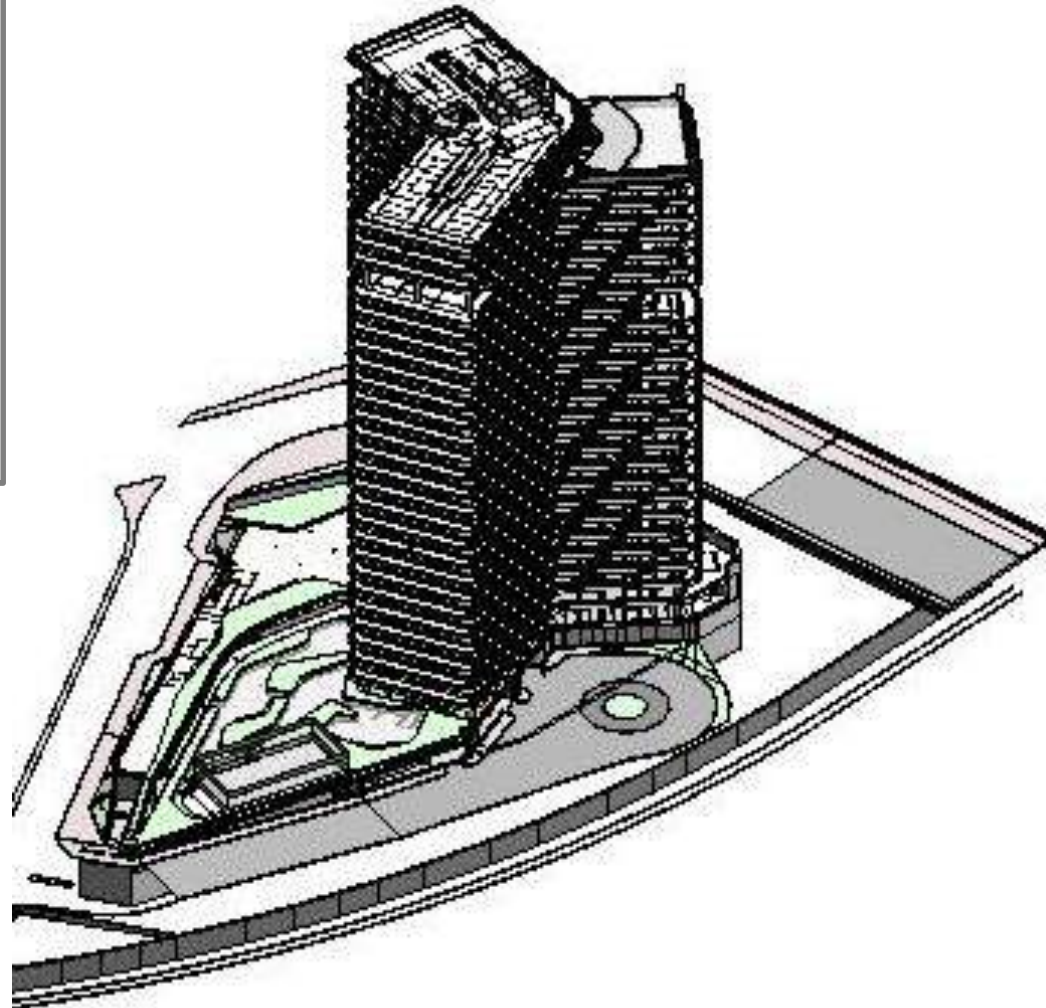
Promotes an early stage design team-up.

### □ Level of Development

Level of information associated with the objects.

## DESIGN METHODOLOGY

- ❑ Among the elements received was the architecture project geometry in a 3D BIM model.
- ❑ The existing topography was modeled in the BIM software.

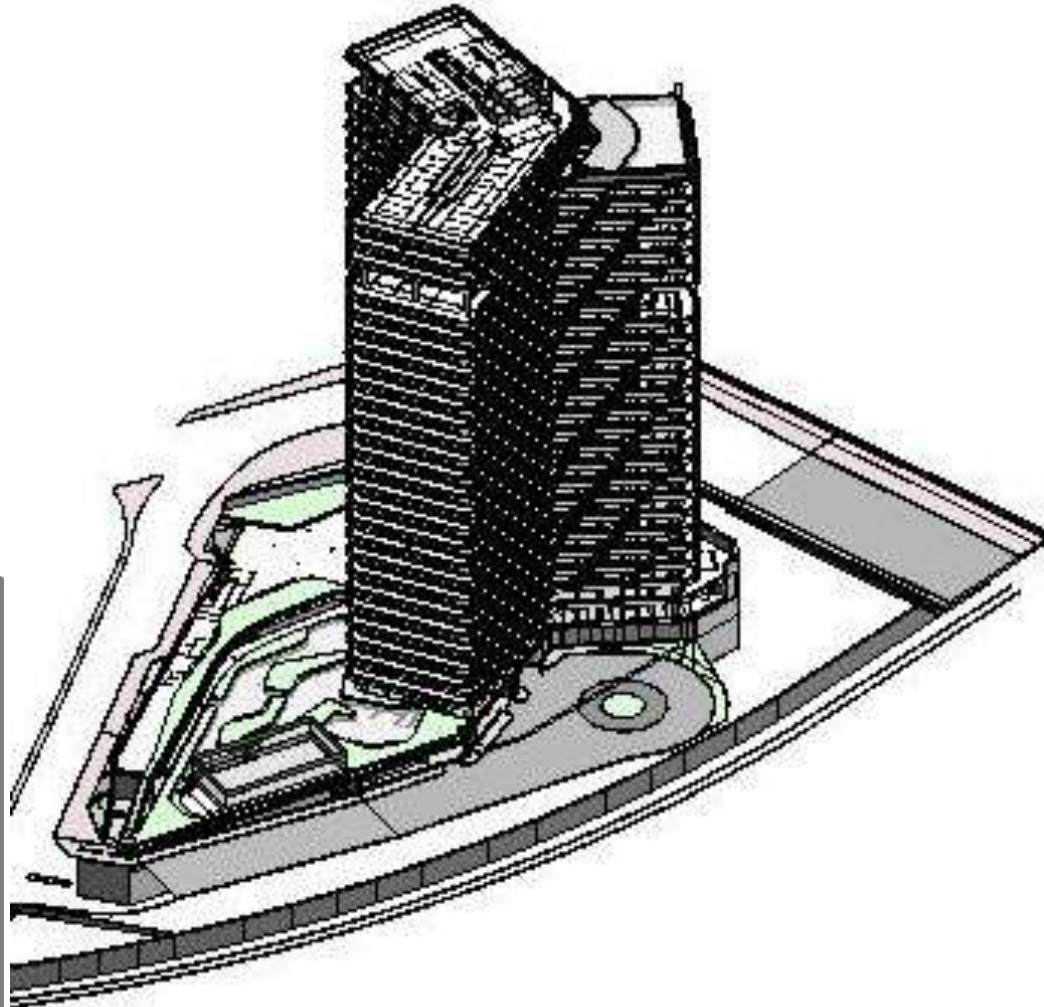


## DESIGN METHODOLOGY

- Among the elements received was the architecture project geometry in a 3D BIM model.
- The existing topography was modeled in the BIM software.



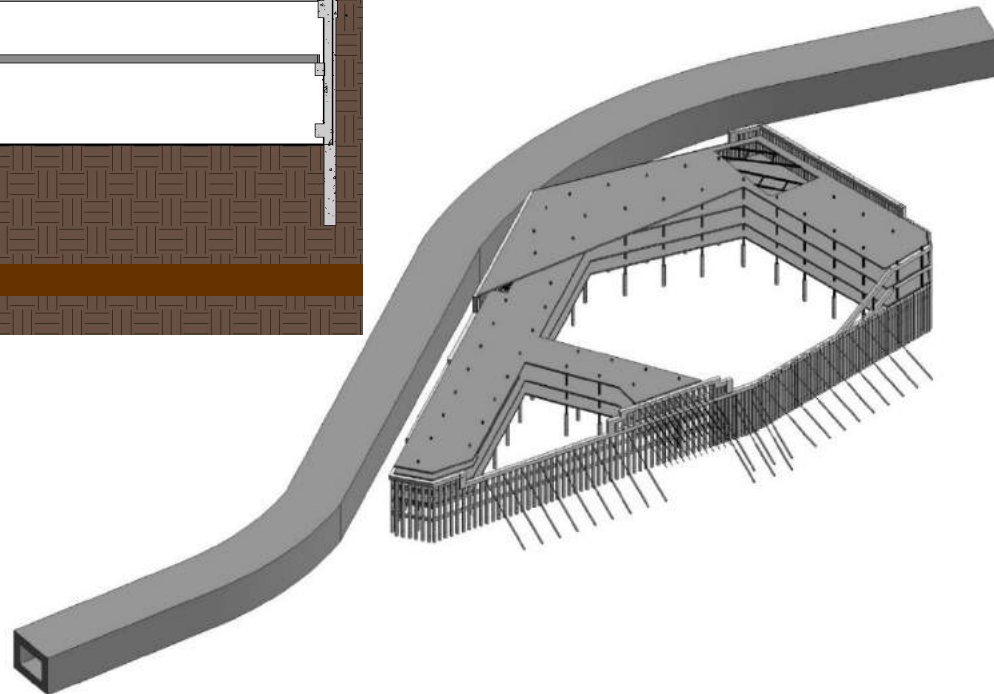
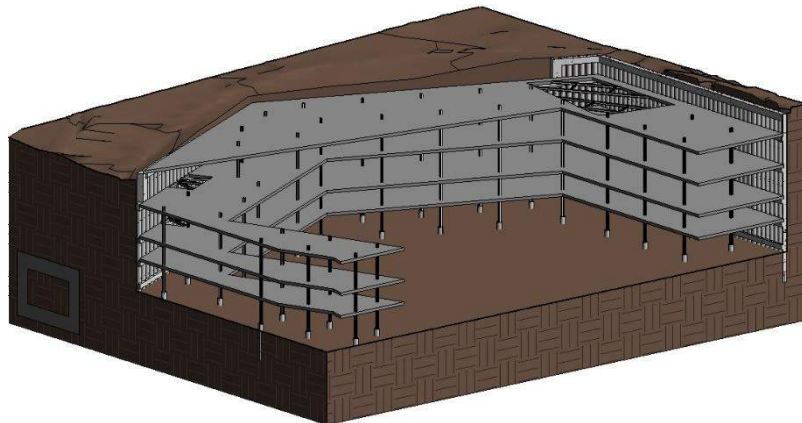
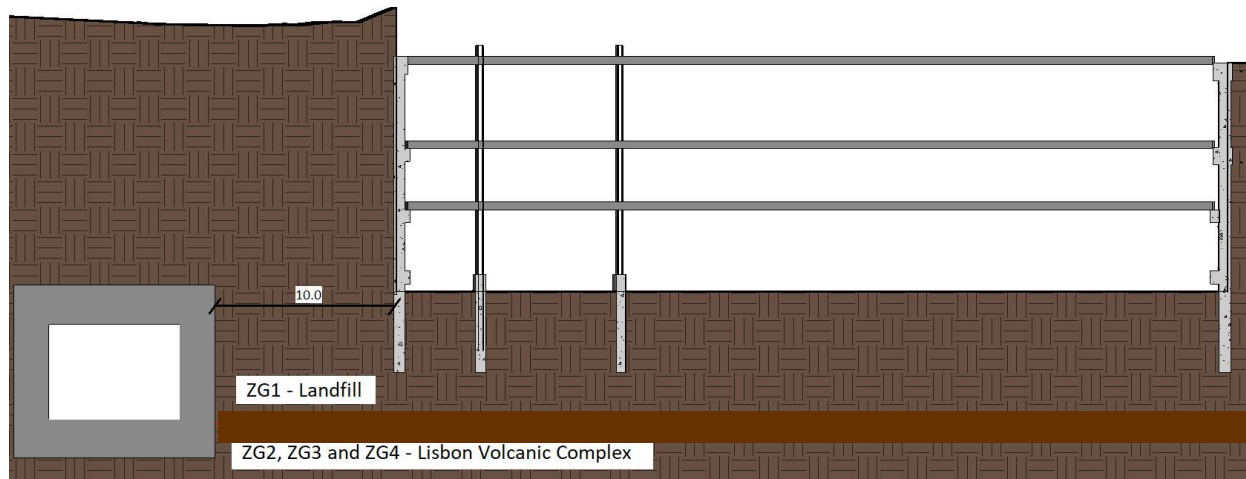
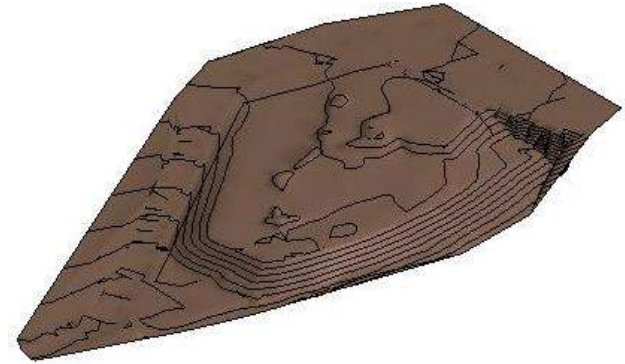
- The architecture model was linked to the file and the geographic position of the surface was coordinated with the architecture model and the existing lot boundary and topography.



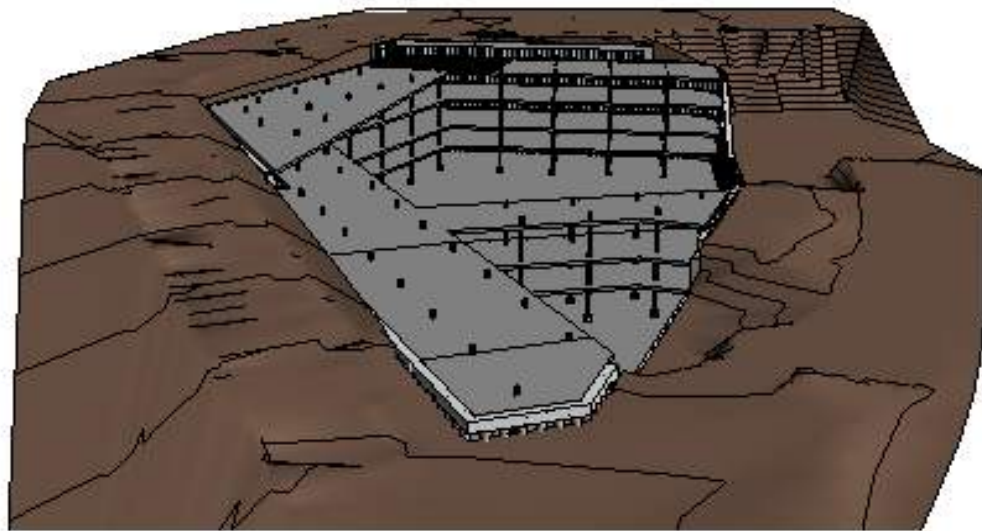


## DESIGN METHODOLOGY

- The modeling of the bored piles wall was done according to the architecture 3D BIM model.



## DESIGN METHODOLOGY

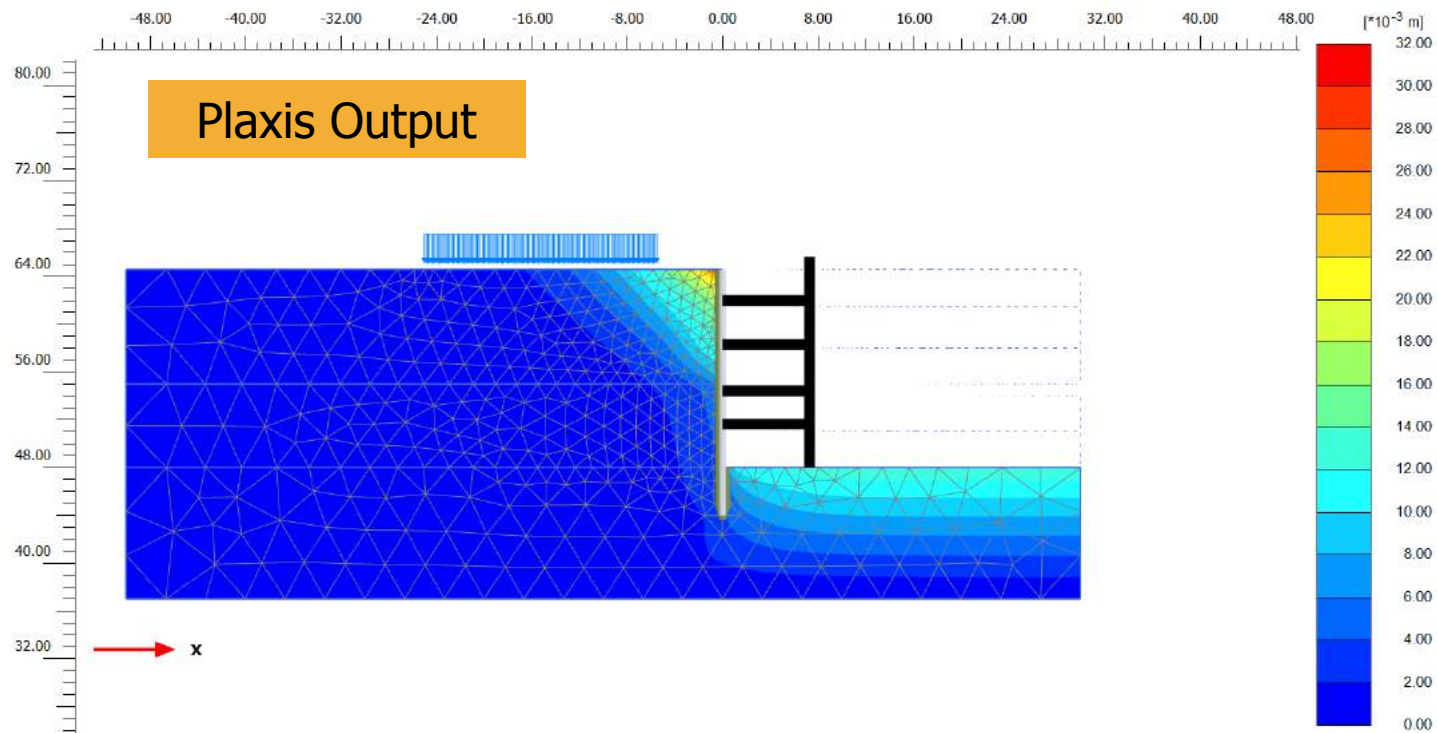


## DESIGN METHODOLOGY

- The solution was evaluated using the geotechnical software (PLAXIS2D)



- Displacements and efforts were estimated and analyzed considering the geotechnical zones and correspondent parameters.



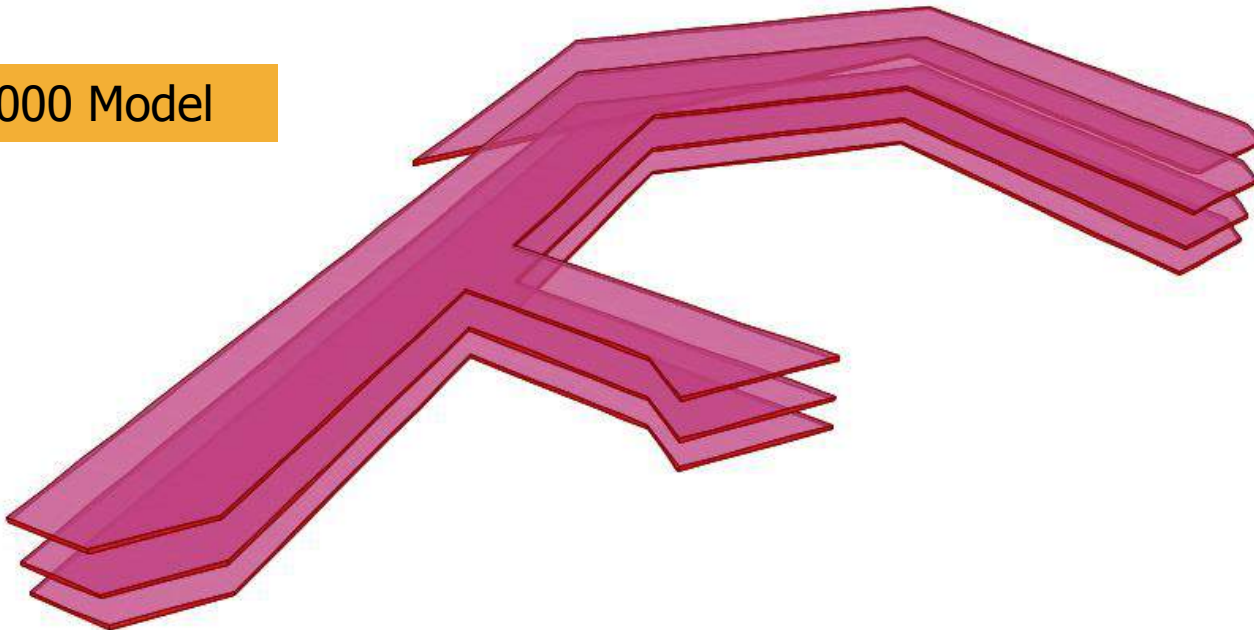
## SAP2000 MODEL IMPORTED FROM A 3D BIM FILE

- ❑ The geometry of the slabs were exported to a structural analysis software (SAP2000) using an IFC file type.




- ❑ Loads obtained from the PLAXIS2D were introduced on the SAP2000 model and the deformations compatibility was checked on a iterative way

SAP2000 Model





## TABLE OF CONTENTS

1. Introduction
2. Infinity Tower Project
3. Proposed Earth Retaining Solution
4. Design Methodology
-  5. Final Remarks

## 5. FINAL REMARKS

## FINAL REMARKS

- ❑ The use of BIM methodology allowed an accurate coordination with the architecture and others engineering projects and promoted efficiency in terms of project documentation, especially when changes were needed.
- ❑ The interoperability among software allowed that the geometry from the 3D BIM model could be exported.
- ❑ The 3D visualization of the project and the restrains helped to find out the best engineering solutions, including the compatibility check between the several architecture and engineering solutions.
- ❑ The BIM model will be a very useful at both the construction and the building maintenance / management under operation phases



**JET** SJ

THE GROUND IS OUR CHALLENGE

THANK YOU FOR  
YOUR ATTENTION

VIELEN DANK