

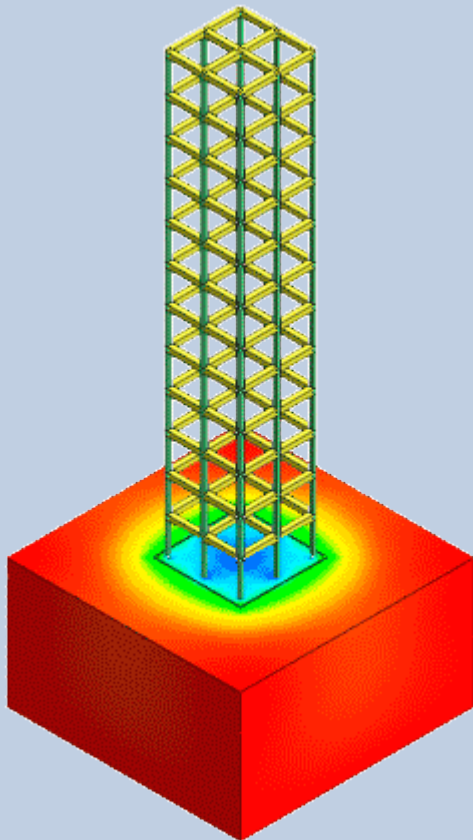
MIDAS ELITE SERIES

SOIL STRUCTURE INTERACTION ANALYSIS OF SKYSCRAPER IN BRAZIL

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BS Consulting
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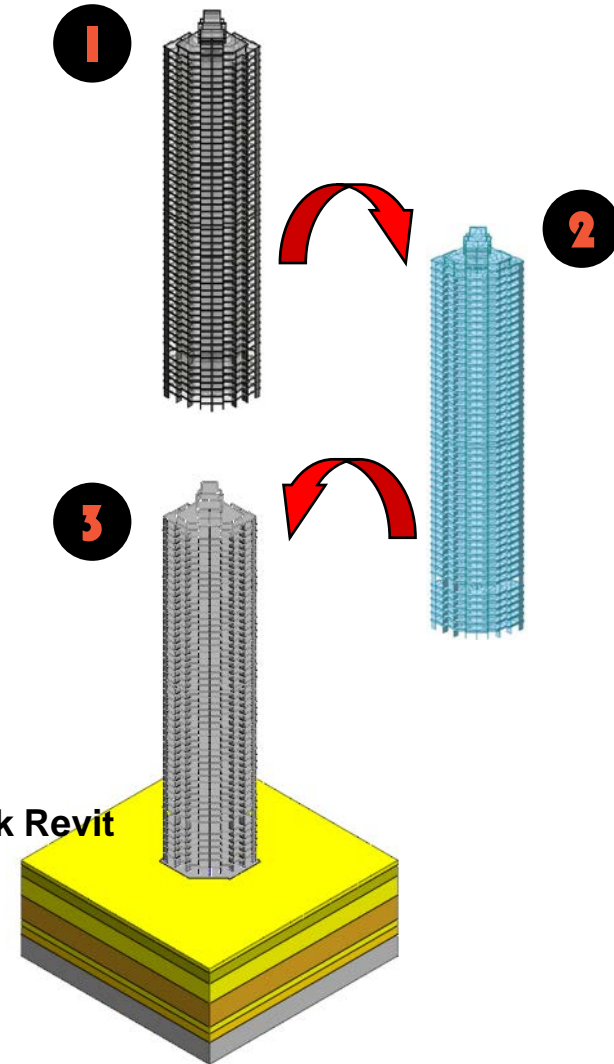
Intro 1

The focus of the case study will be a soil structure interaction analysis of a **55 story** (168 m) building, in a layered soil down to 50 meters.

Due to the geotechnical condition and the size of the building, a **SSI was necessary**, providing prevision of settlements, and how those influence the behavior of the structure.

The presentation is mainly focused in the attempt of unifying different platforms and briefly describing the used process.

- 1** Geometry created by the structural team is replicated in **Autodesk Revit**
- 2** Converted to a structural model in **Midas GEN**
- 3** Imported and analyzed with the ground in **Midas GTX NX**.



Building details 2

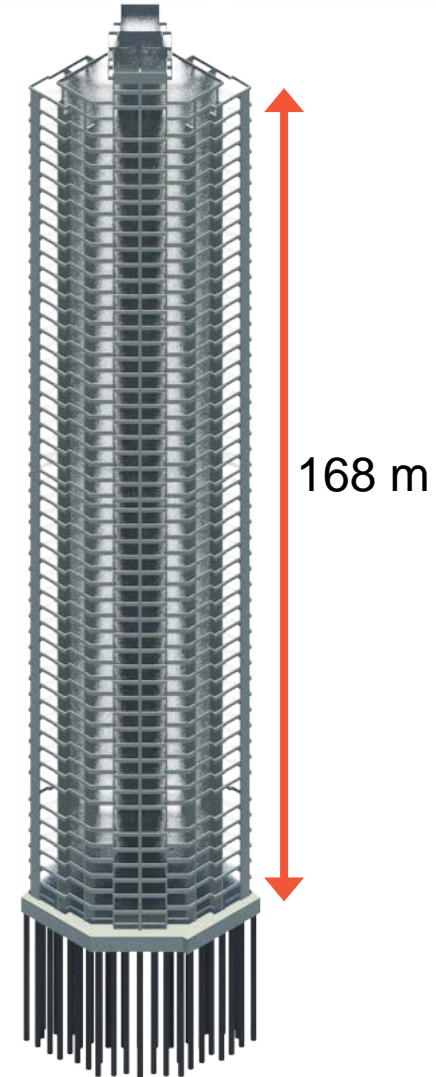
The building comprises 55 story, resulting in 168 m high, being inside the **top 25** tallest buildings in Brazil.

Designed in full **reinforced concrete** structure

Area of each story: **440 m²**

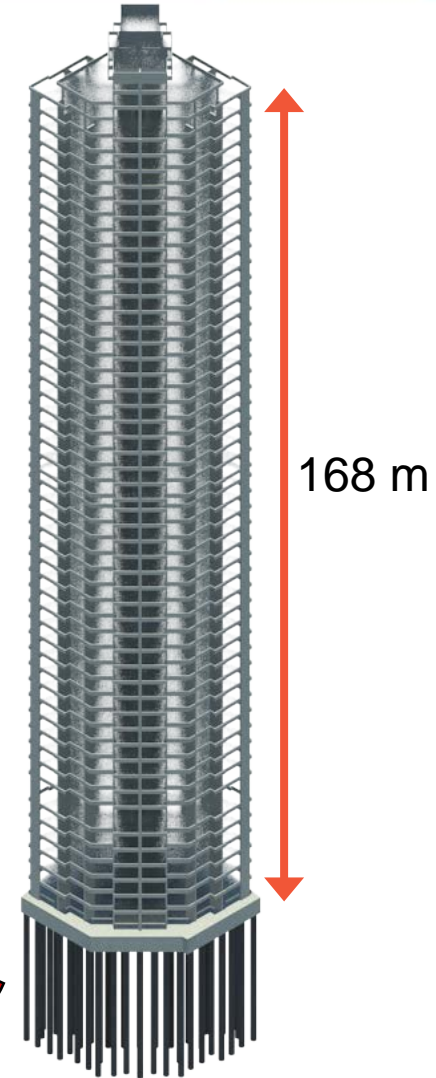
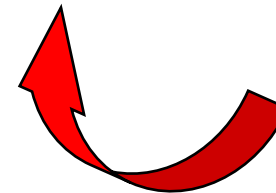
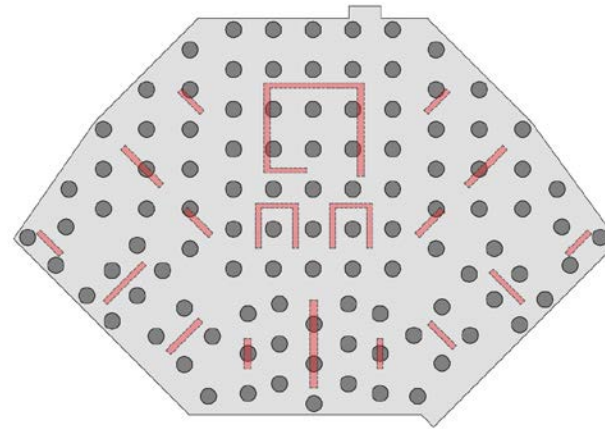
Total of **18 columns**

A total dead load of **300,000 kN**



Building details 2

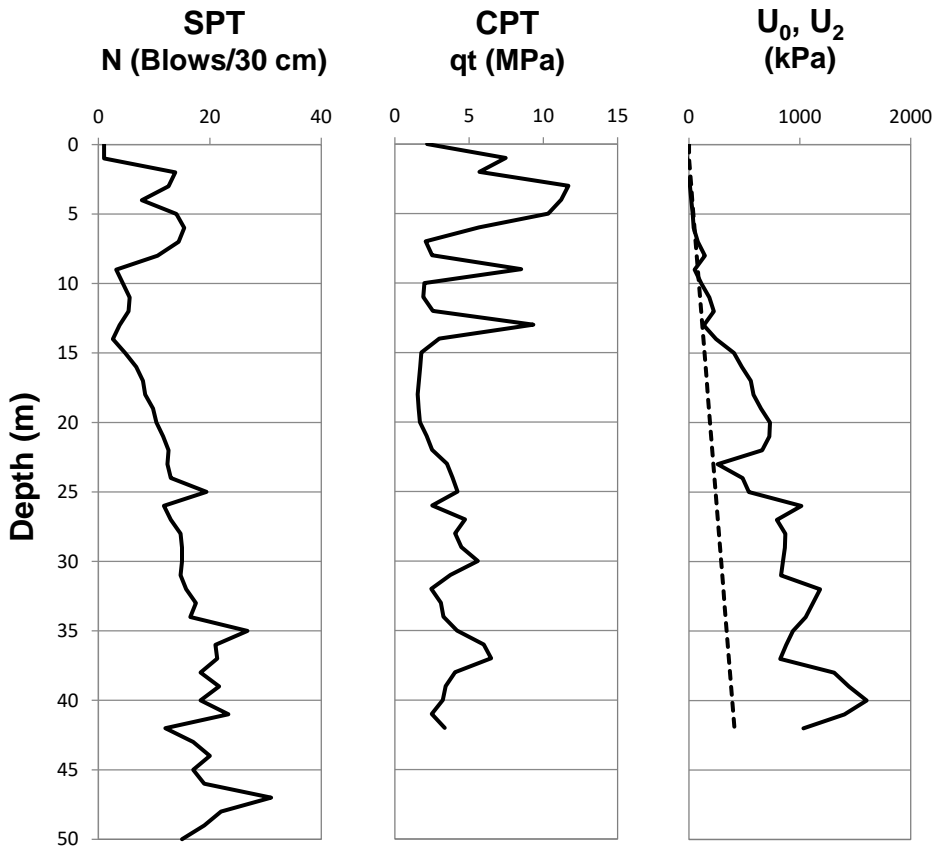
- **Piled raft foundation**
 - **106 piles**
 - **CFA – Continuous Flight Auger - Piles**
 - **100 cm diameter (piles)**
 - **30 m long (piles)**
 - **680 m² (raft)**



Soil Characterization 3

Site Investigation

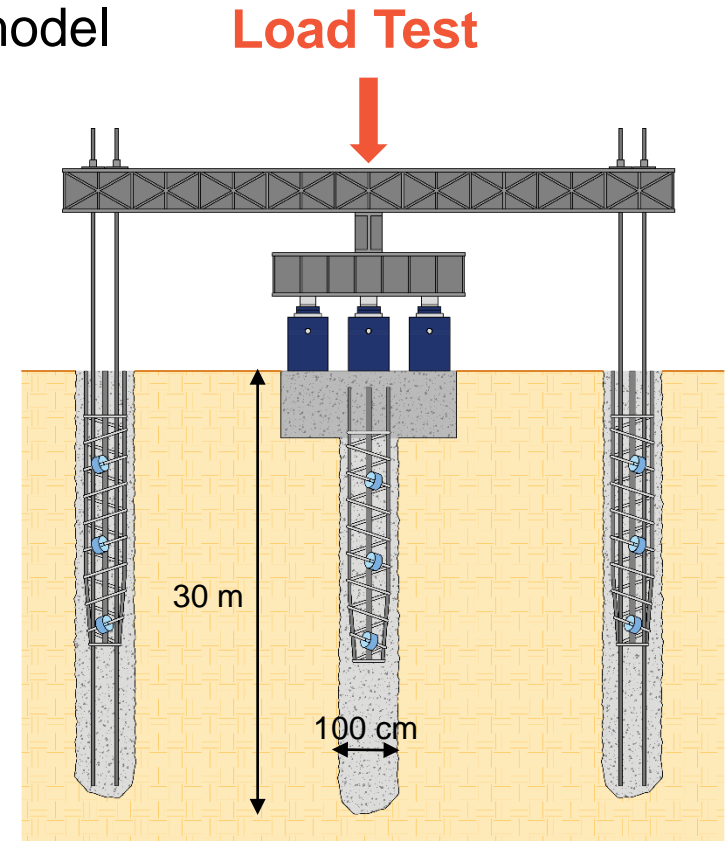
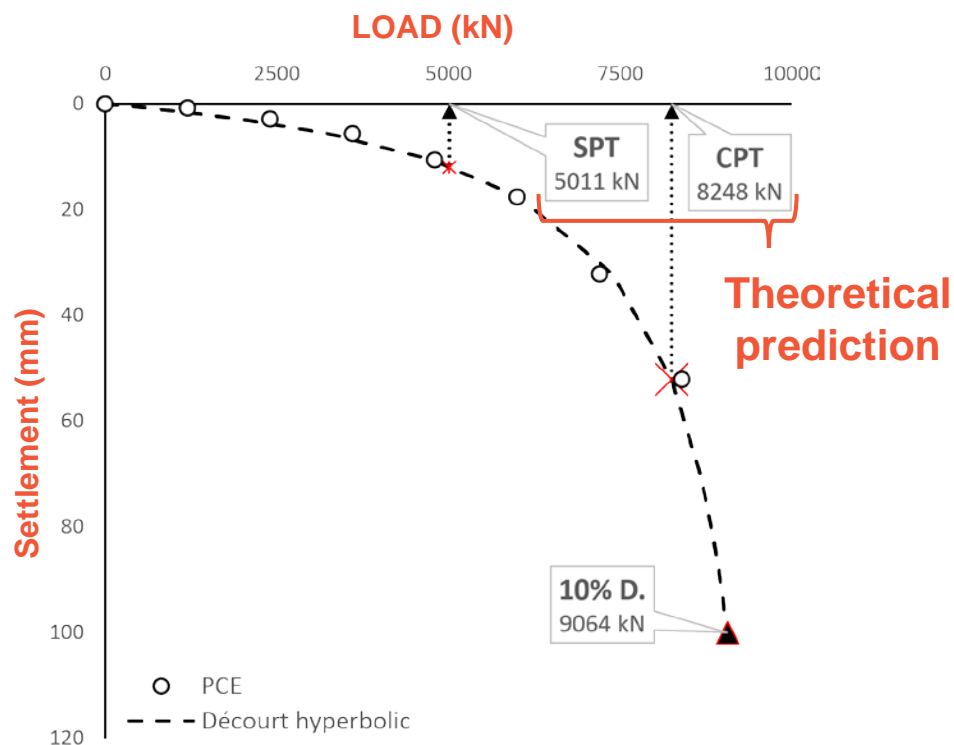
5 SPT – 50 meters deep
4 CPTu – 43 meters deep



- **Sedimentary deposit**
- **Excess** of porewater pressure
- **Low** capacity profile
- **Layered soil** alternating sand and clay

Pile Load Testing Program 4

- **Static** load tests
- **Prior** to the foundation construction
- 3 **CFA Piles** (diameter of 80, 100 and 120 cm)
- Maximum load of **9 MN**
- Results used to **calibrate** GTS NX model



Pile Load Testing Program 4



Reaction Beam



Reaction Piles

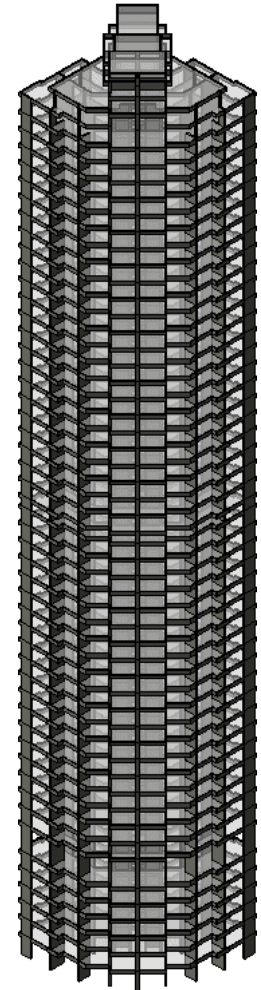
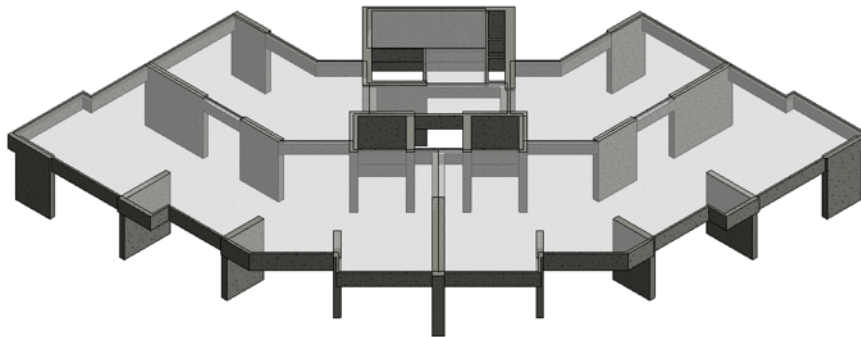


Hydraulic Jack

Load Cell

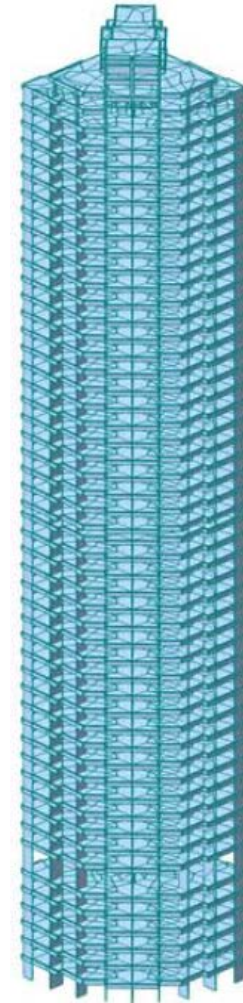
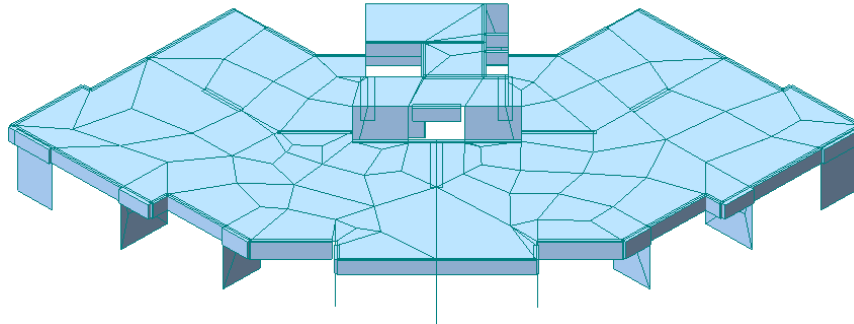
Structural Model – Autodesk Revit 5

- Geometry created by the structural team is replicated in **Autodesk Revit**, including:
 - Materials;
 - Sections;
 - Properties;
 - Analytical model;
 - Loads.
- Using the **Revit-Midas/GEN link**, the model can be updated between the platforms.



Structural Model – Midas Gen 6

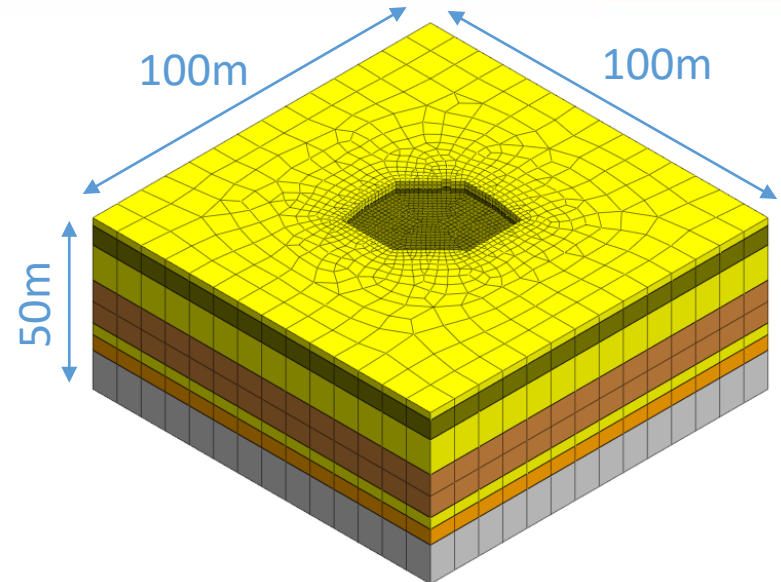
- Revit's model was imported in **Midas GEN**:
 - **Imported data:**
 - Materials;
 - Sections;
 - Properties;
 - Loads.
 - **Input in GEN:**
 - Story information;
 - Initial boundary condition;
 - Wind loads;
- Using the export option, a Midas MXT file was created to make the **link** with Midas GTS NX.



- **Soil layers**

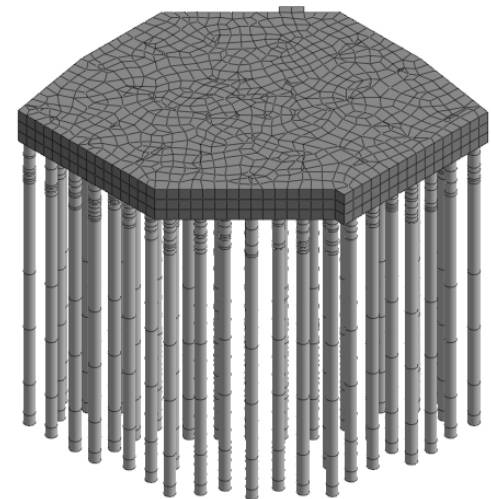
- Constitutive models

- Mohr-Coulomb for sands
 - Modified Cam-clay for clays

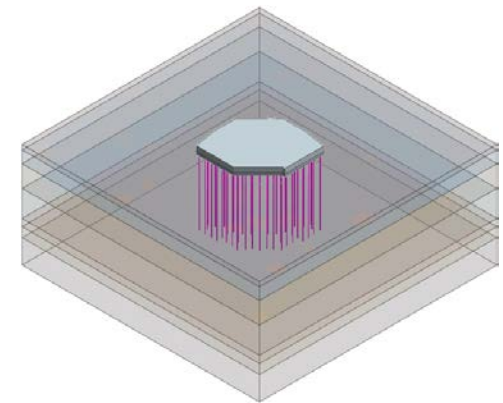
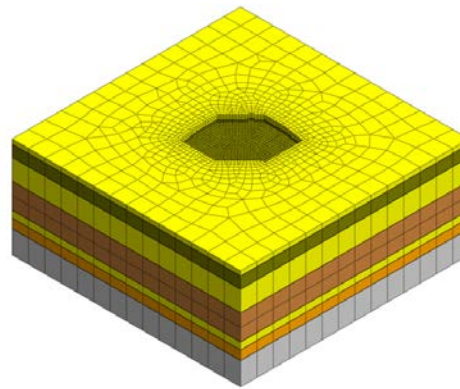
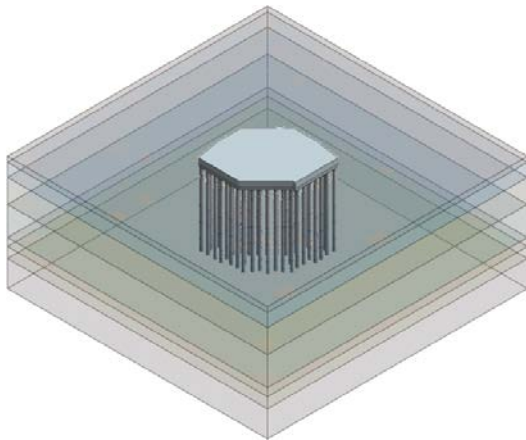


- **Piled Raft model**

- Concrete elastic properties
 - 3.5 m thick raft – as a solid element
 - 106 piles – as beam elements



- **Pile Model Type – Line-to-Solid Interface Model**



Model

=

Soil (solid)

+

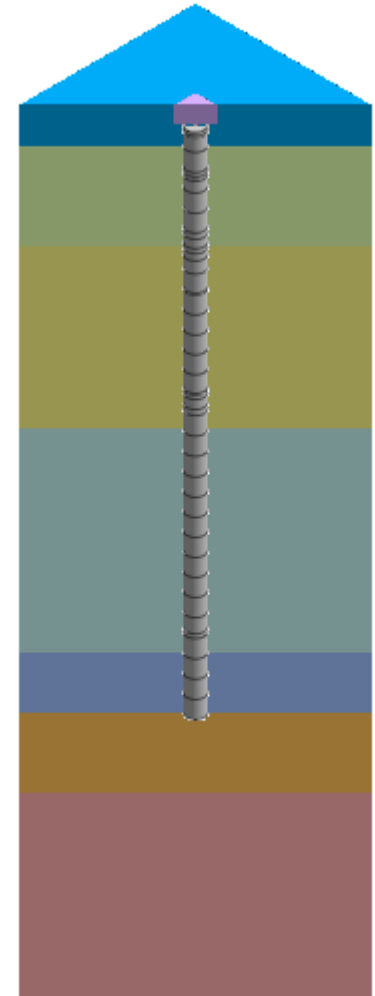
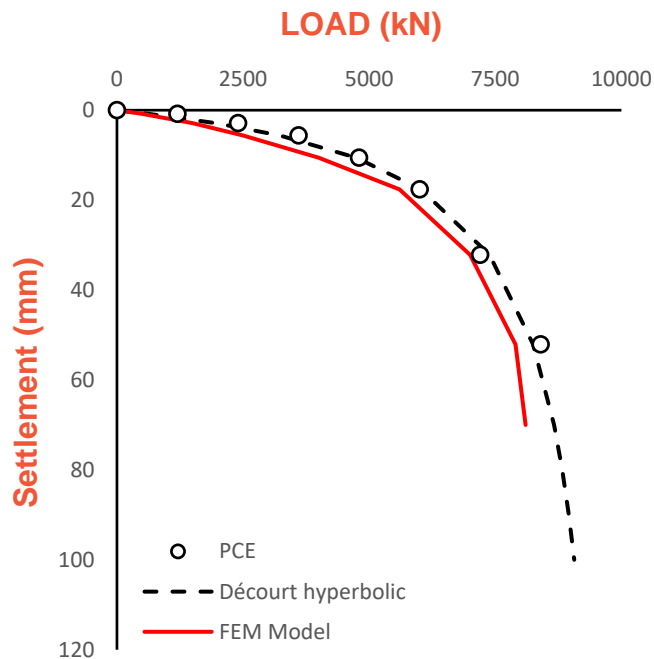
Pile (line)

+

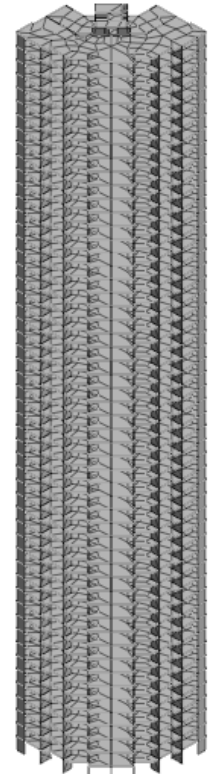
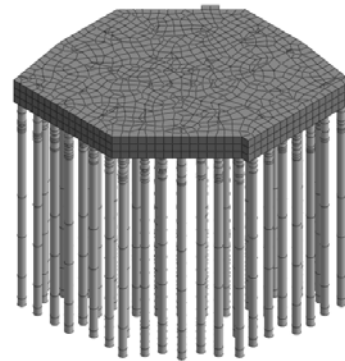
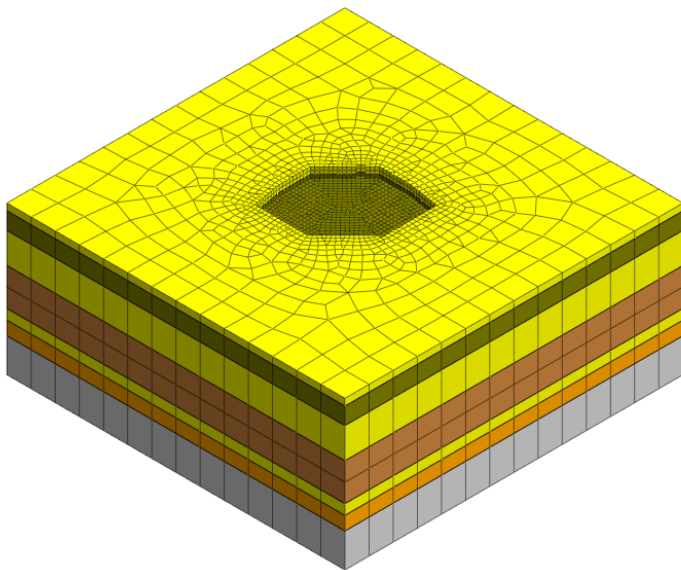
Interface (line-to-solid)

- **Pile load test calibration**

- Reproduce the geometry of the pile load test;
- Define different load steps to read the settlements;
- Class C prediction
- Compare to the pile load test **Load x Settlement** curve



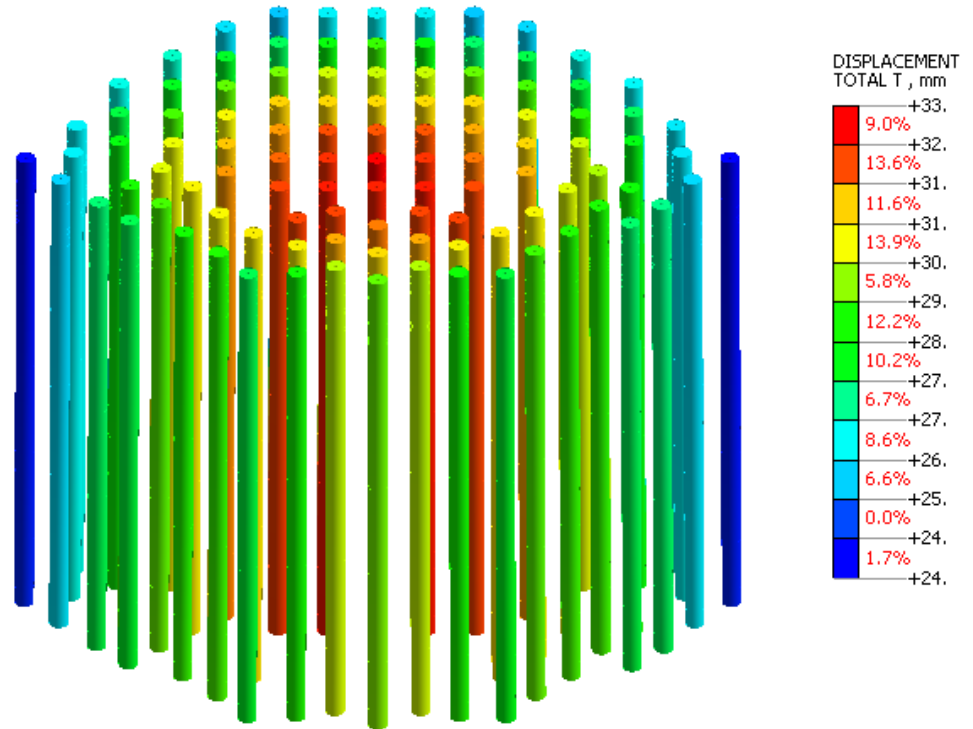
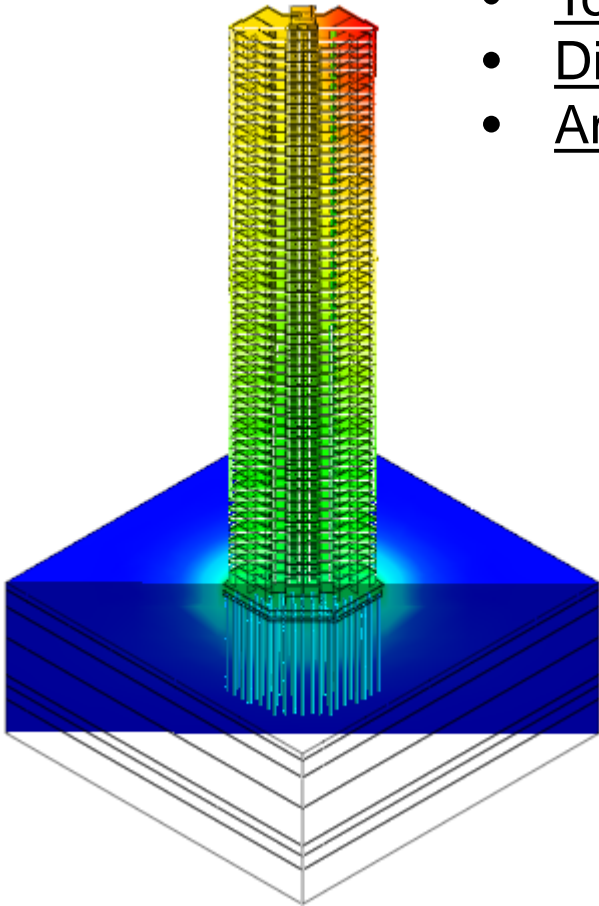
- **Full Model**
 - Soil + Piled-Raft + Structure
- **Advantages:**
 - More accurate values of differential settlements, due to the rigidity/stiffness of the superstructure;
 - Evaluation of wind load cases directly;



Results 8

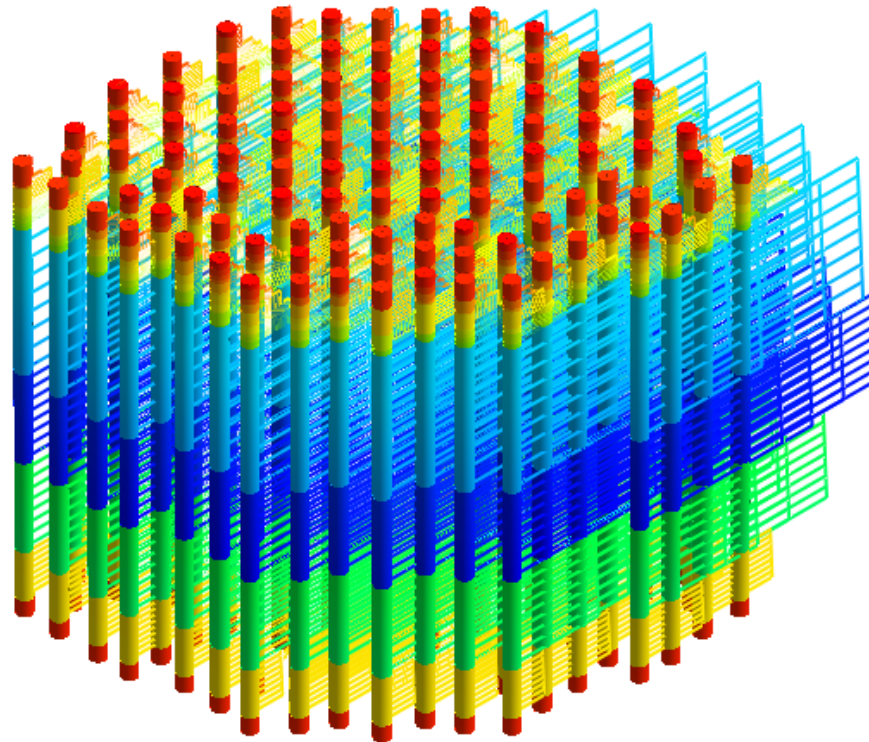
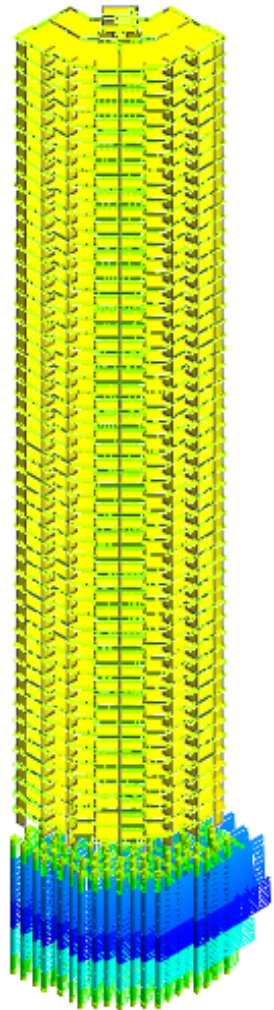
- **Settlements**

- Total settlement;
- Differential settlement Analysis;
- Angular distortion Analysis.



Results 8

- **Pile Loads**
 - Distribution of load along the pile.

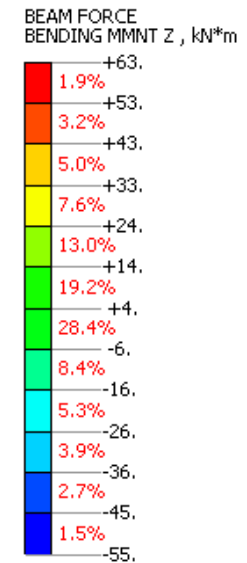
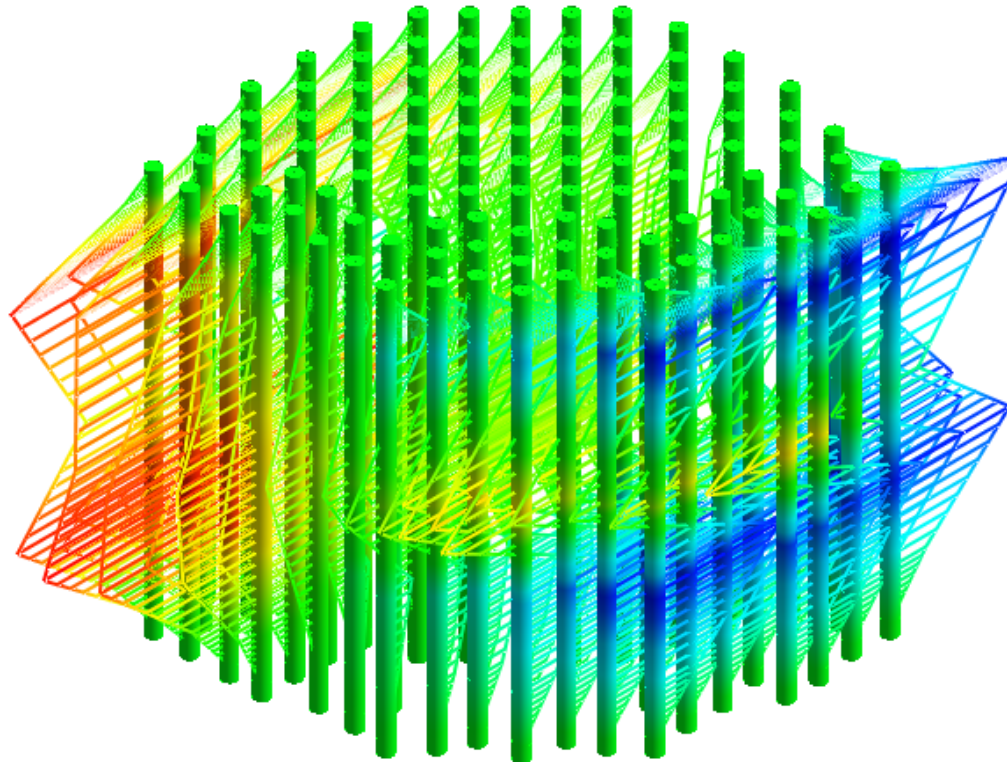
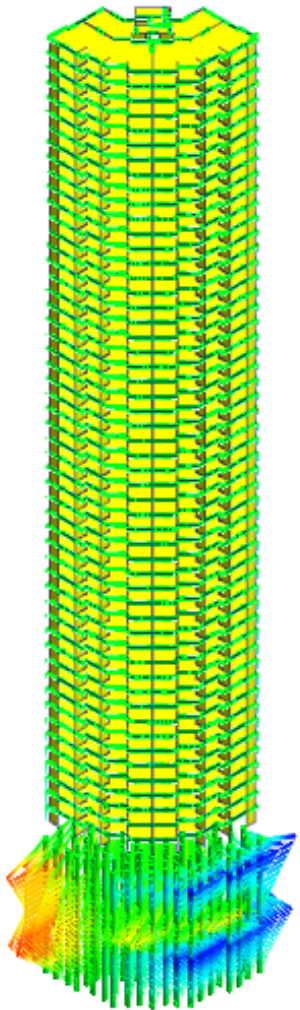


BEAM FORCE
AXIAL FORCE , kN

-1.	
9.7%	-317.
10.4%	-633.
12.2%	-949.
11.0%	-1265.
11.5%	-1581.
5.4%	-1897.
7.8%	-2213.
7.9%	-2529.
5.4%	-2845.
8.1%	-3161.
5.5%	-3478.
5.1%	-3794.

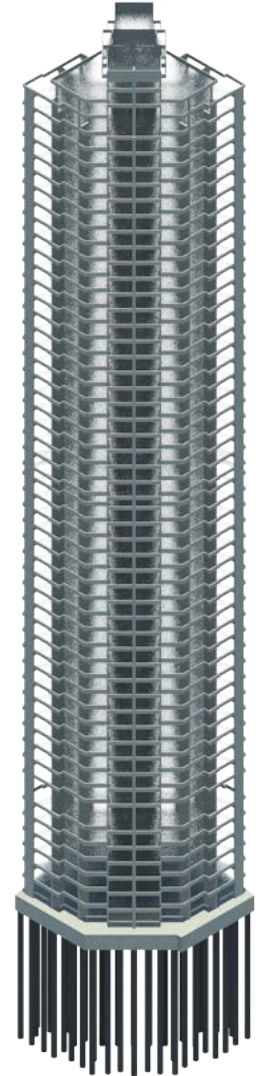
Results 8

- **Pile bending moments**
 - Distribution of bending moments along the pile.



Conclusions 9

- Successful interaction between platforms
Revit + Midas GEN + Midas GTS NX
- Key results (GTS NX):
 - **Settlements** from the piled raft foundation;
 - Distribution of **bending moment** in piles;
 - **Springs** can be exported, being different for each pile;
 - **Area springs** can be exported, simulating the contact of the raft with the soil.
- Working in the same platform reduces the number of iterations between the structural and geotechnical teams.
- Midas offers two powerful platforms – for structural and geotechnical engineering – that are evolving to work together, in a full model, taking SSI to another level.



THANKS!



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