THE MASTERWORKS OF GEOTECHNICAL ENGINEERING

MIDAS

THE MASTERWORKS OF GEOTECHNICAL ENGINEERING

THE MASTERWORKS OF GEOTECHNICAL ENGINEERING

Contents

SOIL STRUCTURE INTERACTION

Analysis methods

Linear / Nonlinear Static Analysis

Construction Stage Analysis

Fully-Coupled Stress-Seepage Analysis

* Dynamic Analysis (Seismic Capacity)

Design considerations

Interface between structures and surrounded soils

Pile, Reinforcement design / Skin friction / End bearing

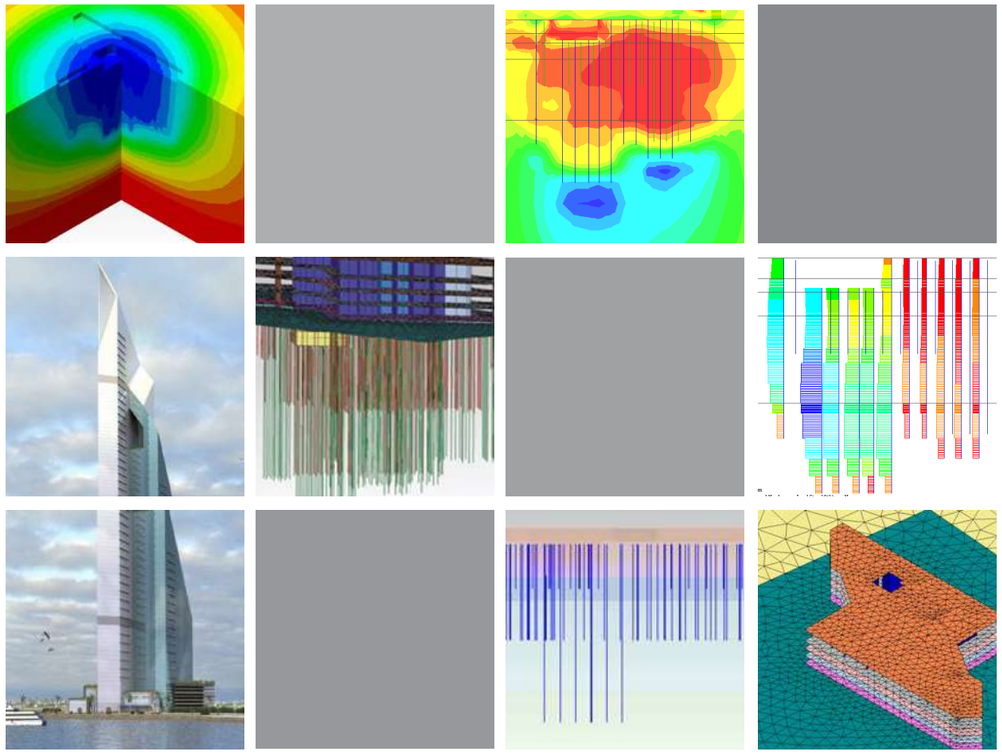
Differential settlements / Lateral movement

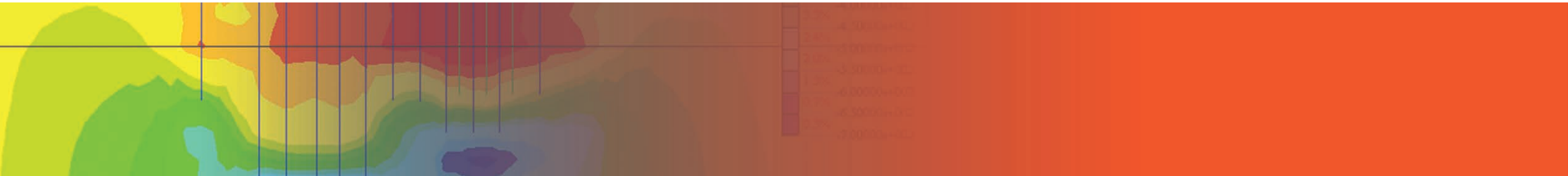
Effect on adjacent structures

Dubai Tower in Qatar

Doha, Qatar

Owner	Sama Dubai (Dubai International Properties)
Engineering Consultant	Hyder Consulting
General Contractor	Al Habtoor - Al Jaber Joint Venture
Architecture	RMJM
Project Type	Mixed-Use Building
Size of the Structure	439m Height (88-Story)
Main features in modelling	- Piled - raft foundation for high - rise building - Analysis results for design (Settlements, Raft forces and bending moments, Pile forces and bending moments)
Description on this project	The proposed development for the Dubai Tower project comprises the construction of an approximately 80 floor high-rise tower with a mezzanine, ground floor and five basement levels. It will be the tallest structure in Qatar when it is complete. The tower was founded on soft sand and required the design of a piled raft in a 3D finite element model to fully understand the behavior.

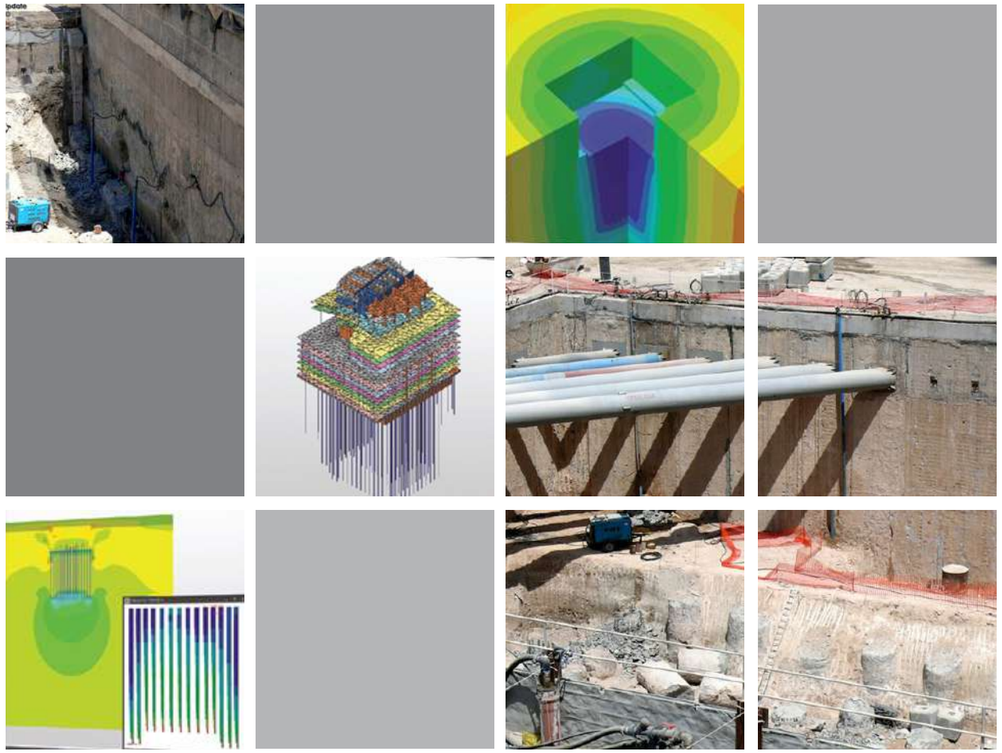




Pentominium Residential Development in UAE

Dubai, United Arab Emirates

Owner	Trident International Holdings
General Contractor	Arabian Construction Company - Hitachi Plant Technologies
Engineering Consultant	Hyder Consulting
Construction Period	Under Construction
Project Type	Residential Building
Size of the Structure	516m Height (122-Story)
Main features in modelling	- Piled - raft foundation for high - rise building - Analysis results for design (Settlements, raft forces and bending moments, pile forces and bending moments)
Description on this project	The Pentominium Residential Development is located on the west side of the creek in Dubai. The development comprises the construction of an approximately 120 story high-rise tower inter-linked by low level podium structure housing up to 7 basement levels. The Pentominium Tower will be founded on a piled raft and required a 3D finite element model to fully understand the behavior of the foundation interaction with surrounding soil.

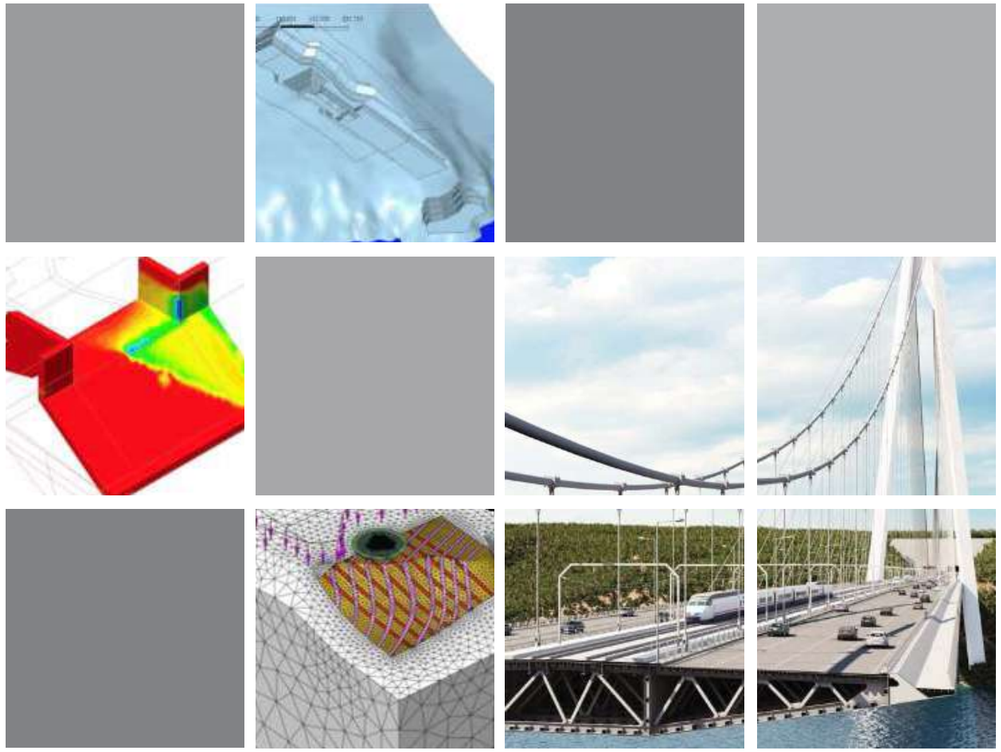


Bosphorus Third Bridge

Istanbul, Turkey

Lombardi

Owner	Republic of Turkey
General Contractor	Hyundai E&C / SK E&C
Engineering Consultant	Lombardi
Construction Period	2013 - 2015
Size of the Structure	1.4km Main Span, 2.2km Total Length
Main features in modelling	- Anchor block and ground approach of the cable stayed bridge - Interface elements between shaft and soil
Description on this project	The Third Bosphorus Bridge is part of the 260 km long Northern Marmara Motorway. The bridge, which is 2.2 km long with a main span of 1.4 km, links Europe to Asia, north of Istanbul. With its width of 59 m, this is the first bridge of the world that accommodates an 8 - lane highway and a 2 - lane railway at the same level.

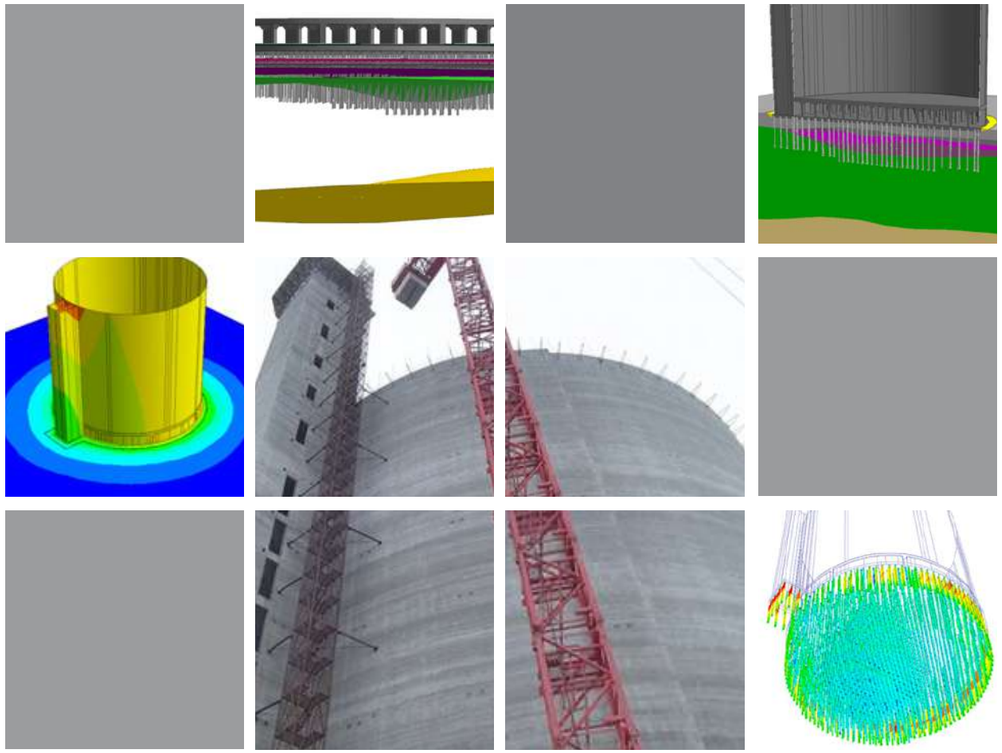


Foundation of Sugar Silo

Gostyn, Poland

GT PROJEKT

Engineering Consultant	GT Projekt
Construction Period	2012 - 2013
Project Type	Silo Foundation
Size of the Structure	50m Diameter, 70m Height, 80,000 tons Capacity
Main features in modelling	- Linear static analysis with construction stages - Hardening soil material and soil - pile interface elements
Description on this project	Special solution was needed for the largest sugar silo in Poland because it would sit on soft soil. It was determined that more than 1,000 displacement piles was needed for the foundation following the design with advanced analysis.

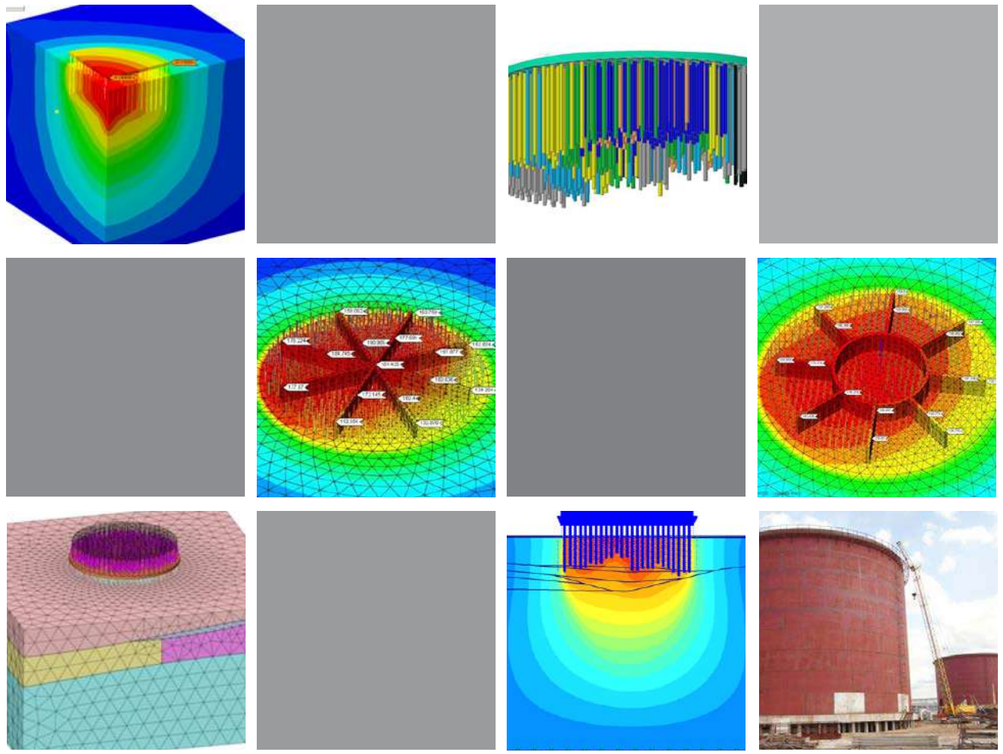


Isothermal Tank

– Storage of Liquefied Hydrocarbons

Leningrad, Russia

Owner	NIPIgaspererabotka
Engineering Consultant	GEOTECH
Construction Period	Completed in 2012
Project Type	Foundation Design
Size of the Structure	20,000 m3
Main features in modelling	Nonlinear analysis with pile elements
Description on this project	Three - dimensional simulation of pile-raft foundation with elastic - plastic deformation of the ground model was considered. The number of foundation's final design used 497 piles, which were modeled with special pile elements in midas GTS NX.

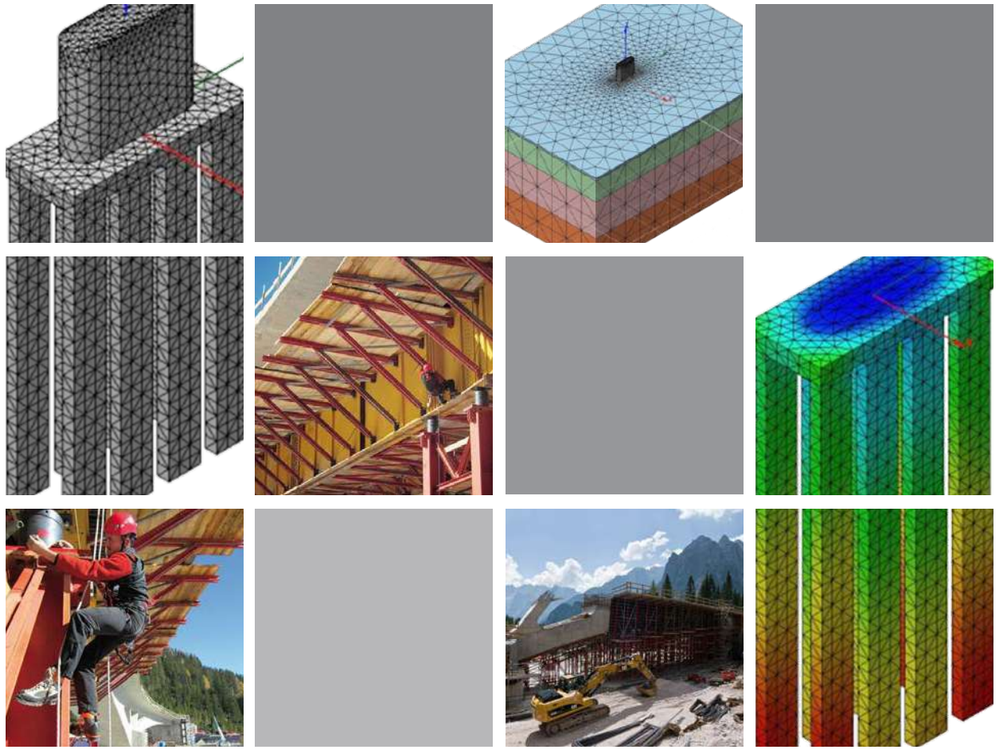


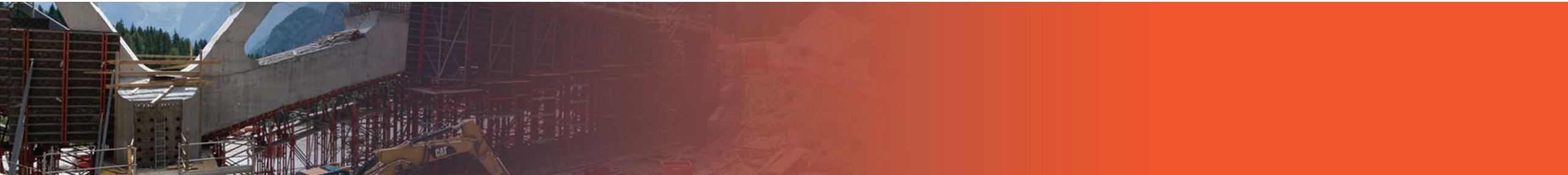
Bridge on the River Rudavoi
- Cortina d'Ampezzo

Belluno, Italy

ULMA

Engineering Consultant	ULMA Construction
Size of the Structure	180m Total Length
Main features in modelling	- Construction stage analysis - Stability analysis for the pier foundation of bridge
Description on this project	After the pier construction, the bridge was completed in three stages. The 70m long stretch between the abutment and the pier was built with horizontal beam - based formwork and full shoring. After concrete hardening and falsework removal, the same material was used in a symmetrical manner between the abutment and the pier on the other side of the bridge. A high capacity shoring tower on a temporary footing supports the central part of the bridge (40m).

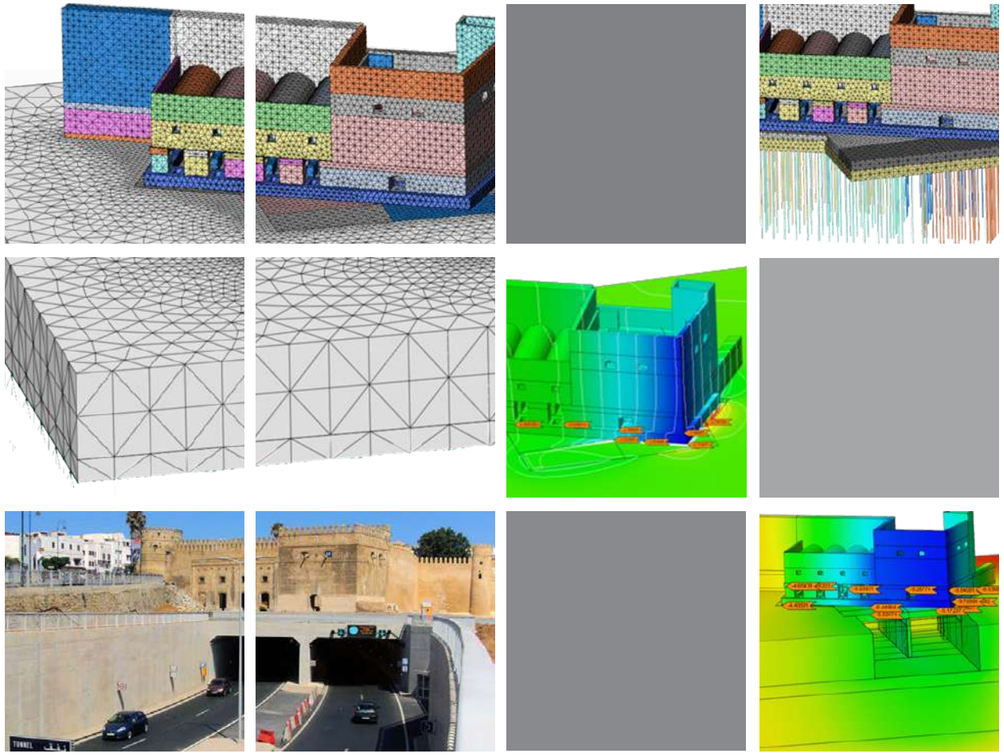




Oudayas Tunnel
- Royal Palace
Rabat, Morocco

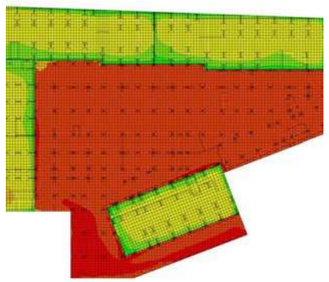
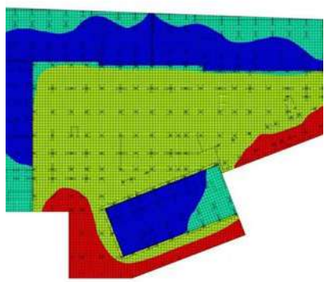
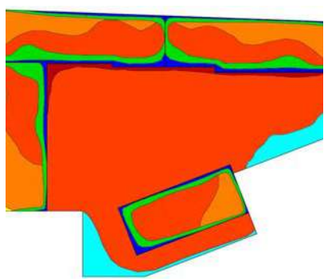
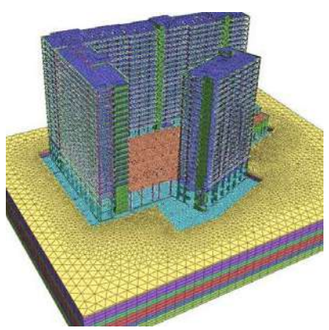
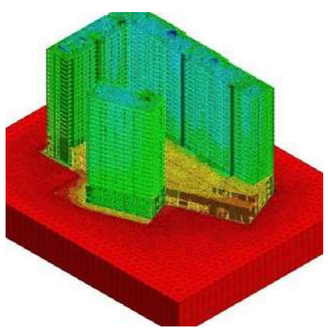
Alpina

Owner	Royaume du Maroc - Agence pour l'Am nagement de la Vall e du Bouregreg
General Contractor	Pizzarotti
Engineering Consultant	Alpina
Construction Period	2007 - 2011
Project Type	Road Infrastructure
Main features in modelling	- Tunnel construction under the complex historical landmark - Modeling of micropiles, berlin wall and slab
Description on this project	The new roadway project is characterized by an extension of tunnel entrance that lies underneath the Des Oudayas monument complex. The complex consists of two historic buildings, the fortress, the library, the walls of the Kasbah, and an Andalusian garden. The design of the Des Oudayas Tunnel was necessary to ensure the stability, integrity, and safety throughout all the excavation and construction phases given the excavation's location under the historic structure. The design had to additionally consider the interaction between two parallel 300 m tunnels with on-going traffic.



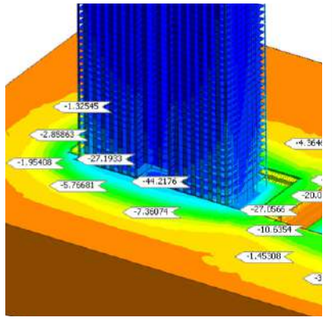
Soil Structure Interaction Differential Settlement

The complex consists of four buildings with 22 above ground and 2 underground floors.
The foundations are monolithic reinforced concrete slabs.
The differential settlement under the applied load and the superstructure were calculated considering the nonlinearity of the soil and interaction with the foundation.

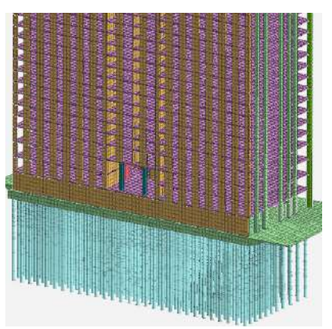
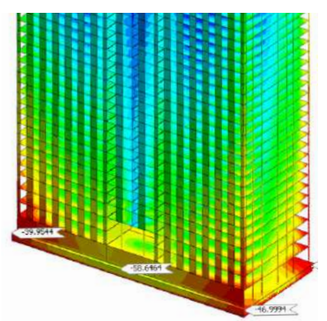






Soil Structure Interaction Differential Settlement

Calculate overall deformations and the member forces of pile foundations,
and the effect on existing community and school buildings.
This is to ensure the safety of existing community and schools.
The high-rise building has a dimension of 29 x 70m and 108m in height.

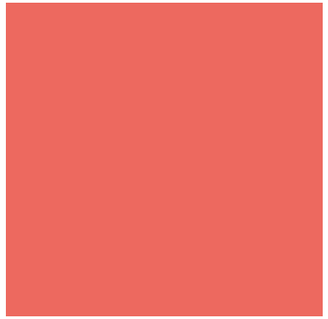
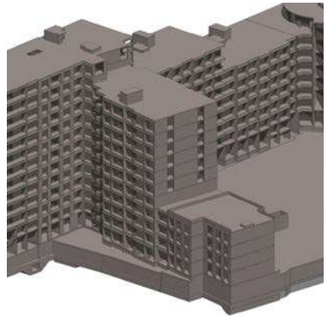
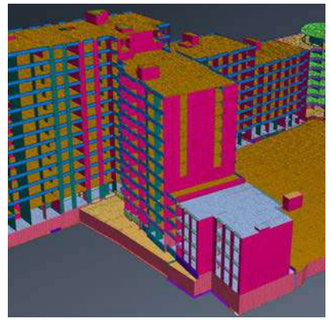
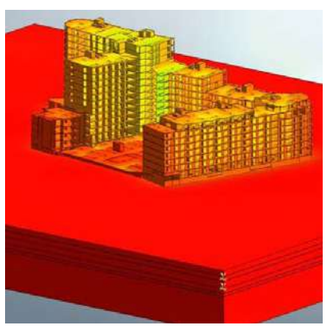
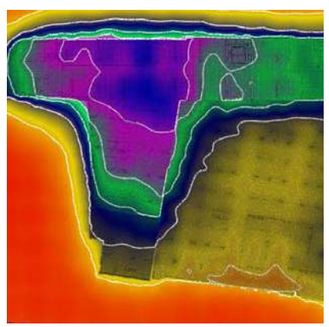
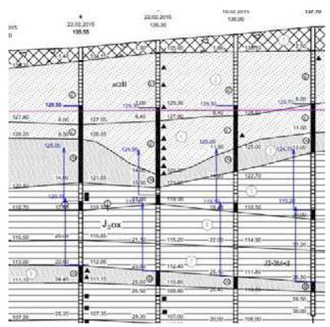





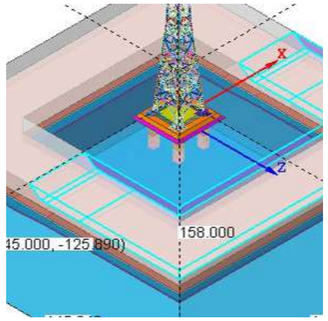
Soil Structure Interaction Differential Settlement

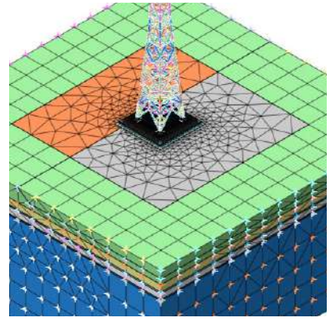
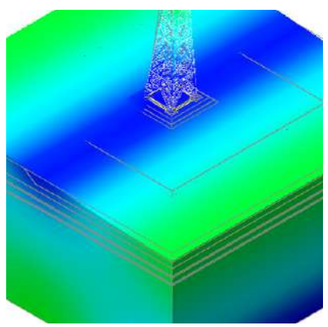
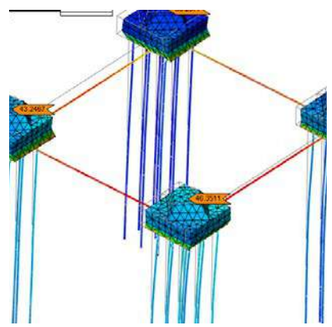
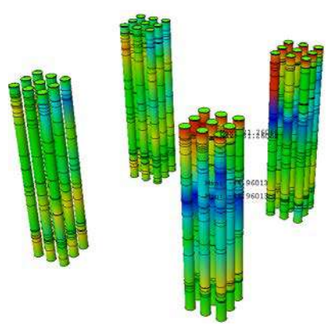
Full soil structure interaction analysis was used to determine the differential settlement considering the nonlinearity of each soil layer.
The superstructure was created with Autodesk Revit and then transferred to MIDAS while the strata data were imported from Excel tables with boring hole data.

Soil Structure Interaction Foundation Design

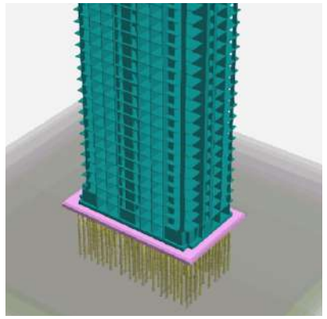
In this project, the combinations of loads and the impacts caused by an earthquake were considered in the foundation design. Bored piles were modeled by 28m long beam rods connected to the surrounded soil with pile interface elements.

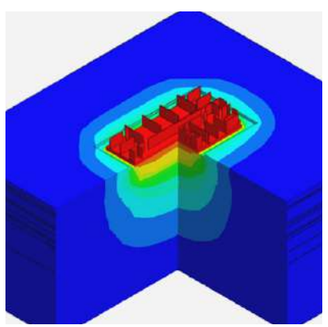
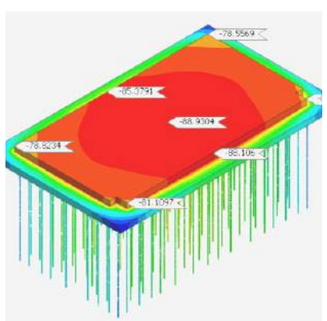


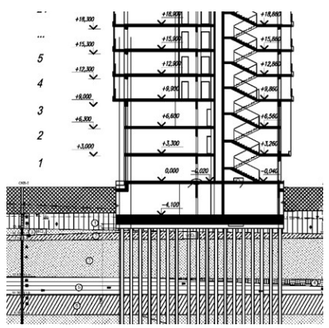





Soil Structure Interaction Differential Settlement

Given the location's soft soil and high water level conditions, the foundation design had to consider both the super and sub structure in same 3D finite element model.

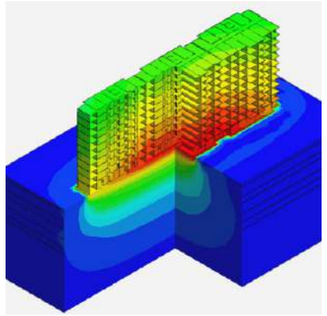
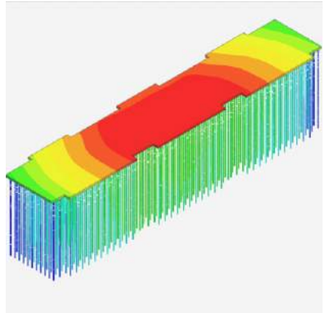
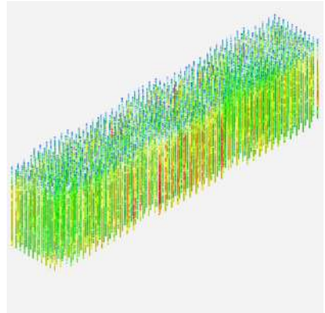




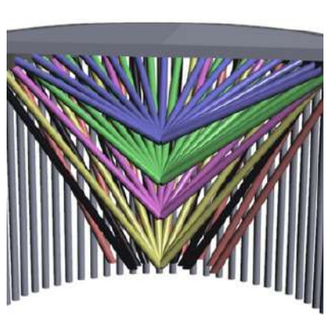
Soil Structure Interaction Foundation Design

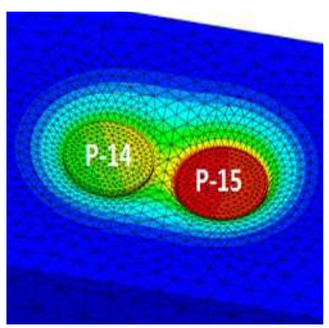
In order to decide the most optimized foundation type considering the field conditions, soil structure interaction analysis were carried out with the different types of foundation in terms of the size, spacing, and material types.

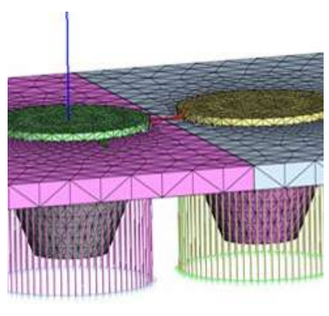





Soil Structure Interaction Reinforcement Design

A 3D model with Jet-piles was developed to determine how to strengthen the base of two reservoirs that sat on fully saturated silt and clay layers. The analysis results were compared with the field measured data.

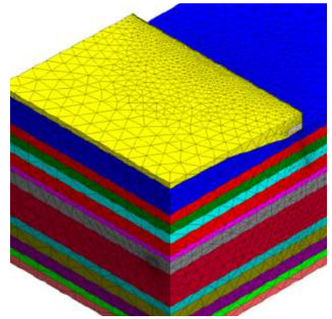


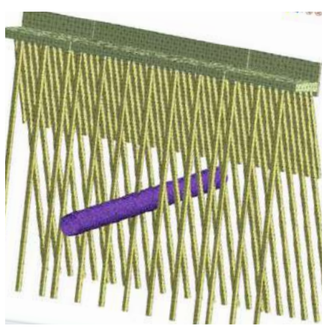




Soil Structure Interaction Pile Design

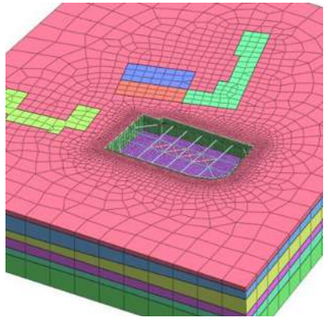
A new tunnel was to pass beneath an existing embankment sustained by a foundation with vertical and inclined piles. A 3D construction stage analysis was required to check the stress redistribution of each pile and calculate the effect of the new tunnel excavation.



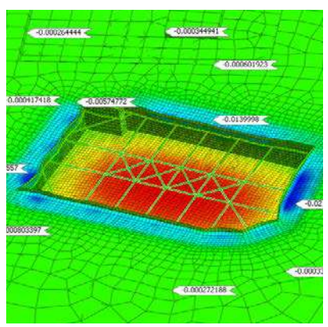
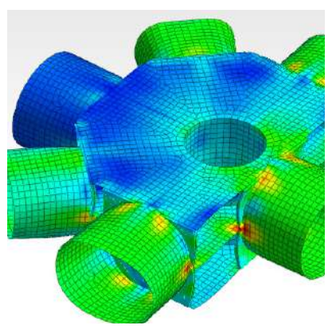


Soil Structure Interaction
Effect on Adjacent Structures

A reinforced concrete building was designed to account for a 2-level underground parking lot and ground water pressure. The excavation pit was supported by a fence with single spacer system made of pipes.

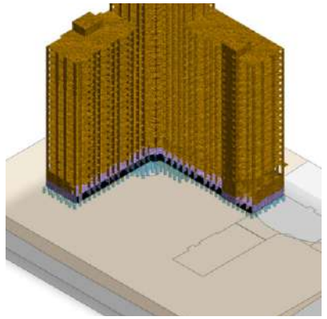


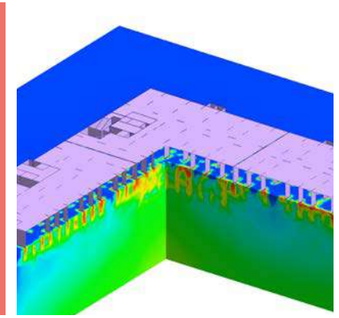
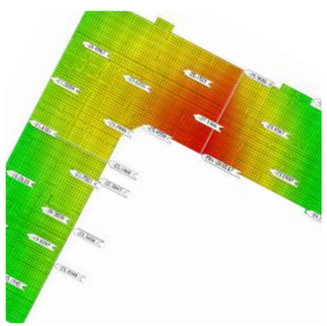
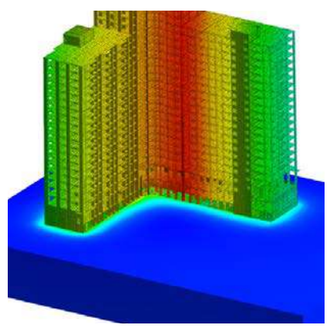


Soil Structure Interaction
Reinforcement Design

A 3D soil structure interaction analysis was carried out to evaluate how to strengthen the base under the high-rise residential building complex. The reinforcement of the base includes a jet-pile arrangement of different lengths under each section of the building.




TUNNELING / UNDEGROUND SPACE

Analysis methods

Linear / Nonlinear Static Analysis

Construction Stage Analysis

Fully-Coupled Stress-Seepage Analysis

* Dynamic Analysis (Seismic Capacity)

Design considerations

Excavation methods / Reinforcement design

Earth pressure (Soil status) / Hydraulic conditions

Adjacent services and structures / Connections

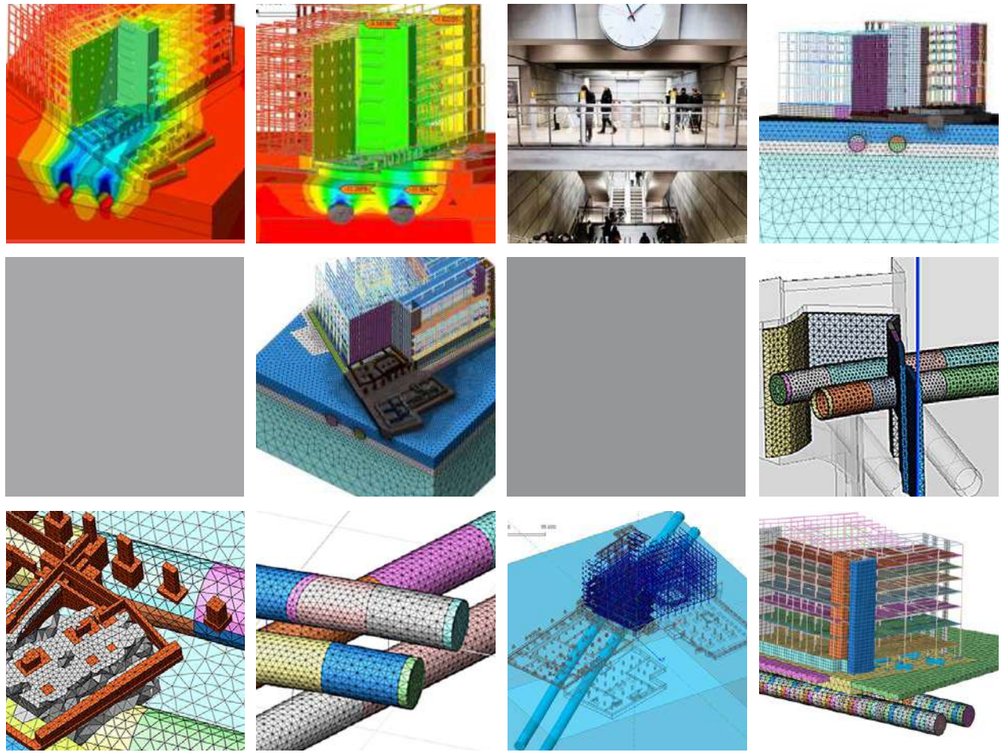
Stress relaxation / Contraction

Cityringen Copenhagen Metro

Copenhagen, Denmark

Lombardi

Owner	Metroselskabet
Engineering Consultant	Lombardi
Construction Period	2011 - 2017
Project Type	Subway Station
Size of the Structure	15,5 km long twin single - track metro tunnels,
Main features in modelling	- Interaction between MIDAS family programs (Gen & GTS NX) - Construction stage analysis for TBM
Description on this project	The Cityringen is a city circle metro - line, approximately 15,5 km long and will serve major areas of the city of Copenhagen including the Danish Parliament, the Central Station, the City Hall, existing major S - train and metro stations and national monuments. The line will have driverless communication - based train control system, with stewards on board. A round trip is expected to take 23 minutes. The headway interval is expected to be 200 sec., with 28 trains of 3 carriages running at 90 km/h.

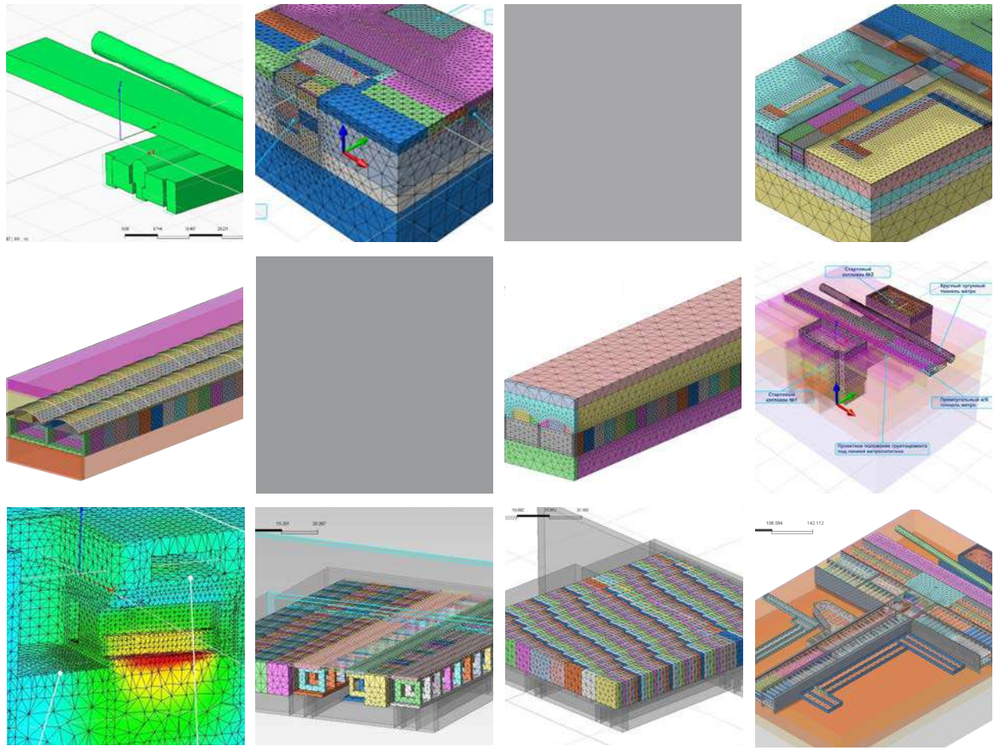


Two - Level Traffic Interchange

Copenhagen, Denmark

Lombardi

Owner	Government of Moscow
Engineering Consultant	Podzemproekt
General Contractor	NPO 'Cosmos'
Construction Period	2007 - 2015
Project Type	Underground Tunnel
Size of the Structure	- Reconstruction of the Leningrad tunnel (660m Length, 12 - 14m Depth) - Construction of Volokolamsk tunnel (1.73km Length, 20m Depth) - Construction of overpasses (390m Length) - Construction Halabyan - Baltic tunnel (1.94km Length, 22.5m Depth)
Description on this project	- Construction stage analysis - Tunneling effects on adjacent structures
Main features in modelling	New tunnel excavations in highly dense urban area were complicated by saturated sand conditions and existing deep tunnels, 3D FEM analysis was required to consider settlement of nearby residential buildings as well as the interaction with two currently operational subway and highway tunnels during construction.

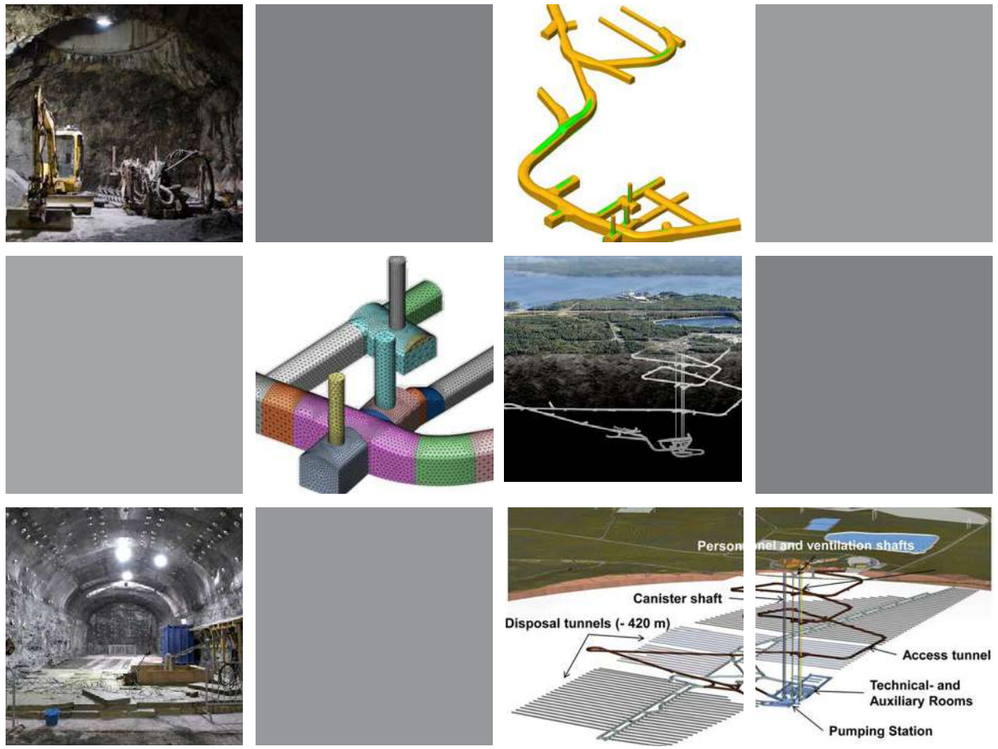


Posiva's ONKALO

Eurajoki, Finland

POSIVA

General Contractor	Kalliorakennus Oy, SK - Kaivin Oy and Destia Oy
Engineering Consultant	Posiva
Construction Period	2004 - Under Construction
Project Type	Nuclear Waste Disposal Facility
Size of Structure	455m Depth
Main features in modelling	- Stability of hard rock excavations in depth up to 500 m and to optimize rock support system - Impact of vibration due to blasting and groundwater level on underground cavern
Description on this project	The Onkalo Spent Nuclear Fuel Repository is a deep tunnel system for the final disposal of spent nuclear fuel. It is first of such repository in the world. It is currently under construction at the Olkiluoto Nuclear Power Plant in the municipality of Eurajoki, on the west coast of Finland, by the company Posiva. It is based on the KBS - 3 method of nuclear waste burial developed in Sweden by Svensk Karnbranslehantering AB (SKB).

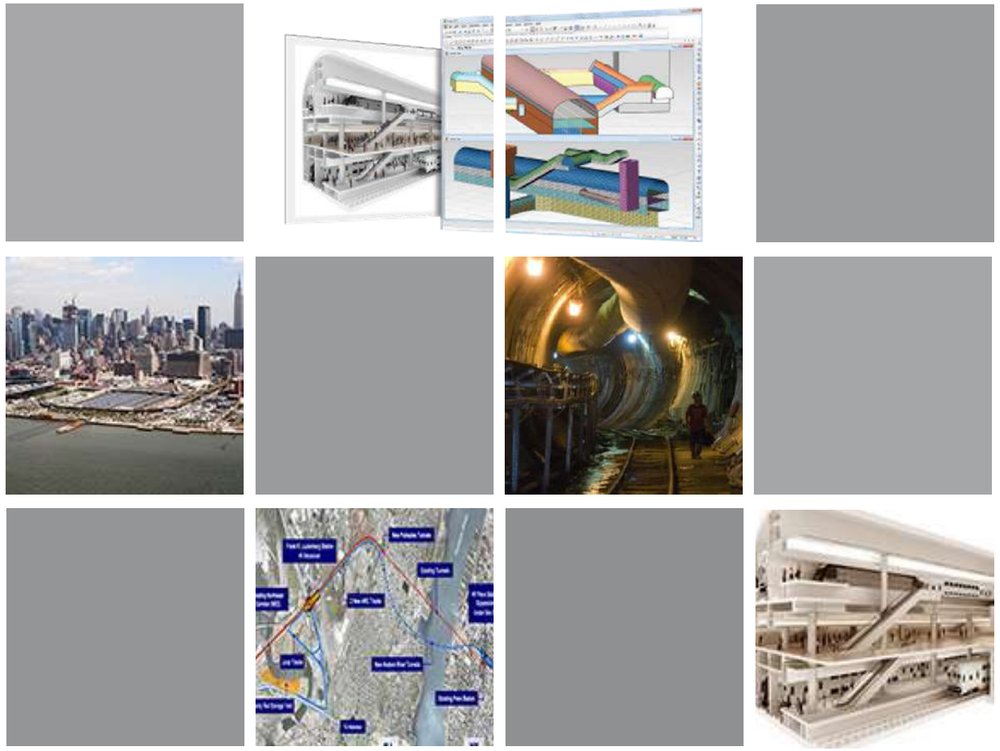


Trans - Hudson Express

New York, USA

Owner	NJ Transit and Port Authority of New York and New Jersey
General Contractor	THE Partnership JV
Engineering Consultant	ILF Consulting Engineers
Construction Period	2009 - 2010
Project Type	Rail Tunnel
Size of Structure	- Palisades Tunnels (1,6km Length) - Hudson River Tunnels (2,3km Length) - Manhattan Tunnels (2km Length) - Station Cavern (29m Wide, 27m Height)
Main features in modelling	- Construction sequences of the subway complex - Stability of lining structures and rock bolts

Description on this project	- NYPSE Caverns and Ancillary Tunnels
	  - Evaluated geotechnical ground properties, geotechnical/geological models developed
	  - Defined excavation stages/sequences
	  - Designed initial ground support
	  - Predicted surface settlements
	- Provided Overbuild Criteria to specify magnitude, distribution and location of loading due to future overbuild along both sides of 34th Street

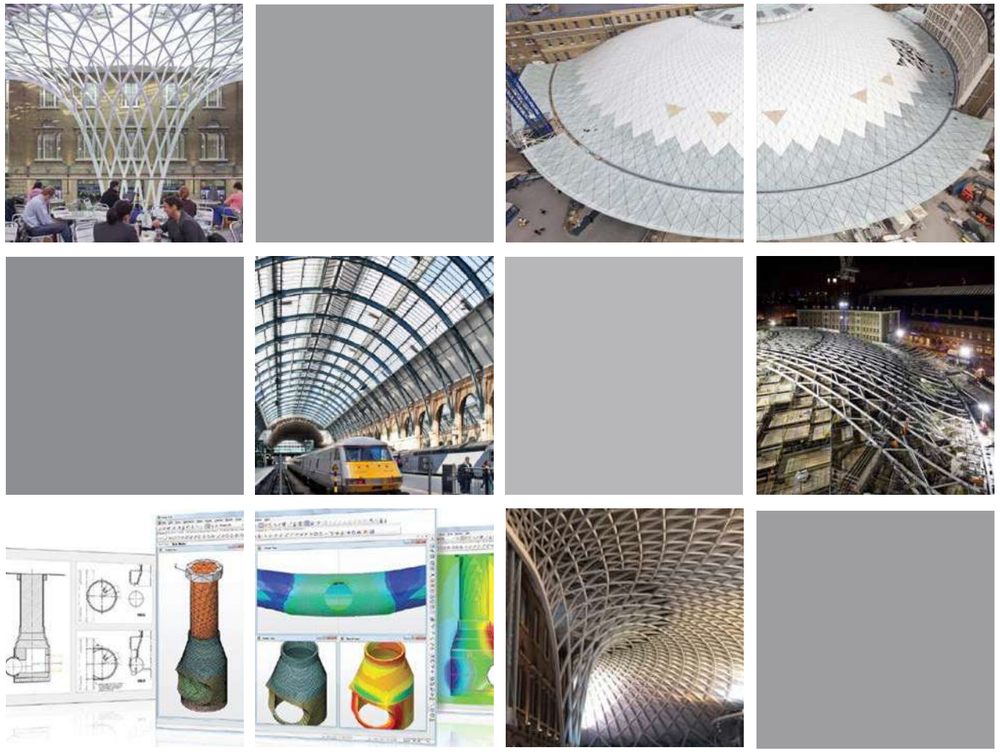


King's Cross Station

London, United Kingdom

ARUP

Owner	Network Rail
Architecture	John McAslan + Partners
Engineering Consultant	Arup/Morgan Sindall
Construction Period	2008 - 2013
Project Type	Railroad Station
Main features in modelling	- The section of the existing tunnel where the shaft intersects is strengthened with block work. - The cylindrical section of the shaft is built with segmental lining. - The tapered section of the shaft is built in 1 m deep stages and lined with sprayed concrete.
Description on this project	The redevelopment of King's Cross station in the city of London is turning a historic rail terminus into a dynamic transport hub. Arup's work as a lead consultant on King's Cross station embraced transport planning, multi-disciplinary engineering services, security, IT, lighting design, acoustics, visualization, and pedestrian modeling



Hangzhou Yintai City Foundation Pit

Hangzhou, China

华东勘测设计研究院有限公司
HUADONG ENGINEERING CORPORATION LIMITED

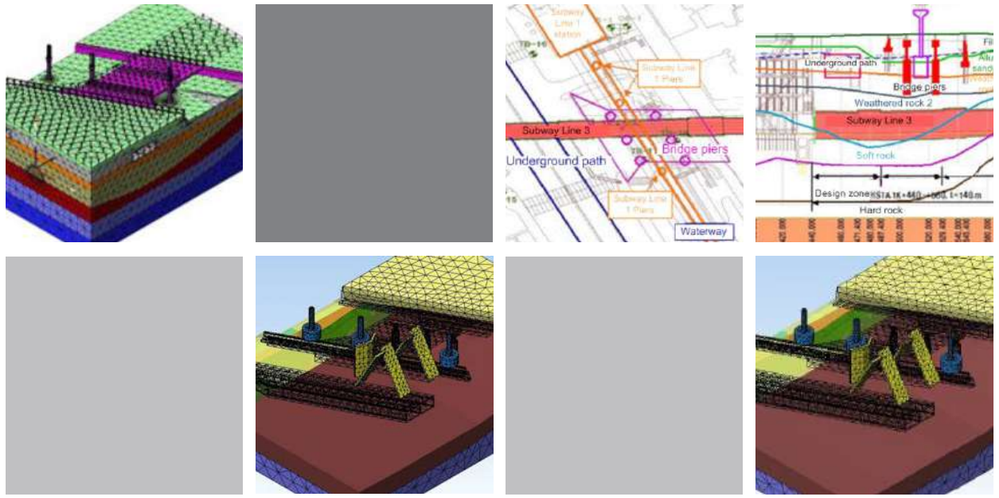
Owner	Intime Group
Engineering Consultant	East China Investigation and Design Institute
Construction Period	2013 - 2015
Size of the Structure	400m Length, 1.3km Total Length
Main features in modelling	The basic excavation depth of the project is 15.6m ~ 17.4m and the local pit depth is 23.7m. The commercial part is close to the Hangzhou subway station and shield tunnel (two adjacent to the subway station, two other near the shield tunnel), the envelope from the subway station and tunnel is 12.0m ~ 15.2m.
Description on this project	This project is located in Hangzhou Linping District. The foundation pit will use bored piles and will have irregular triangular shapes. The Foundation Pit was to be excavated by stages and most additionally consider 5 basements that will be used for commercial retail.

Busan Subway Line 3 Tunnel

- Zone 321

Busan, Korea

ORUM

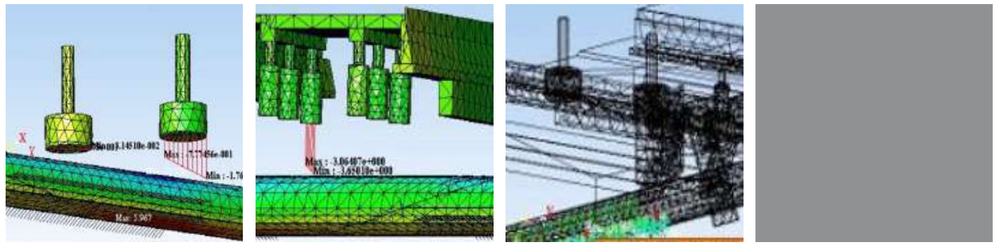


Design for construction

Performing construction stage analysis to check the settlement while checking the initial support capacity for the fan plant structure.

Overview

Two types of analysis were performed based on different 3D model files. The full underground structure was modeled to monitor the initial support capacity including rock bolts and shotcrete, at structural level. A construction sequences analysis of the fan plant was ran to obtain the general stability and settlements of the soil layers, at geotechnical level.



ARC: Trans-Hudson Express Dyer Avenue Fan Plant

W 33rd street, NY, USA

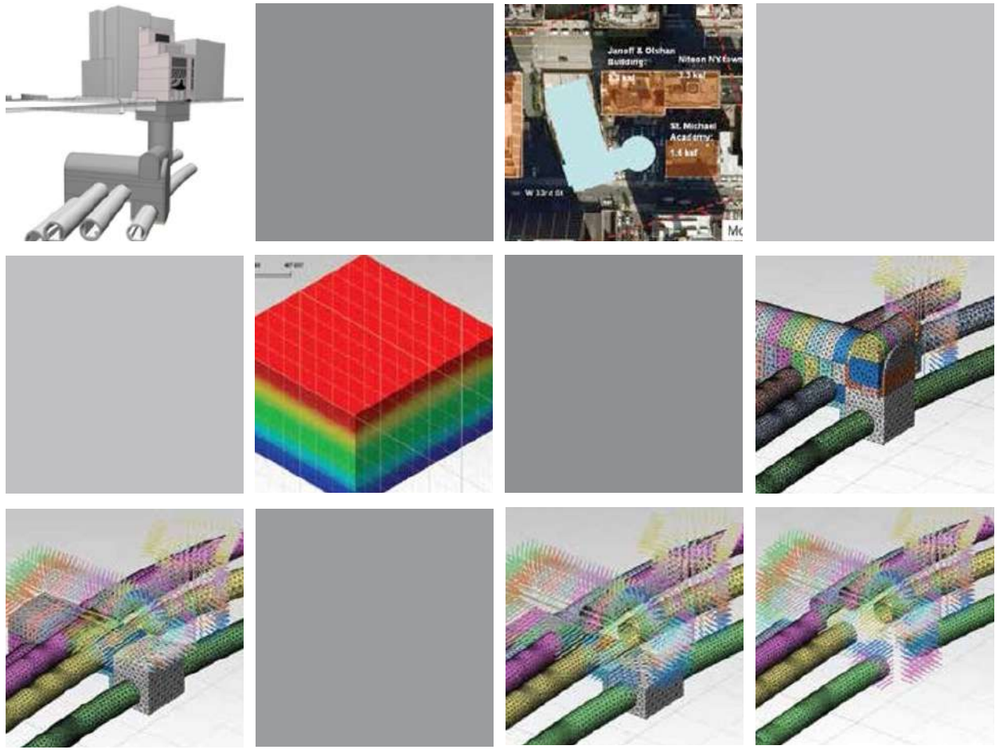
WSP | PARSONS BRINCKERHOFF

Numerical simulation

Performing construction stage analysis to check the settlement while checking the initial support capacity for the fan plant structure.

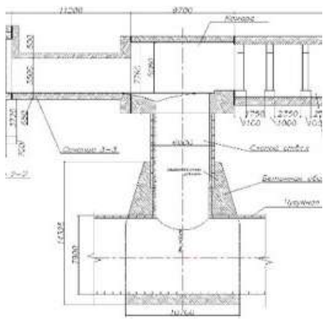
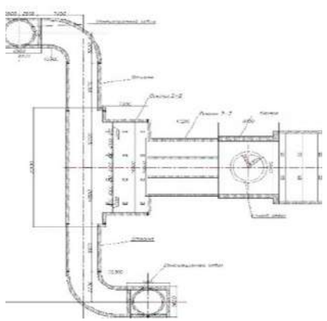
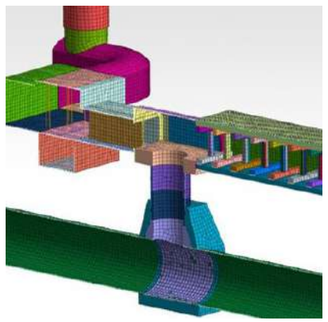
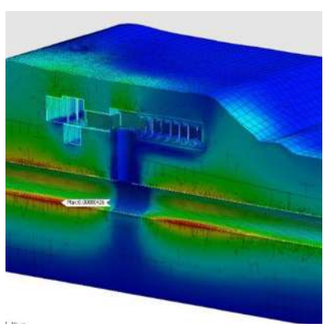
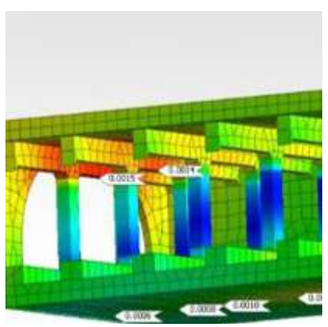
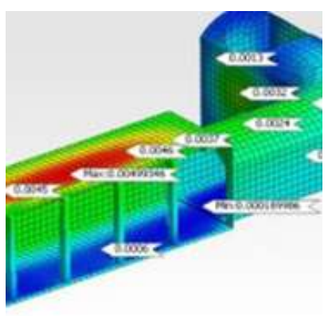
Overview

Two types of analysis were performed based on different 3D model files.
The full underground structure was modeled to monitor the initial support capacity including rock bolts and shotcrete, at structural level.
A construction sequences analysis of the fan plant was ran to obtain the general stability and settlements of the soil layers, at geotechnical level.



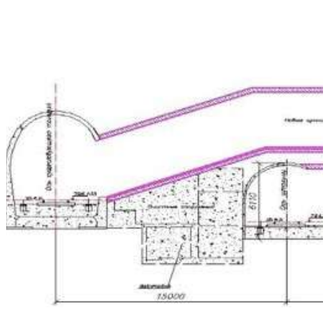
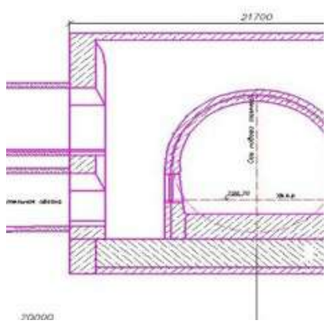
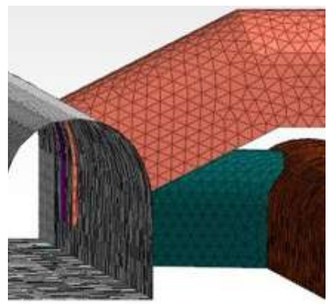
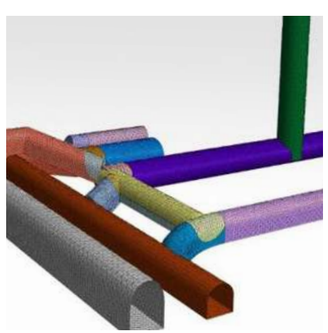
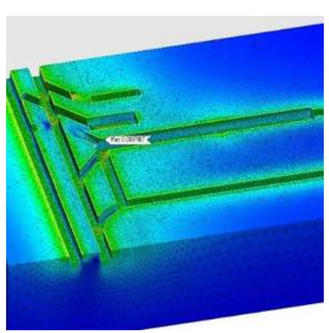
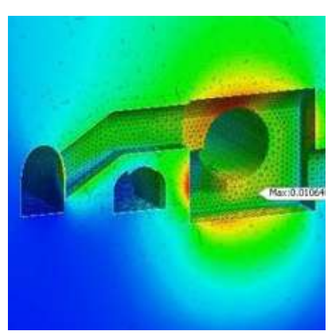
Tunnel Excavation Connection

When examining existing structures, it is necessary to perform verification calculations taking into account actual operating conditions. Because of the intersection of the several underground structures, 3D FE analysis was required to estimate the overall interaction behavior.

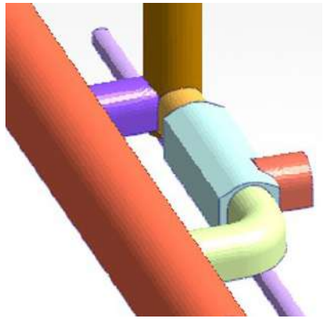
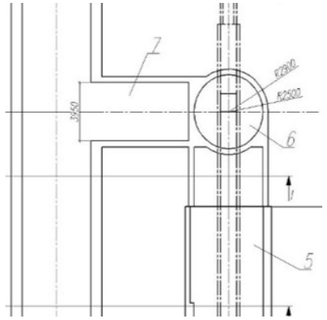
Tunnel Excavation Connection

When designing a new tunnel, it was necessary to assess the effect of the new construction on existing structures. As a result of the 3D FEM analysis, it was possible to estimate the overall deformation along the most critical area.

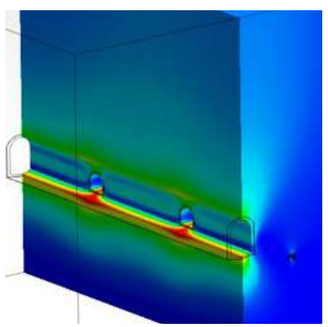
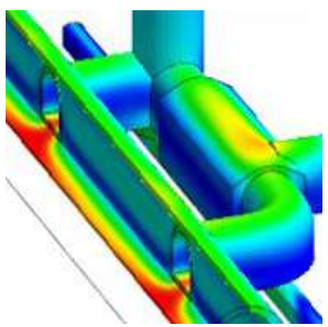







Tunnel Excavation Connection

This project was to assess the stress-strain state of underground structures under the real operating conditions, The main concern was the tunnel located near the additional excavations for galleries and ventilation trunk,

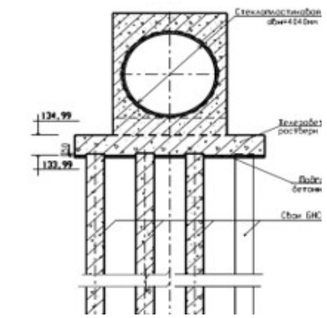



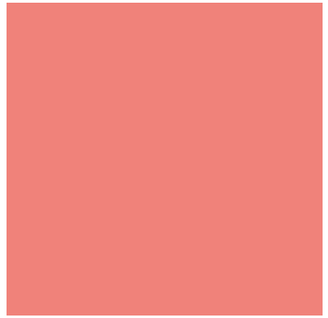
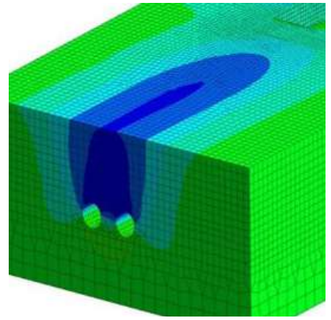
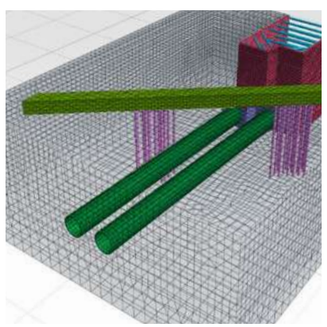
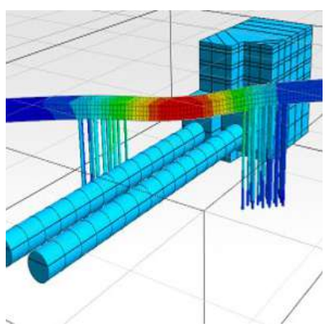


Tunnel Excavation Connection

The main objective of this project was to maintain the operational availability of the reservoir in connection with the construction of new tunnels,
For the reinforcement of the existing structure, bored piles with a diameter of 800mm and a length of 26m were installed under the structure,




EXCAVATION / RETAINING WALL

Analysis methods

Construction Stage Analysis

Fully-Coupled Stress-Seepage Analysis

Slope Stability Analysis

* Dynamic Analysis (Seismic Capacity)

Design considerations

Support system / Type of wall

Internal / external stability

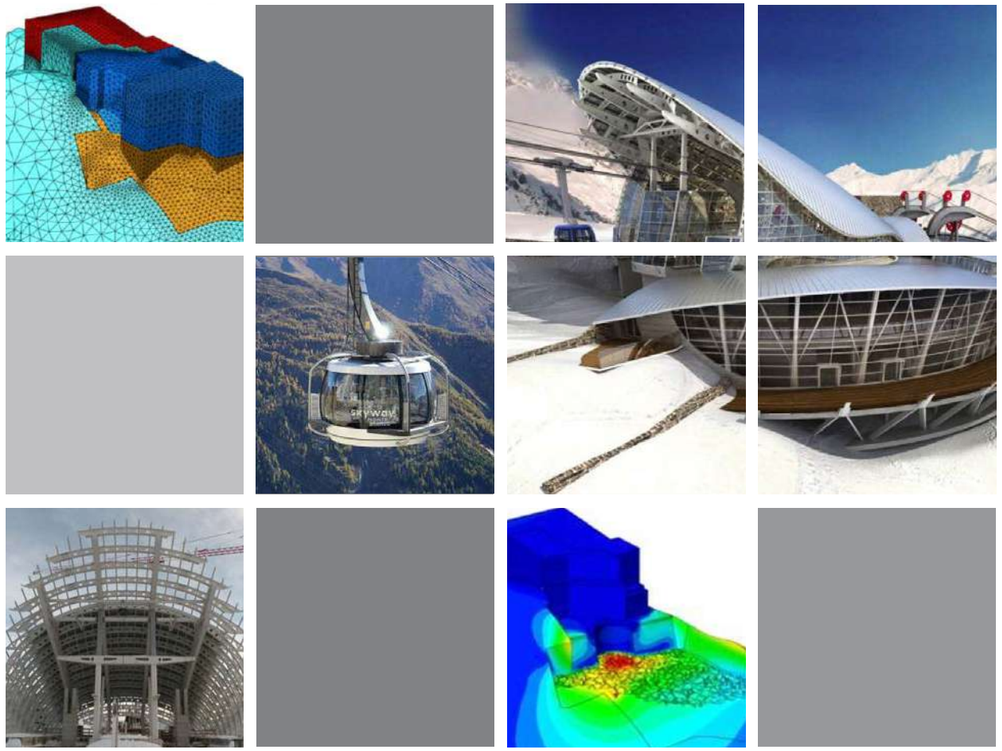
Deformations during and after construction

Effect on adjacent structures

Skyway Monte Bianco
- Funivia del Monte Bianco

Courmayeur, Italy

Owner	Funivie Monte Bianco AG
General Contractor	Cogeis
Engineering Consultant	Holzner & Bertagnolli Engineering
Architecture	Studio Progetti
Design	Dimensione Ingenierie
Construction Period	2010 - 2015
Project Type	Aerial Lift
Main features in modelling	- Rock excavation stability on top of the mountain - Tensile variations of the existing tie rods cableway
Description on this project	The cable car in Aosta Valley, at the entrance to the Mont Blanc tunnel, leads from Courmayeur to 1,200m above sea level. The new cable car valley station is being built near an existing station, as well as a restaurant which must remain operational. A 3D FEM analysis was required to analyze the interaction of the new construction and current adjacent structures.

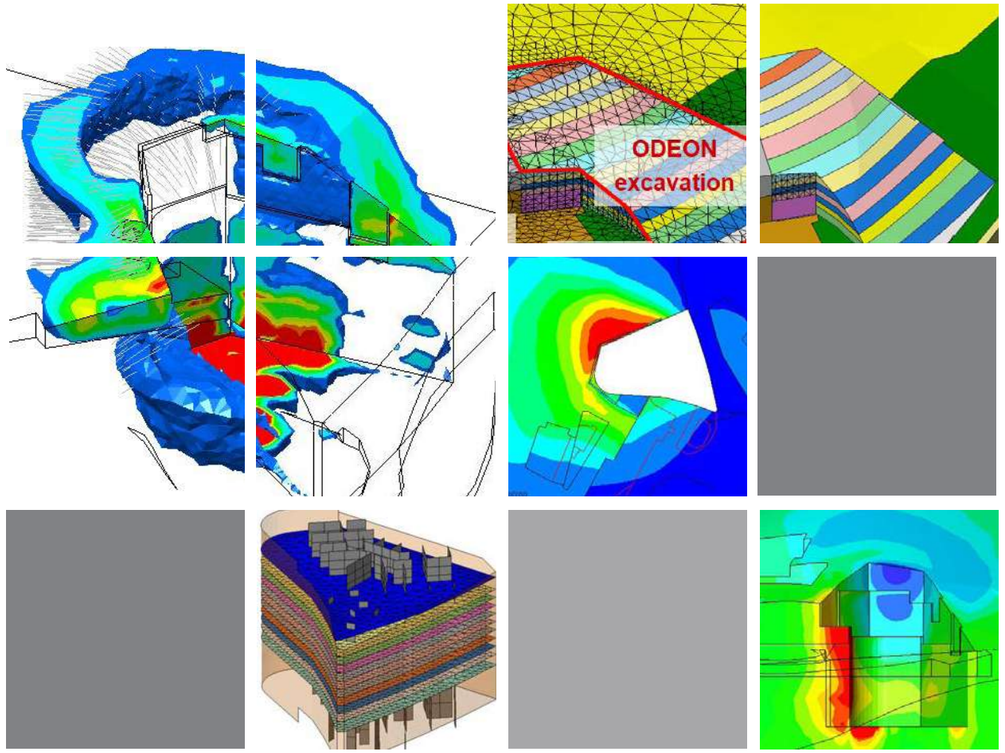


Odeon Tower

Mona

TRACTEBEL ENGIE

Owner	Group Marzocco
General Contractor	Vinci Construction France
Engineering Consultant	Coyne et Bellier
Architecture	Alexandre Giraldi
Construction Period	2010 - 2015
Project Type	Office Building
Size of the Structure	170m Height (49-Story)
Main features in modelling	- Assessment of ground movements especially at adjacent building foundations - Deep excavation in a sloping site and retaining system (especially arching effects on the uphill side)
Description on this project	The Odeon Tower is a double - skyscraper in the Principality of Monaco. It was the first high-rise in the city to be built since the 1980s. But high-rise constructions had been abandoned due to aesthetic concerns and criticism of over-development. 3D model of excavation and construction sequence was necessary to ensure adjacent school buildings will not be affected.

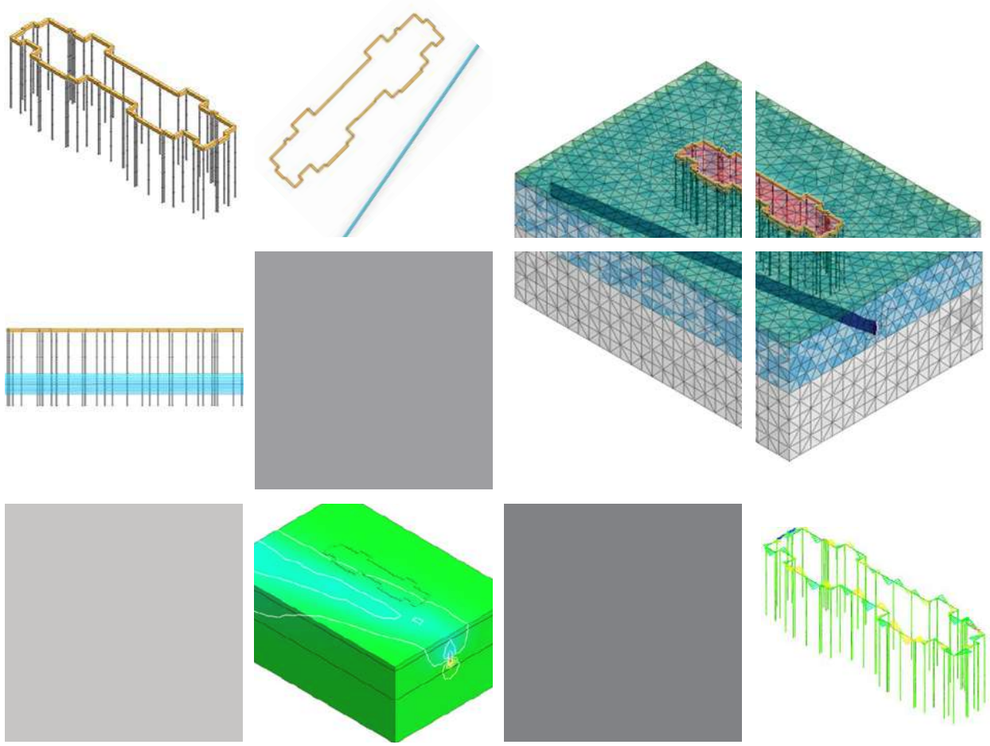


Hefei Metro Line 4

Anhui, China

安徽省交通规划设计研究总院股份有限公司
Anhui Transport Consulting & Design Institute Co.,Ltd.

Owner	Hefei Urban Mass Transit Co., Ltd
Engineering Consultant	Traffic Planning and Design Institute of Anhui Province
Construction Period	Completed in 2015
Project Type	Subway Tunnel
Size of the Structure	68,2×17,2m the Foundation pit
Main features in modelling	The impact of shield construction on buildings
Description on this project	Hefei subway tunnel would be excavated next to a high-rise building with a 21m long pipe pile foundation. The building's foundation runs parallel to the tunnel excavation for an extended segment of the new project. Theorefore, 3D FEM model was required to verify differential settlement on the existing structure.

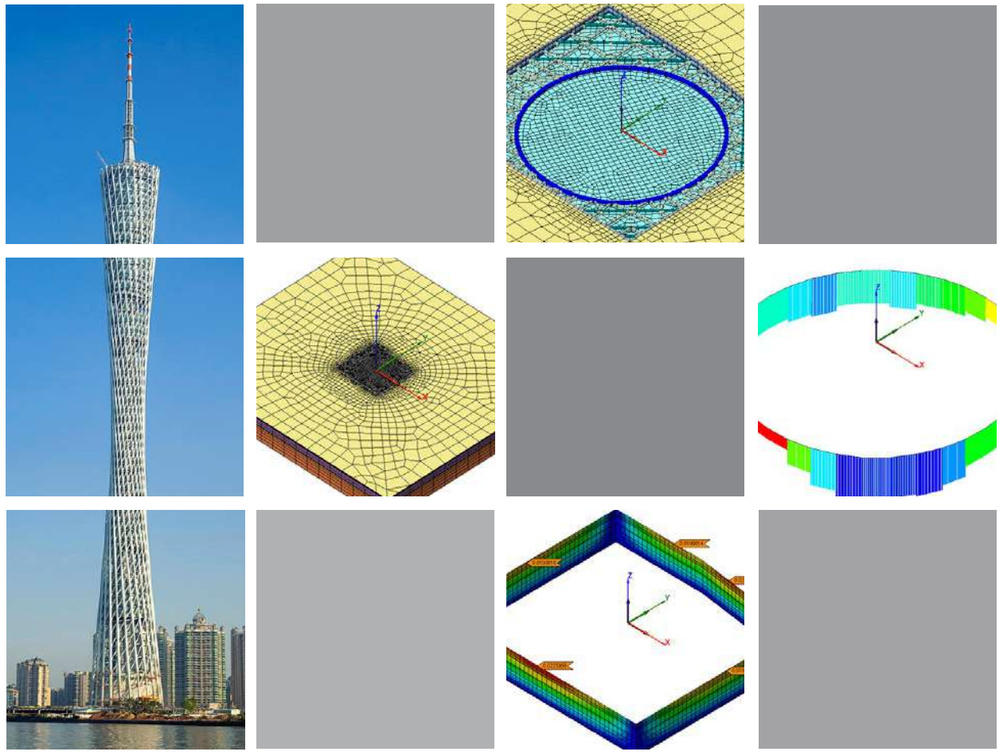


Canton Tower Foundation Ditch

Guangzhou, China

ARUP

Owner	Guangzhou New TV Tower
General Contractor	Guangzhou Municipal Construction Group JV / Shanghai Construction
Architecture	Guangzhou Design Institute
Engineering Consultant	Arup
Construction Period	2005 - 2010
Project Type	Observation & Television Transmission Tower
Size of the Structure	600m Height
Main features in modelling	Foundation pit excavation stability analysis
Description on this project	Canton Tower is constructed as a composite tube-in-tube design, featuring a reinforced concrete core containing all the tower's services and vertical transportation which set inside an outer structure made up of a steel lattice. The two structural components then support series of smaller structures suspended within the tower at different elevations. The slenderness of the tower's design makes it especially vulnerable to sway in the wind, and requires the inclusion of a tuned mass damper system. A 3D FEM model with dynamic loads and construction stages was used to verify the foundation's stability during construction and operational use.



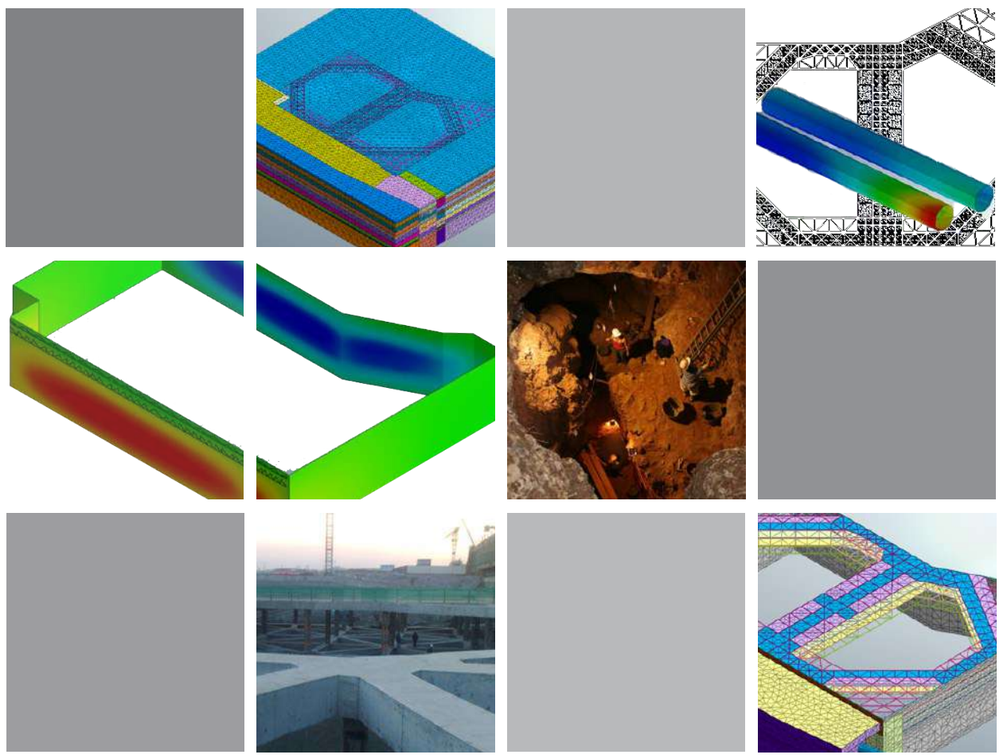
Hangzhou a Block of Commercial

- Financial Space Foundation Pit Works

Hangzhou, China

杭州市勘测设计研究院

Engineering Consultant	Hangzhou Survey and Design Institute
Size of the Structure	20m Height, 26,000m2Area
Main features in modelling	A 3D FEM analysis of the impact of excavation on the subway station and tunnel was used to ensure the design meets the requirements of metro deformation control standards while considering the safe use of existing facilities.
Description on this project	The excavation area is about 26,000m2 and a depth of 20.2m. The pile is constructed by using the bored piles. The excavation pit is surrounded by a building complex and the Metro Line 2 Qingchun Road Station. Analysis was required to verify the excavation will not affect adjacent structures.



Subway Impact Assessment

- Minam Complex Construction

Busan, Korea

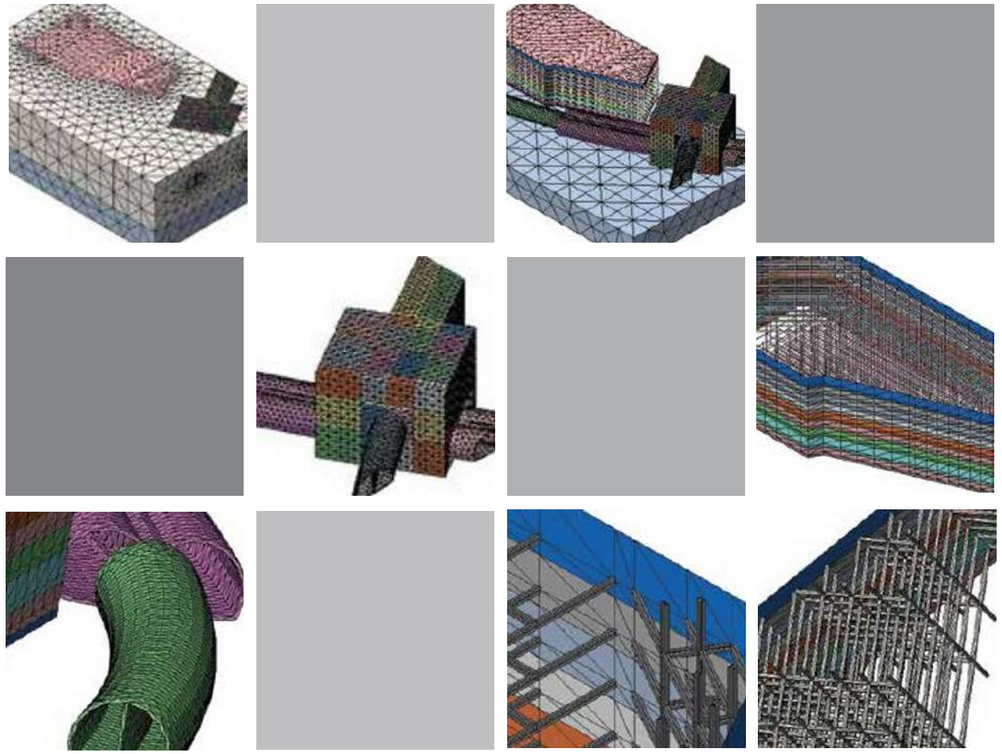
JIN YOUNG CONSULTANTS CO., LTD

Design for Construction

Investigation of existing subway structure subjected to excavation for new building construction.

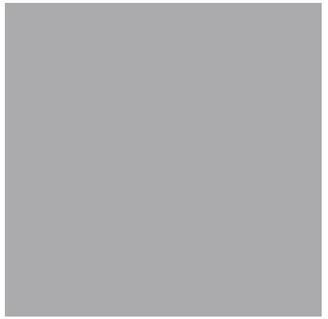
Overview

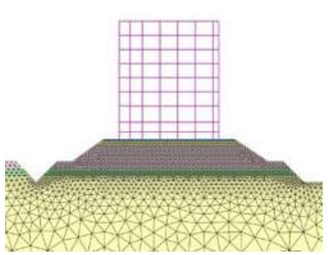
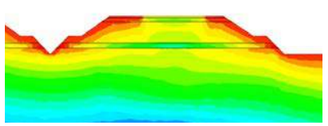
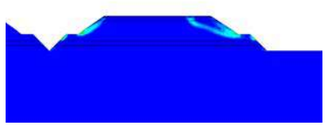
Safety investigation for 2-Arch tunnels and 1-Arch type tunnel where a large-scale excavation for a new building foundation takes place with temporary shoring within close proximity.



Deep Excavation
Effect of Adjacent Structure

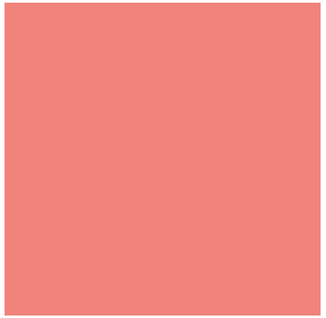
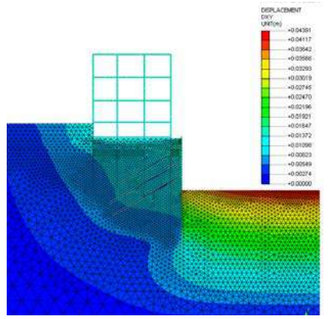
Stability of surrounding area was analyzed during the construction of the excavation of the 12.0m deep foundation pit, given that a 17-story panel house was erected close to the fence pipes at the edge of the excavation.

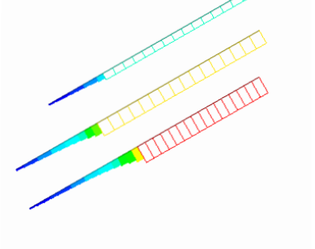



Deep Excavation
Effect of Adjacent Structure

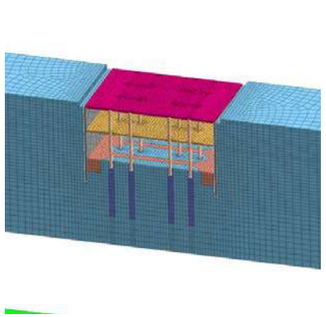
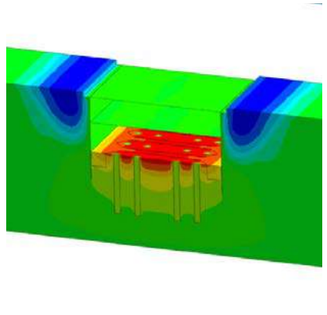
Construction stage analysis was carried out to assess the effect of adjacent structure during the deep excavation of a 15m pit.
18m anchors were used for stability of the retaining walls.



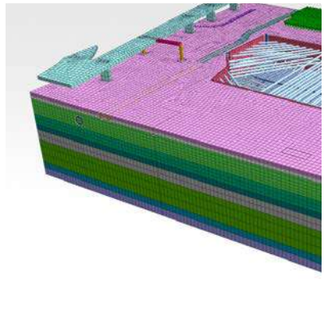
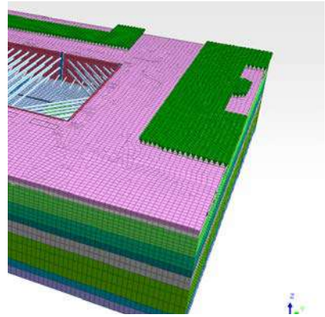
Deep Excavation
Pile Foundation

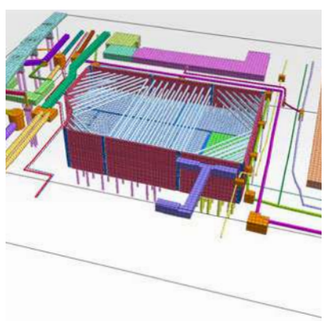
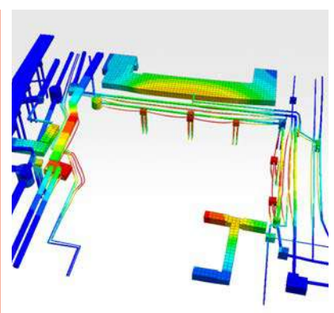
A construction stage analysis was used to design the complex foundation, which is a combination of piled raft and retaining walls with a thickness of 1m and depth of 36m. There is a three-story underground structure of rectangular shape with dimensions in the plan of 170.5m x 58m. Vertical bearing structures are steel columns, which are supported by piles with a diameter of 2m and a depth of 51m.


Deep Excavation
Effect of Adjacent Structure

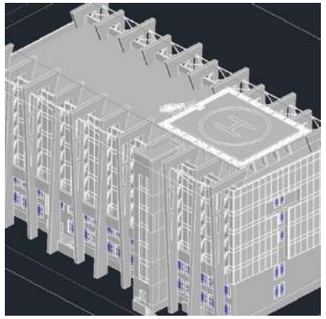
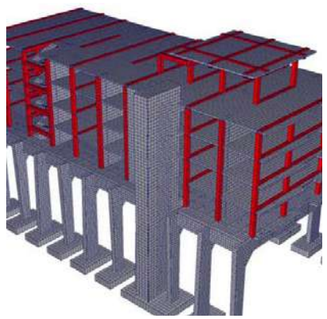
A 3D FEM analysis was used to calculate the impact on surrounding buildings and a network of pipelines during the excavation and construction of multi-functional complex with deep pile foundation.

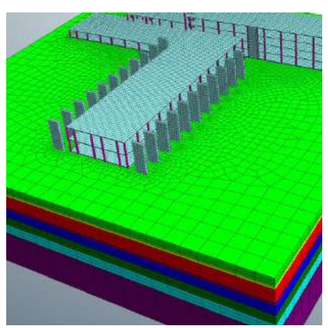
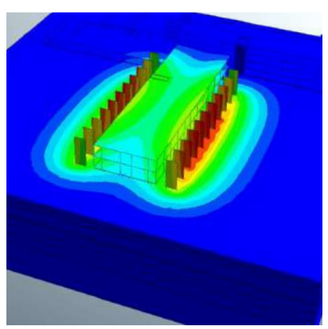



Deep Excavation
Effect of Adjacent Structure

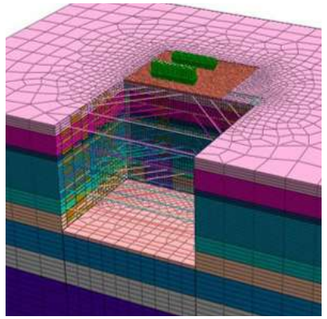
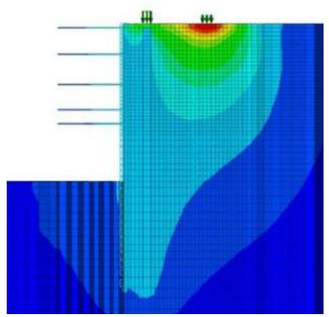
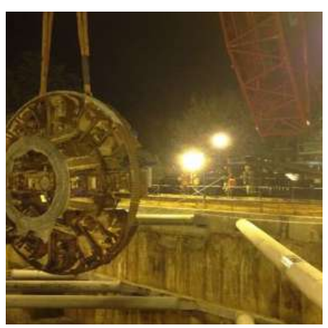
3D soil layers and all the structural members such as pylons, slabs and foundations were modeled completely, in order to asses the effect on the existing building due to the new construction,

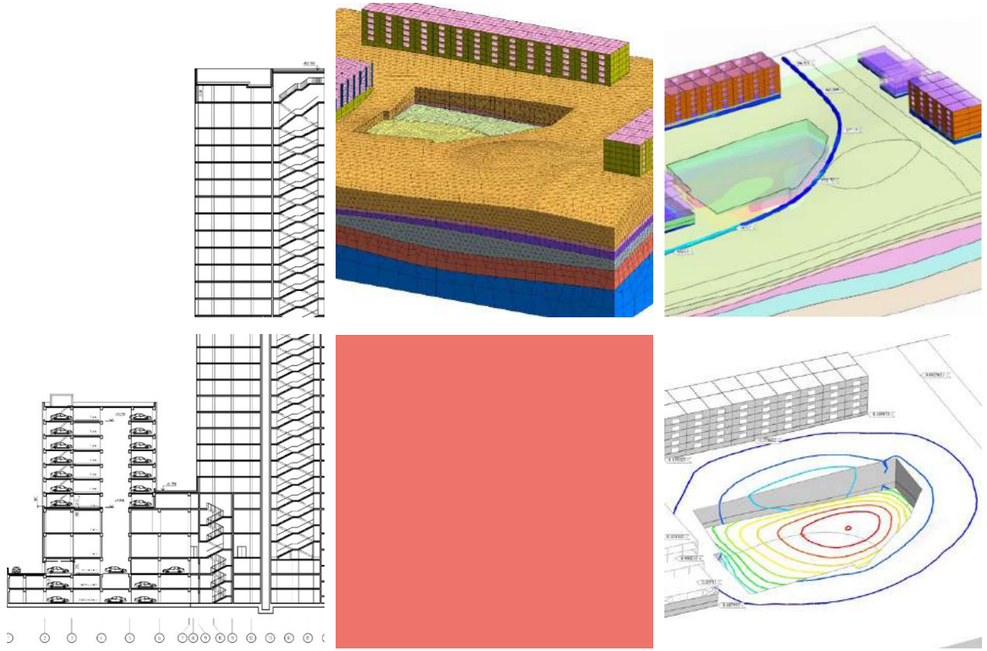
Deep Excavation
Effect of Adjacent Structure

The purpose of this project is to estimate the stability of the underground structures, Verification calculations of the underground structure of the foundation pit were carried out with 4 different geotechnical software including a 3D simulation in GTS NX,

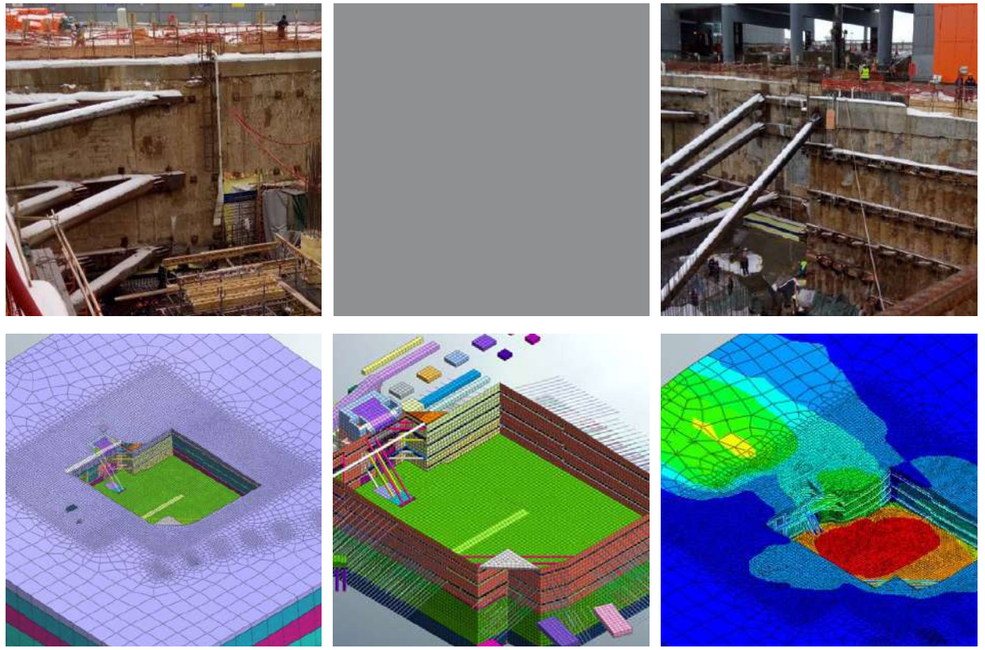

Deep Excavation
Effect of Adjacent Structure

The impact of the new excavation and the phased construction of a high-rise building on the existing buildings, structures was the most critical issue for this project.
Non-uniform soil layers including ground surface were taken into account for more realistic simulation.



Deep Excavation
Effect of Adjacent Structure

A 3D FEM model was necessary to assess the effects of tunneling and construction of a pit for the Southern Station Complex on existing airport facilities.



SLOPE STABILITY / DAM / EMBANKMENT

Analysis methods

Slope Stability Analysis (SRM / SAM)

Seepage Analysis

Fully-Coupled Stress-Seepage Analysis

* Dynamic Analysis (Seismic Capacity)

Design considerations

Min. Factor of safety / Reinforcement methods

Global stability / Potential failure

Dam stability considering water level fluctuations

Seepage face / Velocity / Hydraulic gradient

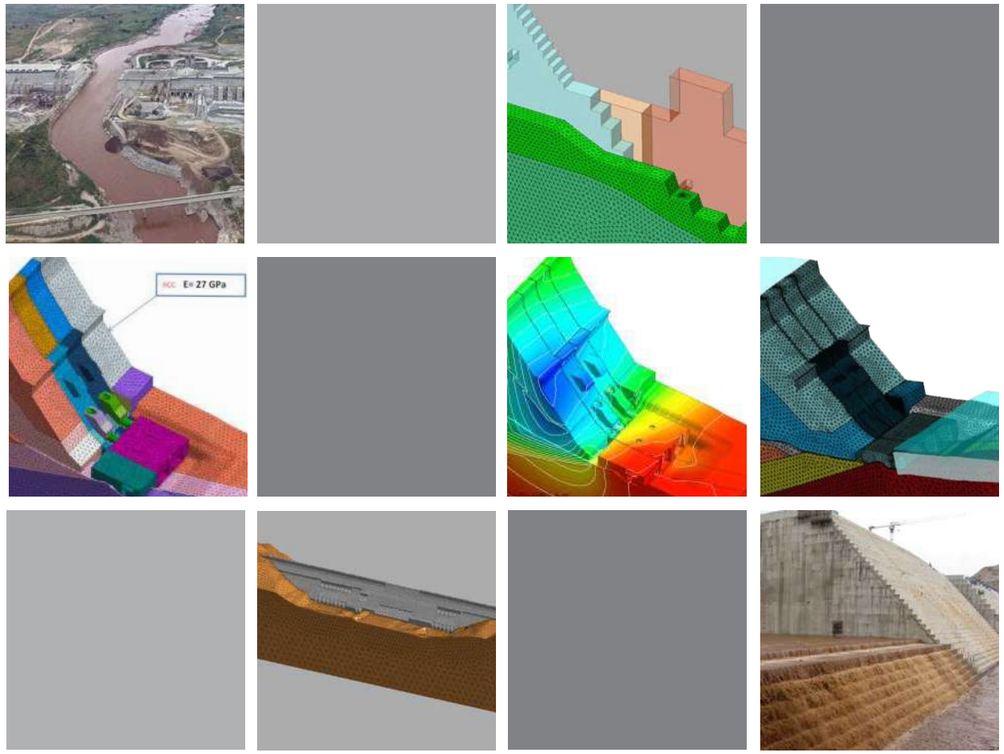
Grand Ethiopian Renaissance

- Dam Project

Nilo River, Ethiopia

STUDIO MASCIOTTA
ENGINEERS + ARCHITECTS

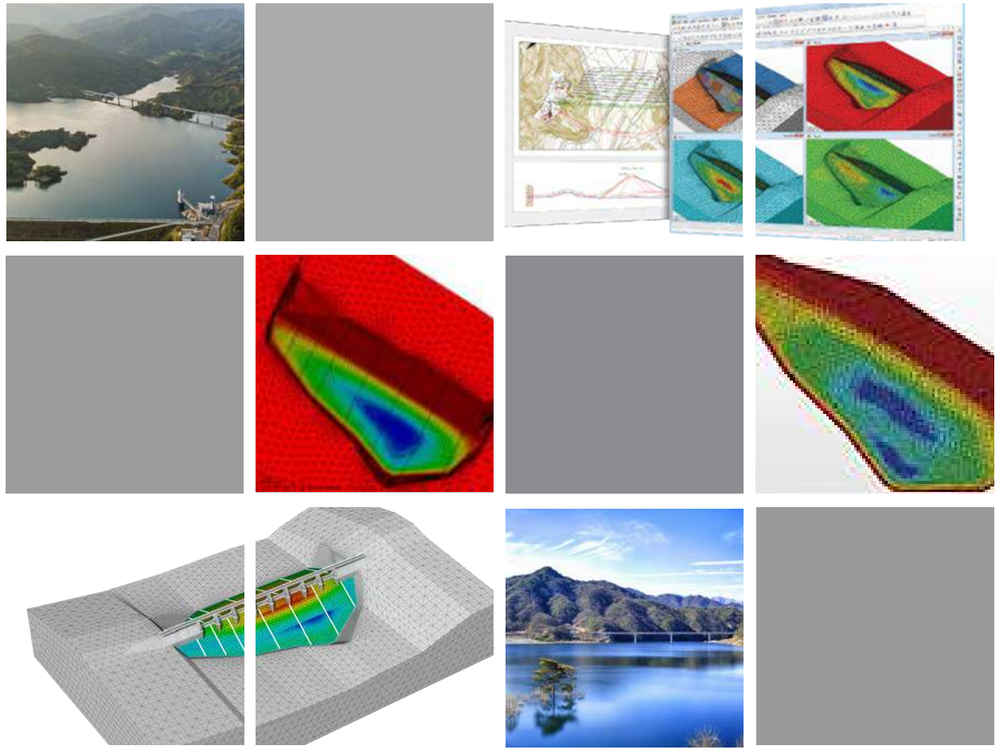
Owner	Ethiopian Electric Power
Engineering Consultant	Studio Masciotta
Construction Period	2011 - 2017
Project Type	Dam
Size of the Structure	173m Height
Main features in modelling	- Stability analysis under static and dynamic loading conditions - Nonlinear static analysis with phased construction
Description on this project	The Grand Ethiopian Renaissance Dam is a gravity dam on the Blue Nile River in Ethiopia. The dam will be the largest hydroelectric power plant in Africa when completed, as well as the 7th largest in the world. The storage reservoir has a surface area of 1561 km² at level of 640 m, i.e. 146 m behind the dam which holds a large volume of water equal to 79 billion m³.



Buhang Dam

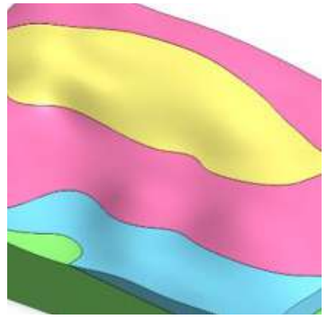
Gimcheon, Korea

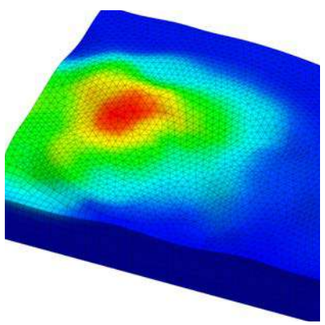
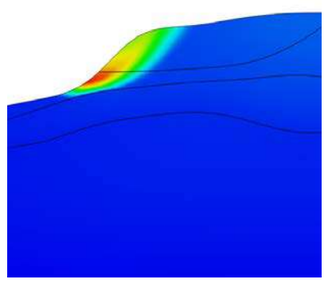
Owner	Korea Water Resources Corporation
Engineering Consultant	GS E&C
Construction Period	2006 - 2014
Project Type	Concrete/Flood - Control Dam
Size of the Structure	472m Length, 75m Height
Main features in modelling	- Evaluate the deformation and member force of cut - off wall due to water pressure - Deformation and stress distribution with constitutive models
Description on this project	Buhang Dam is located in Gimcheon City, Gyeongsangbukdo, South Korea. After typhoon Rusa passed, a dam was deemed to be necessary to prevent flood damage. It is expected to contribute to the development of local communities through the supply of river maintenance water for dams and minimization of flood damage in the Gamcheon coastal area around Gimcheon City. It will also supply drinking water and agricultural water in Gwangcheon and Gumi.



Slope Stability Reinforcement

2D and 3D slope stability analysis has been performed in order to strengthen
the southern slope, made of clay and loose sand, against the potential failure under heavy rainfall.

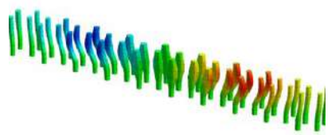
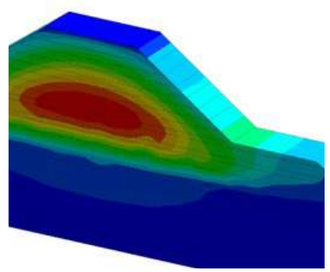
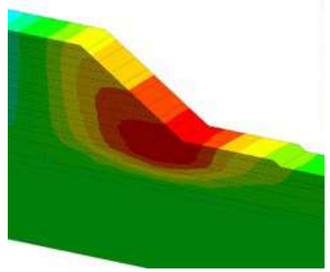
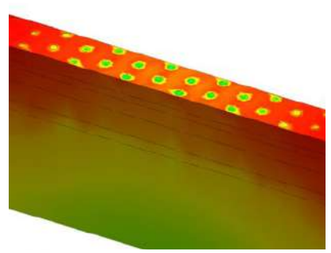



Slope Stability Embankment

3D slope stability analysis with stone pile reinforcement was used
during the filling of an embankment to prevent collapse.

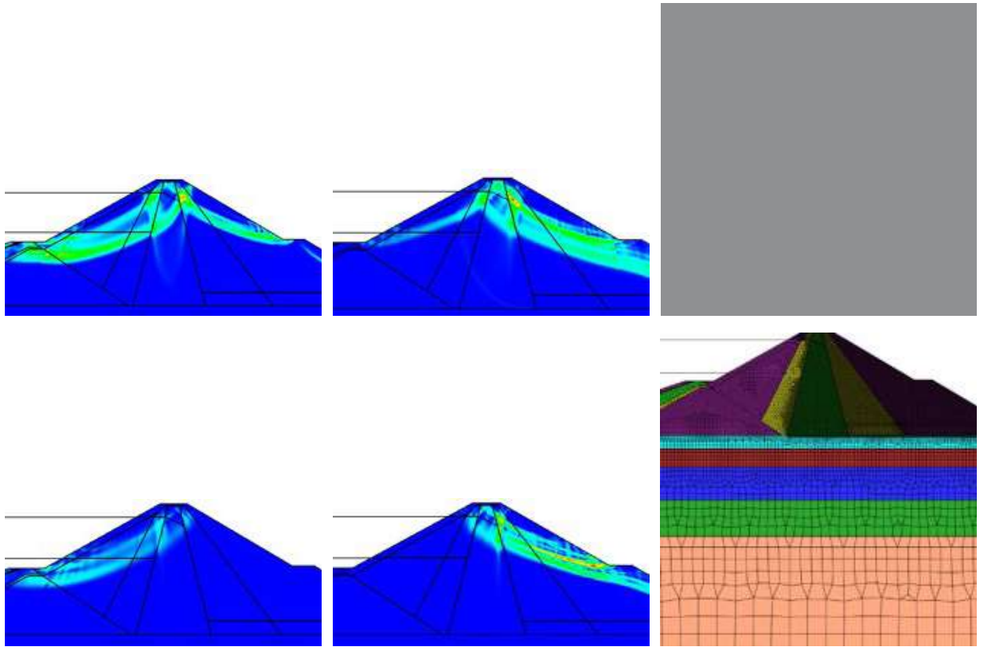


Dam Stability

Effect of Water Level Fluctuations

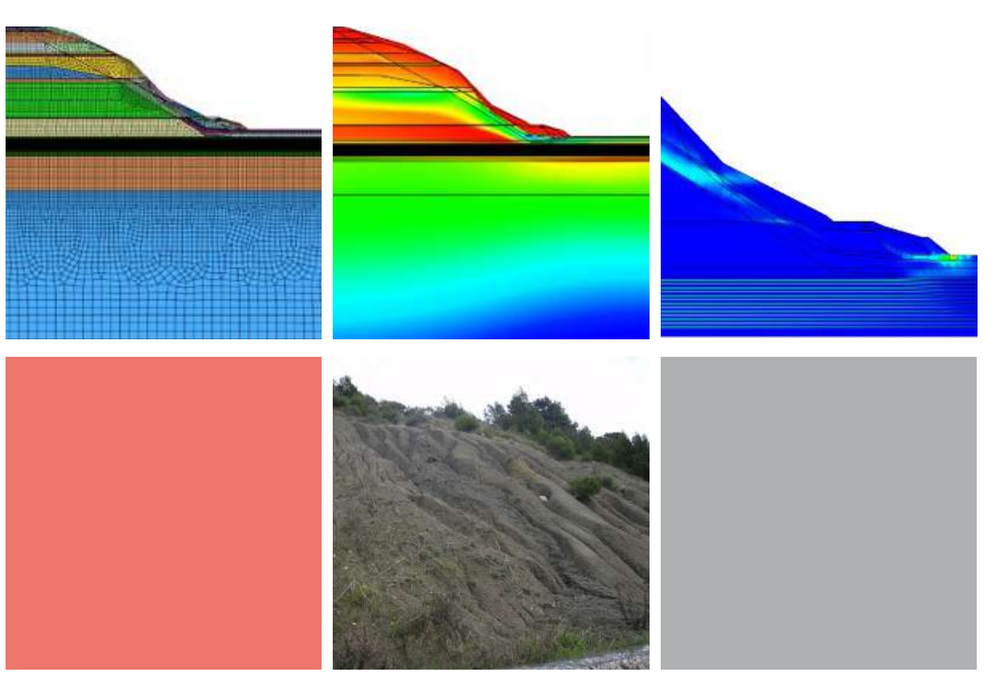
2D seepage-slope coupled analysis was carried out to assess the effect of water level drawdown (rapid or slow) and the rainfall. Additionally, the horizontal seismic effect also taken into account for the overall stability.



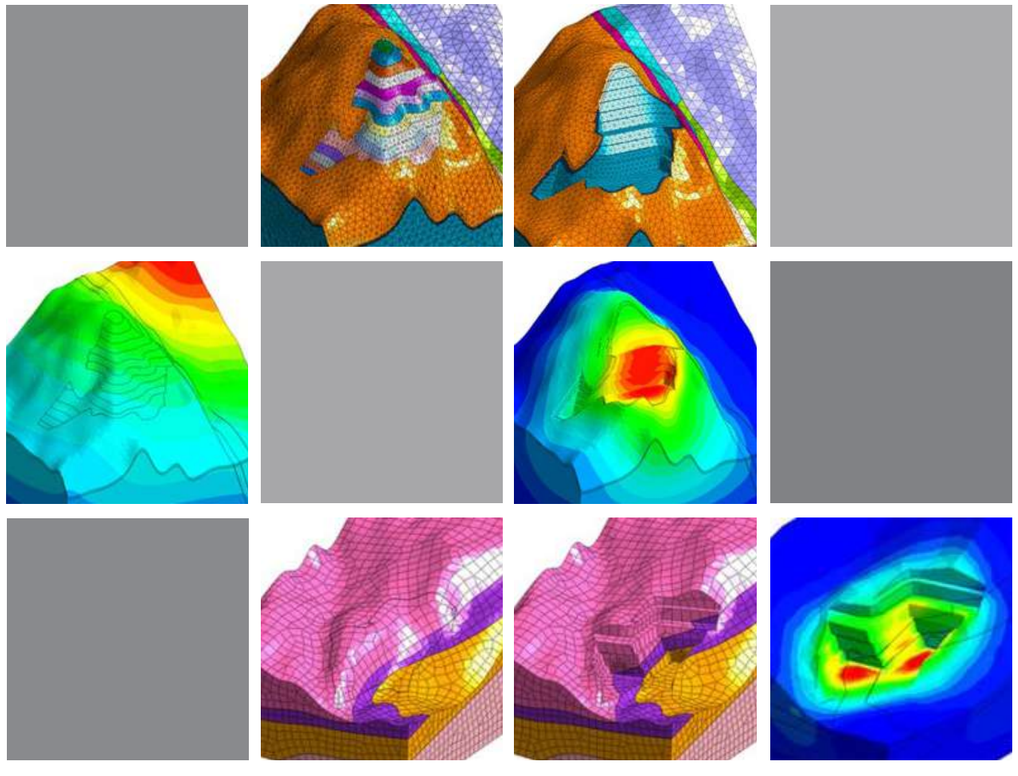
Slope Stability

Potential Failure Surface

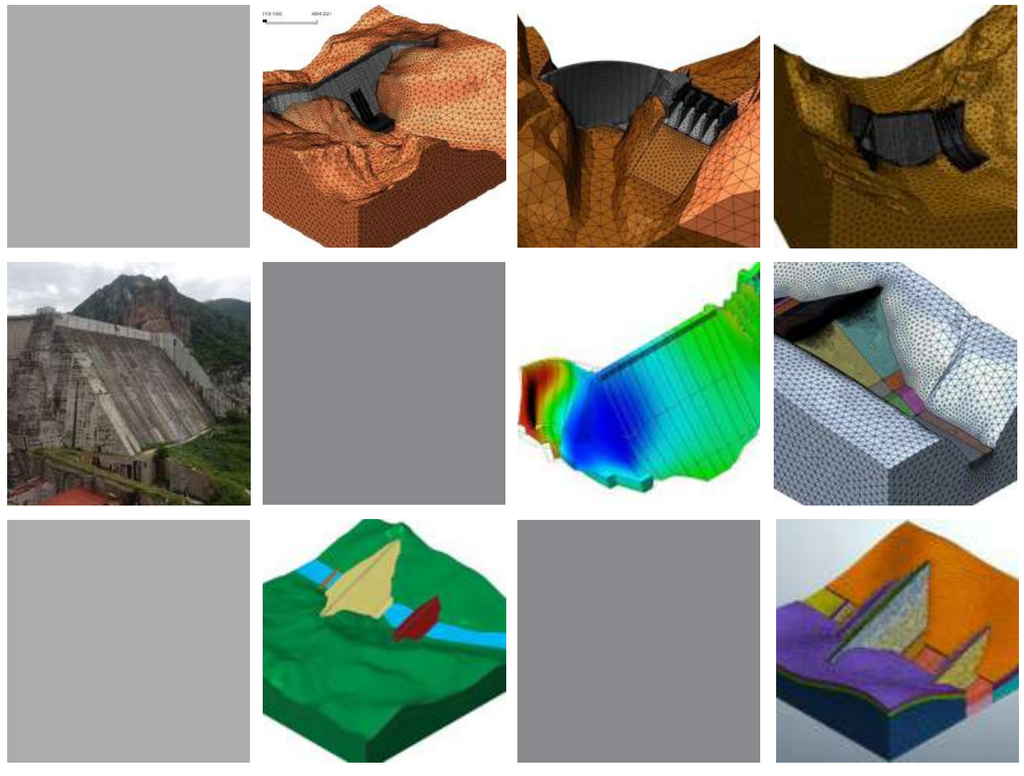
2D FEM analysis was required to determine the stress-strain state, and the strength and stability of the slope since it was considered to be potentially dangerous given the complex geological structure and hydro-geological conditions.



Slope Stability
Staged Excavation



Dam Stability
Soil Structure Interaction



Past and Present Projects and the Potential Future with MIDAS.

Midasoft
1 646 852 9294
http://northamerica.midasuser.com