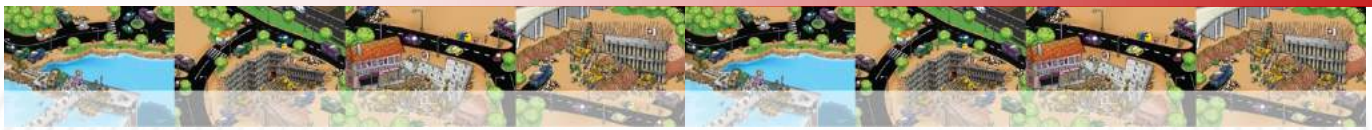
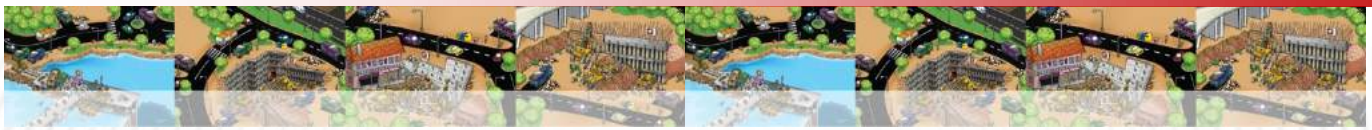


Ground Improvement Solutions for the new Cruise Terminal in Lisbon

Alexandre Pinto, apinto@jetsj.pt
Rui Tomásio, rotomasio@jetsj.pt
João Ravasco, jmravasco@somague.pt

Session S7 – Biogrout & Other Grouting Methods, 1st June 2012

TC 211 – IS – GI Brussels 2012



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- Main constraints
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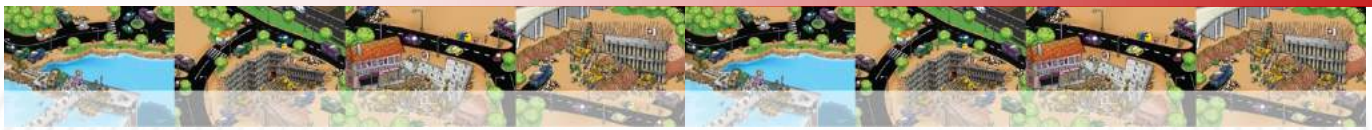
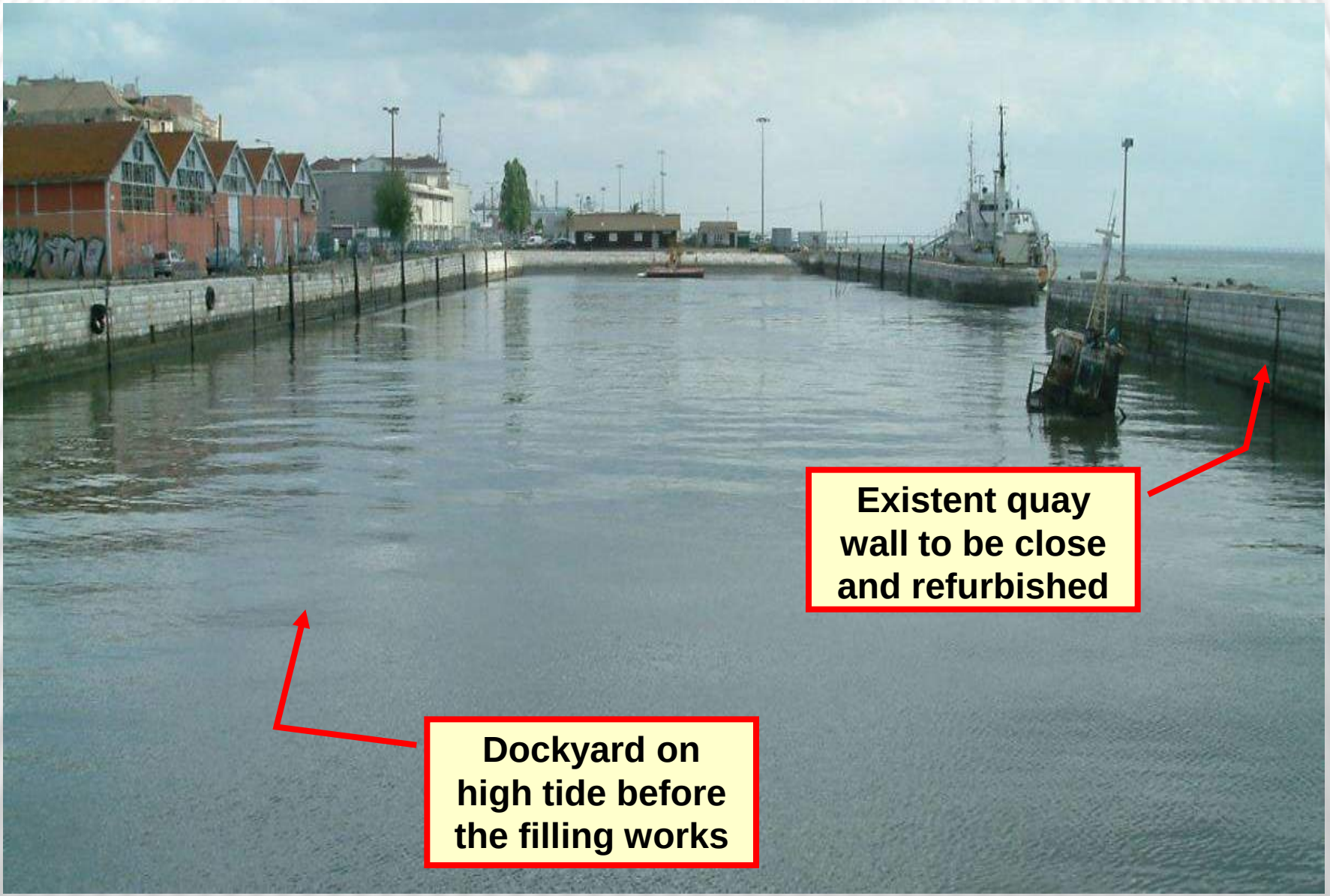
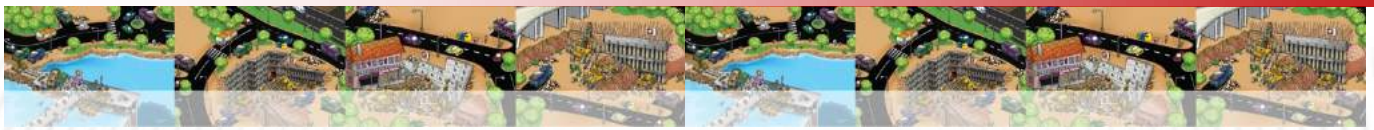
- Alternative solutions
- Conclusion remarks

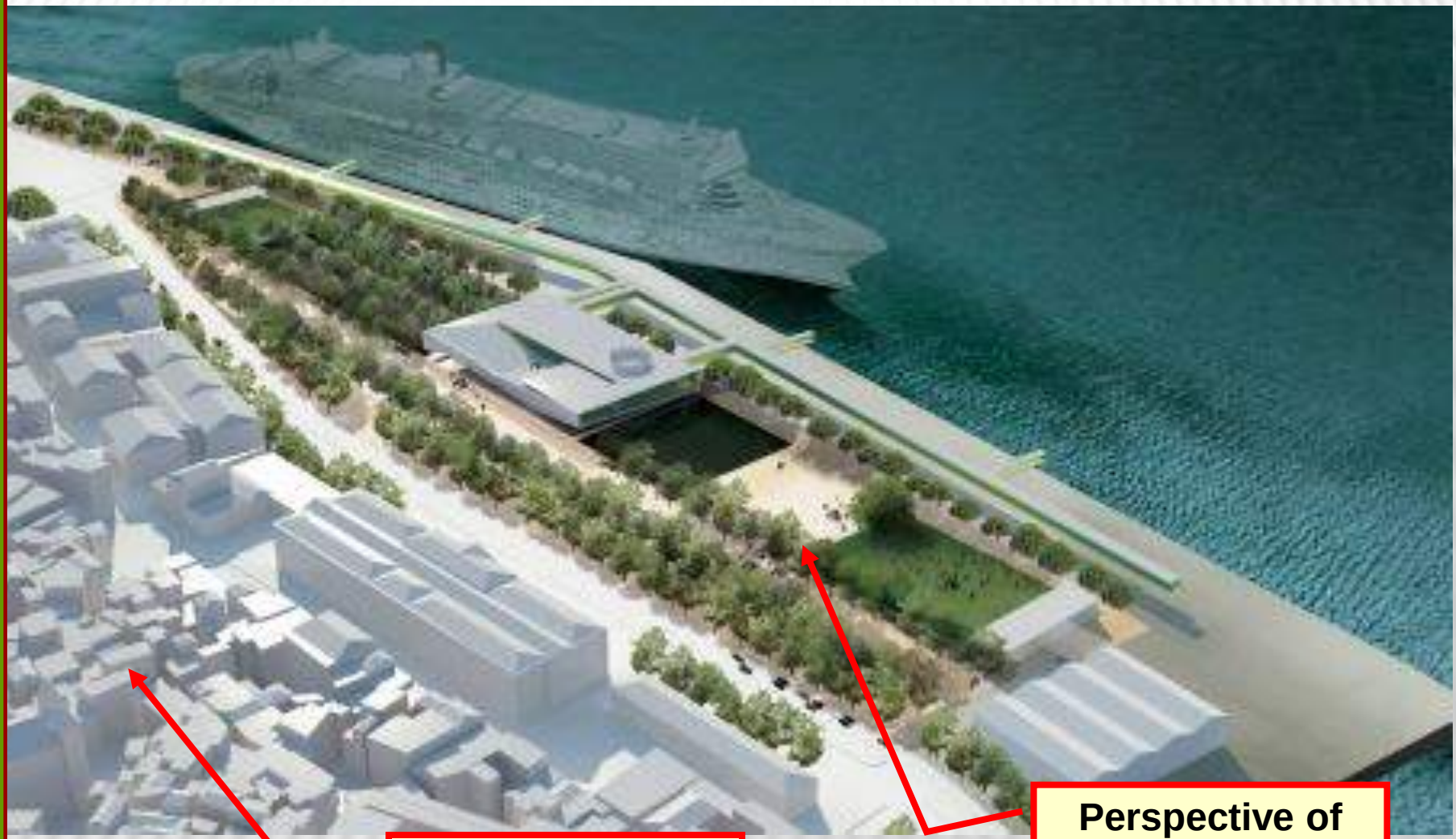


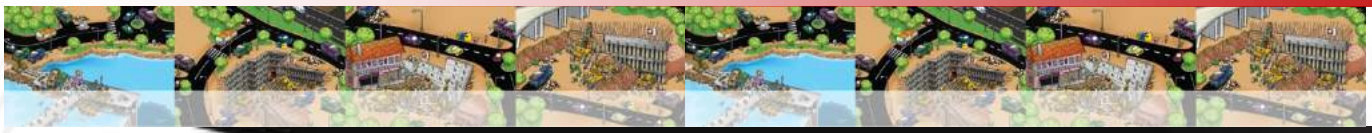
JETSJ geotecnia

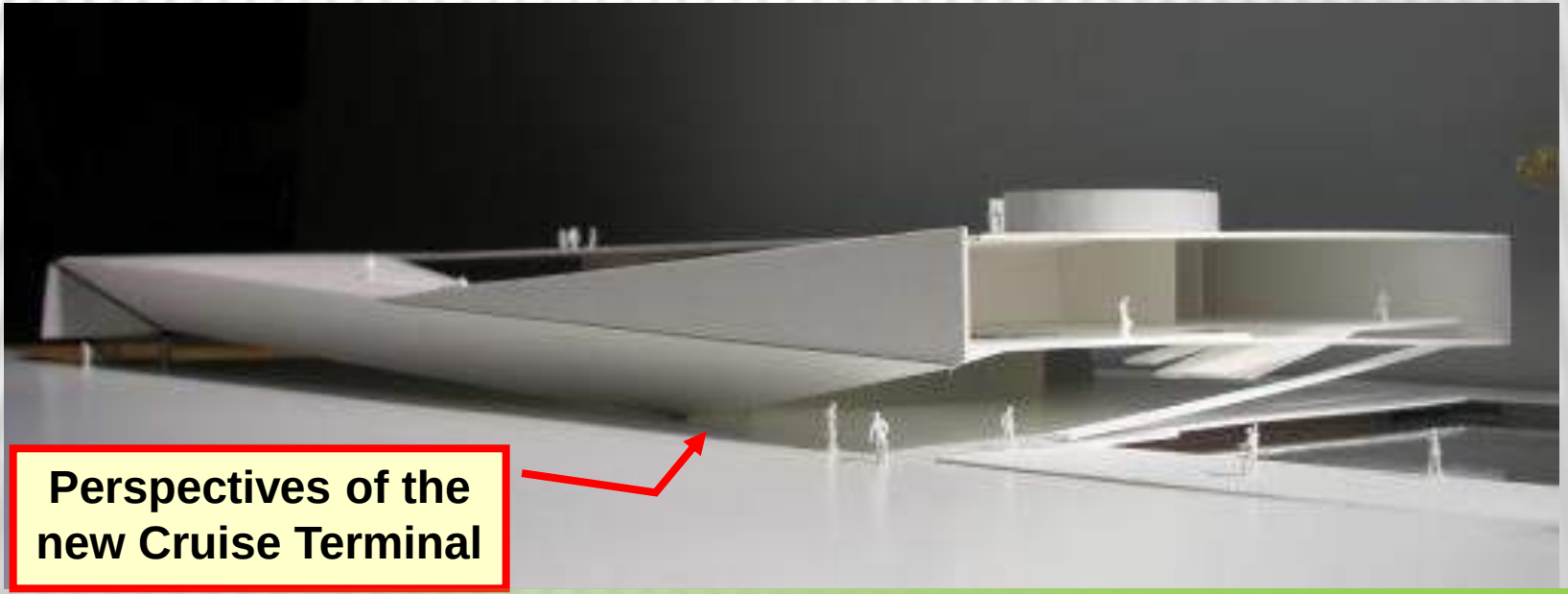

Existent quay wall to be close and refurbished
Dockyard on high tide before the filling works



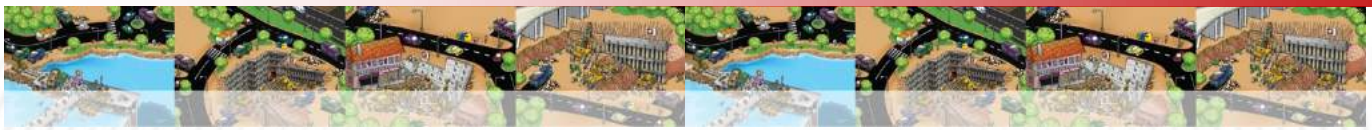
JETSJ geotecnia

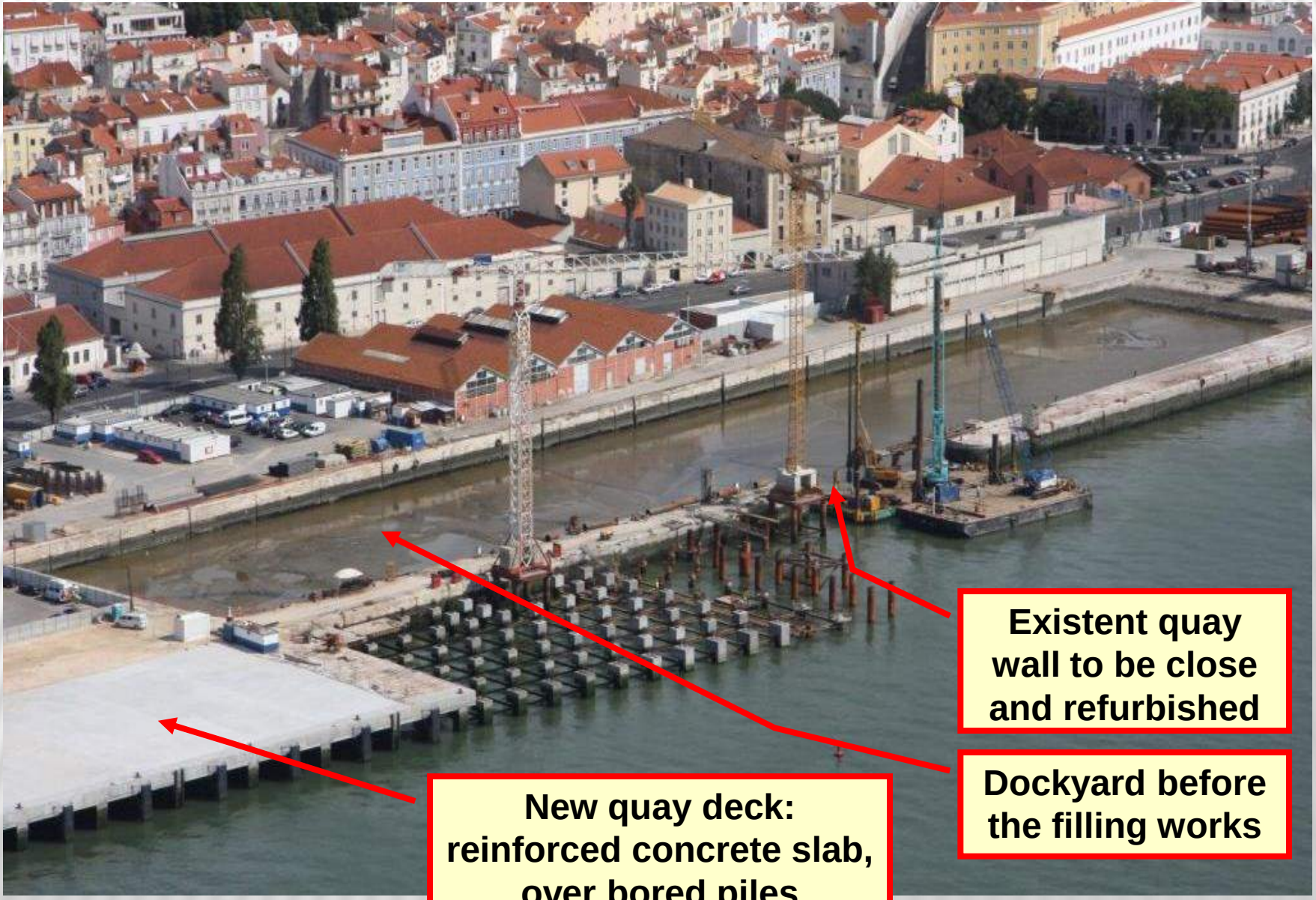


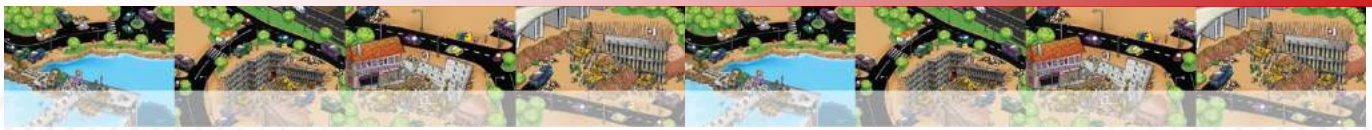




Perspectives of the new Cruise Terminal




Existent quay wall to be close and refurbished
Dockyard before the filling works
New quay deck: reinforced concrete slab, over bored piles



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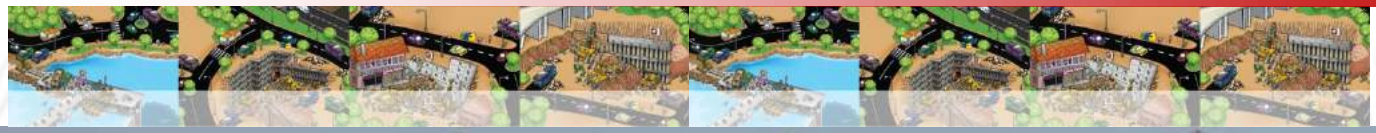
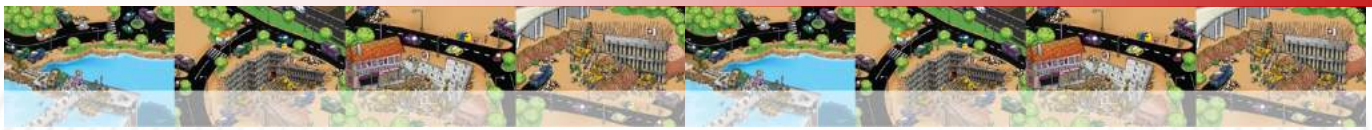
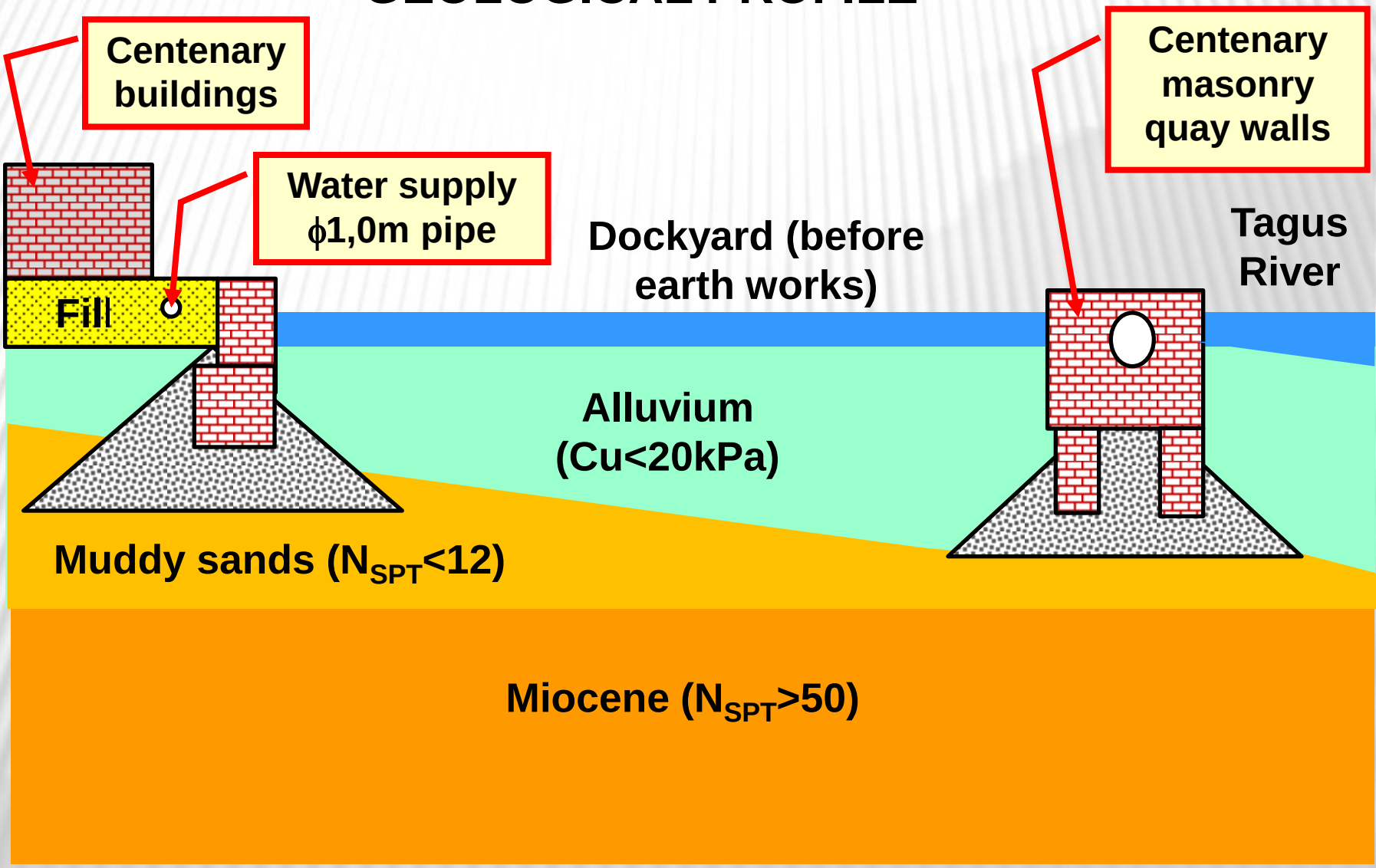


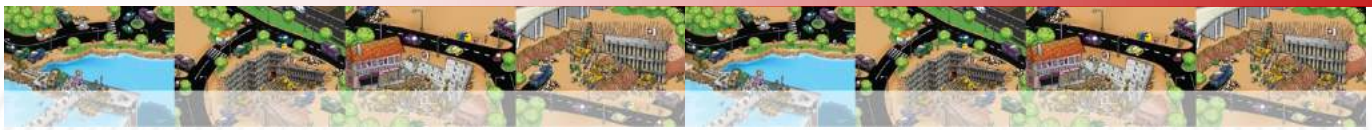

Centenary buildings
Water supply ϕ1,0m pipe
Metro tunnel
Centenary masonry quay walls
Dockyard before the earth works
HAVANA CLUB
Sprague
10:41PM



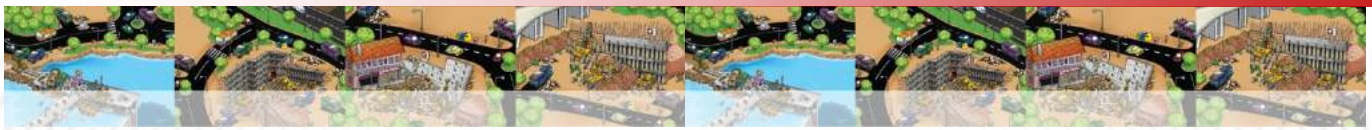
GEOLOGICAL PROFILE




HYUNDAI
210LC-7
Earth works in difficult conditions



Jet grouting works in difficult conditions



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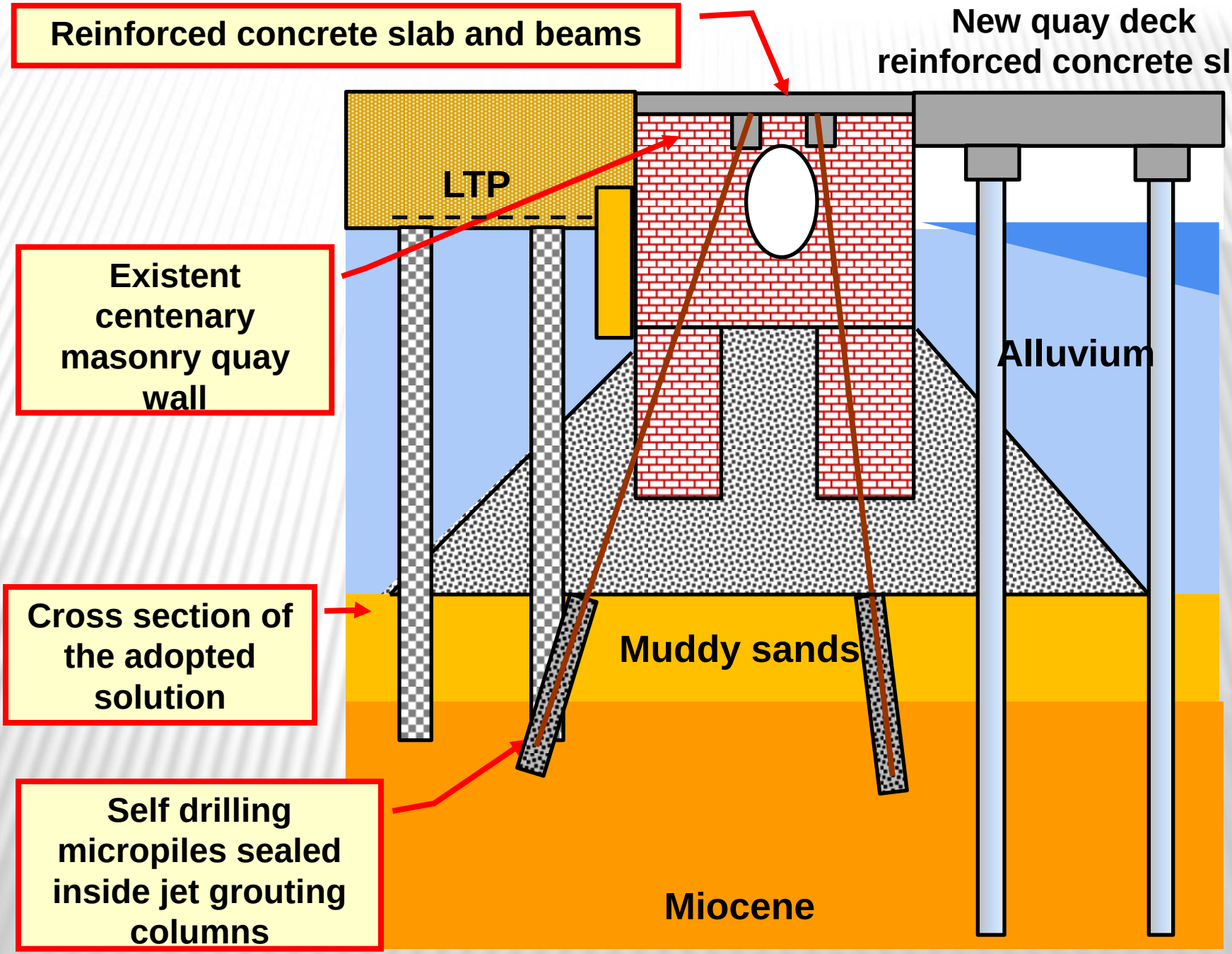
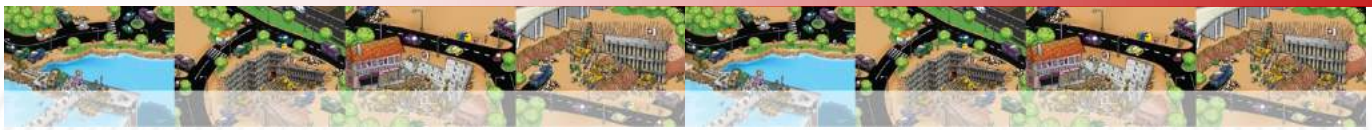
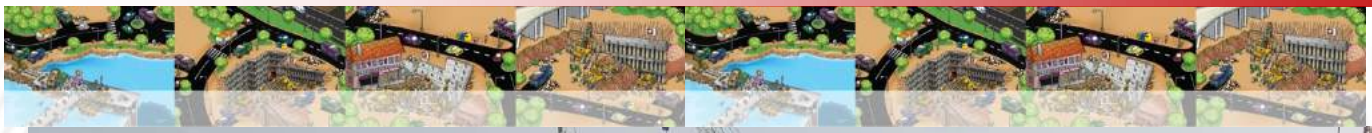

Reinforced concrete slab and beams
New quay deck reinforced concrete slab
LTP
Existent centenary masonry quay wall
Alluvium
Cross section of the adopted solution
Muddy sands
Self drilling micropiles sealed inside jet grouting columns
Miocene



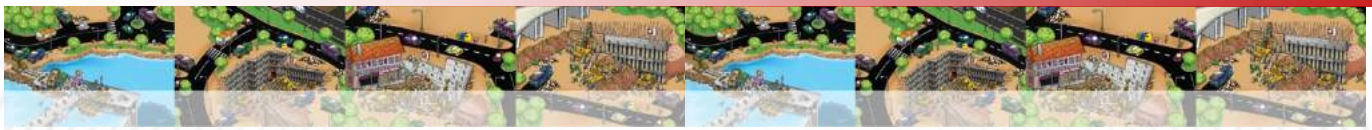

José Ruela
Refurbishment and underpinning micropiles at the top of the existent quay wall

JET SJ geotecnia

Quay wall refurbishment and underpinning beams




Quay wall refurbishment and underpinning beams



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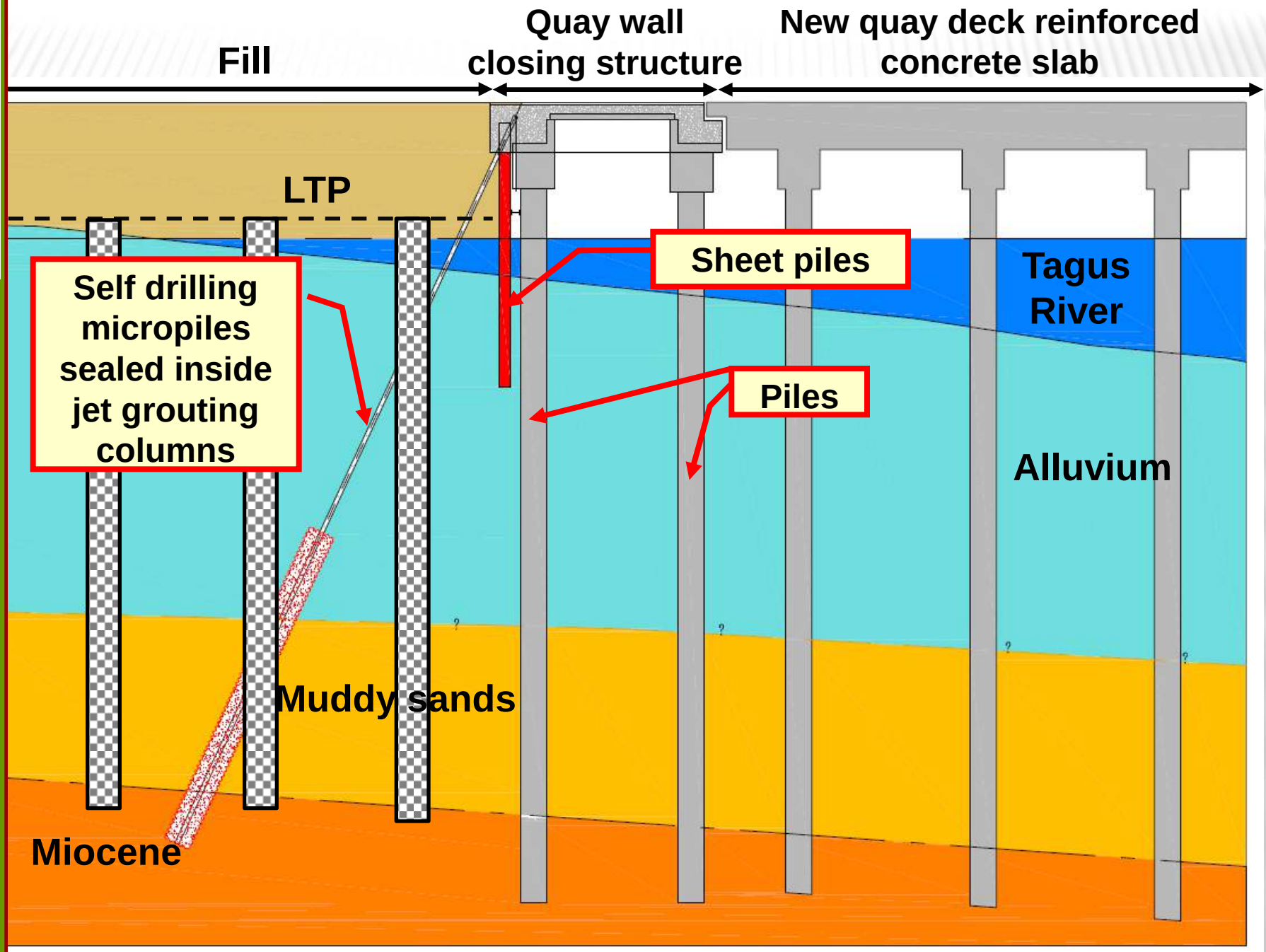
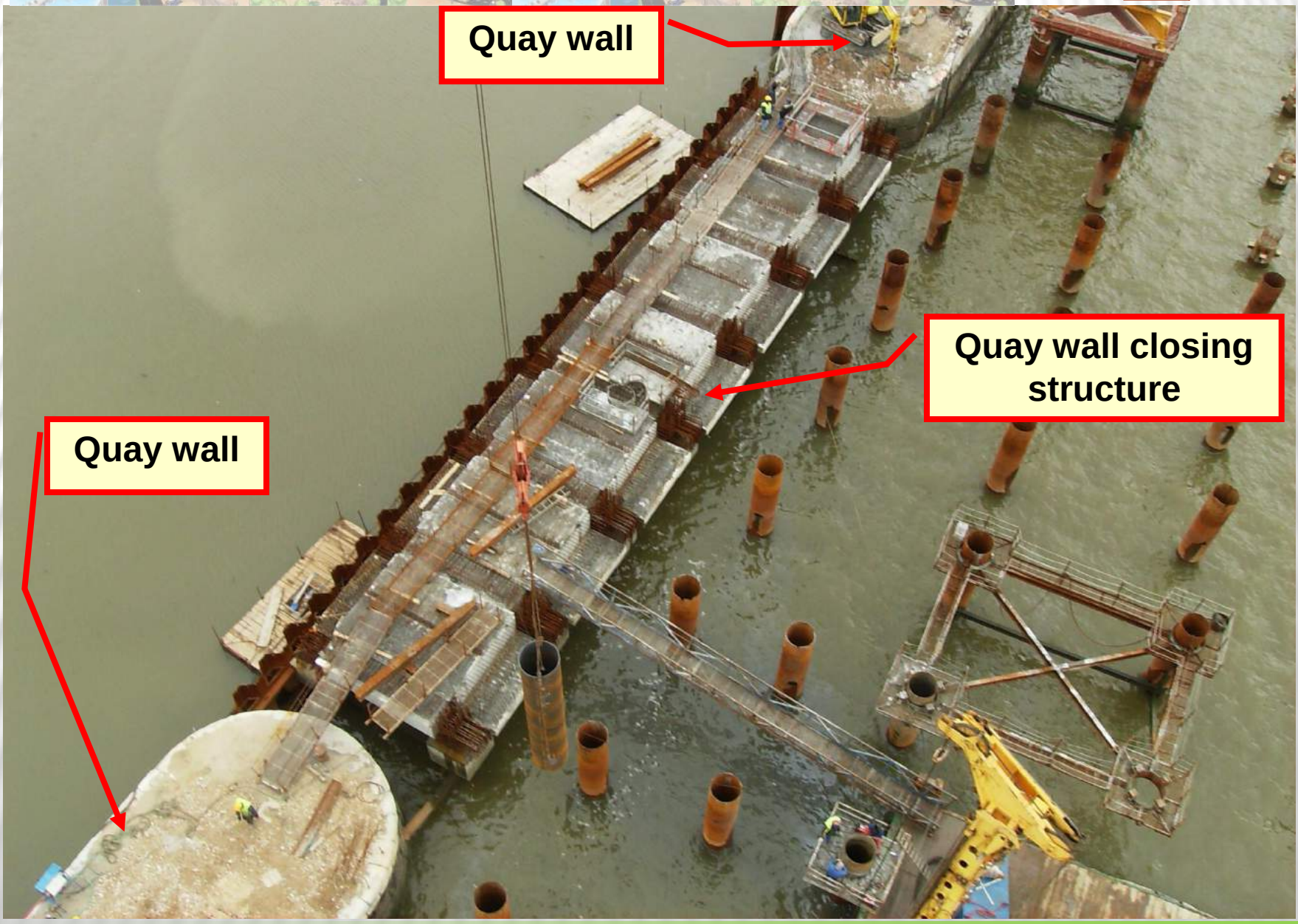
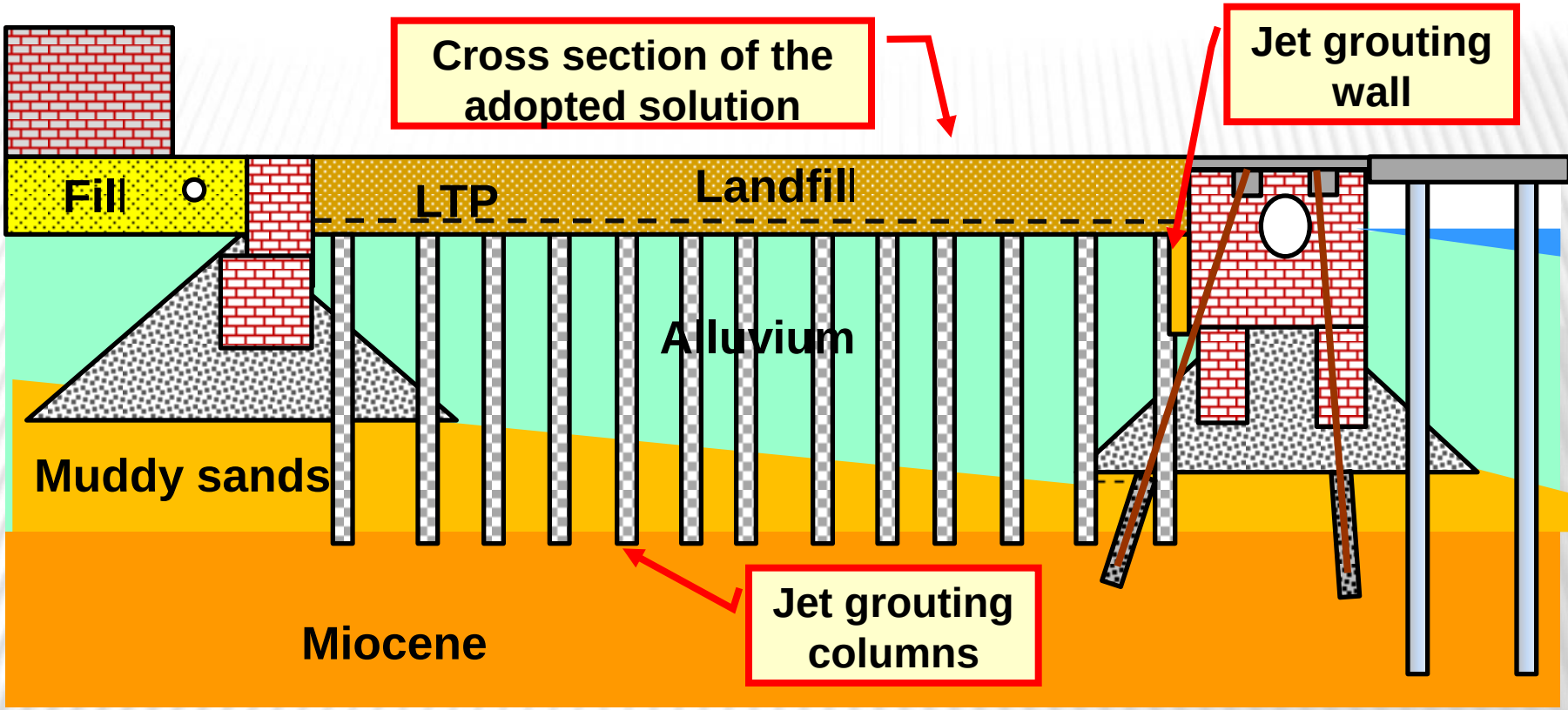
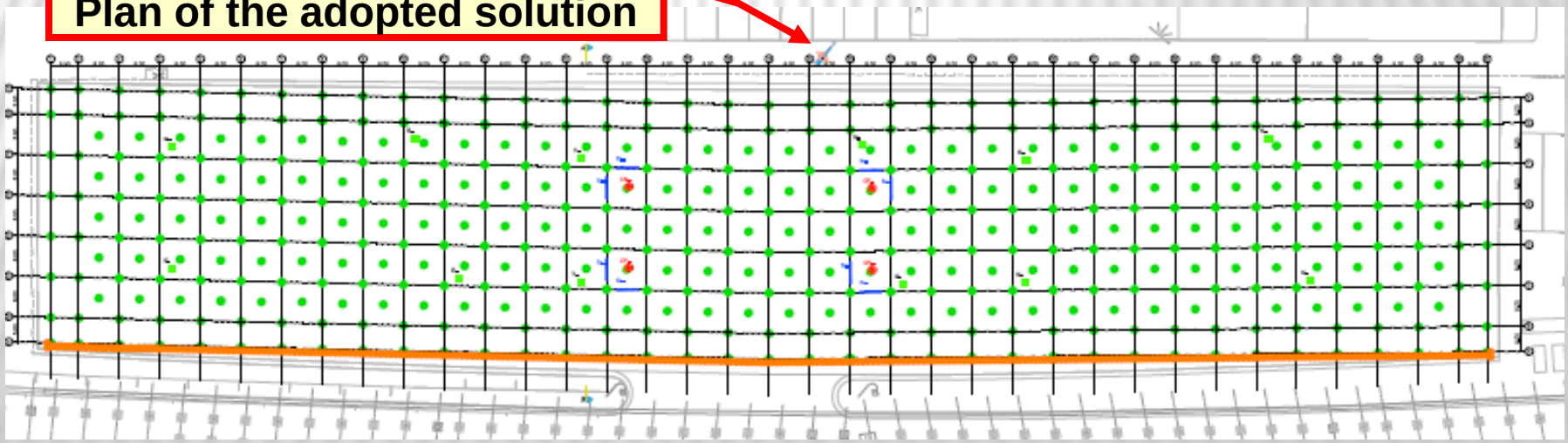
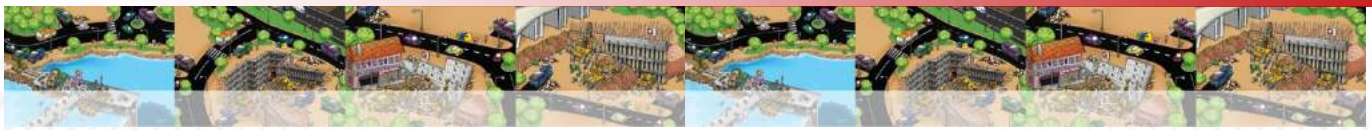

Fill
Quay wall closing structure
New quay deck reinforced concrete slab
LTP
Sheet piles
Tagus River
Self drilling micropiles sealed inside jet grouting columns
Piles
Alluvium
Muddy sands
Miocene


Quay wall
Quay wall closing structure
Quay wall

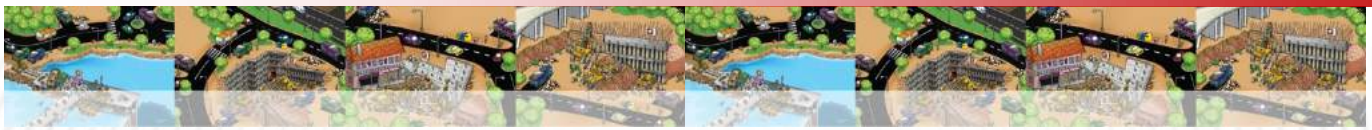


Plan of the adopted solution

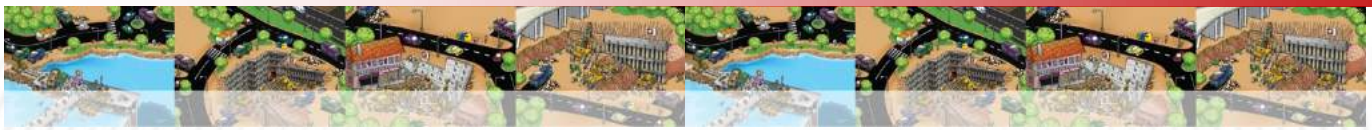




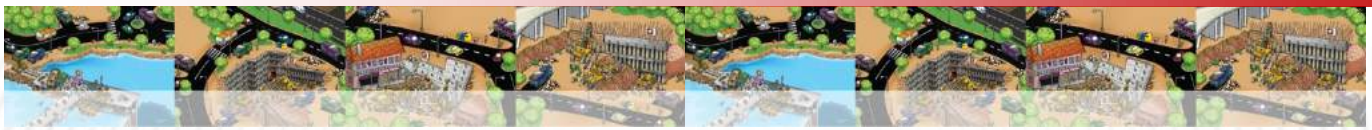

Installation of geogrids



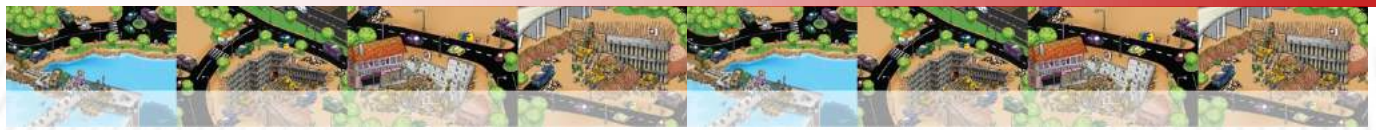

Installation of geogrids



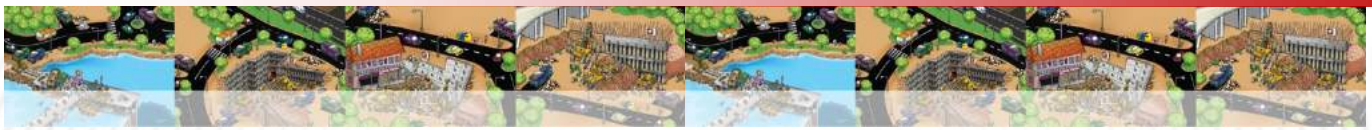

Landfill works on low tide




Landfill works on low tide




Landfill works
after conclusion



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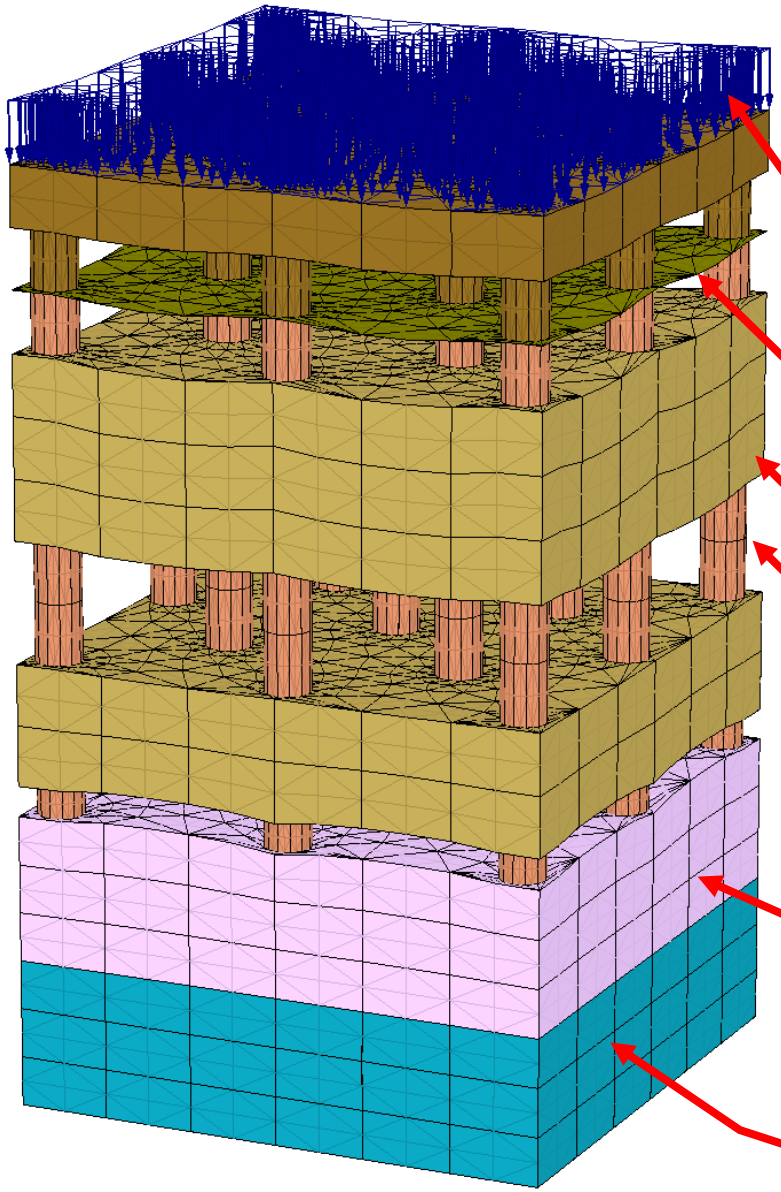
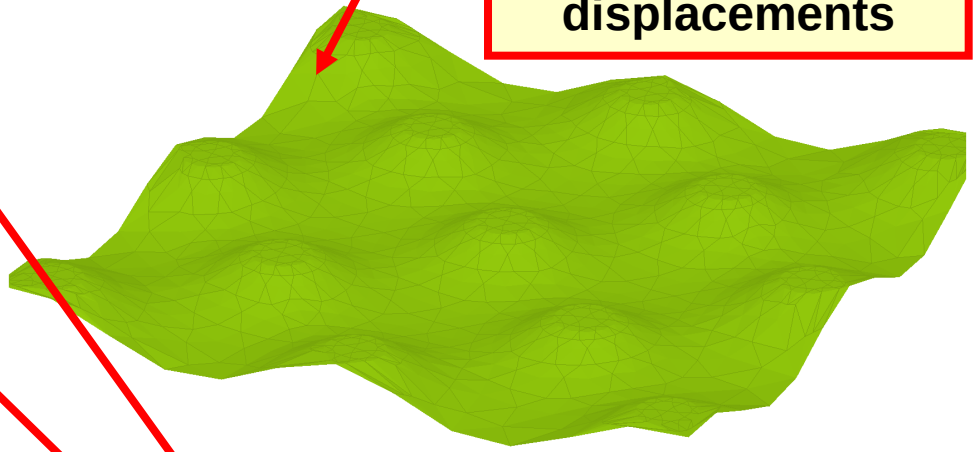
3D FEM MODEL





LTP base vertical displacements

Loads at the surface

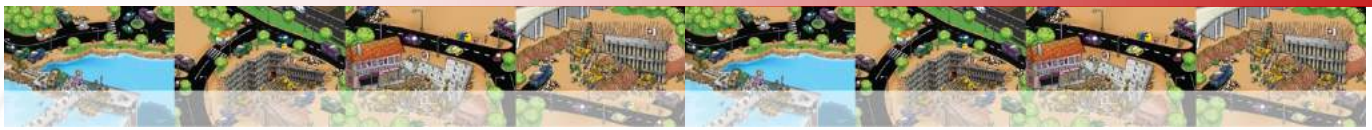
LTP

Muddy alluvium

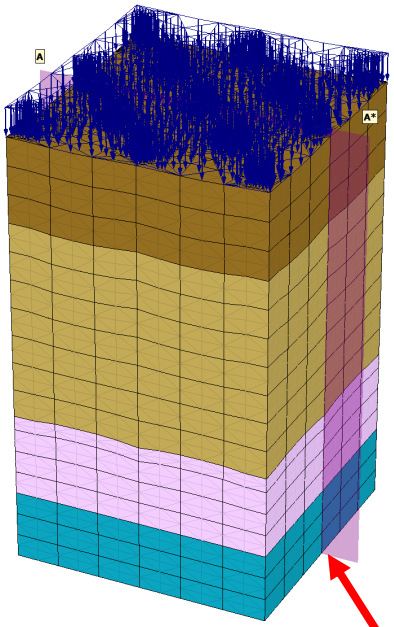
Jet grouting columns

Sandy alluvium

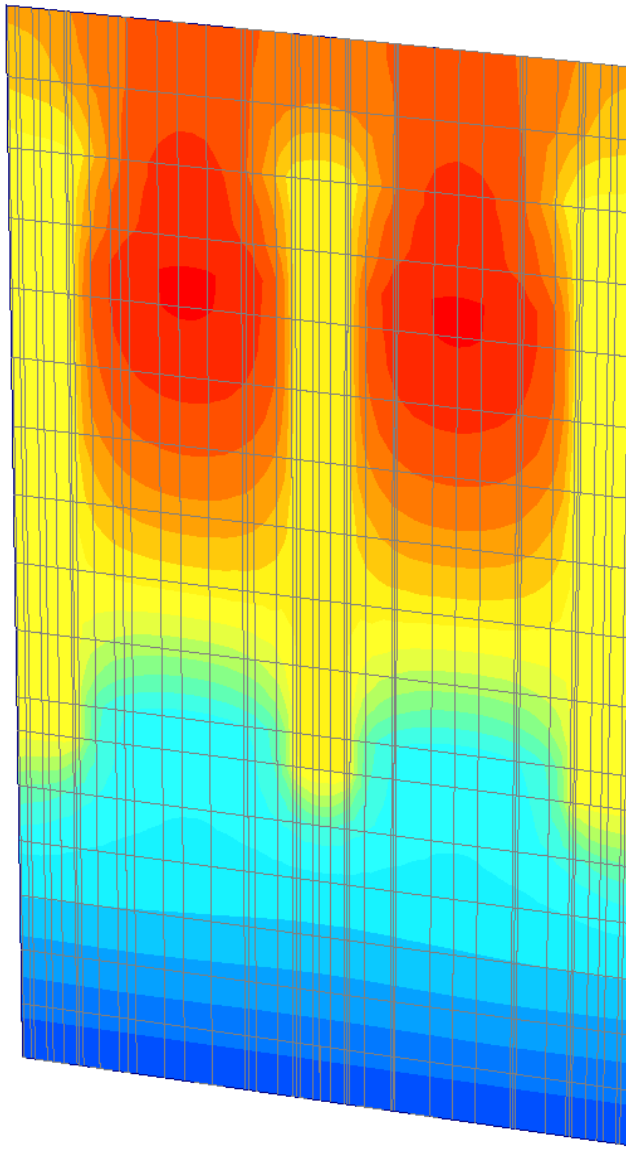
Miocene: dense sand and sandstone



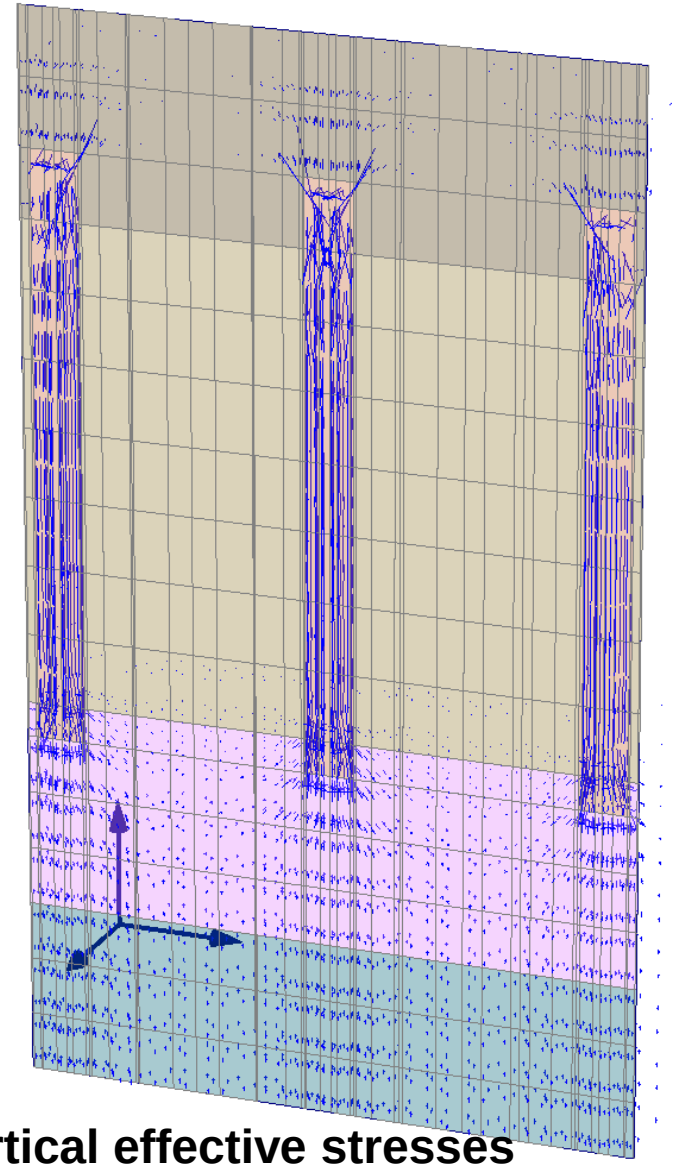
JETSJ geotecnia



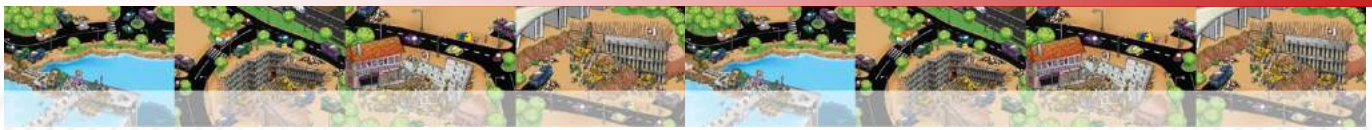
Plan where the results were obtained



Vertical displacements: max 76mm



Vertical effective stresses



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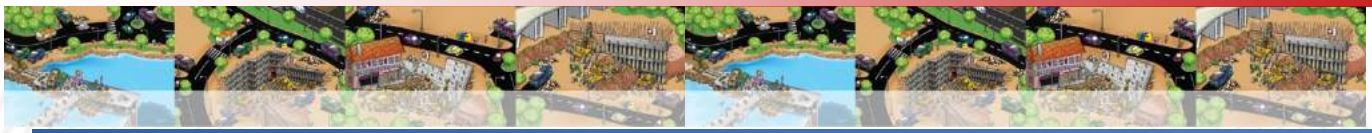
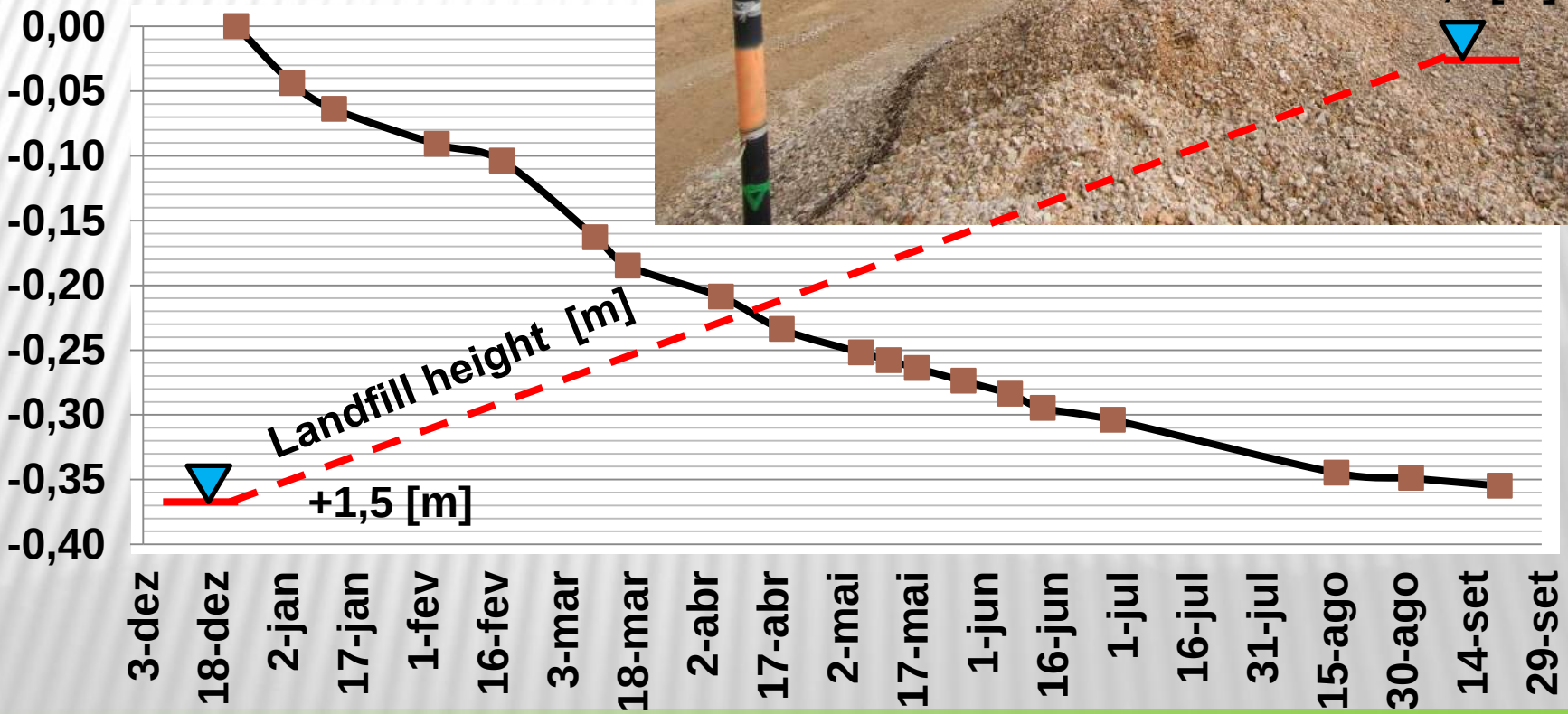
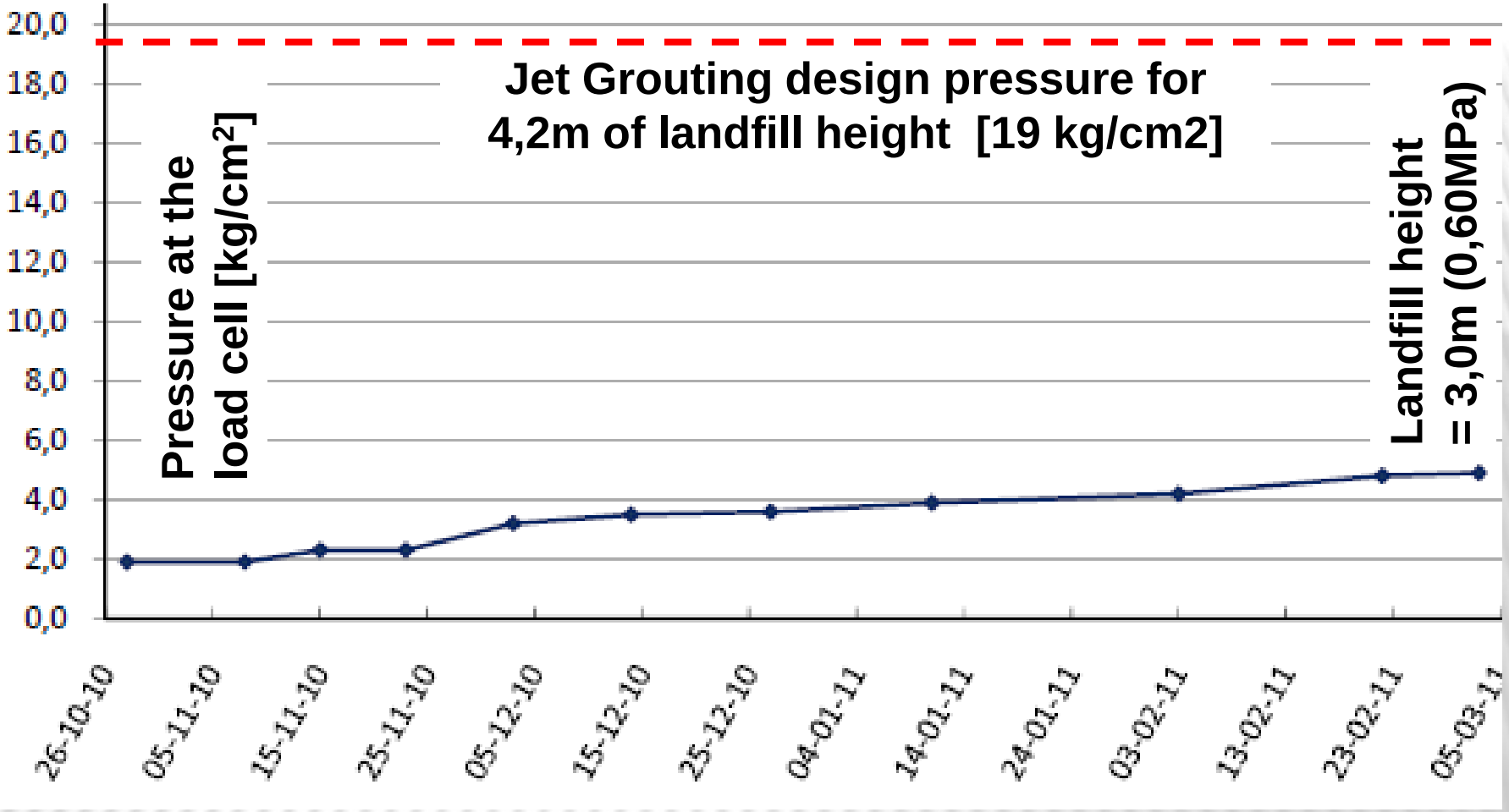



Topographic mark

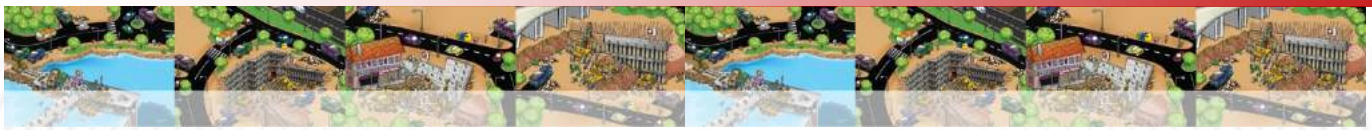
Topographic marks at the landfill base

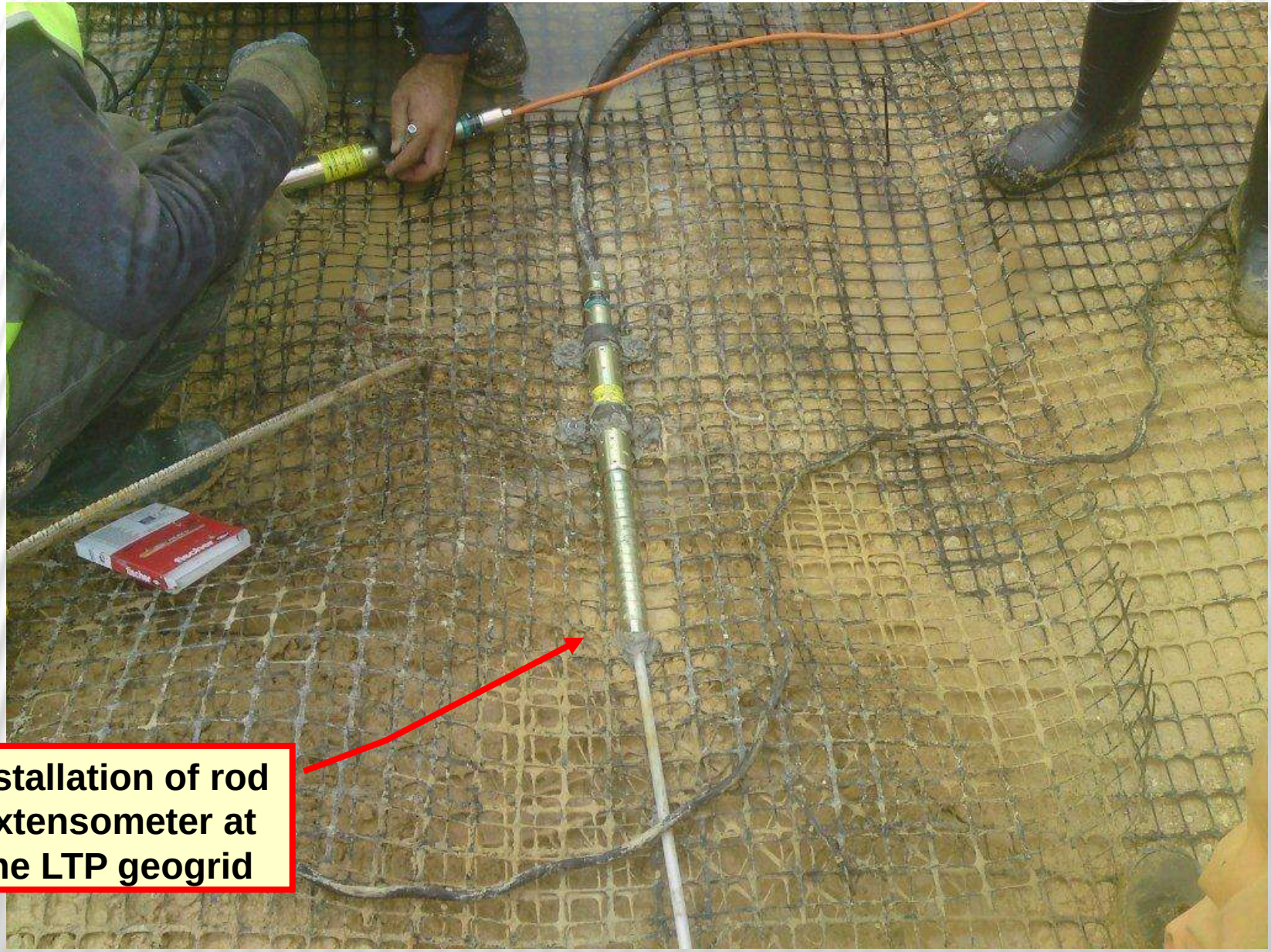
Vertical displacements at the landfill base [m]



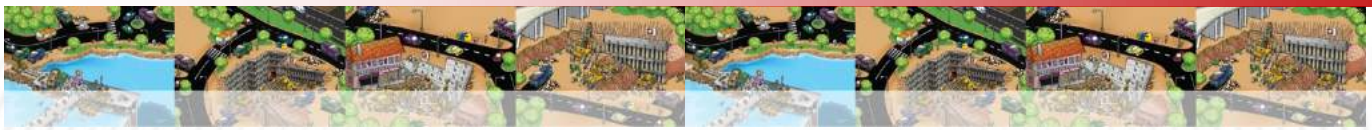

Jet Grouting design pressure for
4,2m of landfill height [19 kg/cm2]
Pressure at the load cell [kg/cm²]
Landfill height = 3,0m (0,60MPa)
20,0
18,0
16,0
14,0
12,0
10,0
8,0
6,0
4,0
2,0
0,0
26-10-10
05-11-10
15-11-10
25-11-10
05-12-10
15-12-10
25-12-10
04-01-11
14-01-11
24-01-11
03-02-11
13-02-11
23-02-11
05-03-11


W.E.C. LINES
ITALIA
APL





Installation of rod extensometer at the LTP geogrid



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UCS tests

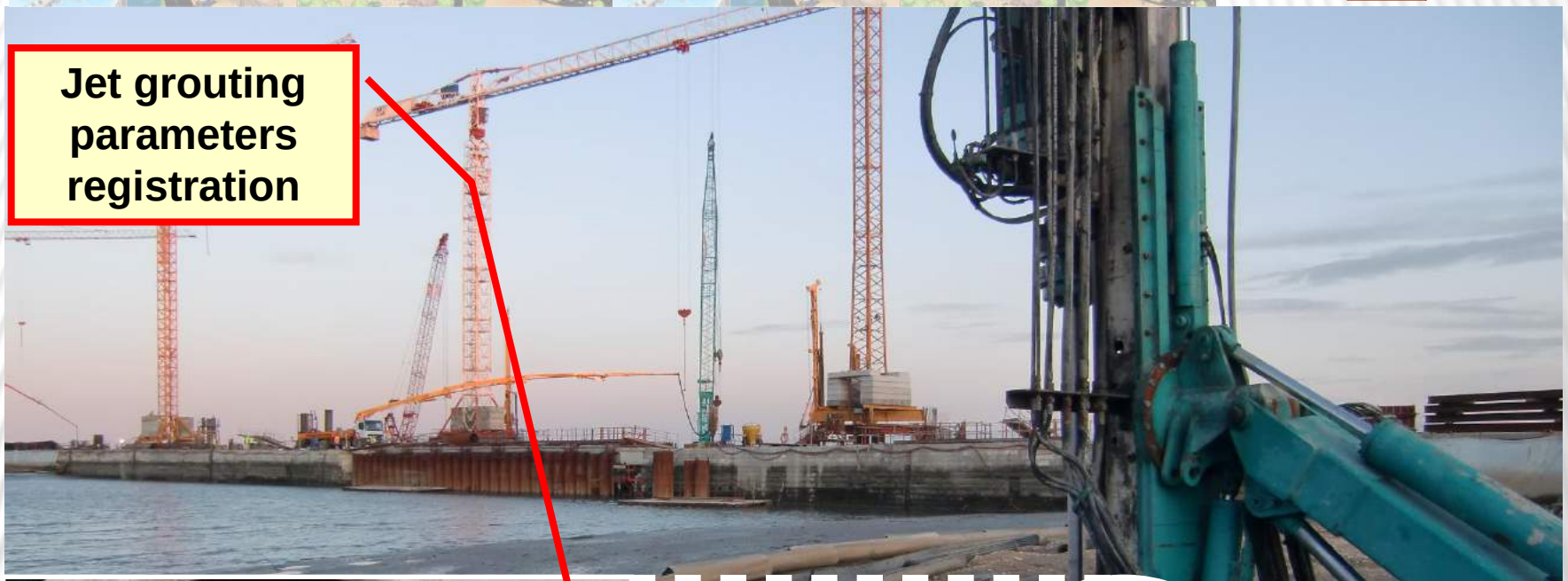
Cores gathering for UCS tests

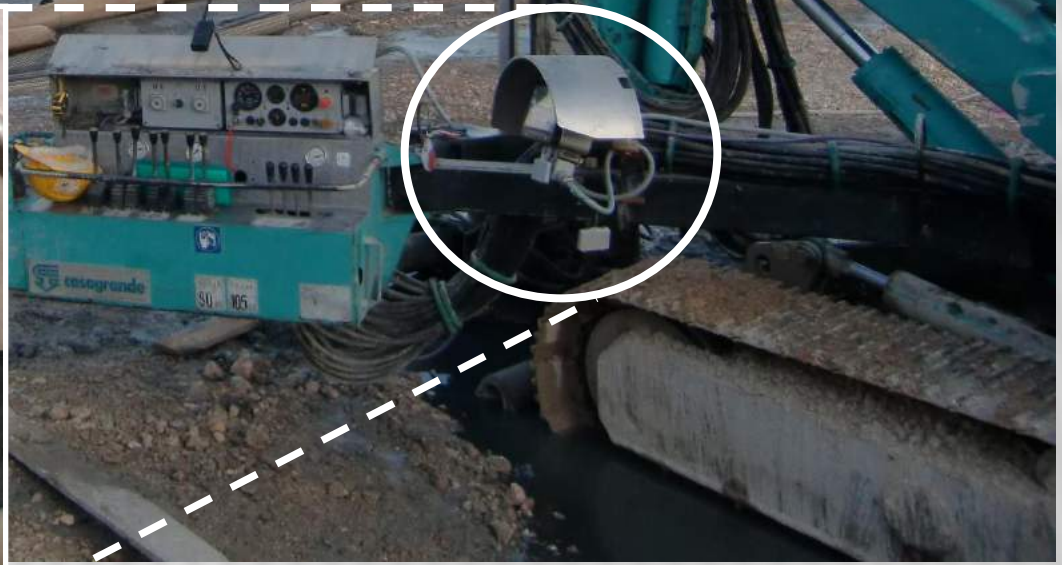
Jet grouting columns full length core samples

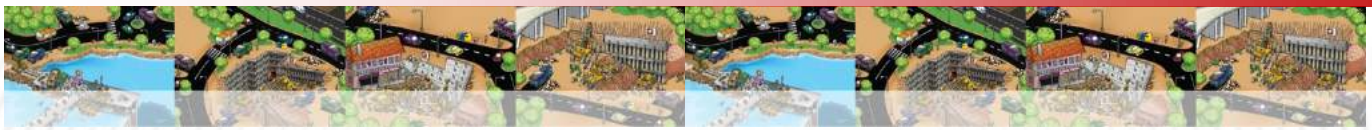
Jet grouting columns core collection

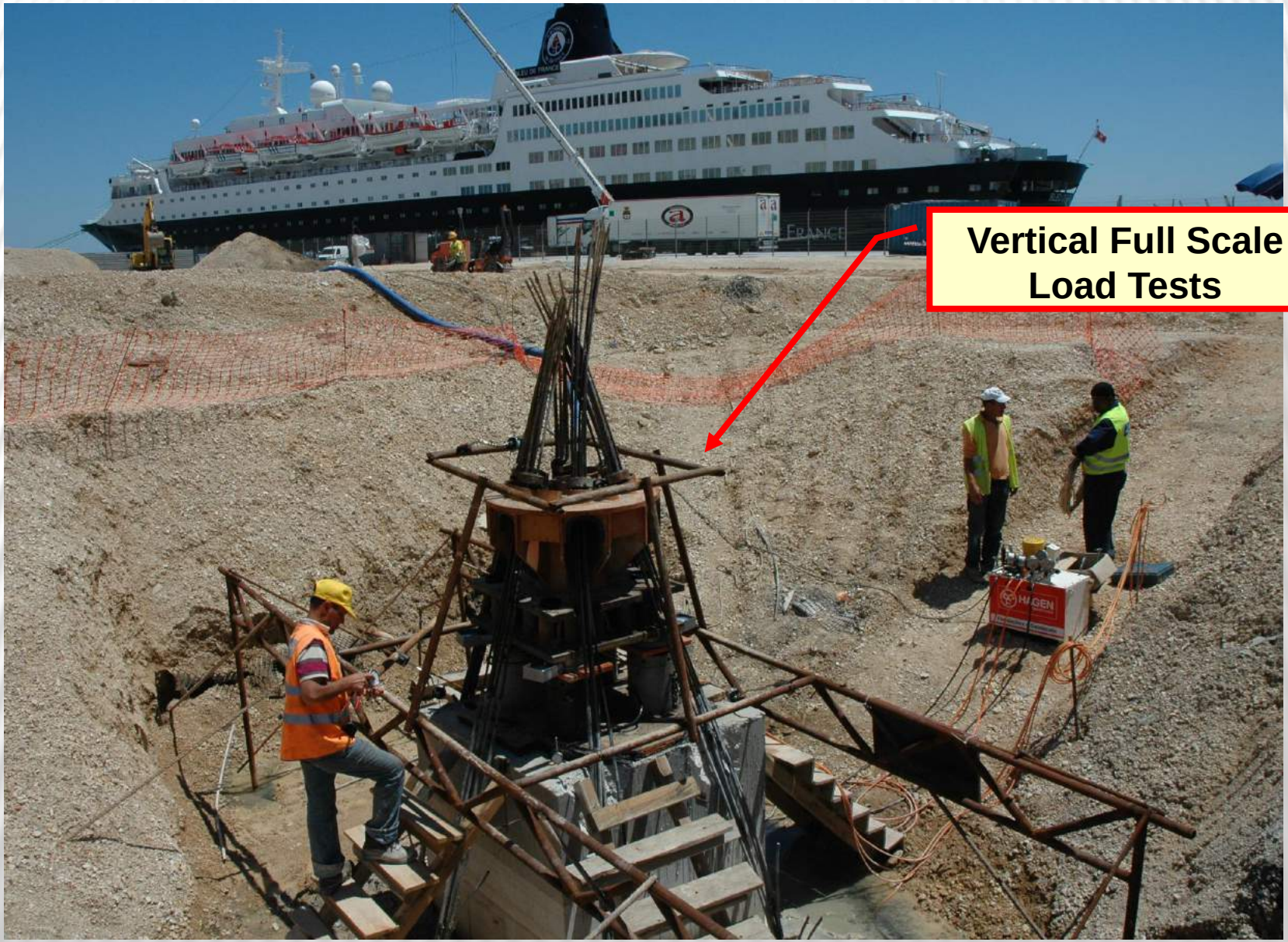
JETSJ geotecnia

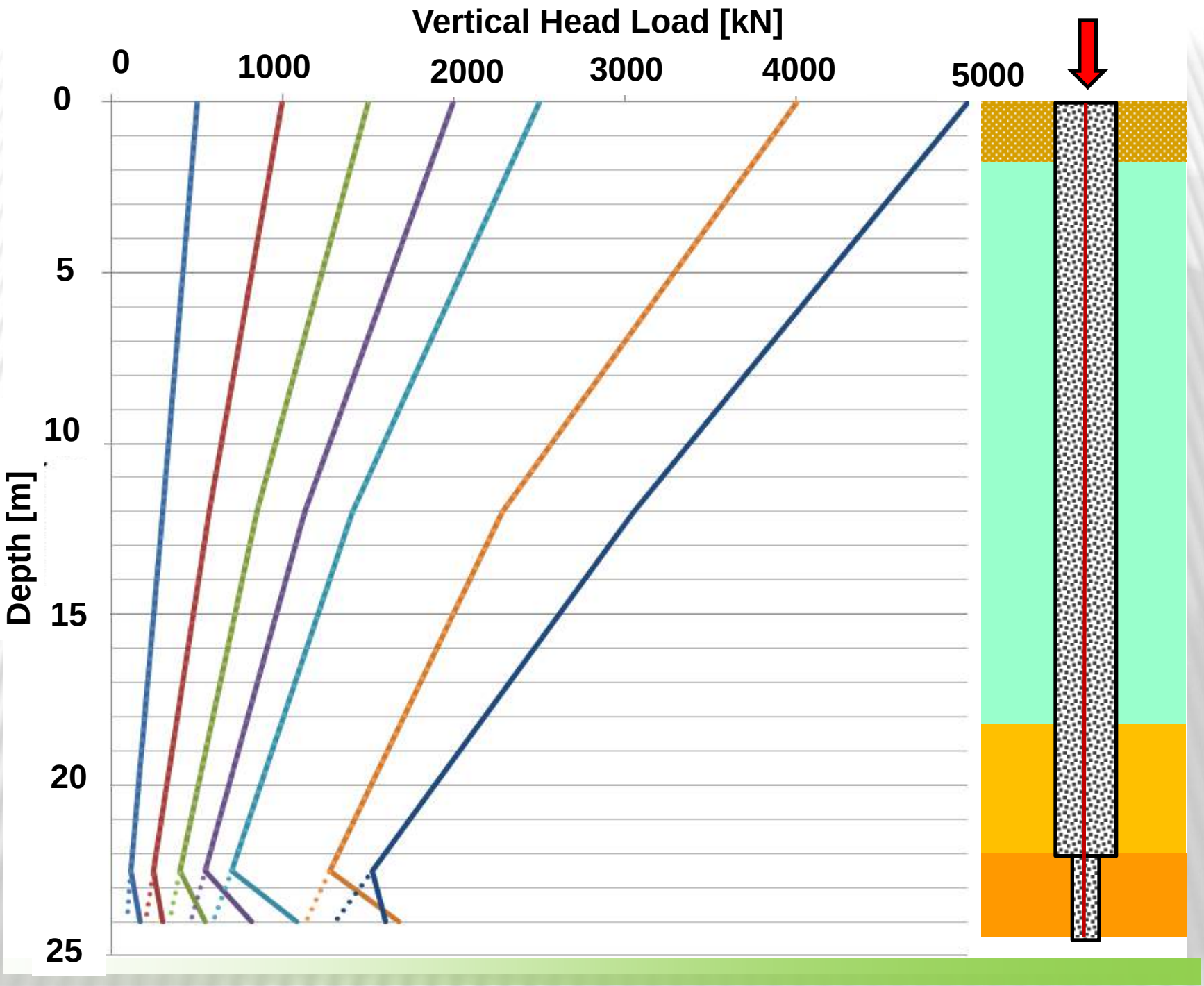
Jet grouting parameters registration

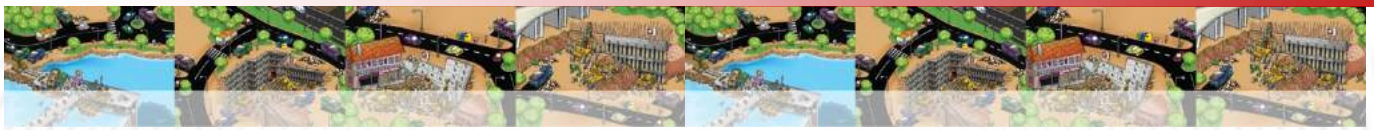


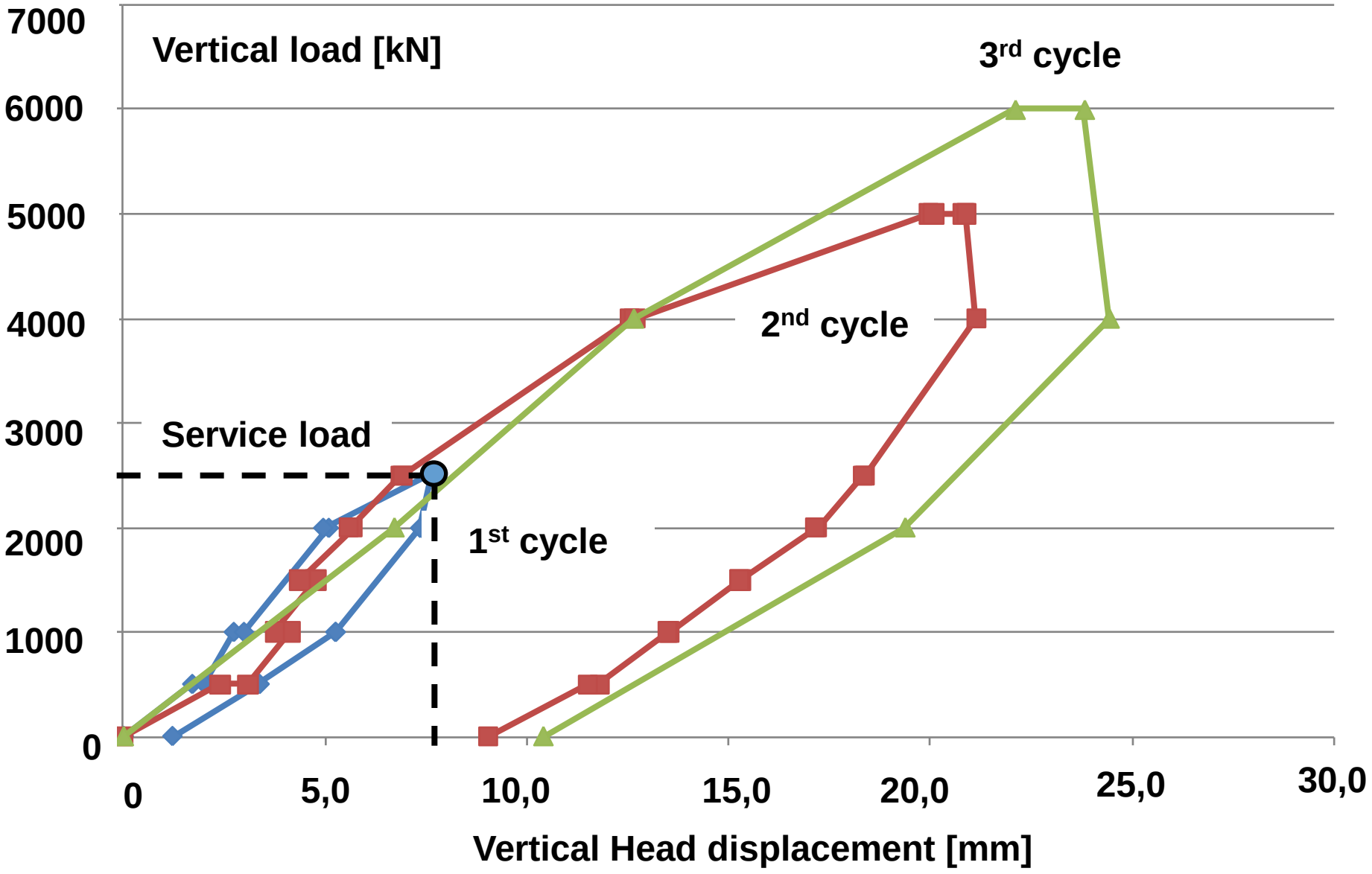


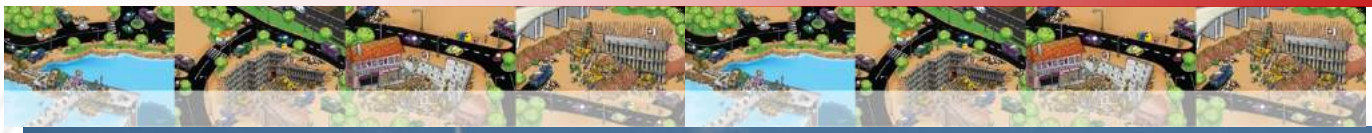



Vertical Full Scale
Load Tests

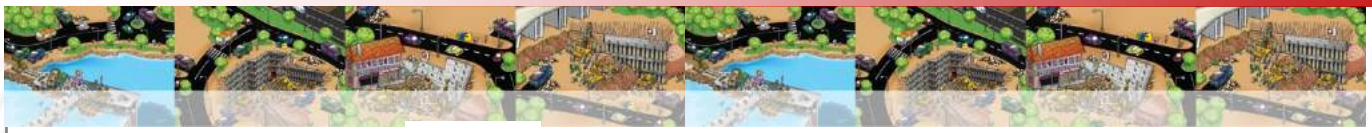

Vertical Head Load [kN]
0
1000
2000
3000
4000
5000
Depth [m]
0
5
10
15
20
25




Vertical load [kN]
7000
6000
5000
4000
3000
2000
1000
0
3rd cycle
2nd cycle
Service load
1st cycle
0
5,0
10,0
15,0
20,0
25,0
30,0
Vertical Head displacement [mm]




Horizontal Full
Scale Load Tests



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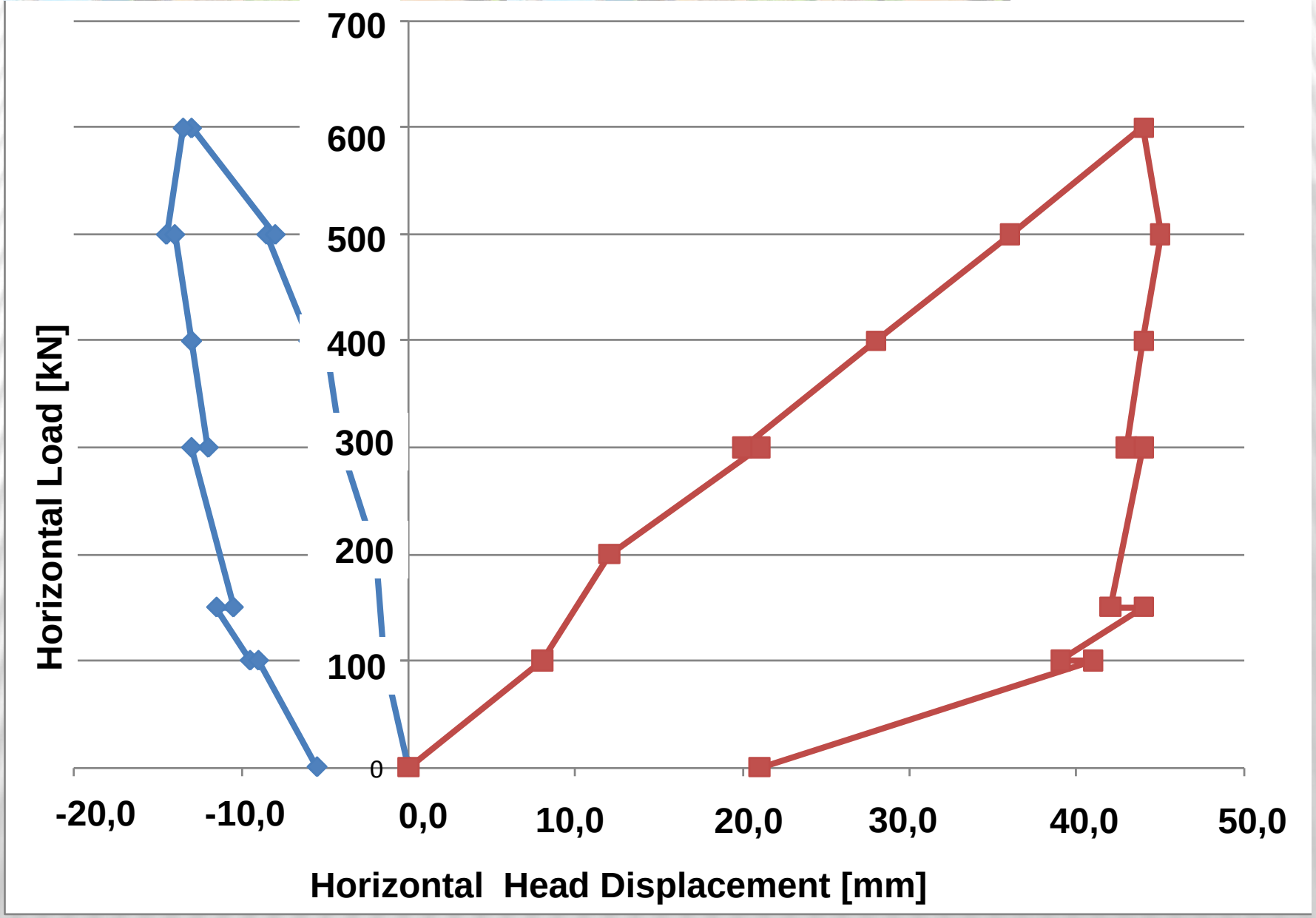

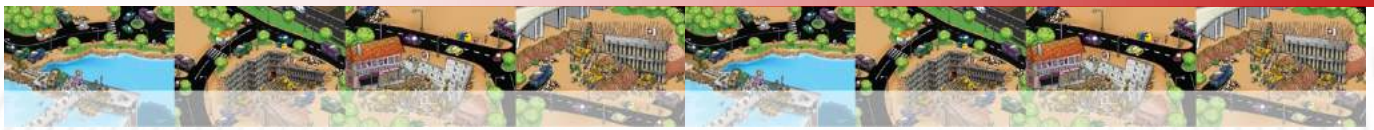

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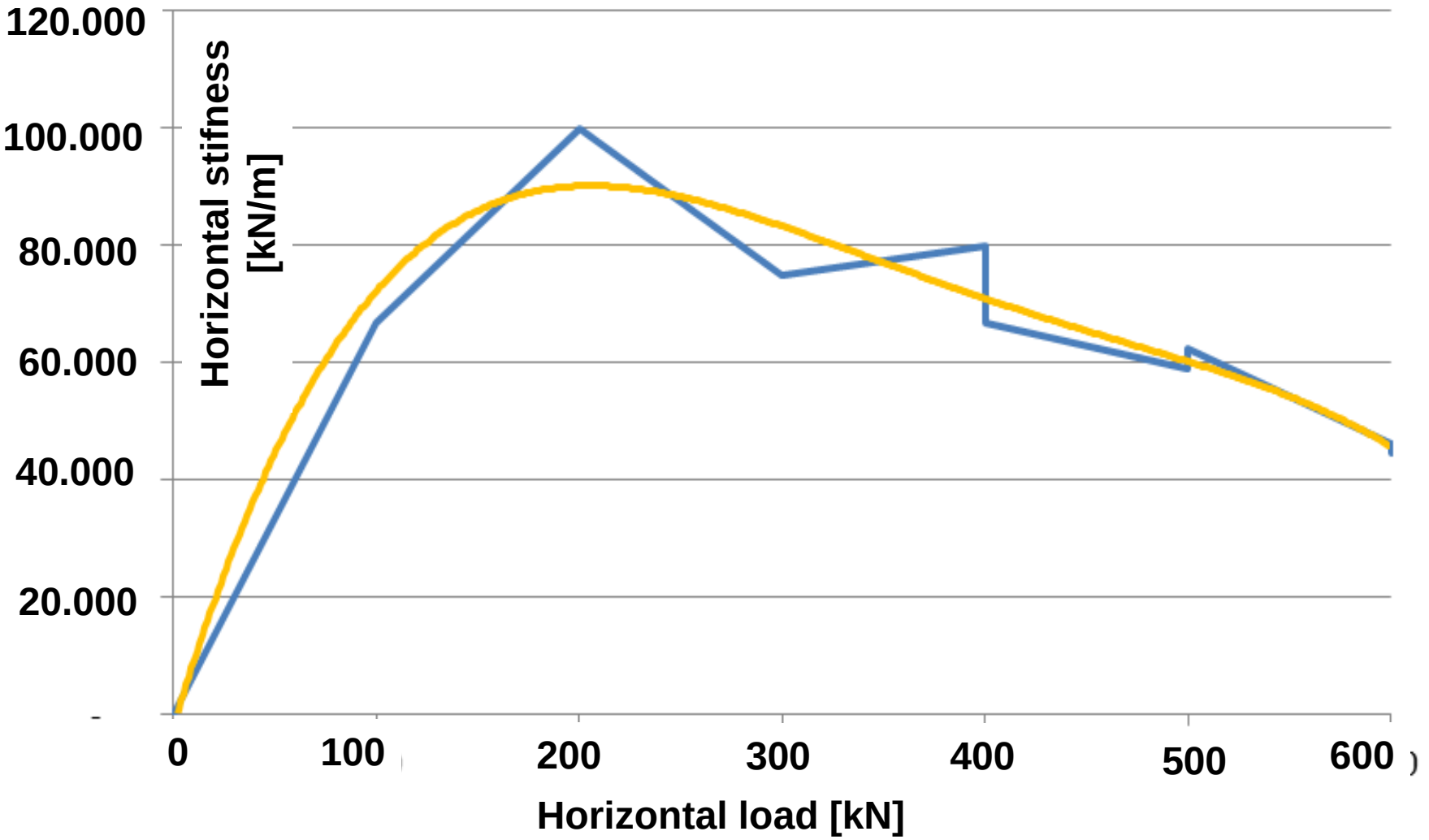
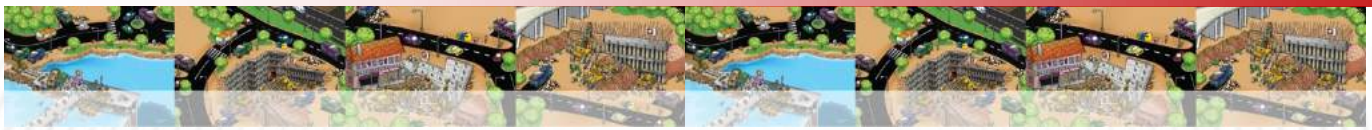
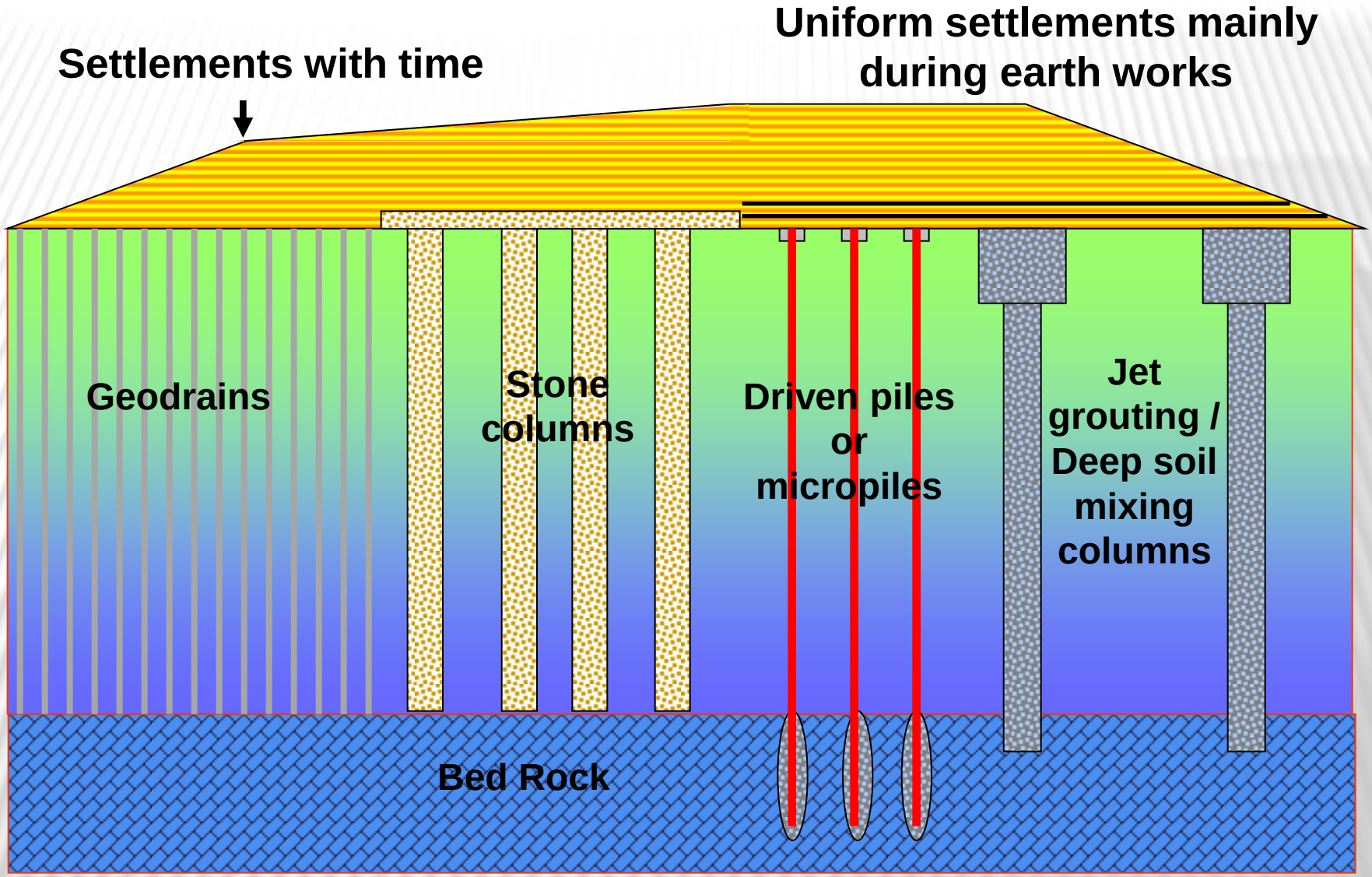


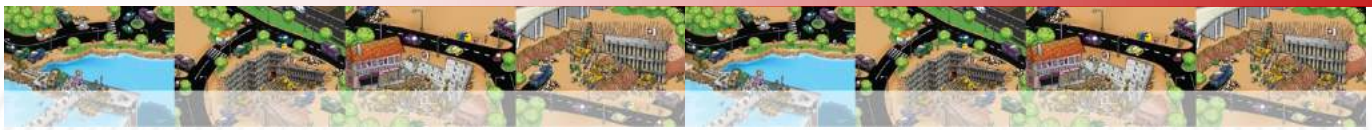


OUTLINE

- Introduction
- Main constraints
- Quay walls refurbishment and underpinning
- Landfill foundations
- Design
- Monitoring and survey
- Quality control / quality assurance
- **Alternative solutions**
- Conclusion remarks


Settlements with time
Uniform settlements mainly during earth works
Geodrains
Stone columns
Driven piles or micropiles
Jet grouting / Deep soil mixing columns
Bed Rock
Preloading
Drainage
Bearing capacity
Foundation stiffness: LTP demanding

OUTLINE



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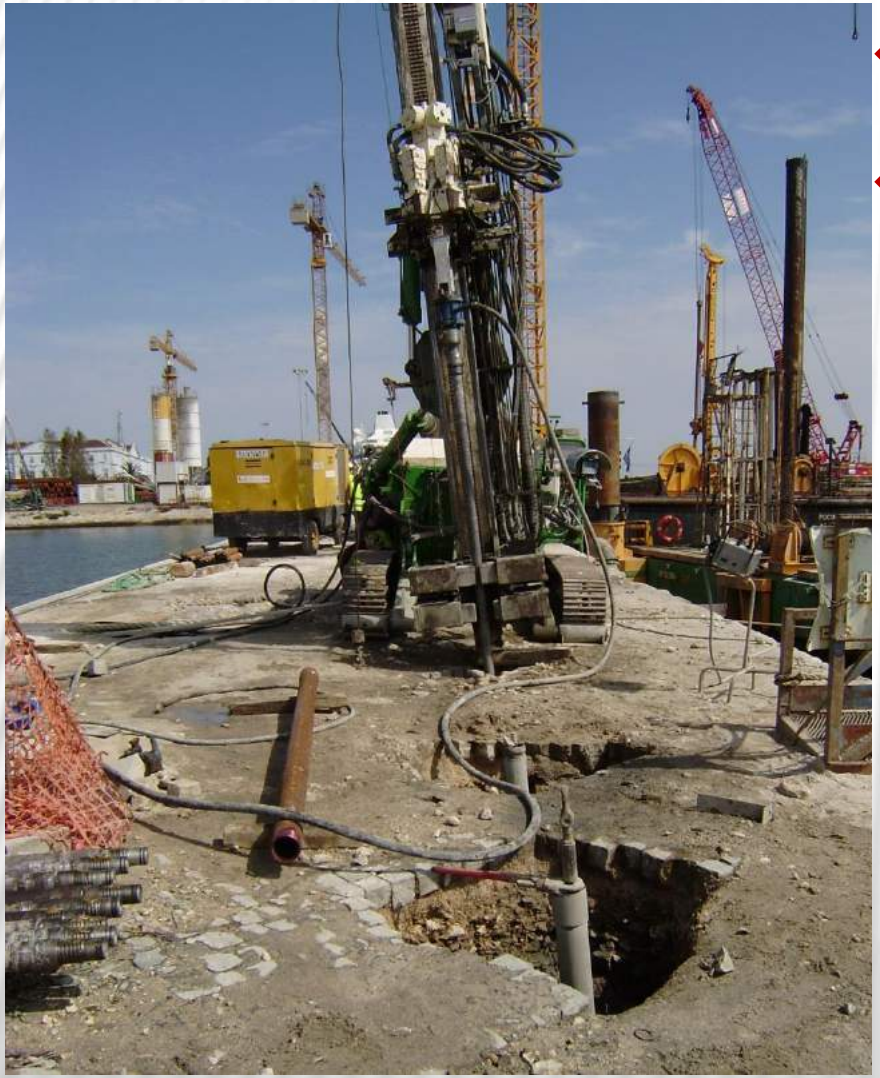
CONCLUSION REMARKS

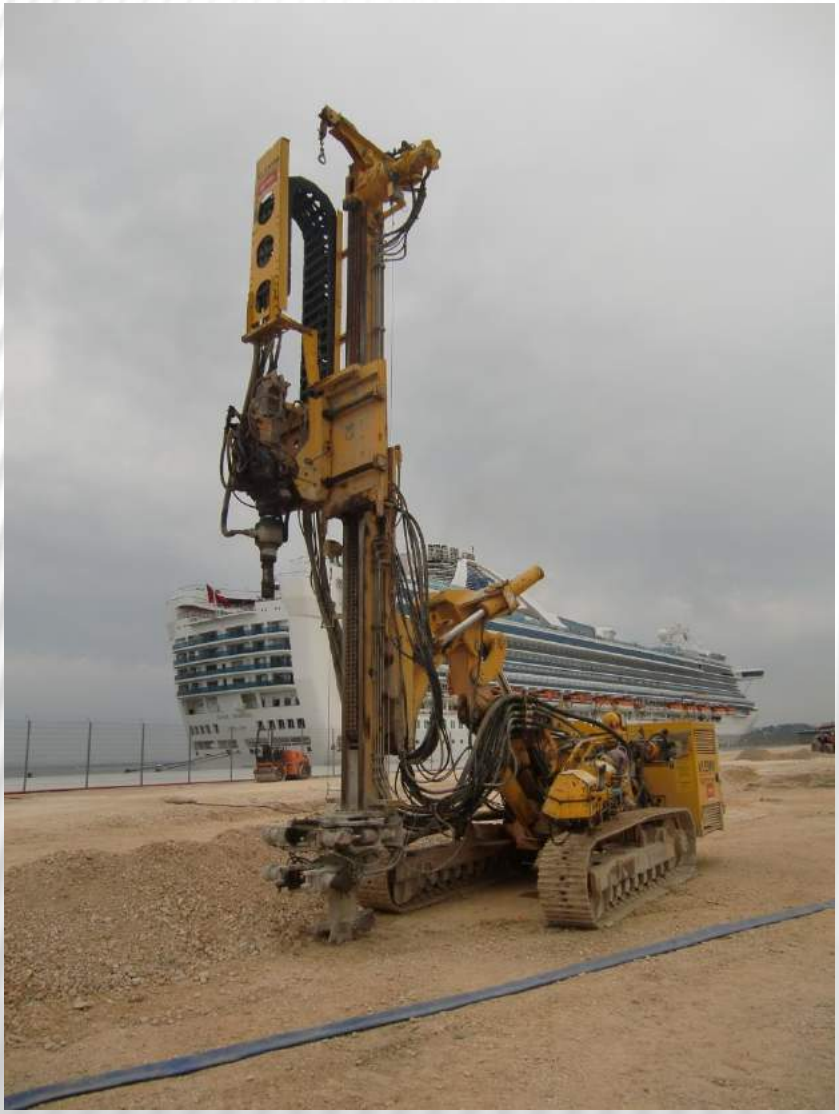
- **BIG VERSATILITY**

CONCLUSION REMARKS



- BIG VERSATILITY
- POSSIBILTY TO REINFORCE THE COLUMNS WITH STEEL PROFILES / MICROPILES

CONCLUSION REMARKS

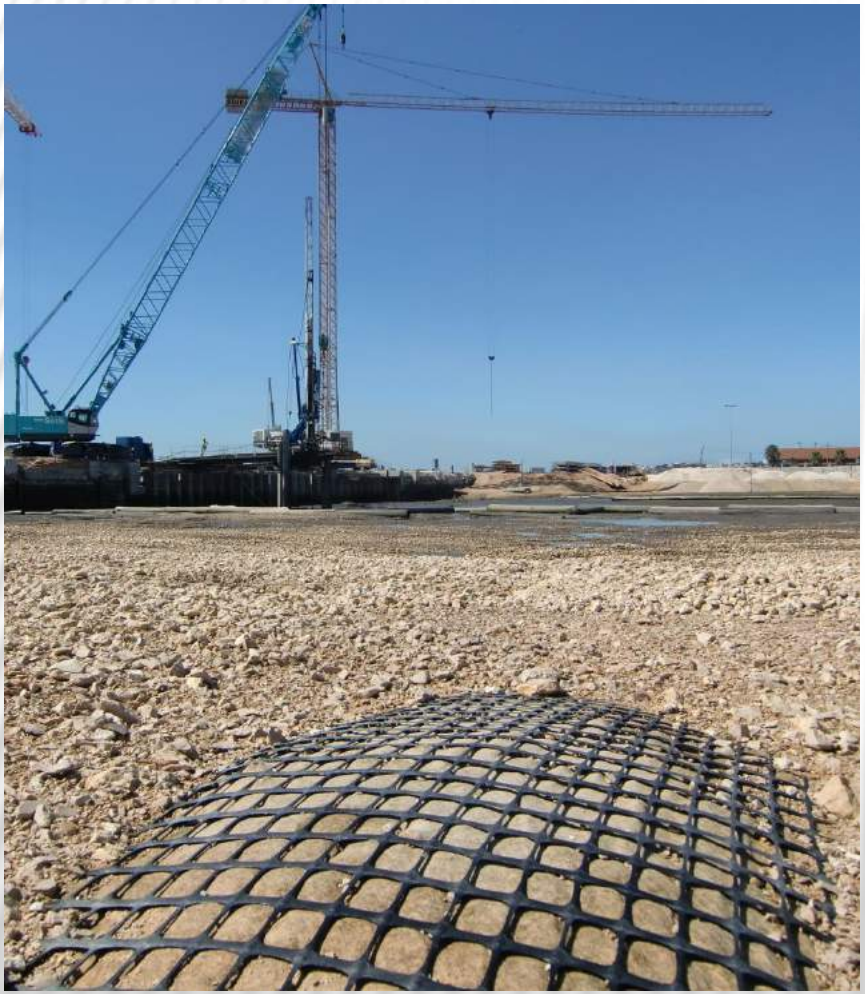


- BIG VERSATILITY
- POSSIBILTY TO REINFORCE THE COLUMNS WITH STEEL PROFILES / MICROPILES
- **NO NEED FOR PRELOADING ON SOFT SOILS**

CONCLUSION REMARKS

- BIG VERSATILITY
- POSSIBILTY TO REINFORCE THE COLUMNS WITH STEEL PROFILES
- NO NEED FOR PRELOADING ON SOFT SOILS
- **ENVIRONMENTAL ADVANTAGES**

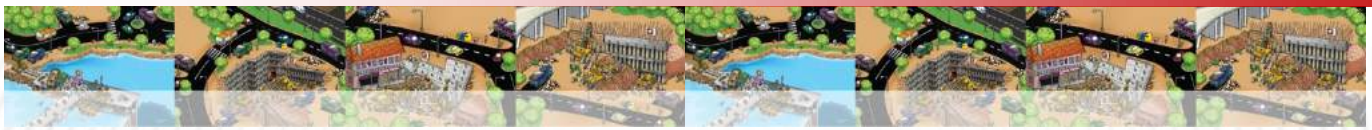
CONCLUSION REMARKS



- BIG VERSATILITY
- POSSIBILTY TO REINFORCE THE COLUMNS WITH STEEL PROFILES
- NO NEED FOR PRELOADING ON SOFT SOILS
- ENVIRONMENTAL ADVANTAGES
- **CONFINEMENT EFFECT ON SOFT SOILS**

CONCLUSION REMARKS

- BIG VERSATILITY
- POSSIBILTY TO REINFORCE THE COLUMNS WITH STEEL PROFILES
- NO NEED FOR PRELOADING ON SOFT SOILS
- ENVIRONMENTAL ADVANTAGES
- CONFINEMENT EFFECT ON SOFT SOILS
- EXECUTION CONTROL: QC / QA



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THANK YOU FOR YOUR ATTENTION

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