

Experimental and Numerical Modelling of Skirts and Plate Anchors for the Foundation of Offshore Platforms

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Previous
EIDEIC



Skills



Skirted
Foundations



Future dev.



State of PhD
Studies



SWOT



Conclusions

Previous EIDEIC

- Research in the field of offshore geotechnical engineering



Previous
EIDEIC

Skills

Skirted
Foundations

Future dev.

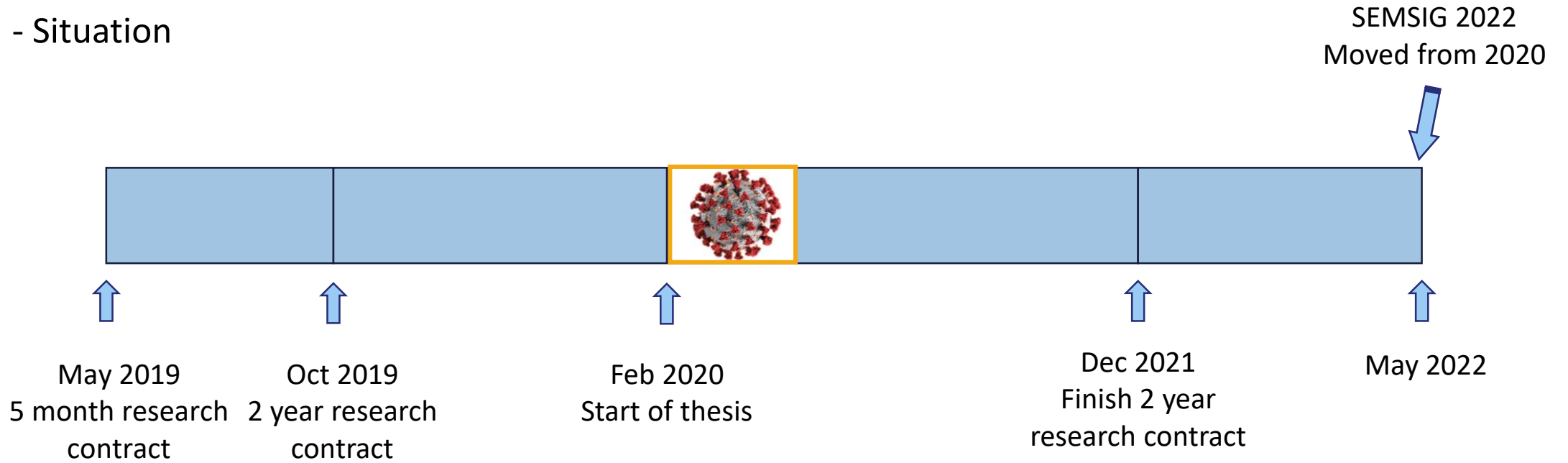
State of PhD
Studies

SWOT

Conclusions

Previous EIDEIC

- Research in the field of offshore geotechnical engineering
- Situation



Previous EIDEIC

Skills

Skirted Foundations

Future dev.

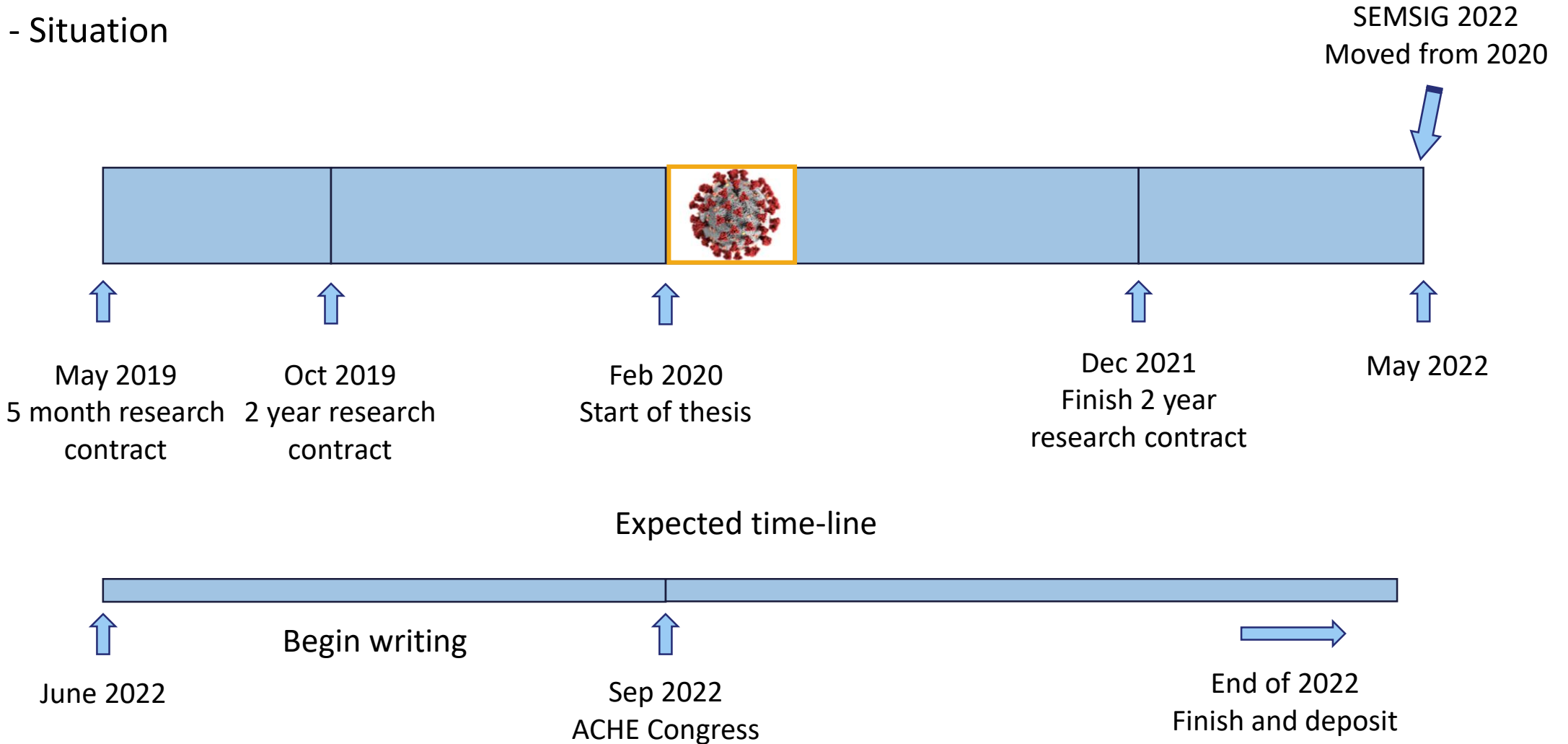
State of PhD Studies

SWOT

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SWOT



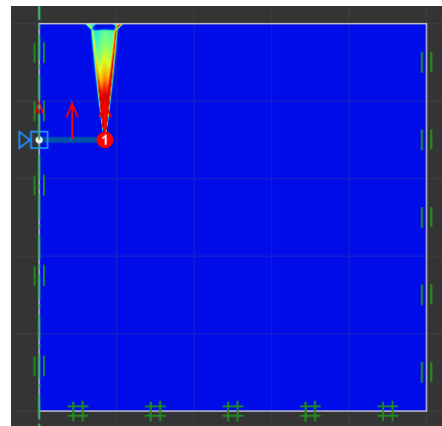
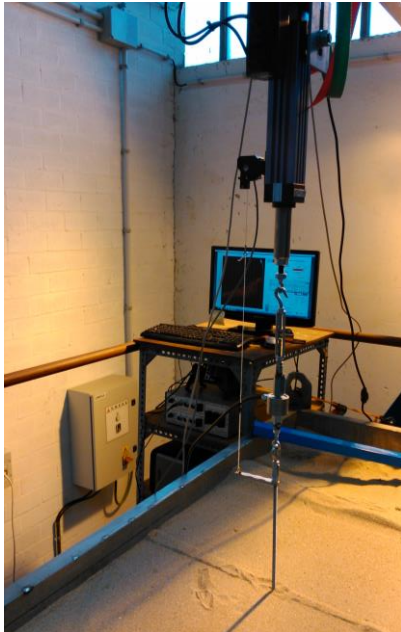
Conclusions

Previous EIDEIC

- Research in the field of offshore geotechnical engineering
- Situation
- Presentation of two active research projects

Analysis of vertical pull-out of plate anchors: numerical modelling and experimental testing

Analysis of skirt penetration in granular soils



Previous
EIDEIC

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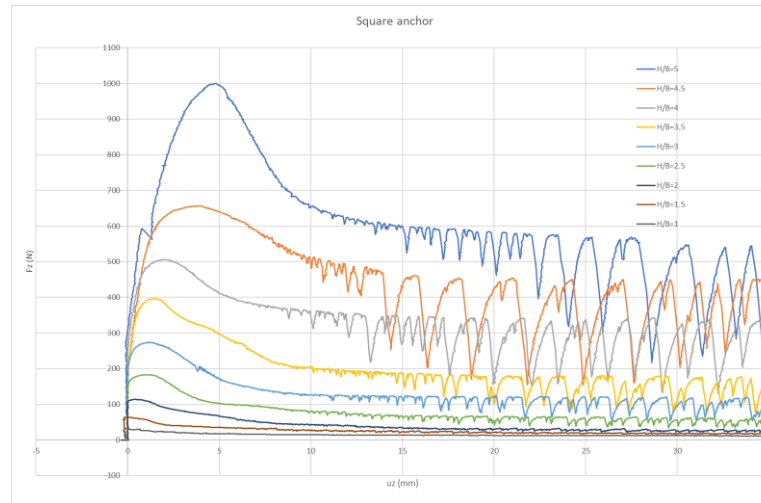
SWOT

Conclusions

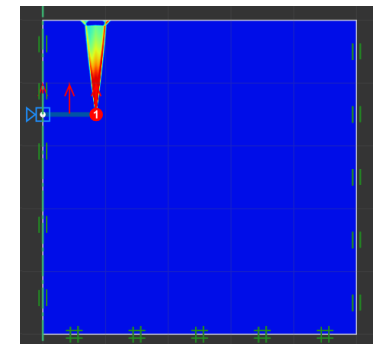
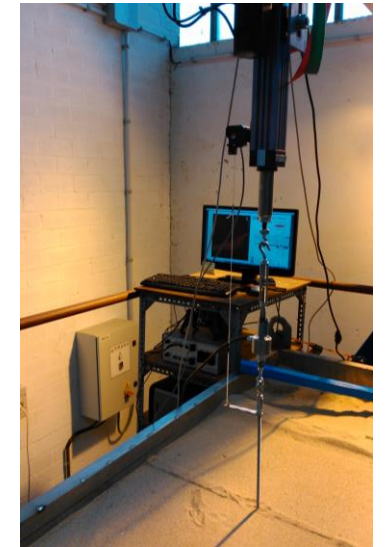
Previous EIDEIC

Analysis of vertical pull-out of plate anchors: numerical modelling and experimental testing

- Experimental Tests – Complicated but showed promising results



- Numerical Analyses – Results led to a communication in a congress
Capacidad de tiro de anclas planas en arcilla mediante análisis límite con elementos finitos
XI Simposio Nacional de Ingeniería Geotécnica (next week)



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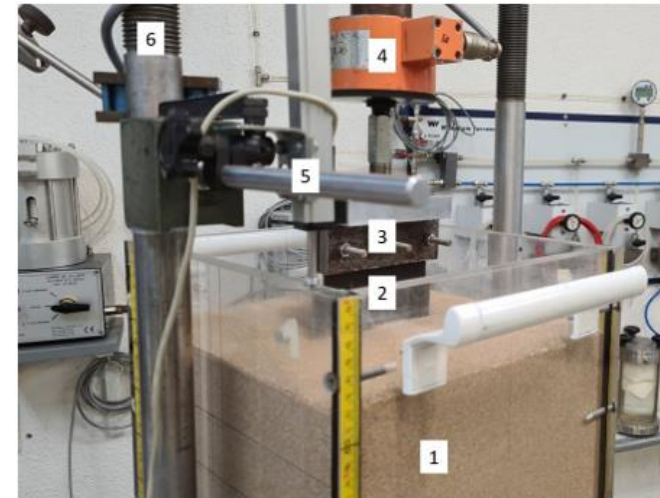
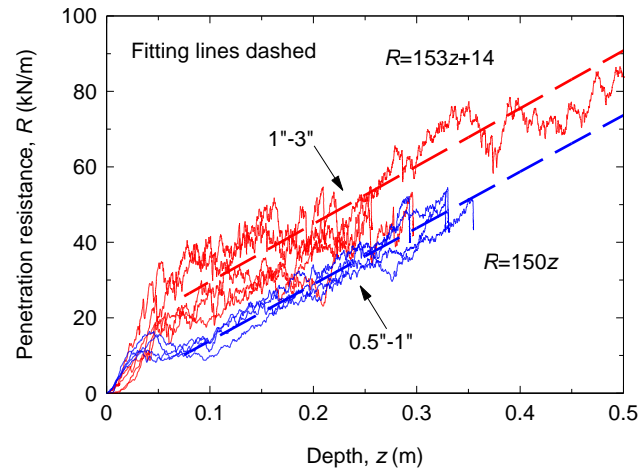
SWOT

Conclusions

Previous EIDEIC

Analysis of skirt penetration in granular soils

- Initial project – Collaboration with IH Cantabria
 - Real scale
 - Two skirt thicknesses and two materials
- Preparation of small scale tests
 - 1:20 scale
 - Five skirt thicknesses and two materials



1	Deposit with soil
2	Skirt
3	Connector
4	Loading cell
5	Displacement sensor
6	Press

Previous
EIDEIC

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Studies

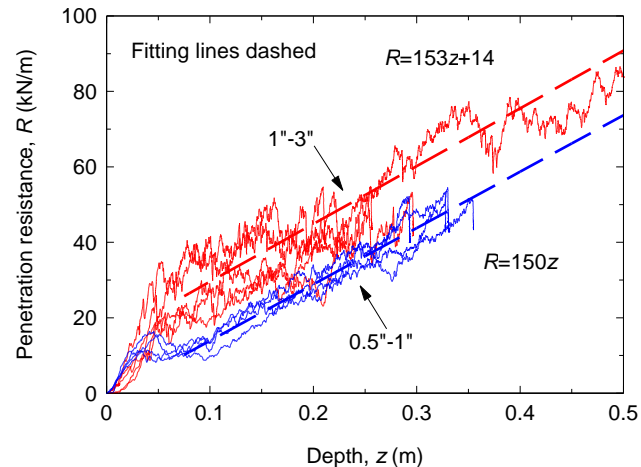
SWOT

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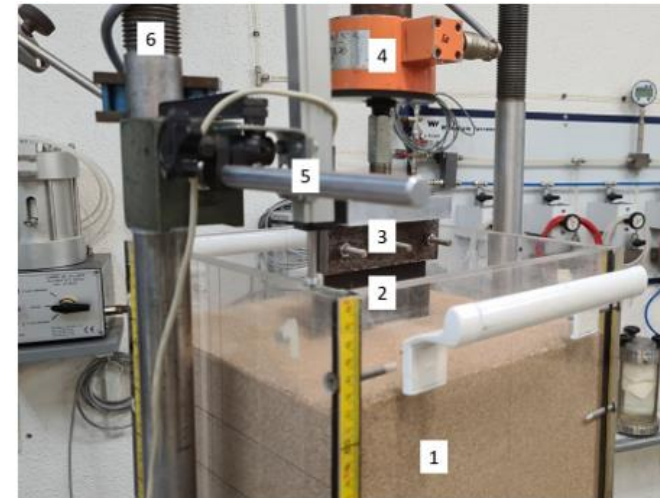
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Focus of this presentation

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SWOT



Conclusions

Skills and capacities

BASIC SKILLS

CB11

Systematic understanding of a field of study and command of the skills and research methods related to the field.

CB12

Skill to conceive, design or create, implement and adopt a substantial process of research or creation.

CB13

Skill to contribute to the enlargement of the knowledge limits through an original research.

CB14

Skill to carry out a critical analysis and assessment and synthesis of new and complex ideas.

CB15

Skill to communicate with the academic and scientific community and with society in general about the scope of knowledge in the ways and languages of common use in the international scientific community.

CB16

Skill to encourage, in academic and professional contexts, the scientific, technological, social, artistic or cultural progress in a society based on knowledge.

CAPACITIES AND PERSONAL ABILITIES

CA01

Cope in context in which there is little specific information.

CA02

Find the key questions to be answered to solve a complex problem.

CA03

Design, create, develop and undertake new and innovative projects in the knowledge scope.

CA04

Work both in teams and individually in an international or multidisciplinary context.

CA05

Integrate knowledge face complexity and formulate judgements with limited information.

CA06

Intellectual criticism and defence of solutions.

Skills and capacities

Previous
EIDEIC



Skills



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Foundations



Future dev.



State of PhD
Studies



SWOT



Conclusions

CB11

Favourable evaluation of the Research Plan throughout the thesis

CB12

Publication in international journals

CA04

International mobility

Previous
EIDEIC



Skills



**Skirted
Foundations**



Future dev.



State of PhD
Studies



SWOT



Conclusions

Skirted Foundations

Literature research

Standards and Recommended Practices

API (2011) and DNV GL (2017)

- Based on CPT data
- Use bearing capacity formulae

$$R = q_{tip} \cdot A_{tip} + f_s \cdot A_{wall}$$

Problem – performing CPT tests

CB11

CA01

CB12

CA02

Previous
EIDEIC



Skills



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Studies



SWOT



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Problem – performing CPT tests

Assume particle size \ll skirt thickness



Not valid for coarse granular soils

CB11

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Not valid for coarse granular soils

CB11

CA01

CB12

CA02

Publications

Andersen et al. (2008)

- Based on triaxial friction angle
- Use bearing capacity formulae

$$\begin{aligned} R &= q_{tip} \cdot A_{tip} + f_s \cdot A_{wall} \\ &= (0,5 \cdot \gamma' \cdot t \cdot N_\gamma + q \cdot N_q) \cdot A_{tip} \\ &\quad + (0,5 \cdot K \cdot \gamma' \cdot z \cdot \tan(\delta)) \cdot A_{wall} \end{aligned}$$

Miyai et al. (2019)

- Penetration resistance increases with the decrease of t/d_{50}
- Better adjustment: $t_{eq} = t + d_{50}$

Previous EIDEIC



Skills



Skirted Foundations



Future dev.



State of PhD Studies



SWOT



Conclusions

Skirted Foundations

CB11

CB14

CA03

CB12

CA01

CA05

LABORATORY TESTS – MATERIALS AND SET UP

Skirts/Steel plates



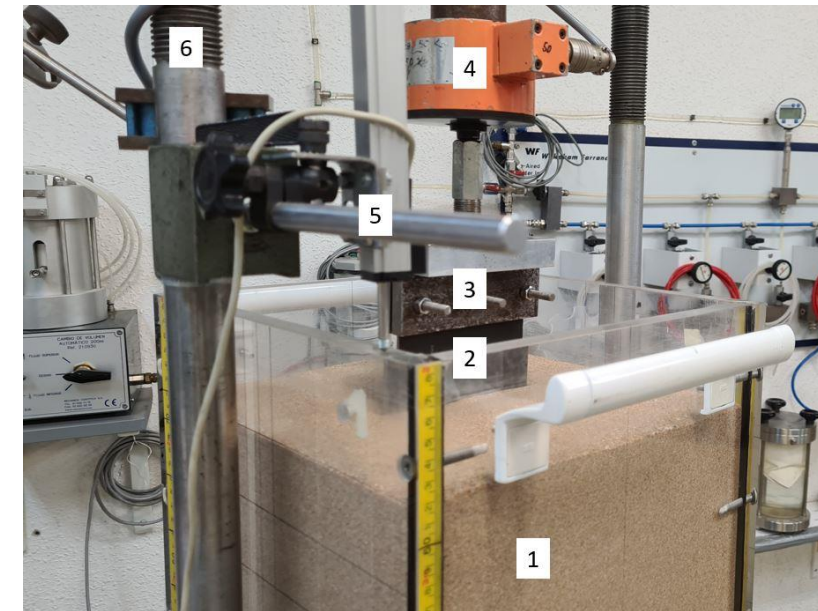
20 – 10 – 5 – 2 – 1 mm



Sand and gravel



Test set up



1	Soil	4	Loading cell
2	Steel plate	5	LVDT
3	Connector	6	Press

Previous
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CA05

LABORATORY TESTS – MATERIALS AND SET UP

Other authors

Reference	Type	Case	t/d_{50}
Varela et al. (under review)	Experimental	Plate	3-32
Miyai et al. (2019)	Experimental	Plate	3
Miyai et al. (2019)	2D DEM	Plate	2,6-63
Arroyo et al. (2011)	Experimental	Cone	67
Arroyo et al. (2011)	3D DEM	Cone	2-4

Our tests

t/d_{50}		
t (m)	d_{50} (m)	
		0,00243
0,001	0,4	3
0,002	0,8	6
0,005	2	16
0,010	4	31
0,020	8	63

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CA03

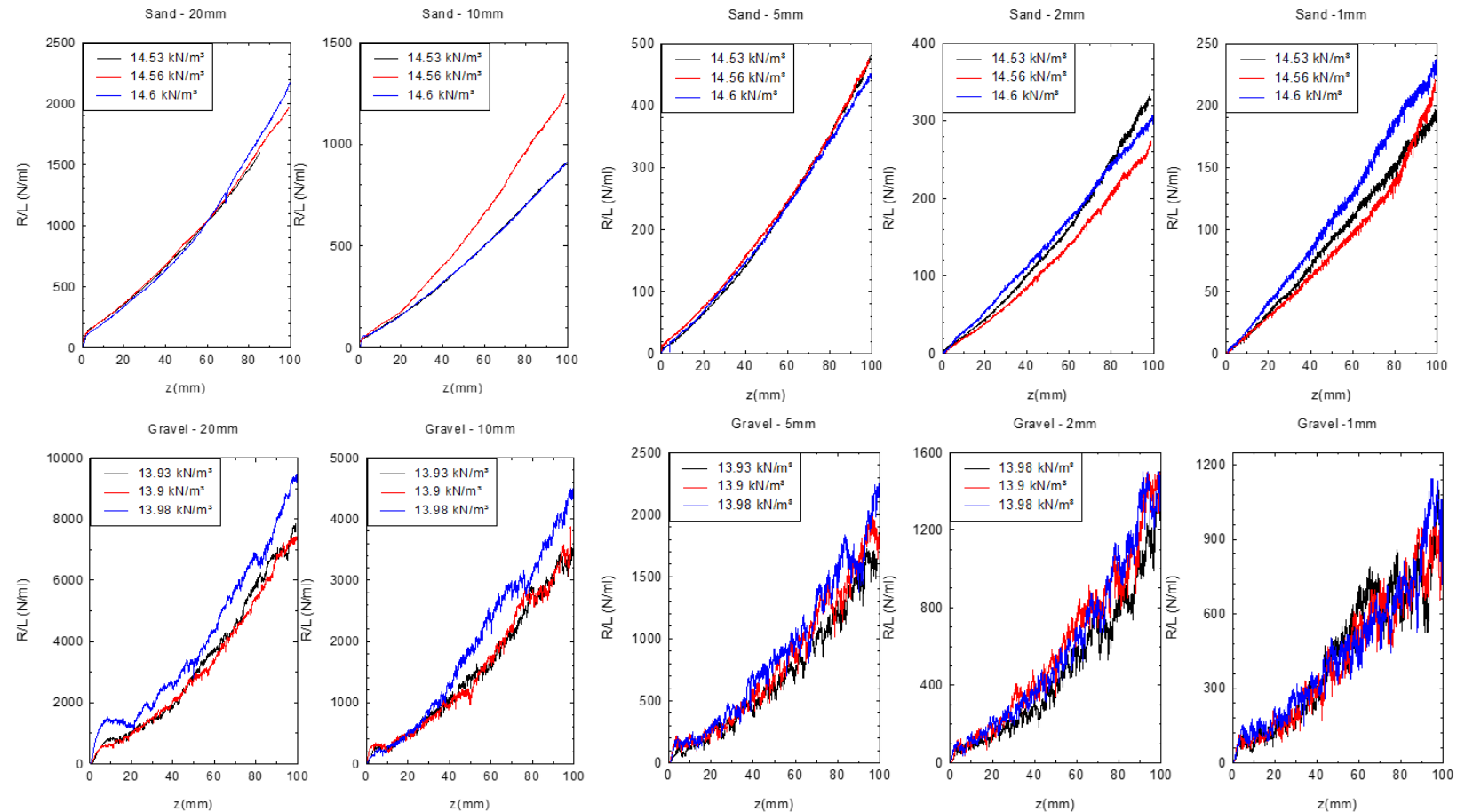
CB12

CA01

CA05

LABORATORY TESTS – RESULTS AND INTERPRETATION

Results - Expressed as R/L (N/ml) – z(mm)



Previous
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Conclusions

Skirted Foundations

CB11

CB14

CA03

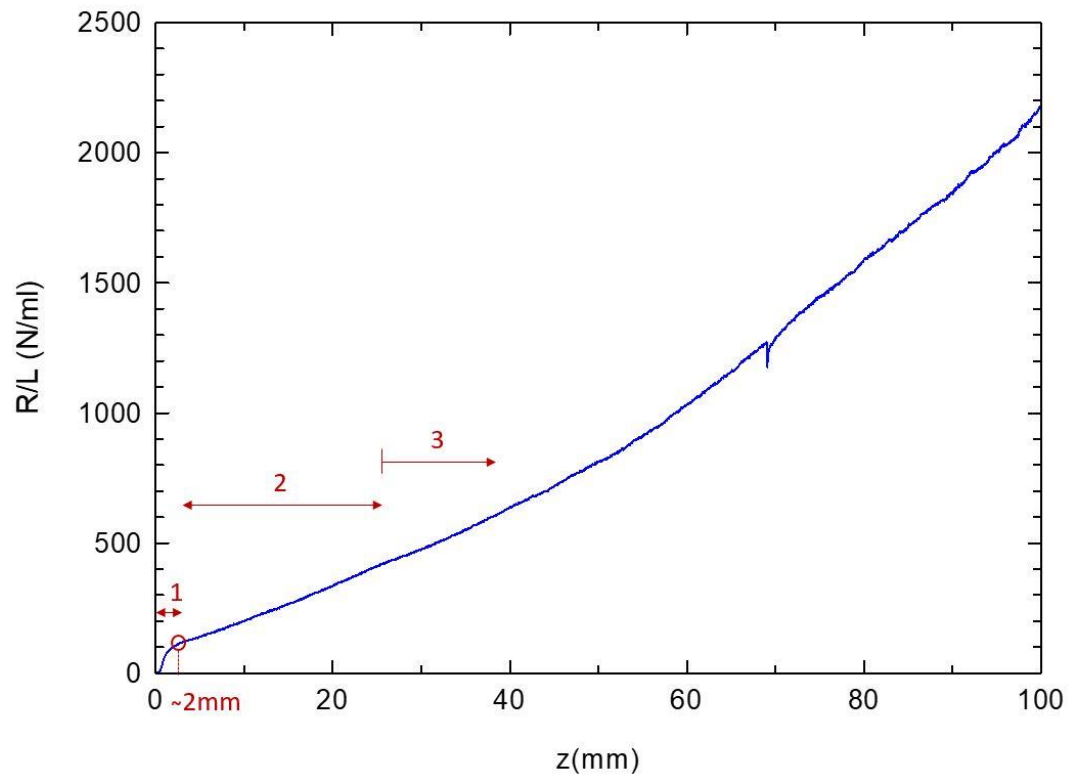
CB12

CA01

CA05

LABORATORY TESTS – RESULTS AND INTERPRETATION

Results



Parts of curves:

1. Rapid increase in load due to the contact
2. Linear increase as the plate is inserted
3. Influence of boundaries (deposit)



Interested in the first 50mm of penetration

Previous EIDEIC

Skills

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State of PhD Studies

SWOT

Conclusions

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CB11

CB14

CA03

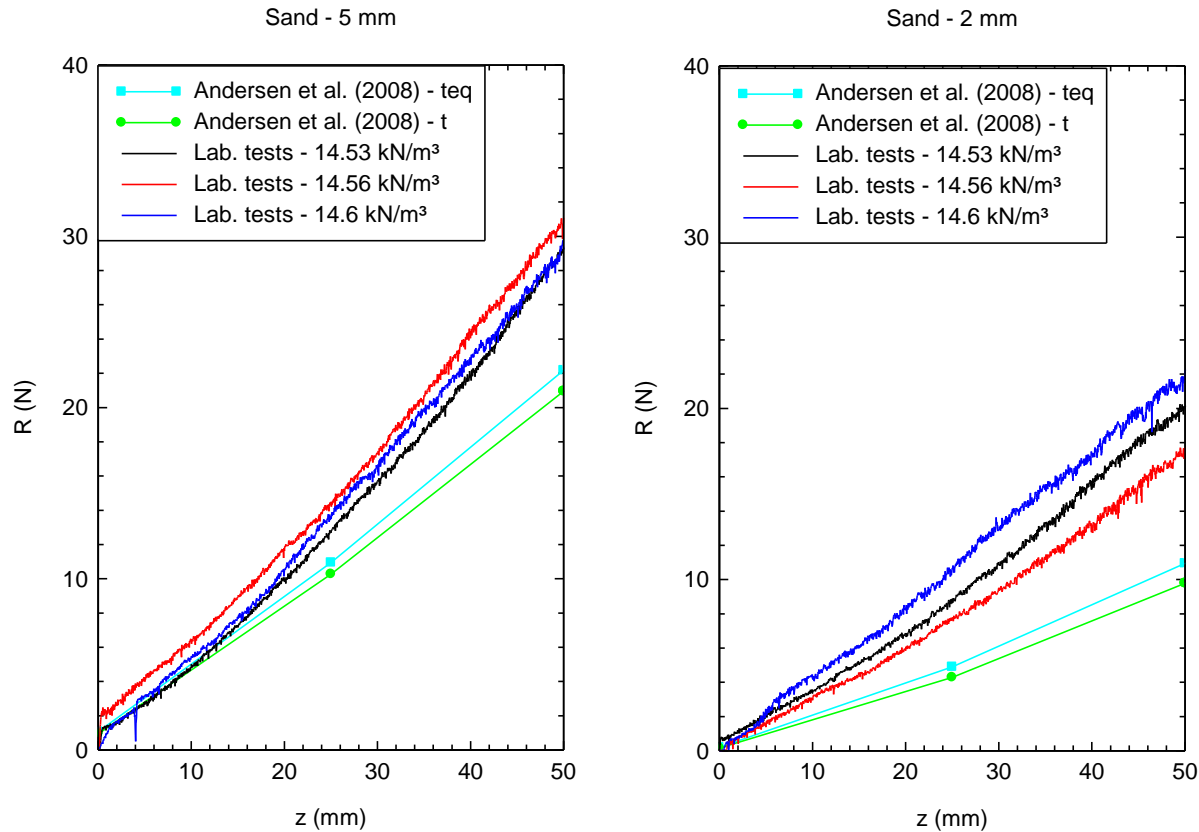
CB12

CA01

CA05

LABORATORY TESTS – RESULTS AND INTERPRETATION

Experimental results VS Analytical Solution (Andersen et al. 2008)



Miyai et al. (2019) adjustment

$$t_{eq} = t + d_{50}$$

d_{99} ?

Friction angle?

Triaxial tests

Backanalysis

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Skills

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Future dev.

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CB14

CA03

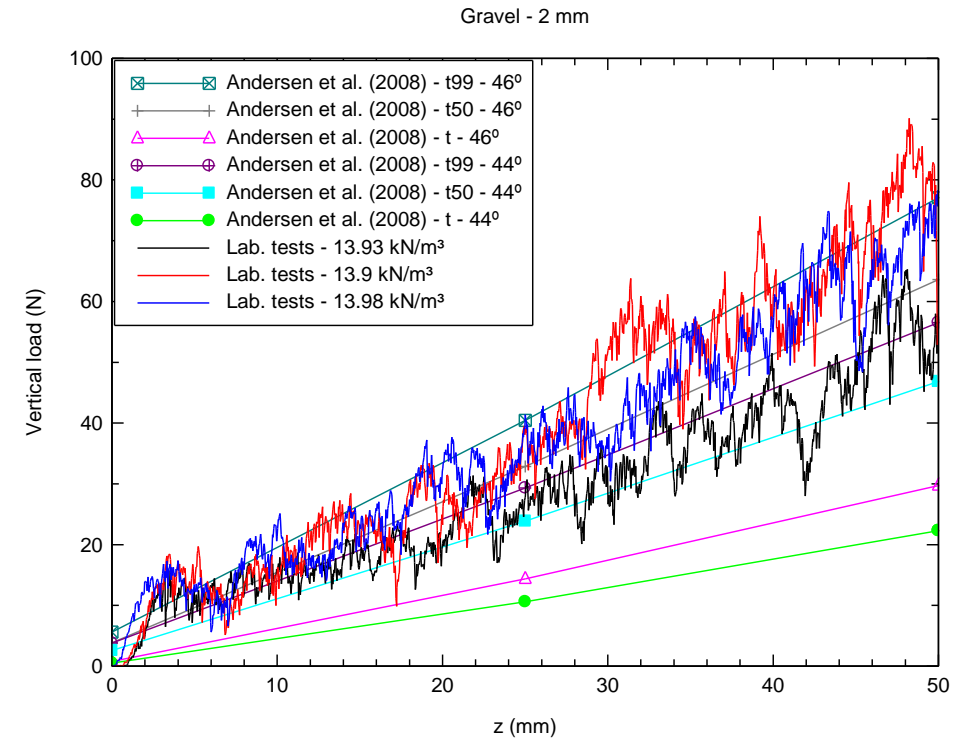
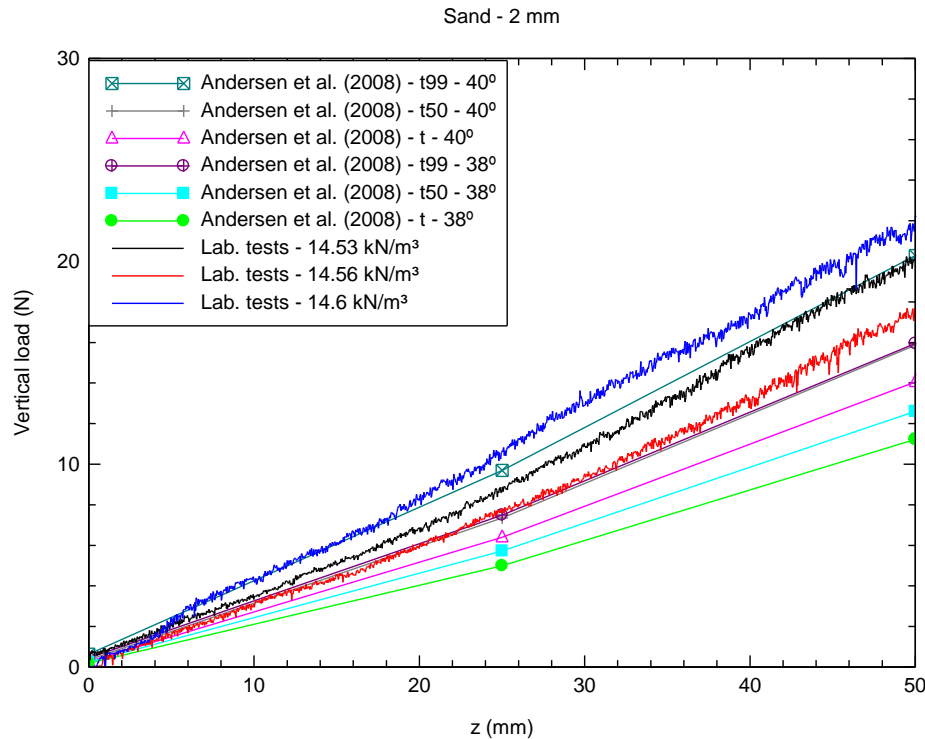
CB12

CA01

CA05

LABORATORY TESTS – RESULTS AND INTEPRETATION

Experimental results VS Analytical Solution (Andersen et al. 2008) applying Miyai et al. (2019)



Better adjustment

Future Development

- Direct Shear tests: analyse friction between steel plate and sand/gravel (in progress)
- Begin writing thesis
- Future research:
 - Expand on numerical analyses on plate anchors
 - More tests on steel plates (different soils, wider range of plate thickness, etc.)
- Publications and communications (next slide)

Previous
EIDEIC



Skills



Skirted
Foundations



Future dev.



State of PhD
Studies



SWOT



Conclusions

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Skills

Skirted Foundations

Future dev.

State of PhD Studies

SWOT

Conclusions

State of Doctoral Studies

CB12

CB15

CA02

CB13

CB16

• Multidisciplinary Training ✓

Basic Skills	40h
Advanced Skills	40h
Specific Training	15h

• International mobility ✗

- Lack of financial support

• Communications

- *Capacidad de tiro de anclas planas en arcilla mediante análisis límite con elementos finitos – XI Simposio Nacional de Ingeniería Geotécnica*
- *Soil-structure interaction of a pile wall at the toe of a natural slope – VIII Congreso de la Asociación Española de Ingeniería Estructural*

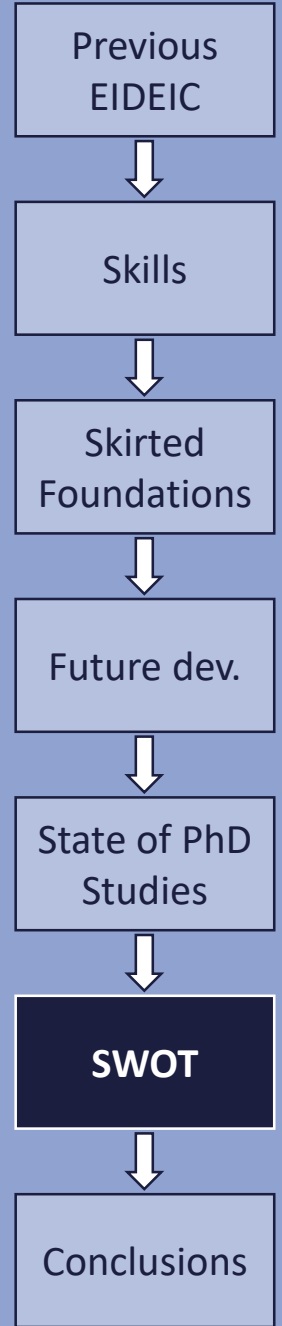
• Annual Evaluations ✓

Year 1	Favourable
Year 2	Favourable
Year 3	In progress

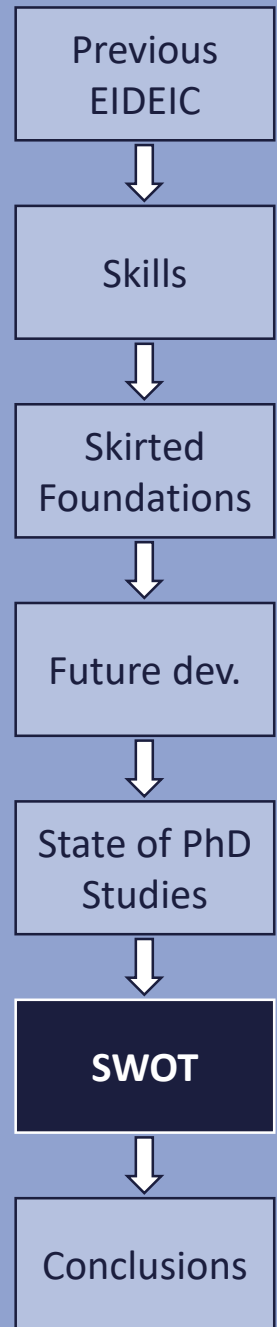
• Publications

- *Full-scale tests of skirt penetration resistance in gravel for offshore wind structures – Under revision*
- *Penetration resistance and sliding capacity of skirted mud mat foundations in gravel for offshore jackets – In progress*
- *Laboratory tests of skirt penetration in loose granular soils – In progress*

SWOT Analysis



SWOT Analysis



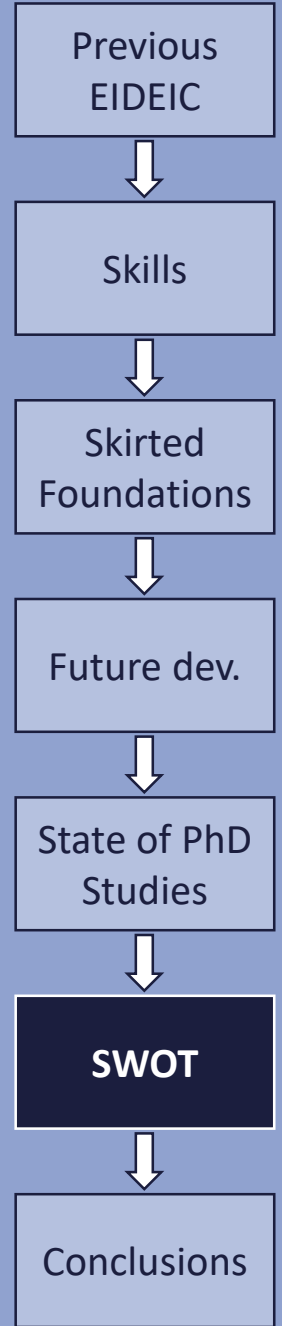
New laboratory tests:

- Unique
- Easy and stable methodology
- Good results

Finished laboratory and computational research (time to write)



SWOT Analysis



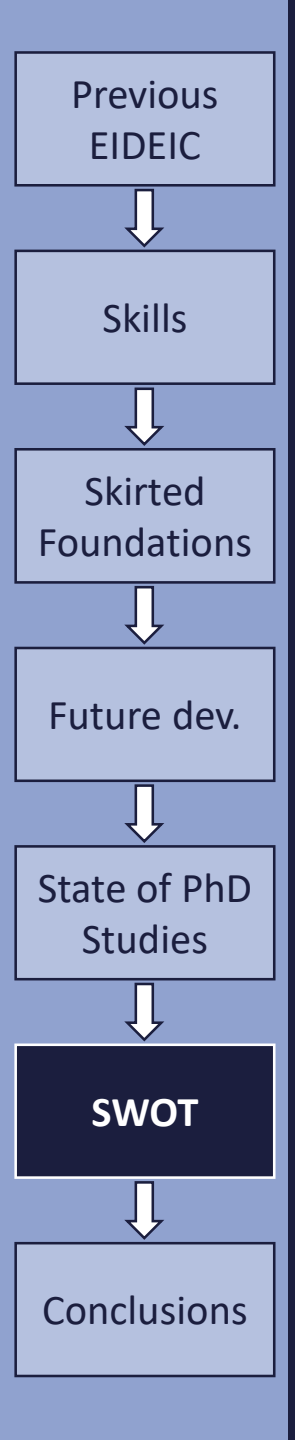
Experimental tests:

- Deposit size
- Density

Results:

- Interpretation
- Material parameters

SWOT Analysis



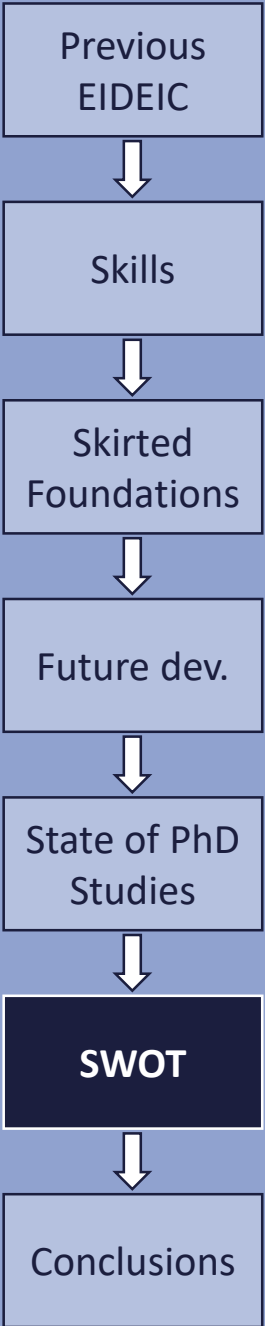
Experimental tests:

- Room for expansion
- Publications

Thesis:

- Research group experience

SWOT Analysis



Time (nearing end of contract)
No international mobility

Previous
EIDEIC



Skills



Skirted
Foundations



Future dev.



State of PhD
Studies



SWOT



Conclusions

Conclusions

- Will finish my thesis with three publications in international journals
- Will participate in two congresses by the end of the year
- The laboratory testing is done (for now) so I will begin writing
- The lack of international mobility may delay the deposit
- The accomplishment of basic, advanced and specific skills is complete

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EIDEIC



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Participation in the “Hilo Tesis” contest with a brief and simple explanation of my thesis (Spanish)



CB16

@evarela6

Thank you for
your attention

