Dynamic soil-structure interaction for wind turbine towers

CentraleSupélec + SEMOFI

NICOLAS BAUDIN
INTERNSHIPS IN FRANCE INITIATIVE

Name of the hosting institution in France	CentraleSupélec
Name of the host laboratory / research team	MSSMAT
Address	8-10 rue Joliot Curie 91190 Gif sur Yvette
Web site	http://www.mssmat.ecp.fr/
Name of the supervisor	Pierre Jehel
Function	Professor
Email	pierre.jehel@centralesupelec.fr
Phone number	+33175316748

Internship offer

Topic of the internship (title)	Dynamic soil-structure interaction for wind turbine towers			
Proposed dates of the internship	**Start:**	2019-09-02	**End**	2020-02-28

Scientific and academic objectives of the internship (detailed description of the internship content, work expected from the intern and expected outcomes):

Dynamic loading needs to be considered when designing wind turbines. On the one hand, the rotational speed of the rotor, the passing blades, and the wind gusts induced all generate dynamic loads on the wind turbine tower with dominant frequencies usually below 1 Hz. On the other hand, wind turbine tower is anchored in the ground and the dynamic loading is transmitted to the soil. To accurately simulate the structural behavior of wind turbines, the dynamic response of the soil surrounding the foundation needs to be accounted for and soil-structure interaction should be considered. Besides, soil properties may vary with respect to the loading frequency. The objective of this internship is twofold:
1) The experimental investigation of the sensitivity of the response of a given soil (to be determined) to the frequency of the dynamic loading. This will be done performing cyclic triaxial tests.
2) Developing the numerical model of a coupled system {wind turbine + soil} that accounts for the soil response dependence on the frequency content of the loading.
See annexe for more details

Name of industrial partner	SEMOFI
Role of the industrial partner in the internship project	Co-supervision and co-location of the intern at Sémofi and MSSMat laboratory: - Entreprise Sémofi, Villeneuve-le-Roi (94) - Laboratoire MSSMat UMR CNRS 8579, CentraleSupélec / Université Paris-Saclay
Main contact at the French industrial partner	Cami Kastrio
Targeted Australian university	Any

Expected profile of applicant

Level of study	Bachelor's degree with honours or Master's student
Discipline	Civil or mechanical engineering
Required qualities, knowledge and skills	Scientific skills: Soil mechanics and dynamics, Structural mechanics and dynamics, Computational mechanics, Experimental testing. This is a multidisciplinary subject that brings together both skills in computational mechanics and civil engineering. Consequently, candidates are expected to have a strong background in one of these two fields and a strong interest in the other one. Experience with Matlab, Python or Fortran will be a plus. Candidates willing to pursue a PhD program will be favoured.
Other specific eligibility criteria	Due to institutional cooperation and agreements, candidates from Flinders University, University of Queensland, University of Technology Sydney and Macquarie University will be welcomed

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Description of the internship:
Dynamic loading needs to be considered when designing wind turbines. On the one hand, the rotational speed of the rotor, the passing blades, and the wind gusts induced all generate dynamic loads on the wind turbine tower with dominant frequencies usually below 1 Hz [1]. On the other hand, wind turbine tower is anchored in the ground and the dynamic loading is transmitted to the soil. To accurately simulate the structural behaviour of wind turbines, the dynamic response of the soil surrounding the foundation needs to be accounted for and soil-structure interaction should be considered. Besides, soil properties may vary with respect to the loading frequency [2].

The objective of this internship is twofold:
1) The experimental investigation of the sensitivity of the response of a given soil (to be determined) to the frequency of the dynamic loading. This will be done performing cyclic triaxial tests (see below).
2) Developing the numerical model of a coupled system {wind turbine + soil} that accounts for the soil response dependence on the frequency content of the loading.

Other objectives:
- Developing the collaboration between Sémofi and CentraleSupélec;
- Open position for a Geotechnical Engineer at Sémofi after the intership.

Supervision:
- Dr. Kastriot Çami (Sémofi), kastriot.cami@semofi.fr
- Dr. Pierre Jehel (MSSMat), pierre.jehel@centralesupelec.fr

Place of internship:
The intern will work both at Sémofi and MSSMat laboratory:
- Entreprise Sémofi, Villeneuve-le-Roi (94)
- Laboratoire MSSMat UMR CNRS 8579, CentraleSupélec / Université Paris-Saclay

References
[1] S. Adhikari and S. Bhattacharya, Dynamic analysis of wind turbine towers on flexible foundations. *Shock and Vibration* 19 (2012), 37-56.
[2]J.-F. Serratrice, Comparison of cyclic triaxial strength of soils tested in their natural state, 9ème colloque AFPS (2015), Marne-la-Vallée, France.

Triaxial cyclic test machine (Sémofi)

Soil	Effective confinement	Loading type	Loading frequency (Hz)				
	100 kPa	Sine	0,05	0,25	0,5	1	5

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