Université Gustave Eiffel

LABORATOIRE GEOEND
GÉOPHYSIQUE ET ÉVALUATION NON DESTRUCTIVE

PhD position 2023-2026

EXPERIMENTAL AND NUMERICAL ANALYSIS OF GUIDED WAVE PROPAGATION IN CABLES FOR THEIR NON-DESTRUCTIVE EVALUATION

Keywords : acoustic, waves, modes, cables, experimentation, signal processing, simulation, finite elements

Beginning : from october 2023
Host laboratory : GERS – GeoEND (Geophysics and non-destructive evaluation)
PhD Speciality : Acoustics
Location : Université Gustave Eiffel, Nantes campus, France
Doctoral affiliation : Centrale Nantes ou Le Mans Université
PhD school : Sciences de l'Ingénierie et des Systèmes (SIS)
Supervision : Fabien Treyssède (DR, HDR), supervisor
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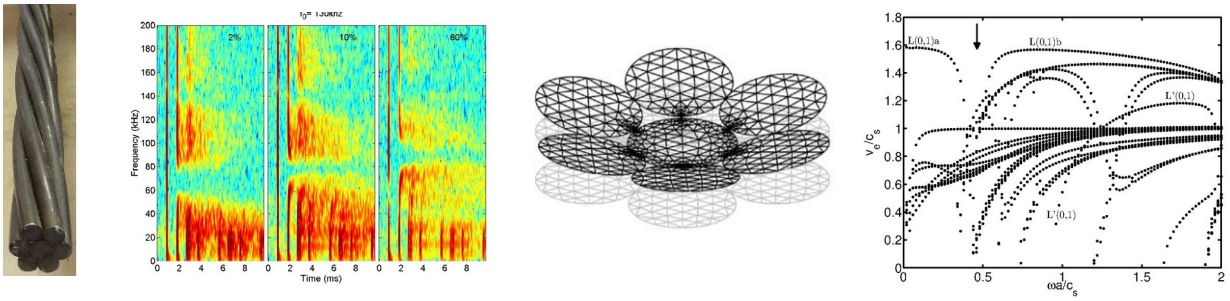
Laurent Laguerre (DR, HDR), co-supervisor
(https://www.ifsttar.fr/menu-haut/annuaire/fiche-personnelle/personne/laguerre-laurent/)
Planned financing : 3-year doctoral contract (1858€ gross monthly for the first 2 years, 2165€ for the third)



From left to right : seven-wire strand, time-frequency measurement results, mode shape and dispersion curve numerical results. These curves predict various phenomena with high potential for cable NDE. One of the goals of the PhD will be to prove these predictions by experiments.

Context :
Guided waves can propagate over long distances with little loss of energy. They are of potential interest for the non-destructive evaluation and structural health monitoring of slender civil engineering structures (cables, bars, etc.). However, the development of robust monitoring methods faces several challenges. On the one hand, civil engineering structures are usually partially or completely buried in an infinite environment. They are often only accessible to one of their end. On the other hand, the multimodal and dispersive nature of guided waves complicates the interpretation of measurement results, so that their exploitation requires propagation models. In this field, significant progress has been made in recent years at Université Gustave Eiffel through the development of original numerical modeling tools, based on finite element methods dedicated to guided waves, and taking into account various phenomena [1–5]: source, presence of defects, embedment in a solid matrix, curvature of the guide, prestress…

Project :
The non-destructive evaluation of civil engineering cables, made up of helical multi-wire strands, is the flagship application of the laboratory's work in the field of guided waves. The objective of the thesis is to improve the understanding of phenomena governing wave propagation in such structures. For this, the doctoral student will use the numerical and experimental tools available, relying on the strong skills and know-how acquired by the laboratory around cables for many years. Indeed, the cable models developed in the laboratory [4, 5] are now capable of reproducing and interpreting phenomena observed experimentally, initially unexplained [6, 7]. These same models also predict other phenomena, hitherto unknown but of interest for non-destructive evaluation (NDE) [8]. A first part of the thesis work will thus consist in the experimental validation of these predictions. The second part of the work will consist in developing a numerical model of wave diffraction in a cable, with the aim of understanding and clarifying

the mechanisms of inter-wire energy transfer (which are likely to affect the detectability of defects). The simulation results will then be corroborated by laboratory experiments.

Profile : Applicants should hold a Master or equivalent in mechanics, acoustics or physics and have a strong background in numerical methods, finite elements and waves or structural dynamics. An interest for experimentation would be appreciable. We are looking for excellent and highly motivated students.

Please send a CV, cover letter, official transcripts of the last two years, along with the names and complete contact information of two references before April 3rd 2023 to:

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Further details for the application process: **https://www.ifsttar.fr/offres-theses/index.php**

References :

[1] F. Benmeddour, F. Treyssède and L. Laguerre, "Numerical modeling of guided wave interaction with non-axisymmetric cracks in elastic cylinders", International Journal of Solids and Structures 48, 764-774 (2011).

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[8] F. Treyssède, "Investigation of the interwire energy transfer of elastic guided waves inside prestressed cables", Journal of the Acoustical Society of America 140, 498-509 (2016).