

Research Topic for the ParisTech/CSC PhD Program

Field : *Materials Science, Mechanics, Fluids*

Subfield: Applied Physics, Mathematics,

Title: Crack modeling and detection in a rotating shaft: A standard approach

ParisTech School: Arts et M étiersParisTech

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(Lab, website):

Short description of possible research topics for a PhD:

we have recently presented a generic methodology to deal with the mechanics of beams and shafts with cracks. By considering an appropriate expression of the system elastic energy, the procedure of identification of the crack breathing mechanism becomes simple and comprehensive. The 3D computations indispensable to the identification process are significantly reduced when the system energy properties are exploited. An adimensional function is identified giving a fine and precise description of the system flexibility evolution when the crack breathes. This breathing function is exclusively inherent to the crack geometry and completely independent of the model parameters. Hence, the approach is universal and could be applied straightforward to similar problems. Moreover, we gave a nonlinear fitting formula of the identified function that all the process of identification could be skipped when a cracked transverse section is to be inserted in a beam-like model of a cracked shaft. This standard and generic methodology is completed by a detailed description of the technique of construction of a cracked beam finite element (CBFE). A validation of the approach in quasistatic is given for a cantilever beam with one, then two cracked transverse sections. This generic approach will be used to explore the nonlinear dynamics of a multi-cracked shaft and to develop a methodology for early crack detection based on the analysis of the vibrational behavior of the shaft.

Required background of the student: mechanics, physics, applied mathematics

A list of 5(max.) representative publications of the group:

- [1] El Arem Saber, Maitournam Habibou “A cracked beam finite element for rotating shaft dynamics and stability analysis”. *Journal of Mechanics of Materials and Structures* 2008;3(5):893–910.
- [2] El Arem Saber “Shearing effects on the breathing mechanism of a cracked beam section in biaxial flexure”. *European Journal of Mechanics, A/Solids* 2009;28:1079–87.
- [3] El Arem Saber, Nguyen Quoc-Son. “Nonlinear dynamics of a rotating shaft with a breathing crack”. *Annals of Solid and Structural Mechanics* 2012;3(1):1–14.
- [4] EL Arem Saber, Ben Zid Maha. “On a systematic approach for cracked rotating shaft study: breathing mechanism, dynamics and instability”. *Nonlinear Dynamics* 2017;88:2123–38.