Post-doctoral position

« Development of an optimization method to determine parameters of an elasto-visco-plastic law used in structural analyses »

Scientific context

Prediction of long-term behaviour of structural polymers is critically important for ensuring the safety and security of many technological equipment. For example, the transport of oil and gas through flexible pipes relies on the long term performance of the polymer sealing sheath. However, understanding and modeling of the long term behaviour of structural polymers remains a challenge and is the subject of this postdoc proposal.

More specifically, IFPEN has been working for several years on the mechanical behaviour of polymer sheaths under extreme conditions: corrosive fluids, high pressure, high temperature… Constitutive relations have been developed in order to describe the elasto-viscoplastic behaviour in such conditions. The obtained law has been implemented in a finite element code and results are convincing: the calculations of the behaviour of several grades of semi-crystalline polymers under different multi-axial stress states have been confirmed by experimental measures.

Based on this successful developments, we wish to push further. In particular, we aim at

- developing a robust law under increasingly extreme conditions (in terms of pressure and temperature in particular)
- elaborating a simple and efficient methodology to infer the parameters of the constitutive law developed.

Objectives

The successful candidate will thus focus on the following challenges:

- The improvement of the robustness of the mechanical law developed at IFPEN [1], in particular by testing new integration schemes of elasto-viscoplastic equations. Several numerical resolution methods should be tested and evaluated in terms of performance, robustness and time calculations. IFPEN structural cases will be used for these comparisons. The development of very stable integration schemes for these intricate calculations (complex geometries, non-linear behaviour laws, phenomenon of material ageing) will be the most critical step.
- Identification of the most important parameters of this constitutive law thanks to sensitivity analysis.
- Definition of an objective function, that takes into account prior uncertainties on the most important parameters and past knowledge.
- Use or develop efficient, derivative free optimization methods to infer the parameters of this constitutive law. A workflow methodology with a prototype should be developed. The tools already developed at IFPEN will be used and compared with the proposed solutions [2-4].

References:

[1] Cangémi L., Meimon Y. "A Two-Phase Model for the Mechanical Behaviour of Semicrystalline Polymers", Oil & Gas Science and Technology – Rev. IFP, 555-580 (2001)
[2] Andrew R. Conn , Katya Scheinberg and Luis N. Vicente, “Introduction to Derivative-Free Optimization”, MOS-SIAM Series on Optimization, 2009
[3] Langouët H., “Derivative Free Optimization with constraints”, 2010
[4] Pauwels B., « Optimisation sans dérivées sous incertitudes appliquée à des simulateurs coûteux », thèse UTPS 2016

Candidate profile:

- The candidate should have a double competence in mathematical and mechanical fields.
- Strong expertise in optimization and programming (Matlab, C ++ programming / Fortran..)
- Knowledge of a Finite Element software (Abaqus™) will be appreciated

Localization :

IFP Energies nouvelles 1-4 avenue de Bois Préau, 92852, Rueil-Malmaison Cedex, FRANCE

Contact :

-Applied Mechanical Division : Dr Eléonore Roguet (eleonore.roguet@ifpen.fr) -Mechatronics, Computer Science and Applied Mathematics Division : Dr Frédéric Delbos (frederic.delbos@ifpen.fr)