This project is an exellent oportunity to join 'Composite and Hybride materials' research team of the department of Polymers and Composites Technology & Mechanical Engineering (http://tpcim.imt-lille-douai.fr/accueil/en-bref/) at IMT Lille Douai (http://imt-lille-douai.fr/) (France) with co-supervising from 'Composite Material Group' (https://www.mtm.kuleuven.be/Onderzoek/Composites) at KU Leuven (Belgium).

PhD project

Title: Modelling of fibre reinforced composites based on FFT.

Keywords: Textile composites materials, Fast Fourier Transform (FFT), conformal FE models, damage, µCT.

Fibrous materials in general and textile composites in particular, have wide range of applications in aerospace, automobile and civil industry due to their superior mechanical performance along with high damage tolerance. In recent years, high demands of weight reduction have accelerated the use of composite materials in structural parts.

The fact that textile composites are heterogeneous by nature led to development of design strategy oriented to multi-scale methods providing better understanding of complex mechanisms at different material scales. It also can give insight into effect of manufacturing imperfections (deformation of the textile preform or porosity) which must be considered in the realistic material modelling. Nowadays, one of the most powerful experimental methods is X-ray micro-computed tomography (micro-CT) which is used successfully for characterization and analysis of the internal geometry in composite materials.

In general, models are implemented into FEM solvers and can be addressed to study non-linear material response including damage mechanisms. However, this demands additional effort in preparation of input data in order to establish numerical model. Moreover, accuracy and efficiency is achieved when conformal mesh constructed.

As an alternative to FEM, Fourier solvers can be used effectively due the following advantages: solving kernel equation by Fast Fourier Transform (FFT) and reduced data treatment to prepare input (in certain cases can be applied directly to micro-CT images). In spite of the main advantages, the applications of the FFT solvers have

received small attention for multi-scale modelling of the textile composites. One of the aims of this project is to perform detailed investigations of this technique.

The goal of the proposed research is to construct accurate and effective numerical tool for modeling complex material behaviour of fibrous materials with different phenomena at finer scales based on FFT method. The project will include the following parts:

- State-of-the-art in multi-scale simulation (Analytical/numerical)
- State-of-the-art in material modelling of fibrous materials
- Understanding and application of the FFT techniques
- Experimental analysis and characterization of the textile composites
- FFT model and application to test cases
- FE model with conformal meshing
- Comparison of both FFT and FEM with emphasizing damage in fibrous materials
- Model validation.

Conditions:

Master (or Engineering) degree of mechanical engineering or applied mathematics, FEM, programming language C++ / FORTRAN, strong knowledge in applied mathematics, high level of proficiency in written and spoken English, knowledge in composites materials is preferred.

Additional conditions: selected candidates will be asked to solve few case study problems related to the project.

Work conditions

Duration: Three years (Estimated starting date: no later than 1st January 2019).

Finance: First year gross salary 1785€ / per month, it can be increased in second and third year depending on quality of results.

Place: Main place of work is IMT Lille Douai (France) with several secondments to KUL (Leuven, Belgium).

Official application must include copy of your curriculum vitae, cover letter and recommendation letter(s).

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