Numerical modelling of fibre/matrix interface

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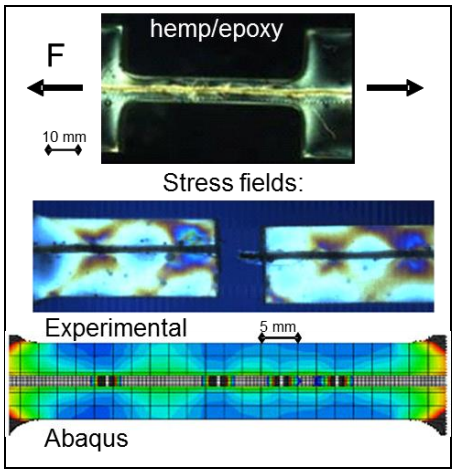
PhD students :

- 2013 - … : Amélie Perrier, « Etude expérimentale et numérique du comportement mécanique de l'interface renfort/matrice dans des éco-composites. »
- 2010-2013 : Davi Vasconcellos, « Comportement en fatigue avant et après impact de composites tissés chanvre/époxy. » (with European Label)
- 2007-2010 : Claire Bonnafous, « Analyse multi-échelle des mécanismes d'endommagement de composites chanvre/époxy à renforts tissés. Caractérisation de l'interface fibre/matrice. »

Context :

The numerical modelling of fibre/matrix interface is a crucial step towards the simulation of composite behaviour. In particular, in plant fibre composites, the interface quality is strongly affected by the fact that natural fibres are hydrophilic, whereas the polymer matrix is hydrophobic. Moreover, the high variability of natural fibre properties has to be taken into account. The aim of this research topic is to identify key-parameters that control the constitutive law of fibre/matrix interface, and to develop corresponding finite element models. Numerical simulations are performed at different scales, and compared to multi-scale experimental measurements in order to be optimised.

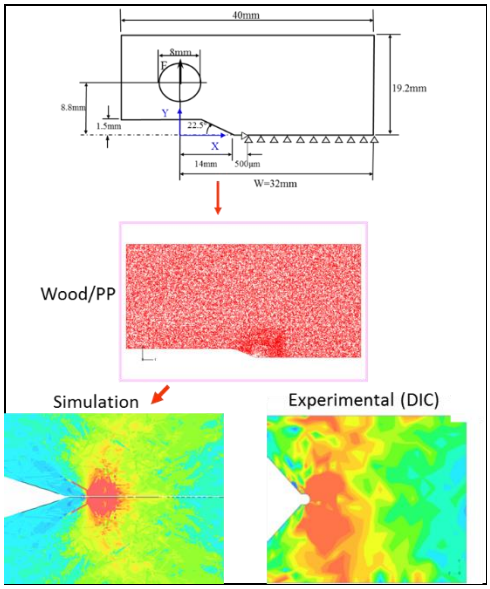


Finite element modelling of single-fibre composite

- ✓ Numerical model for particles in polymer matrix. Application to EPDM/PP composites. Comparison of axisymmetric, 2D and 3D models. Study of cavitation phenomenon.
- ✓ Simulation of one short fibre in polymer matrix. Analysis of stress fields at fibre/matrix interface. Influence of fibre orientation.
- ✓ Finite element modelling of a single-yarn composite. Application to hemp/epoxy material. Comparison of numerical stress fields with photoelasticimetry results. Comparison of computed strain fields with Digital Image Correlation (DIC) measurements. Determination of model parameters by inverse analysis approach.

Numerical simulation at macro-scale

- ✓ Development of finite element models to predict behaviour of composite structures, taking into account the material microstructure.
- ✓ Modelling short fibre composites by creating a preprocessed program for random fibre elements generation. Application to wood/PP composites. Influence of fibre geometry and ratio. Comparison with tensile and fracture experimental tests.



- ✓ Simulation of woven composite material by using a simplified geometry definition, modelling warp and weft yarns, and by taking into account variability of fibre properties. Application to woven hemp/epoxy composite. Comparison of numerical and experimental damage evolution. Analysis of strain fields with DIC measurements at the weave scale.

Some publications :

J.C. DUPRE[1], F. LAGATTU,
[1] *: Equipe photomécanique, LMS, Université de Poitiers.*
"Thermal and mechanical couplings in plain and wood fibre reinforced polypropylene during tensile and fracture tests." Polymers and Polymer Composites, vol.15, n°6, pp. 453-462, 2007.

O. De ALMEIDA, F. LAGATTU, J. BRILLAUD,
"Analysis by a 3D technique of volumetric deformation gradients : application to polypropylene/EPR/talc composites." Composites Part A, 39, 2008, pp. 1210-1217.

M. SHEN[1], F. TOUCHARD, G. BEZINE, J. BRILLAUD,
[1] *: Université de Tianjin, Chine.*
"Development of a finite element model for Random Short Wood Fibres Reinforced Composites", European Physical Journal, On-line Journal, 8 pages, 2010.

C. BONNAFOUS, D. VASCONCELLOS, F. TOUCHARD, L. CHOCINSKI-ARNAULT,
"Experimental and numerical investigation of the interface between epoxy matrix and hemp yarn", Composites Part A, vol. 43, 2012, pp. 2046–2058.

M. SHEN[1], F. TOUCHARD, G. BEZINE, J. BRILLAUD,
[1] *: Université de Tianjin, Chine.*
"Direct numerical simulation of fracture behaviour for random short wood fibers reinforced composites, comparison with digital image correlation experiments", International Journal of Thermoplastic Composite Materials, 1-19, 2013. DOI : 10.1177/0892705713489324.

D. VASCONCELLOS, F. TOUCHARD, L. CHOCINSKI-ARNAULT,
"Tension-tension fatigue behaviour of woven hemp fibre reinforced epoxy composite: a multi-instrumented damage analysis." International Journal of Fatigue, 59, pp.159-169, 2014.