Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes the PhD subject and supervisor proposed by the French Polytech network of 14 university engineering schools. Please contact the PhD supervisor by email or Skype for further information regarding your application.

Supervisor information	
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Country	France

PhD information	
Title	Cliquez ou appuyez ici pour entrer du texte.
Main topics regards to CSC list (3 topics at maximum)	Calculation of materials and simulation for design

Required skills in science and engineering	Strong knowledge in mechanics of material, continuous mechanics and numerical simulation. Affinity for experimental characterisation

Subject description (two pages maximum)

Respect for the challenges and constraints of the new energy and environmental situation is undoubtedly the key point for the future of the transport sector. One way, used for several years now in aeronautics and currently strongly activated in automotive applications, is to minimize masses while maintaining the quality of the service provided. The use of composite materials with fibrous reinforcements performance of which is well established enables to obtain substantial gains as regards this aim. This explains why the rate of composites increased significantly especially in recent years in aeronautics (53% by weight in the A350). As a result, many national and European projects are emerging in order to generalize the use of fiber-reinforced composites in automotive. Although the use of composites already makes it possible to increase the ratio service / mass performance of vehicles, their potential is still very far from being fully exploited, mainly for two reasons :

• Manufacturing processes are insufficiently mastered and optimized

• Models and calculation/optimization tools of associated structures are not efficient enough

Concerning these two points, one of the major issues is to develop representative and exploitable models of the mechanical behavior of fibrous composites at the different steps of the processes. The latter requires to achieve the modeling of the mechanical behavior of dry of prepreg fibrous textile reinforcements. Fibrous media are by nature multi-scale materials because they are composed yarns, themselves composed of thousands of fibers. The heterogeneity of these materials and their very strong anisotropy related to the interlacement of the fibers as well as the non-ideally ordered distribution of the fibers, lead to an important complexity for the analysis and the modeling.

If some models still exist for specific laodings (shear, bending, tension,…), the latter cannot be oncsidered as intrinsic behavior laws and as a consequence there is no homogenized behavior model that is consistent and truly representative of textiles. The MMP (Mechanics of Materials and Processes)) team of the Laboratoire de mécanique Gabriel Lamé is working on this issue. Today, thanks to multi-scale approaches, very promising results, both in terms of experimental characterization and mechanical models of fibrous media, have been obtained. These studies enabled an interesting understanding of the mechanical behavior of reinforcements and in the case of simple or coupled loadings (traction, bending, shearing, compression ...). Nevertheless, a long way remains to pass from a sum of "merged" responses to an homogenized constitutive law usable in continuous approaches. Among the fundamental locks, the constitutive laws of continuous materials, known as Cauchy, do not easily accommodate the specificity of the bending behavior of fibrous reinforcements. In addition, fibrous media models are far from being accurate, especially in compression and bending. One of the most promising way, in order to obtain the looked for, behaviour law of fibrous media is to start from the

behavior of one fiber which is quite well known and from the fiber packing in the yarns and fabrics. An initial work has been done to create a first microscale virtual estimator (Oussama Haji, 10/12/18); this work has attempted to simulate the behavior of a fiber (diameter 0.1mm) bundle and to validate it using X-Ray tomography measurements. This very interesting and efficient tool has know to be developped, adapted to lower scale fibres (fews microns) and to be used to understand and model the mechnaical behaviour of a bundle in different interlacement configurations.

The goal of the PhD thesis proposed here, is then, to create the behaviour law of roving yarns using a coupled approach : experimental characterization and multi-scale modeling . The candidate will therefore:

- Take ownership of the first microscale virtual estimator, develop and improve it.
- Use the developped microscale numerical estimator to perform simulations with different loading paths so as to understand the physical phenomena involved.
- Propose and identify a material behaviour law for roving yarns within the scope of the study
- Implement the behavior at the upper scale.
- Perform the experimental validation tests