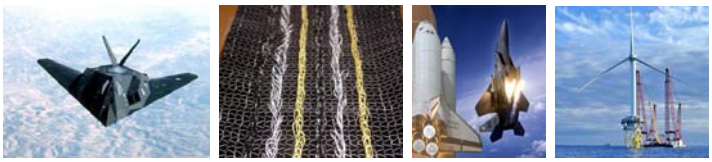


Textile Composites

Extension of the Publication Paradigm: The Textile Composites Archive
J Whitcomb (Texas A&M Univ) SV Lomov, I Verpoest (KU Leuven) P Boisse (INSA Lyon) J Crookston, A Long (Univ of Nottingham) M Zako (Osaka Univ)
Although interest in textile composites is increasing rapidly, their complex, multiscale microstructure is a major hindrance to the development of robust predictive analyses. Not only are the required experiments and analyses complex, but describing the results of research efforts does not fit well within the tight confines of a normal journal paper. A Textile Composites Archive is proposed as an extension of the publication paradigm. **(D11:1)**

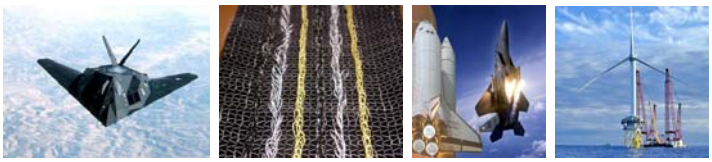
A Voxel-Based Homogenization Technique for the Unit Cell Elastic and Thermoelastic Analysis of Woven Composites
S Smitheman, A Jones, A Long, W Ruijter (Univ of Nottingham)
A voxel-based homogenization technique for predicting how a textile reinforced composite will warp during manufacture is outlined. An approach is detailed involving the finite element analysis of a unit cell, based upon a textile geometric model, and good agreement with experimental data for various fibre/resin systems and weave patterns is shown. **(D11:2)**

A Proposal of FE Modeling for Off-Axis Woven Fabric Laminate
Y Fujita, Y Watanabe, T Kurashiki, M Zako (Osaka Univ)
As finite element modelling of off-axis woven laminate is very complex, it is difficult to analyze the mechanical behaviour. To solve this problem, M3 method has been applied. As a result, it is recognized that the off-axis woven fabric with complex elements can be analyzed. **(D11:3)**

Meso-Scale Modelling in Thermoplastic 5-Harness Satin Weave Composite
S Daggumati, I De Baere, W Van Paepegem, J Degrieck (Ghent Univ) J Xu, S Lomov, I Verpoest (KU Leuven)
In this paper, meso-scale modelling of a satin weave composite is presented. Numerical results such as local strain variation, damage initiation strain and damage initiation locations are validated using different experimental techniques. Based on the experimental feedback, FEA of the unit cell is improved by changing the boundary conditions and using the stack of unit cells for simulation. **(D11:4)**

Investigation of Mechanical Properties of Tow Steered CFRP Panels
K Hazra, K Potter, P Weaver (Univ of Bristol)
As an automated preforming technique, tow steering offers excellent opportunity to tailor preforms. However, inherent limitations of this technique include in-plane and through-thickness presence of stitch yarn, backing fabric and a stitch-heavy side of the preform. A soluble stitch yarn is used to overcome these limitations. **(D11:5)**

Mechanical Behaviors of Non-Crimp Fabric Composites based on Multi-Scale Analysis
T Kurashiki, K Hamada, S Honda, M Zako (Osaka Univ)
In order to estimate the mechanical behaviors of Non-Crimp Fabric (NCF), the FE model of stitching yarn and laminates with resin-rich regions are generated individually, and the damage development under tensile loading is estimated based on the multi-scale analytical method. The numerical and experimental results are described. **(D11:6)**



Prediction of Damage Progression in Textile Composites in an Oxidizing Environment
J Whitcomb, J Varghese (Texas A&M Univ)
A coupled analysis framework was developed to predict the damage progression in textile composites in an oxidizing environment. Mechanical properties were degraded based on the oxidation state. A general oxidation analysis is extremely computation intensive so novel strategies were developed that exploit characteristics of the oxidation in polymer composites. **(D11:7)**

Fibre Orientation Effects on the Tensile Properties of Biaxial Carbon/Epoxy NCF Composites
K Vallons, I Duque, S Lomov, I Verpoest (KU Leuven)
In this work, fibre orientation effects on the tensile properties of a cross-ply carbon/epoxy NCF composite were studied. Both static and dynamic properties were investigated for several sample orientations. On 5° oriented samples the influence of the sample width was studied. **(D11:8)**

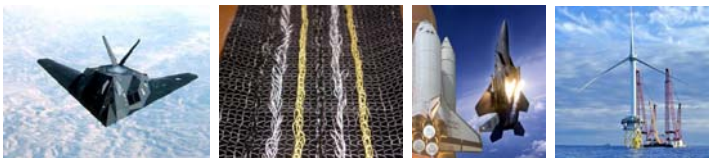
Progressive Damage in Stitched Composites: Static Tensile Tests and Tension-Tension Fatigue
S Lomov, V Koissin, J Kustermans, I Verpoest (KU Leuven) V Carvelli, V Tomaselli (Politecnico di Milano) B Van den Broucke (EADS IW) V Witzel (Univ Stuttgart)
The paper describes progressive damage in static tension and tension-tension fatigue in structurally stitched carbon/epoxy NCF composites, in comparison with their non-stitched counterparts. Analogies between damage development in quasi-static tensile test and tension-tension fatigue are analyzed and links between the damage initiation in quasi-static tests and fatigue life are established. **(D11:9)**

A New Meso-Scale Modelling of Static and Fatigue Damage in Woven Composite Materials with Finite Element Method
J Xu, S Lomov, I Verpoest (KU Leuven) SR Daggumati, W van Paepegem, J Degrieck (Ghent Univ)
Goal of this work is to simulate the initiation and propagation of fatigue damage on meso-level. Meantime, investigation of damage for static loading is an appropriate starting point. WiseTex, SACOM and ABAQUS build up the development environment. The paper focuses on: (a) Static damage modelling (SDM) and experiments. (b) A feasible algorithm for fatigue damage modelling (FDM). **(D11:10)**

Mechanical Properties of Carbon Fiber Braided Composites with CNT
T Ito, A Otani, A Nakai, H Hamada (KIT)
The effect of incorporation of Carbon nano tube (CNT) on the mechanical properties of the braided composites was investigated. The tensile test and the in-situ observation were performed for evaluation of the mechanical property and the crack initiation and propagation. **(D11:11)**

Compressive Failure of 2D Woven Composites
NV de Carvalho, ST Pinho, P Robinson (Imperial College London)
This paper presents experimental and numerical research on the compressive failure of orthogonal 2-D Woven composites with different degrees of nesting, emphasizing the role of the tows' interlacing region. Resulting optical micrographs demonstrate the influence of nesting on the sequence of events leading to failure of woven composites. **(D11:12)**

Homogenization Creep Analysis of Plain-Woven GFRP Laminates
T Matsuda, K Nakata, M Kawai (Univ of Tsukuba)
In-plane creep behavior of plain-woven glass fiber/epoxy laminates subjected to a constant stress is analyzed using the time-dependent homogenization theory. It is shown that the in-plane creep behavior of the plain-woven GFRP laminates exhibits marked anisotropy, and is strongly affected by their laminate configurations. **(D11:13)**



Effect of Ribbon Sensor Inclusion on the Mechanical Properties of 2/2 Twill Carbon/Epoxy Woven Composites
X Wang, N Ravirala, H Abichou, M Dixon (DeepSea Eng & Management Ltd)
This paper will report an investigation into mechanical properties of 2/2 twill carbon/epoxy laminates. Finite element (FE) techniques have been employed in conjunction with Hashin failure criterion to predict the effective elastic constants and failure strengths. Reasonable good agreement has been observed between the FE predicted and experimental results. **(D11:14)**

A Multilevel Finite Element Analysis of a Textile Composite
B Piezel, L Laiarinandrasana, A Thionnet (MINES ParisTech)
The textile composite under study is a multi-scale material. A representative volume element is defined by a periodic cell of the material. Parallel finite element computations are performed in order to compare macroscopic response and to access to the local heterogeneous stress/strain fields. **(ID11:1)**

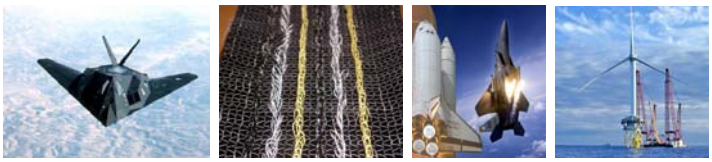
Development of Ductile-Hybrid Composites (DHC) by the Braidtrusion Process
F Hampton, C Doyle, R Runyen (Villanova Univ), F Ko (Univ of British Columbia)
Ductile-hybrid composites (DHC) for civil engineering infrastructure have been developed at Villanova University and AMPEL, University of British Columbia. A variety of products, including internal concrete FRP reinforcement and structural shapes, mimic the behaviour of steel with tri-linear stress-strain behaviour (elastic, plastic, strain hardening). **(ID11:2)**

Analysis of Yarn Bending Behaviour
B Cornelissen, R Akkerman (Univ of Twente)
This paper addresses the bending aspect of intra-yarn mechanical behaviour ofindividual multi-filament yarns for future use in draping simulations. Yarn specimensdeform nonlinearly under their own weight when clamped at one side. The nonlinearrelation between the applied moment and the bending rigidity is established. **(ID11:3)**

Investigation of the Deformation of Carbon Fibre Rovings in Curved Paths
P Schiebel, JK Backhaus, AS Herrmann (Faserinstitut Bremen)
Stitching carbon multifilaments allows reinforcement of composite parts along complex paths. In this work, the deformation of rovings on curved paths, as well as the influence of the seam properties on the distribution of the carbon monofilaments, is investigated. Analytical model and FEA simulation are used and verified with polished cut images. **(ID11:4)**

Mechanics of Flexible Textile Composites
H Arshad, R Ramgulam, P Potluri (Univ of Manchester)
This paper concerns the mechanical behaviour of woven fabric structures in flexible composites. Mechanics of such structures can be acknowledged by understanding the behaviour of constituent yarns upon tensile loading, and the influence of polymer matrix on it. The yarns are treated as elastica in the model. **(ID11:5)**

Multiscale Modelling of the Mechanical Behaviour of Woven Composite Materials
G Couégnat, E Martin, J Lamon (LCTS), N Carrère (ONERA)
The present paper proposes a multiscale model of the mechanical behaviour of woven composite materials. The DMD model is based on a physical description of the underlying microstructure of the material and the damage mechanisms. The model is applied to a woven-ceramic-matrix composite material and its predictive capabilities are evaluated on several structural tests. **(ID11:6)**



Development of Ice Hockey Sticks using Braided Composites
S Nasu, A Ohtani, A Nakai, H Hamada (KIT)
For development of new customised ice hockey sticks with braiding technique, bending properties and the deformation behavior of rectangular braided composite pipes with different fiber orientation angle were investigated by three-point bending test and FEM. From the result, it was found that the modulus in circumferential direction was important for the deformation of rectangular braided pipes. **(ID11:7)**

Mechanical Properties and Fracture Behavior of Hybrid Braided Composite Tube
Y Sasaki, Y Tanaka, A Ohtani, A Nakai, H Hamada (KIT)
Matrix hybrid is defined as using the different resin in a composite material. In this study, matrix hybrid braided composite tube was fabricated with two different kind of resin. The relationship between absorbed energy and fracture behavior of matrix hybrid braided composite tube were clarified quantitatively by 3 points impact bending tests and cross sectional observation. **(ID11:8)**

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