PHOTOMECHANICS 2006

FULL PROGRAMME

SUNDAY 9TH JULY 2006

18:00-20:00 Pre-registration and welcome reception at the *Holiday Inn* hotel, downtown Clermont-Ferrand

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MONDAY 10TH JULY 2006

08:00 Registration and refreshments

08:45 Welcome address
Blaise Pascal Amphitheatre

KEYNOTE LECTURE 1

Blaise Pascal Amphitheatre
Chair: J.M. Dulieu-Barton, University of Southampton, UK

09:00 ***Photomechanics in dynamic fracture and friction studies***
K. Ravi-Chandar (USA)

Session 1 **– FRACTURE MECHANICS**

Blaise Pascal Amphitheatre
Chair: J.M. Dulieu-Barton, University of Southampton, UK

09:45 ***Application of photoelasticity in mathematical modelling of crack tip stress fields***
K. F. Tee (United Kingdom), C. J. Christopher (United Kingdom), E. A. Patterson (USA) and M. N. James (United Kingdom)

10:05 ***Optical investigation of mixed-mode dynamic crack growth in a functionally graded composite***
H. V. Tippur and M. S. Kiruguilige (USA)

10:25 ***The path of a growing crack - experiment and simulation***
P. Ståhle, C. Bjerkén and J. Gunnars (Sweden)

10:45 Refreshments

Session 2 **– MICROMECHANICS 1**

Blaise Pascal Amphitheatre
Chair: F. Hild, ENS Cachan, France

11:10 ***Determination of mechanical behavior of cortical bone using local strain field***
L. Henry, T. Hoc, A. Meunier and D. Aubry (France)

11:30 ***Evaluation of local strain fields in hot worked stainless steel***
L. E. Hernandez-Castillo (United Kingdom), N. Rupin (France),
C. Boldetti (United Kingdom), C. Pinna (United Kingdom) and M. Bornert (France)

11:50 ***Local strain measurements by correlation of digital images obtained by white light confocal interferometery***
S. Bénédic, N. Bourgeois, S. Berveiller and A. Eberhardt (France)

12:10 ***Experimental investigation on the mechanical behavior of grains in a poly crystalline alloy***
B. B. Bartha and C. J. Boehlert (USA)

12:30 Lunch

Session 3 **- 3D MEASUREMENTS**

Blaise Pascal Amphitheatre
Chair: J.J. Orteu, Ecole des Mines d'Albi, France

14:20 ***3D digital correlation applied to X-ray microtomography images of in-situ triaxial tests on argiliceous rock***
N.Lenoir, M.Bornert, J. Desrues, P. Bésuelle and G. Viggiani (France)

14:40 ***Depth-resolved displacement measurement using tilt scanning speckle interferometry***
P. D. Ruiz and J. M. Huntley (United Kingdom)

15:00 ***Improvement of accuracy of strain measurement by digital volume correlation for transparent materials***
A. Germaneau, P. Doumalin and J.C. Dupré (France)

15:20 ***Calibrating the tomographic 3D-DSP system***
F. Forsberg (Sweden)

15:40 ***Application of an advanced Fourier polarimetry in tomographic photoelasticity***
H. Yang, R. A. Tomlinson and W. R. B. Lionheart (United Kingdom)

16:00 Refreshments

Session 4-a **– LOCALISATION**

Blaise Pascal Amphitheatre
Chair: E. Hack, EMPA, Switzerland

16:30 ***Strain field analysis on multiphase materials at the nano- and micro-scale using grid methods***
D. Kempf, V. Vignal, G. Cailletaud and R. Oltra (France)

16:50 ***Heterogenous plastic deformation of polycrystals : visualization and modeling***
T. Marin and G. Nicoletto (Italy)

17:10 ***On elastic soliton propagation in layered wave guides***
I.V. Semenova, G.V. Dreiden and A.M. Samsonov (Russia)

17:30 ***Local strain inhomogeneity in hot mix asphalt by digital image correlation***
A. Montepara, E. Romeo, R. Roncella and G. Tebaldi (Italy)

17:50 ***Application of speckle interferometry to mechanical analysis of Ti weld bead***
S. Mistou, J. Alexis, C. Ferdinand, T. Masri and M. Karama (France)

Session 4-b **– DAMAGE AND FATIGUE**

Leonard de Vinci Amphitheatre
Chair: G. Nicoletto, Universita di Parma, Italy

16:30 ***Damage progression in an open hole composite tensile test using full-field measurements***
F. Pierron (France), B. Green (United Kingdom) and M. R. Wisnom (United Kingdom)

16:50 ***A hybrid technique for damage detection on laminated plates***
H. M.R. Lopes, J. V. A. Santos, R. M. Guedes and Mário Vaz (Portugal)

17:10 ***Assessment of the local stiffness reduction on a composite impacted plate with the virtual fields method***
J.-H. Kim, F. Pierron, K. Syed-Muhamad, M. Grédiac, E. Toussaint (France) and M. R. Wisnom (United Kingdom)

17:30 ***Thermographic analysis of fatigue dissipation properties of DP60 steel***
B. Berthel, A. Galtier, B. Wattrisse and A. Chrysochoos (France)

17:50 ***Damage analysis of 2024-T3 aluminium specimens using infrared thermography***
M.-L. Pastor, X. Balandraud, J.-L. Robert and M. Grédiac (France)

18:30 Shuttle to the City Hall

19:00 Drinks reception at the City Hall of Clermont-Ferrand

20:00 Delegates are free to find dinner in a local restaurant in downtown Clermont-Ferrand. One shuttle bus will leave the city hall for the hotels at 20:00.

TUESDAY 11TH JULY 2006

KEYNOTE LECTURE 2

Blaise Pascal Amphitheatre
Chair: J. Botsis, Ecole Polytechnique Fédérale de Lausanne, Switzerland

08:45 ***Digital image correlation: from measurement to identification***
F. Hild (France)

Session 5 **– IDENTIFICATION 1**

Blaise Pascal Amphitheatre
Chair: J. Botsis, Ecole Polytechnique Fédérale de Lausanne, Switzerland

09:30 ***A review of identification methods based on full field measurements***
S. Pagano (France)

09:50 ***Identification of constitutive parameters using full-field measurements: comparison between the Virtual Fields Method and Finite Element Model Updating methods***
S. Avril and F. Pierron (France)

10:10 ***Comparison between homogeneous and heterogeneous field information for plastic material identification***
D. Lecompte, H. Sol, J. Vantomme and A.M. Habraken (Belgium)

10:30 Refreshments

Session 6 **– THERMOMECHANICS**

Blaise Pascal Amphitheatre
Chair: A. Vautrin, Ecole des Mines de Saint-Etienne, France

11:00 ***Thermomechanical observations of phase transformations during tensile tests of NiTi tubes***
P. Schlosser, H. Louche, D. Favier, L. Orgéas, P. Vacher and L. Debove (France)

11:20 ***Thermo-kinematical analysis of rubber-like coupling effects in necked polyamide samples***
B. Wattrisse, J.-M. Muracciole, S. Moreau, Y. El Kaïm and A. Chrysochoos (France)

11:40 ***Experimental thermomechanical study and reconstruction of heat sources***
N. Renault, V. Mollimard, S. André and C. Cunat (France)

12:00 ***Stress separation on a composite component using thermo and photoelastic techniques***
U. Galietti, D. Modugno, C. Pappalettere and G. Vitale (Italy)

12:20 ***An experimental approach to stress separation in thermoelastic stress analysis***
J.M. Dulieu-Barton, P. Stanley and T.S. Phan (United Kingdom)

12:40 Lunch

Session 7-a **– MICROMECHANICS 2**

Blaise Pascal Amphitheatre
Chair: M. Bornert, Ecole Polytechnique, France

14:30 ***Failure criterion for transversely loaded unidirectional model composites***
D.C. Foster and G.P. Tandon (USA)

14:50 ***In-situ surface strain measurements during low-cycle fatigue tests***
A. El Bartali, V. Aubin and S. Degallaix (France)

15:10 ***Microstructure deformation detection***
M.J. Huang and C.W. Lin (Taiwan)

15:30 ***Full-field measurement of microcantilever displacement induced by molecule adsorption – Identification of mechanical parameters***
N. Garraud, F. Amiot, F. Hild and J.-P. Roger (France)

Session 7-b **– STRUCTURAL APPLICATIONS**

Leonard de Vinci Amphitheatre
Chair: K. Ravi Chandar, University of Texas at Austin, USA

14:30 ***High speed digital holographic interferometry for the investigation of dynamical events in mechanical components***
G. Pedrini and W. Osten (Germany)

14:50 ***ESPI-measurement of strain gradients in a CFRP-reinforced bending beam***
E. Hack and A. Schumacher (Switzerland)

15:10 ***Application of ESPI investigating the static deformation of a lead-free joint***
D. Karalekas (Greece), J. Cugnoni and J. Botsis (Switzerland)

15:30 ***Measure of the 3D distortion of an optical bench in cesic due to temperature variation from 20 K to 320 K***
V. Chalvidan, C. Devilliers and B. Chataigner (France)

15:50 ***Wrinkling behaviour of sheared elastic membranes: experimental and numerical analysis***
R. Bouzidi and C. Ferreira (France)

16:10 Refreshments, exhibition and session 8: poster session (see below)

18:30 Shuttle to the hotels

20:00 Conference banquet

Restaurant: *le Pariou*, Casino de Royat, Allée Pariou, 63130 Royat, 04 73 29 52 52

23:00 Shuttle to the hotels

WEDNESDAY 12TH JULY 2006

KEYNOTE LECTURE 3

Blaise Pascal Amphitheatre
Chair: J. Huntley, Loughborough University, UK

08:45 ***Development of an international standard for optical strain measurement***
E. Patterson (USA)

Session 9 **– BENCHMARKING AND CALIBRATION**

Blaise Pascal Amphitheatre
Chair: J. Huntley, Loughborough University, UK

09:30 ***Resolution and spatial resolution of digital image correlation techniques***
M. Bornert (France)

09:50 ***Towards a fully validated digital image correlation system***
N. McCormick, J. Lord and A. Ive (United Kingdom)

10:10 ***An innovative method for 3D shape/displacement/strain and temperature measurement using a single sensor***
T. Sentenac, Y. Le Maoult, Y. Rotrou, L. Robert and J.-J. Orteu (France)

10:30 Refreshments

11:00 Session 10 **– PLASTICITY**

Blaise Pascal Amphitheatre
Chair: E. Patterson, Michigan State University, USA

11:00 ***Onset localization of plastic strains studied by ESPI strain rate measurement***
B.Guelorget, C. Labergere, M. Boudifa, M. François (France), C. Vial-Edwards (Chile), G. Montay, K. Saanouni and J. Lu (France)

11:20 ***Strain and strain rate distribution in PLC bands***
L. Casarotto, R. Tutsch, H. Dierke and H. Neuhäuser (Germany)

11:40 ***Identification of hardening parameters using full-field strain measurements and numerical simulation of a heterogeneous tensile test***
S. Belhabib, H. Haddadi, M. Gaspérini and P. Vacher (France)

12:00 ***Identification of an elasto-plastic constitutive equation using the Virtual Fields Method***
Y. Pannier, S. Avril, R. Rotinat and F. Pierron (France)

12:20 ***Determination of elastic-plastic strains by digital image correlation***
T. Marin, G. Nicoletto, E. Romeo and R.Roncella (Italy)

12:40 Lunch

14:30 Session 11-a **- IDENTIFICATION 2**

Blaise Pascal Amphitheatre
Chair: U. Galietti, Politecnico di Bari, Italy

14:30 ***Parameters identification using field measurements of polymer membranes during bubble inflation technique***
S. Hmida-Maamar, F. Schmidt, L. Robert and V. Velay (France)

14:50 ***In-situ characterization of constrained lead-free solder materials by digital image correlation and inverse numerical methods***
J. Cugnoni, J. Botsis and J. Janczak-Rusch (Switzerland)

15:10 ***Integrated strategy for identification of plate stiffness components***
G. Silva , R. Le Riche, J. Molimard and A. Vautrin (France)

15:30 ***Study of the dissipative behavior in reprocessed PET by image correlation***
L.K. Nait-Ali, A.S. Caro-Bretelle, P. Ienny, L. Ferry and A. Bergeret (France)

15:50 ***Material identification using an end-loaded bimaterial cantilever beam***
J.F. Cardenas-Garcia, G.G. Weber (USA) and L.R. Molisani (Argentina)

Session 11-b **– RESIDUAL STRESSES AND NDTI**

Leonard de Vinci Amphitheatre
Chair: F. Pierron, ENSAM Châlons-en-Champagne, France

14:30 ***Performance evaluation of residual stresses gradient measurement combining radial in-plane ESPI with incremental hole drilling***
A. Albertazzi Jr., M. Viotti, G. Scherer and F. Silva (Brazil)

14:50 ***Underwater holographic interferometry for structural analysis***
J.-M. Monteiro, H.-M. Lopes, J.-L. Valin Rivera and M. Vaz (Portugal)

15:10 ***A non-linear algorithm of photoelastic tomography for the axisymmetric problem***
H. Aben, A. Errapart, J. Sanko and J. Anton (Estonia)

15:30 ***Phase-stepping integrated photoelasticity***
F.W. Hecker (Germany)

15:50 ***Thermal waves for imaging of defects with lockin-speckle interferometry (OLI)***
H. Gerhard and G. Busse (Germany)

16:10 Closure address

16:30 Shuttle 1 to the railway station, to the airport and to the hotels

16:30 Shuttle 2 to the Puy-de-Dôme

17:30 Short walk and sightseeing at the top of the Puy-de-Dôme

20:00 Shuttle to the hotels/downtown

POSTER SESSION AND EXHIBITION

Posters

1- Camera calibration and deformation measurement using a grid of circular dots
P.F. Luo and Y. Hsu (Taiwan)

2- Stereolithography for 3D photoelasticity
W. Cooke, R.A. Tomlinson, G. Gibbons and G.C. Calvert (United Kingdom)

3- Structured illumination applied to determine the topography of an off-set MW parabolic satellite antenna
E. Cortizo, J.A. Bava and M. Garavaglia (Argentina)

4- A stereo-photogrammetric system for 360-deg measurements on tubular samples
U. Galietti, K. Genovese, L. Lamberti and C. Pappalettere (Italy)

5- 3D full field measurement based on micro-geometrical texture patterns
H. Bubaker-Isheil, J.-F. Fontaine, T. Sliwa and C. Zimmer (France)

6- Full field 3D profilometry with the Volkov phase unwrapping method
P. Tavares and M. Vaz (Portugal)

7- Characterization of the mechanical behaviour of materials at a microscopic scale : development of a optical full-field measurement method
R. Moulart, R. Rotinat, F. Pierron and G. Lérondel (France)

8- Comparison of digital speckle photogrammetry techniques and existing techniques in the monitoring of strain in high pressure steam pipes
M. Kourmpetis, A. Morris and J.-P. Dear (United Kingdom)

9- Thickness measurement of free films by means of a double-side white-light profilometer : principle and calibration
C. Poilâne and P. Sandoz (France)

10- Measurement by elasticity on plastic fan blade
A Di Renzo, M. Marsili, M. Moretti and G.-L. Rossi (Italy)

11- Structured illumination applied to study thermo-mechanic deformations of a circular steel plate
P. Fluxa, J. Cordero, E. Cortizo, J.-A. Bava and M. Garavaglia (Argentina)

12- The mesure of temperature in a process with frictional heating
D. Raveau, Ch. Proust, V. Pina, P. Hervé and D. Jamois (France)

13- Detection and characterization of composite damage using infrared thermography during aircraft maintenance : methodology and experimental results on flying parts
P. Servais and N. Gerlach (Belgium)

14- A thermoelastic approach to determine the fatigue limit of mechanic components
J. Pirisinu, G. Rossi, R. Marsili and F. Cianetti (Italy)

15- Solution to the hole method problem in orthotropic materials using genetic algorithms
J.-F. Cardenas-Garcia, Y. Zhou and A. Zapata (USA)

16- Application of full field optical measurement techniques to investigate variability of Poisson effect in wood and wood-plastic composites (WPC) in creep conditions
H.-L. Frandsen (Denmark), L. Muszynski (USA), Y. Wang (USA) and A. Sevrain (France)

17- Identification of orthotropic stiffness of composites with the virtual fields method: optimization and experimental validation
F. Pierron, G. Vert (France), R. Burguete (United Kingdom), S. Avril, R. Rotinat (France) and M. Wisnom (United Kingdom)

18- Identification of elastoplastic parameters distributions using digital image correlation
F. Latourte, A. Chrysochoos, S. Pagano and B. Wattrisse (France)

19- A coupled FE based inverse strategy from displacement field measurement subject to an unknown distribution of forces
E. Pagnacco and D. Lemosse (France)

20- Analysis of the strain distribution during the simple shear test using the digital image correlation method
A Aouafi, M. Gaspérini and J.-L. Dournaux (France)

21- Measuring displacement field and detection of unbonded regions in a single lap joint with moiré interferometry
J. Ribeiro, M. Vaz, H. Lopes, J. Monteiro and P. Piloto (Portugal)

22- Experimental evidence of the load transfer zone in curved composite patches using the grid method
J.-D. Mathias, X. Balandraud and M. Grédiac (France)

23- Characterization of the mechanical behaviour of cancellous bone by means of a three dimension scanner technique
C. Noirfalise, G. Poumarat and J.-F. Destrebecq (France)

24- Generalized onion-peeling method for integrated photoelasticity of axisymmetric problems
J. Anton and H. Aben (Estonia)

25- Strain field analysis of cancellous bone under compression by image correlation
H. Lopes, C. Nabais, R.M. Guedes, J.-L. Morais and J.-A. Simoes (Portugal)

26- Discrepences between experiments and modelling : 3D-ESPI deformation measurements on compact tension test
B. Gautier, A.-S. Bretelle, P. Lenny and P. Slangen (France)

27- A novel application of electrolytic plating as a birefringent coating for photoelastic techniques
J. Nawasra, G.C. Calvert and P. Bryanston-Cross (UK)

Exhibitors

1- CEDIP Infrared

2- Foretech

3- Polytech-Pi

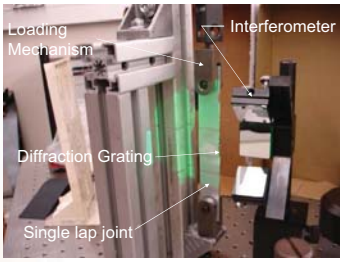
LOME – Laboratory of Optics and Experimental Mechanics
www.fe.up.pt/~inegi/lome

MEASURING DISPLACEMENT FIELD AND DETECTION OF UNBONDED REGIONS IN A SINGLE LAP JOINT WITH MOIRÉ INTERFEROMETRY

Ribeiro[1], J., Vaz[2], M., Lopes[1], H., Monteiro[3], J., Piloto[1], P.
[1]ESTIG – Instituto Politécnico de Bragança; [3]INEGI – Instituto de Engenharia Mecânica e Gestão Industrial; [2]DEMEGI – Faculdade de Engenharia da Universidade do Porto
Rua Dr. Roberto Frias, s/n, 4200-465 Porto, Portugal.

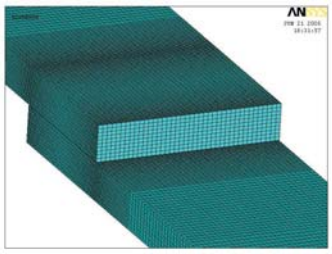
INTRODUCTION

Adhesives are increasingly being used to replace traditional fastening methods in industrial applications such as welding, bolts and rivets. In cars and other transport applications, weight reduction is a key factor in new developments, hence the use of lightweight adhesives is rapidly expanding.



Adhesives are used to bond many different material types including ceramics, metals, glass, plastics and composites. The key advantages of adhesives include the distribution of loads across the entire joint area, excellent fatigue properties, attenuation of mechanical vibrations and noise, sealant functions, reduction in galvanic corrosion between dissimilar metals, and a faster more cost-effective assembly method.

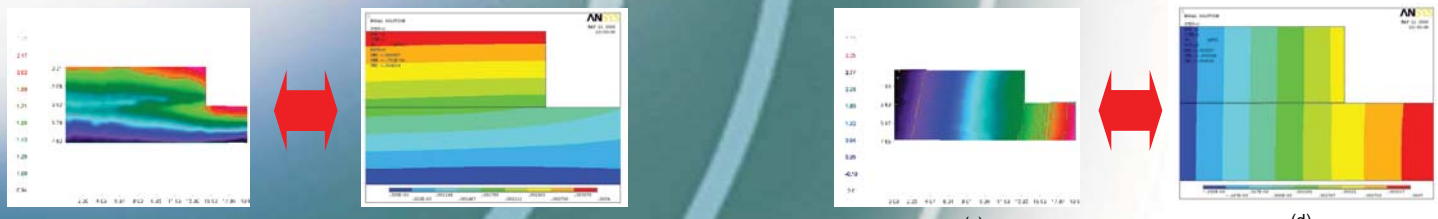
The goal of this work is the development of an experimental technique to measure the displacement field and to perform detection of unbonded regions in a single lap joint. The proposed experimental technique is based on the use of Moiré Interferometry.



RESULTS

The master grating (in two directions) was generated by a laser interferometry optical setup. A tension load was applied to a lap joint and its deformation was assessed by the interference between the reference grating (1200 l/mm in two orthogonal directions), recorded on the object surface, and virtual master grating generated by laser interferometry. Image processing techniques, PROITEC package, was used to assess the in-plane displacement field.

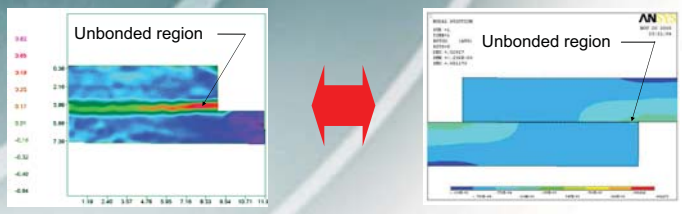
A numerical model was implemented with a finite elements programme (ANSYS®) to calculate the displacement fields and compare with experimental results.



(a) (b) (c) (d)

Figure 1. Displacement field: *u* direction - (a) experimental results and (b) numerical simulation ; *v* direction - (c) experimental results and (d) numerical simulation .

An artificial defected lap joint was produced and used to record its displacement field. Differentiation algorithms were used to assess the strain field gradients. An unbonded region in a single lap joint was numerically simulated and the obtained results are compared with those obtained in the experimental work.



(a) (b)

Figure 2 . Detection of unbonded region: (a) experimental; (b) numerical.

CONCLUSIONS

The Moiré Interferometry technique can be used to measure, with a very good resolution, the displacement field (u, v) in single lap joints. This experimental technique could be a very interesting alternative for the detection off unbonded regions for these kind of joints.

REFERENCE

Post, D.; Han, B.; Ifju, P. (1997) High Sensitivity Moiré: Experimental Analysis for Mechanics and Materials, *Springer Verlag*.