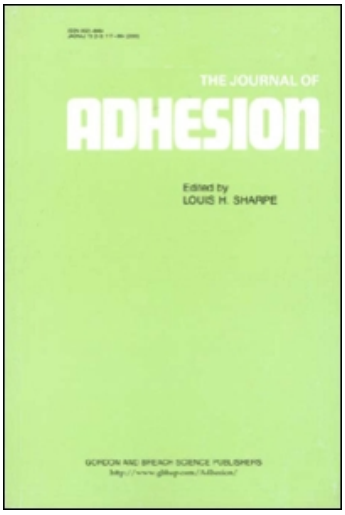

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Guest Editorial

Lucas F. M. da Silva[a]; Andreas Öechsner[b]
[a] Departamento de Engenharia Mecânica, Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal [b] Department of Applied Mechanics, Faculty of Mechanical Engineering, Technical University of Malaysia - UTM, 81310 UTM Skudai, Johor, Malaysia

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Guest Editorial

This special issue of *The Journal of Adhesion* (JA) contains selected papers presented at the Special Session on "Adhesive Bonding" held at the 3rd International Conference on Advanced Computational Engineering and Experimenting (ACE-X 2009) meeting. ACE-X 2009 was chaired by both of us and Professor H. Altenbach and was held in Rome, Italy during June 22–23, 2009. The goal of the conference was to provide a unique opportunity to exchange information, to present the latest results, and to review the relevant issues in engineering mechanics research today.

The importance of science and technology of adhesion in engineering applications spurred the chairman of the ACE-X 2009 meeting to include a special session dedicated to this subject, organized by one of us (LFMdS) and Professor Luca Goglio. Approximately 70 papers were presented by researchers from more than 20 countries in the Adhesive Bonding Special Session. The organizers wish to thank the authors and delegates for their participation and cooperation, which made this Special Session possible.

In order to share the work presented in the Special Session on Adhesive Bonding, a selection of papers was prepared and the result is presented in the present Special Double Issue. A wide range of topics was covered and many excellent papers were submitted. The criterion adopted for the selection was papers related to "Durability of Adhesive Joints." Durability is a general term that is related to the residual strength of the joint when subjected to water, temperature, and/or dynamic loading (fatigue or impact). This subject is probably the major challenge that the adhesion community faces today. The short term strength is well understood and predicted but it is incomparably more difficult to predict the durability of an adhesive joint.

One way to improve durability is by using a surface preparation that guarantees a strong bond between the adhesive and the substrate. Jo *et al.* investigated the reliability of fine-pitch, flip-chip bonding with ultrasonic energy and non-conductive film (NCF). The surface treatment was carried out with H_2SO_4 before flip-chip bonding (FCB). Ultrasonic FCB exhibited excellent reliability in the thermal cycling and high temperature storage tests, whereas ultrasonic FCB with NCF showed good reliability in the humidity and temperature test.

The durability can also be improved by the use of smart adhesive joints. A smart adhesively bonded single lap joint system was developed by Khalili *et al.* by surface bonding of piezoelectric patches onto a typical single lap joint in order to reduce the maximum peel and shear stress concentrations at the edges of the adhesive layer. It was demonstrated that by adjusting the applied electric field of the piezoelectric patches, the joint-edge peel and shear stresses can be adaptively controlled.

Cyclic loads are treated in the papers of Bernasconi *et al*. Pirondi and Moroni, and Ashcroft *et al*. Bernasconi *et al*. report results of fatigue tests on adhesive lap joints of thick (10 mm) composite laminates. The finite element analysis evidenced a close relationship between the peak elastic stresses and the number of cycles to failure. This behaviour suggests that peak elastic stresses in the adhesive layer could be adopted as a design criterion. Pirondi and Moroni propose a routine interacting with the finite element software to represent the fatigue crack growth in a bonded joint using cohesive elements. The cohesive zone model was modified to model both the monotonic loading damage and the fatigue crack growth rate. Good agreement was found with experimental data from the literature in pure Mode I and Mode II. Ashcroft *et al*. show that in bonded composite joints, anomalous fatigue crack growth is seen when mixed mode samples are tested. This behaviour was attributed to the nature of the fatigue fracture, in which a complex fracture path was observed involving failure in both the adhesive layer and the composite adherend. A mechanistically based model for predicting this behaviour is proposed. The model is applied to experimental data and a good fit was seen.

Impact loads are very frequent in applications where adhesives are used. Avalle *et al.* investigated adhesively bonded hybrid structures (crash boxes) of aluminium and steel. The performance is evaluated in terms of energy absorption in a stable axial plastic progressive collapse. It was shown that a traditional top-hat shaped crash box with an aluminium plate bonded to a steel hat section has the same efficiency as that of the whole steel structure and is lighter. Khalili *et al.* conducted Charpy impact tests on repaired notched aluminium specimens. The aluminium specimens contained a single-edge notch and were repaired with a metal sheet, composite, and fibre metal laminate (FML) hybrid composite patches on one of the side faces of the specimens. The results showed that the notched specimens repaired with single- and double-sided FML patches with carbon fibre absorbed more energy than the other specimens. Dynamic loading is also studied in the paper by Darwish and Alsamhan. A numerical analysis is used to study the joint strength of double containment joints.

The dynamic behaviour of double containment joints with a circular cross-section was dynamically tested. The dynamic test showed that decreasing the support diameter and increasing the slot depth not only improve the static strength but also the dynamic performance. Decreasing the support diameter gives higher natural frequency and damping capacity.

When a component partly breaks, repairing it can obviously prolong its durability. Repairing techniques are treated by Barreto *et al.* and Campilho *et al*. Barreto *et al.* studied the tensile strength of adhesively bonded repairs with carbon fibre reinforced plastic patches on wood members in pure tension experimentally and numerically. The comparative analysis of the test results and the simulations showed a good correlation between both and provided design principles for these structures. In the same line as Barreto *et al.*, Campilho *et al.* propose a repair technique with adhesively bonded carbon epoxy patches for wood members damaged by horizontal shear and under bending loads. An experimental and numerical parametric analysis was performed on the patch length and a good correlation was found. For the particular materials and dimensions employed, the repair with patch length of 105 mm practically restores the undamaged strength of the beam.

The preparation of this special issue has been an interesting experience for the guest editors. The review process gave a deeper insight into the various aspects of adhesive bonding and the chance to discuss the manuscripts in detail directly with the authors. We would like to thank the authors for their patience with the process and the reviewers for providing critical evaluations of these manuscripts. Finally, we especially thank Dr. Lou Sharpe, editor of JA, who made this special issue possible.

Dr. Lucas F. M. da Silva
Departamento de Engenharia Mecânica, Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465
Porto, Portugal

Professor Andreas Öechsner
Department of Applied Mechanics, Faculty of Mechanical Engineering, Technical University of Malaysia - UTM,
81310 UTM Skudai, Johor, Malaysia